

**MultiCare** 

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**BetterConnected**

**Tacoma General Hospital**

**Emergency Department  
and  
Cancer Center Expansion**

**Project Manual**

September 26, 2008

**Volume 4**

Landscaping, Mechanical & Electrical



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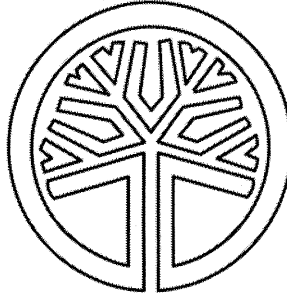
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PROJECT:  
MultiCare  
Tacoma General Hospital  
Emergency Department and  
Cancer Center Expansion



STATE OF WASHINGTON  
REGISTERED  
LANDSCAPE ARCHITECT  
*ME Brands*  
MARK E. BRANDS  
CERTIFICATE NO. 680

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Landscape Architect of Record      09/26/2008  
Date



## SECTION 12 93 00 SITE FURNISHINGS

### PART 1 GENERAL

#### 1.1 DESCRIPTION:

Work Included: Provide all labor, materials and equipment necessary to supply and install the following:

- A. Benches
- B. Trash and Ash Receptacles
- C. Bike Racks

#### 1.2 RELATED SECTIONS:

Section 323005 - Concrete Paving for Site Work

#### 1.3 QUALITY ASSURANCE:

- A. Manufacturer's Instructions: Adhere to manufacturer's instructions for product handling, assembly, installation, and maintenance.
- B. Manufacturer's original factory finish must be intact for the installation to be considered satisfactory. On-site touch-up will not be accepted.

#### 1.4 SUBMITTALS:

- A. For each Product Specified, submit the following for approval prior to delivery:
  - 1. Manufacturer's product data.
  - 2. Manufacturer's installation instructions.

### PART 2 PRODUCTS

#### 2.1 GENERAL:

- A. All products shall be supplied as specified, or approved equal.

#### 2.2 BENCHES:

- A. Ipe wood benches: Model SBHUD-96S, 96" long x 16" high x 18" deep, by Forms+Surfaces, 6395 Cindy Lane, Carpinteria, CA 93013, (800)451-0410, [www.forms-surfaces.com](http://www.forms-surfaces.com). Surface mount.

#### 2.3 TRASH RECEPTACLE:

- A. FairWeather TR-12 or approved equal: steel trash receptacle with vertical slats, and optional spun steel dome top, powder coated black, with steel liner powder coated to match receptacle. FairWeather: (360) 895-2626, Port Orchard, WA; Local representative: Site Lines (800) 235-2440. Surface mount.

#### 2.4 ASH URN

- A. FairWeather AU-12 or approved equal: steel ash urn with vertical slats, powder coated black, with steel liner powder coated to match receptacle. FairWeather: (360) 895-2626, Port Orchard, WA; Local representative: Site Lines (800) 235-2440. Surface mount.

#### 2.5 BIKE RACKS:

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- A. FairWeather BR-3 or approved equal: steel bike rack, powder coated black. FairWeather: (360) 895-2626, Port Orchard, WA; Local representative: Site Lines (800) 235-2440. Direct bury bike racks.

### 2.7 INSTALLATION MATERIALS:

Other materials required for product installation which may not be supplied or shipped by the manufacturer or otherwise specified for fabricated items include the following;

- A. Concrete for Direct Burial Footings:  
Concrete for direct burial post footings shall conform to WSDOT Specifications (most recent edition).
- B. Anchoring Devices for Bolt-down, Surface Installation:  
Where the manufacturer does not provide a specification for anchoring, use only approved stainless steel wedge anchors as follows;
  - 1. Size to the largest standard diameter that the manufacturer's pre-made hole will accommodate without force, typically 5/8".
  - 2. Size to ¾ of the actual depth of concrete to support the installation. Use 2¾" length on standard concrete flatwork.

## PART 3 - EXECUTION

### 3.1 EXAMINATION:

Verify installation conditions as satisfactory to receive work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.2 DIRECT BURIAL INSTALLATIONS:

- A. All below-grade steel components scheduled for direct burial installation shall be coated in an approved manner prior to installation, typically either factory powder coating or hot-dipped galvanized.
- B. Provide footing excavations sized per measured plans provided with the Contract Drawings, manufacturers printed assembly and installation instructions, or as directed by the Engineer, typically 12" diameter x 18" depth for most installations under 100 lbs/footing.
- C. Coring and Saw-cutting:
  - 1. All products scheduled for direct burial installation within new paved areas are to be installed prior to paving.
  - 2. In the event that paving is installed prior to site furnishings scheduled for direct burial installation, saw-cutting will not be approved as a means of penetrating pavements. Coring, to the specified size of the footing, is the only method that may be considered.
  - 3. Do not core completed work of the Contract to accomplish product installation without prior approval of the Engineer.
  - 4. Where site furnishings are scheduled for installation in existing pavement of any type or where the Engineer has approved coring of pavement installed as part of the work of the Contract, the Contractor shall insure

## SECTION 12 93 00 SITE FURNISHINGS

an adequate supply of clean water and continuously flush and clean cuttings from pavement surfaces to remain.

- D. Concrete footings shall be neatly and evenly crowned slightly above adjacent finished grade where adjacent finished grade is generally level, matching adjacent finished grade where adjacent finished grade is sloped, or level to the bottom of base aggregate where installation in paved areas is scheduled.
- E. Remove all concrete slurry from surrounding surfaces and site furnishings prior to request for inspection.

### 3.3 SURFACE INSTALLATIONS:

- A. Surface installations shall be made only upon approved concrete surfaces.
- B. Use only manufactured approved anchoring devices.
- C. Where the manufacturer does not provide a specification for anchoring, use only approved stainless steel wedge anchors as follows;
  - 1. Do not proceed with anchor installation until concrete pavement has had a minimum of 14 days cure time under normal conditions. Where weather conditions are beyond the range of normal, do not proceed with anchor installation without the approval of the Engineer.
  - 2. Size to the largest standard diameter that the manufacturer's pre-made hole will accommodate without force, typically 5/8".
  - 3. Size for embedment of  $\frac{3}{4}$  of the actual depth of concrete to support the installation, in no case less than 2 $\frac{1}{2}$ ". Allow for depth of nut plus 3-5 threads protrusion above finished installation.
  - 4. Do not over drill beyond 1/8" the depth necessary to accommodate the anchor.
  - 5. Torque to 80-85% of the anchor manufacturers recommended maximum.
  - 6. Provide at least one anchor for every bolt location hole for any site furnishing.

### 3.4 INSTALLATION OF MANUFACTURED ITEMS:

Install all equipment in accordance with Specifications, Drawings and manufacturer's directions. Where these may be in conflict, the more stringent requirements govern.

### 3.5 INSTALLATION OF FABRICATED ITEMS:

All fabricated items shall be installed consistent with the measured plans provided in the Contract Drawings utilizing materials

### 3.6 CLEANUP:

Remove all metal, wood, and concrete debris, protective wrappings and coverings, and shipping materials from the project site. Remove all residues, repair all stains, scuffs, abrasions, and marks from the finished product prior to requesting inspection. Fully restore all areas of the site that were impacted by the installation activities.

END OF SECTION 02870



## SECTION 32 14 00 UNIT PAVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Brick pavers set in mortar setting beds.
  - 2. Concrete pavers set on pedestals and mortar setting beds.
- B. Related Sections include the following:
  - 1. Division 07 Section "Waterproofing" for waterproofing and protection board under plaza deck pavers.
  - 2. Division 32 Section "Concrete Paving"

#### 1.3 SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. Select paragraph above or first paragraph and list below. If retaining below, edit list to coordinate with products retained in Part 2.
- C. Product Data: For the following:
  - 1. Pavers.
  - 2. Mortar and grout materials.
  - 3. Paver Pedestals
- D. Samples for Initial Selection: For the following:
  - 1. Joint materials involving color selection.
- E. Samples for Verification:
  - 1. Full-size units of each type of unit paver indicated.
  - 2. Joint materials.
  - 3. Exposed edge restraints.
- F. Compatibility and Adhesion Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.
- B. Preconstruction Compatibility and Adhesion Testing: Submit to latex-additive manufacturer, for testing indicated below, samples of paving materials that will contact or affect mortar and grout that contain latex additives.
  - 1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be nonstaining to, installed pavers and other materials constituting paver installation.
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## SECTION 32 14 00 UNIT PAVING

- D. Preinstallation Conference: Conduct conference at Project.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store liquids in tightly closed containers protected from freezing.
- E. Store asphalt cement and other bituminous materials in tightly closed containers.

### 1.6 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Mortar and Grout:
  - 1. Cold-Weather Requirements: Protect unit paver work against freezing when ambient temperature is 40 deg F and falling. Heat materials to provide mortar and grout temperatures between 40 and 120 deg F. Provide the following protection for completed portions of work for 24 hours after installation when the mean daily air temperature is as indicated: below 40 deg F, cover with weather-resistant membrane; below 25 deg F, cover with insulating blankets; below 20 deg F, provide enclosure and temporary heat to maintain temperature above 32 deg F.
  - 2. Hot-Weather Requirements: Protect unit paver work when temperature and humidity conditions produce excessive evaporation of setting beds and grout. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.
    - a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

## PART 2 - PRODUCTS

### 2.1 BRICK PAVERS

- A. Brick Pavers: salvage and reuse existing brick pavers from site.

### 2.2 CONCRETE PAVERS

- A. Type: 24" x 24" Architectural Slabs, Vancouver Bay, Platinum color. Distributed by Mutual Materials
- B. Meet the following required technical specifications;
  - 1. Compressive Strength: Average compressive strength shall not be less than 8000 PSI (55 MPA) with no individual unit less than 7300 PSI (50 MPA) when tested not less than 28 days from the date of production in accordance with ASTM C-140, or CSA A231.1 – 99.
  - 2. Flexural Strength: Average flexural (transverse) strength shall be at least 655 PSI (4.5 MPA) with no individual unit below 582 PSI (4.0 MPA) when tested in accordance with CSA A231.1 – 99.

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3. Water Absorption: Average water absorption shall not be greater than five percent (5%) with no individual unit greater than seven percent (7%), when tested in accordance with ASTM C-140, or CSA A231.1 – 99.
4. Scaling Resistance: Specimen shall not have an average loss of mass greater than 300 g/m<sup>2</sup> of the total inundated surface area of the individual paving slab after 28 cycles of freezing and thawing, or 800 g/m<sup>2</sup> after 49 cycles. Specimen with a architectural finish shall not have an average loss of mass greater than 500 g/m<sup>2</sup> of the total inundated surface area of the individual paving slab after 28 cycles of freezing and thawing, or 1200 g/m<sup>2</sup> after 49 cycles. When tested in accordance with CSA A231.0 – 99.
5. Dimensions: Dimensions of paving slabs, and concave or convex warpage shall not differ from those agreed upon by the manufacturer by more than the following amounts:
  - a. Length and width: - 1.0 mm to + 2.0 mm
  - b. Height: + 3.0 mm
  - c. Concave or convex warpage in one dimension by the following amounts:
    - i. Up to 450 mm, 2.0 mm; or
    - ii. Over 450 mm, 3.0 mm
  - d. Dimensions are based on manufacturer's standard drawing for particular shape identified.
6. Center Point Load Test of Pedestal-supported Slabs: 1,800 lbs.

### 2.3 ACCESSORIES

- A. Pedestals: Appian Way pedestal system distributed by Mutual Materials,

### 2.4 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 57
- B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
- C. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D 448 for Size No. 10.

### 2.5 MORTAR SETTING-BED MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Sand: ASTM C 144.
- D. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.
  1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering latex additives that may be incorporated into the Work include, but are not limited to, the following:
  2. Manufacturer: Subject to compliance with requirements, provide latex additive by one of the following:
    - a. Boiardi Products Corporation.
    - b. Bonsal, W. R. Company.

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- c. Bostik Findley Inc.
  - d. C-Cure.
  - e. Custom Building Products.
  - f. DAP Inc.
  - g. Jamo Inc.
  - h. Laticrete International, Inc.
  - i. MAPEI Corp.
  - j. SGM.
  - k. Summitville Tiles, Inc.
  - l. TEC Incorporated; H. B. Fuller Company.
- E. Water: Potable.

2.6 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored sand as required to produce required color.
  - 1. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed sand-portland cement grout.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering latex additives that may be incorporated into the Work include, but are not limited to, the following:
    - b. Manufacturer: Subject to compliance with requirements, provide latex additive by one of the following:
      - 1) Boiardi Products Corporation.
      - 2) Bonsal, W. R. Company.
      - 3) Bostik Findley Inc.
      - 4) C-Cure.
      - 5) Custom Building Products.
      - 6) DAP Inc.
      - 7) Jamo Inc.
      - 8) Laticrete International, Inc.
      - 9) MAPEI Corp.
      - 10) SGM.
      - 11) Summitville Tiles, Inc.
      - 12) TEC Incorporated; H. B. Fuller Company.

2.7 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout if they have reached their initial set before being used.
- B. Mortar-Bed Bond Coat: Mix neat cement or cement and sand with latex additive to a creamy consistency.
- C. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of

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latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

- D. Latex-Modified, Portland Cement Slurry Bond Coat: Proportion and mix portland cement, sand, and latex additive for slurry bond coat to comply with written instructions of latex-additive manufacturer.
- E. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and sand to match setting-bed mortar, except omit hydrated lime and use enough water to produce a pourable mixture.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 2. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

#### 3.2 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Clean concrete substrates to remove dirt, dust, debris, and loose particles.
- C. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

#### 3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
  - 1. For concrete pavers, a block splitter may be used.
- D. Exercise care in handling coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. Remove coating from bonding surfaces before setting brick.
- E. Joint Pattern: Brick pavers to match existing pattern in alley.
- F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

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1. Provide joint filler at waterproofing that is turned up on vertical surfaces, unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
- G. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- H. Expansion and Control Joints: Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

### 3.4 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing setting bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.
- C. Apply mortar bed over bond coat immediately after applying bond coat. Spread and screed setting bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately 1/2 inch.
- E. Place mortar bed with reinforcing wire fully embedded in middle of setting bed. Spread and screed setting bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Cut back, bevel edge, remove, and discard setting-bed material that has reached initial set before placing pavers.
- G. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- H. Place pavers before initial set of cement occurs. Immediately before placing pavers on setting bed, apply uniform 1/16-inch thick, slurry bond coat to bed or to back of each paver with a flat trowel.
- I. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
- J. Spaced Joint Widths:
  - a. For architectural slabs, provide 3/8-inch nominal joint width with variations not exceeding plus or minus 1/16 inch.
  - b. For brick pavers, match installation of existing pavers in alley.
- K. Grout joints as soon as possible after initial set of setting bed.
  1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
  2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
  3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
  4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.

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- L. Cure grout by maintaining in a damp condition for seven days, unless otherwise recommended by grout or liquid-latex manufacturer.

3.5 PEDESTAL SETTING APPLICATION

- A. Install per manufacturers recommendations.

3.6 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
  - 1. Remove temporary protective coating from brick pavers as recommended by protective coating manufacturer and as acceptable to unit paver and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

END OF SECTION 321400



## SECTION 32 30 05 CONCRETE FINISHING FOR SITE WORK

### PART 1 - GENERAL

#### 1.1 REFERENCE STANDARDS:

Conform to requirements of the following Reference Standards or as modified and supplemented hereinafter.

1. ACI Specifications for Structural Concrete for Buildings, ACI 301
2. ACI Recommended Practice for Cold Weather Concreting, ACI 306
3. ACI Recommended Practice for Hot Weather Concreting, ACI 605

#### 1.2 QUALITY ASSURANCE:

- A. Concrete Work: Concrete work where indicated to be exposed is architecturally finished concrete; special care must be taken to provide specified, finished surfaces without gravel pockets, and other defacements. Engineer shall inspect concrete after removal of forms and before concrete repair work begins.
- B. Mockups: After approval of verification sample and before installing paving, produce field sample panels to demonstrate the approved range of selections made under sample submittals. Before installing paving, produce mock-ups approximately 36 inch x 36 inches by 6 inches minimum to demonstrate the expected finish, color, and texture of both vertically and horizontally cast (exposed slabs, and stairs) concrete.
  1. Locate panels as indicated or, if not indicated, as directed by Architect.
  2. Demonstrate methods of curing, aggregate exposure, sealers, and coatings, as applicable.
  3. In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
  4. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
  5. Demolish and remove field sample panels when directed.
- C. Approved mock-ups will serve as the design reference sample and, with Architect approval, may be integrated into Work.

#### 1.3 PROTECTION:

Protect persons and adjacent materials and finishes from dust, dirt and other surface or physical damage during finishing operations, including materials driven by wind.

### PART 2 - PRODUCTS *(Not Used)*

### PART 3 – EXECUTION

#### 3.1 REPAIRS:

- A. Immediately after removal of forms and inspect all surfaces for defects. Repair or patch defects only after defects are inspected by the Engineer and then only with the Engineer's permission. Do all cutting and repair within 48 hours after removal of forms; cure repairs same as new concrete.
- B. Defective Areas: Where patches are allowed, repair and patch areas; must match the surrounding areas in color and texture so as to be indistinguishable after completion, including curing and finishing. Determine mix for color by trial mixes before patching; after initial cure, dress patch or repair area mechanically or by hand for texture match.

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### 3.2 FINISHES FOR FORMED SURFACES:

- A. Rough Form Finish: Provide for surface of walls and footings adjacent to grade or below grade. This is the concrete surface having texture imparted by form facing material use with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth Formed Finish: Provide a smooth formed finish on formed concrete surfaces exposed to view. This is an as-cast concrete surface obtained with selected form facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections completely and smoothed. Repair and patch honeycombs and defective areas as directed by the Engineer. Tie holes shall not be filled.
- C. Sacked Finish:
  - 1. On all designated surfaces of the exposed concrete, provide a sacked finish by coating the concrete with sacking mortar. Sacking of patched or defective concrete surfaces may be required by the Engineer for areas not otherwise already requiring this work.
  - 2. Repair and patch tie holes, honeycombs and defective areas and trowel to smooth finish. Remove fins and other projections completely and smoothed.
  - 3. Thoroughly wet surface to prevent absorption.
  - 4. Coat entire surface with sacking mortar as soon as surface of concrete approaches surface dryness.
  - 5. Thoroughly and vigorously rub mortar over area with clean burlap pads to fill all voids.
  - 6. While mortar is still plastic but partially set (so it cannot be pulled from voids), sack-rub surface with dry mix of sacking mortar (leave out water). There should be no discernible thickness of mortar on concrete surface, except in voids; all surfaces should be uniformly textured.
  - 7. Immediately begin a continuous moist cure for 72 hours.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated. Provide for face surface of walls adjacent to plaza, walks and stairs.
- E. Sandblasted Concrete Finish: Where indicated, provide light and medium sandblast finish. Abrade to uniform texture and bite as determined/field samples.

### 3.3 FINISHES FOR UNFORMED SURFACES:

- A. Screed all slabs, for whatever finish, to true levels or slopes, work surfaces only to the degree required to produce the desired finish; do no finishing in areas where water has accumulated, drain and rescued; in no case use cement and sand sprinkling to absorb moisture. Carefully finish all joints and edges with proper tools, unless otherwise specified.
- B. Rough Screed Finish: Consolidate, level, and screed all surfaces to obtain evenness and uniformity; remove all surplus concrete after consolidation by striking off with sawing motion against guide strips. Provide for top horizontal surfaces of non-exposed footings. Provide for concrete slab under synthetic safety surfacing.
- C. Float Finish: Apply float finish to monolithic slabs to receive trowel or other finishes. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has

## SECTION 32 30 05 CONCRETE FINISHING FOR SITE WORK

disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float surface to a uniform, smooth, granular texture.

- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighthen 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.
- E. Broom Finish: Apply a non-slip broom finish to all exterior concrete slabs, stairs, walks, and ramps, and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route.
- F. Sandblasted Concrete Finish: Where indicated, provide light and medium sandblast finish. Abrade to uniform texture and bite as determined/field samples.
- G. Defective Work: Remove and replace when directed by the Engineer, surfaces which show excessive shrinkage cracks.

### 3.5 CURING:

- A. Protect freshly deposited concrete from premature drying and excessively hot or cold temperatures; maintain minimal moisture loss at relatively constant temperature for necessary hydration time and proper relatively constant temperature for necessary hydration time and proper hardening of concrete.
- B. Duration of Curing: In addition to the initial overnight curing, continue final curing operations until the cumulative number of days or fractions thereof (not necessarily consecutive) occurs, during which time the temperature of the air in contact with the concrete is above 50 degrees F, equals 7 days. If high-early strength concrete has been used, continue final curing operation for 3 days total time, calculated as before. Take care to prevent rapid drying at the end of the curing period.

### 3.6 INSPECTION:

Contractor shall notify Engineer that they are starting concrete finish repair work at least 48 hours prior to the beginning of work.

### 3.7 CLEANING:

Leave premises clean and free of residue from work in this section.

END OF SECTION 323005



## SECTION 32 84 00 PLANTING IRRIGATION

### PART 1 - GENERAL

#### 1.1 DESCRIPTION:

Furnish and install sprinkler systems in conformance with the drawings and specifications, complete and ready for use. The work consists of furnishing all materials necessary for a complete installation, including, wire sleeves, pipe, valves, fittings, sprinklers, controller, valves, back-flow prevention device, and all appurtenances related thereto. Included shall be all labor of installation, including trenching, plumbing, back-filling, electrical work, adjustments, and all other items of labor necessary for a satisfactory operating system.

#### 1.2 QUALITY ASSURANCE:

Qualifications: Contractor must be a Washington State licensed landscape contractor. The irrigation system must be installed under the direct supervision of a journey irrigation mechanic or journey plumber. All potable water system components shall be installed by a licensed plumber and all testing of the backflow prevention equipment shall also be done by a licensed plumber.

#### 1.3 REFERENCES:

Division 32 Section "Plants" coordination with tree planter.

Division 33 Section "Subdrainage" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.

#### 1.4 SUBMITTALS:

- A. Submit complete materials list prior to performing any work. Submit manufacturer catalog data and full descriptive literature, including current manufacturer's price list.
- B. Equipment or materials installed or furnished without prior approval of the Engineer will be rejected and such materials will be required to be removed and replaced with approved materials at the complete expense of the Contractor.

#### 1.5 PROJECT CONDITIONS:

- A. Underground utilities and elements: Locate all underground utilities and elements prior to digging and/or driving stakes. Take care, to neither disturb nor damage any existing above ground or underground utilities or elements. Keep streets, sidewalks and site clean, free from debris and affected drains open and free flowing at all times. Engage the services of a private utilities locating service for location of utilities within the site. Contact the Engineer for "as-built" information for on-site irrigation and water system information.
- B. Site inspection and layout: Before proceeding with any work, the Contractor shall inspect the site, carefully check all grades and verify all dimensions and conditions affecting the work to satisfy him/her that he/she may safely proceed. Changes or alterations to the system to meet actual conditions shall be made at the Contractor's expense. Irrigation plan is diagrammatic and is not intended to show exact locations of existing or proposed piping, valves or controllers. Locate new items as closely as possible to related curbs, walls, fences or edges of paving. Pipelines shown parallel on drawing may be placed in a common trench but separated by at least 6 inches. Sprinkler heads are shown accurately and shall be installed as indicated by center of symbol.

#### 1.6 GUARANTEE:

- A. Contractor shall provide one year written guarantee as per Paragraph 3.07 of this section.
- B. Guarantee shall include restoration of planted or paved areas due to settlement of trenches.

## SECTION 32 84 00 PLANTING IRRIGATION

- C. Guarantee shall include one complete winterization and one complete de-winterization of the irrigation system.

### PART 2 - PRODUCTS

#### 2.1 COPPER PIPE:

All copper pipe shall be Type K copper and shall conform to industry standards and be in conformance with applicable ASTM or ANSI standards.

#### 2.2 BRASS PIPE:

Brass pipe and fittings shall conform to industry standards and be in conformance with applicable ASTM or ANSI standards.

#### 2.3 PLASTIC PIPE:

- A. PVC pipe (mainline) upstream of the control valves (mainlines) shall be Schedule 40 or better and shall conform to all requirements of ASTM D1785-86.
- B. PVC pipe (zone lines) downstream of the control valves (laterals) shall be Schedule 40 or better and shall conform to all requirements of ASTM D1785-86.
- C. All PVC pipe shall be marked with the manufacturer's name, class of pipe and NSF seal. Pipe shall bear no evidence of interior or exterior extrusion marks. Pipe walls shall be uniform, smooth and glossy. Pipe may be pre-belled or with individual solvent-weld couplings.
- D. All PVC fittings shall be of the solvent weld type except where risers, valves, etc., require threaded transition fittings. All fittings shall conform to the requirements of ASTM D2466-78. All threaded PVC fittings and nipples shall be Schedule 80 or better.
- E. All PVC pipe must be delivered in at least twenty foot (20') lengths.
- F. All PVC pipes and fittings for swing joints shall conform to all requirements of ASTM D3139.
- G. Sleeves required for main and lateral lines located under paving shall be Schedule 40 PVC, with the inside diameter (I.D.) of sleeve to be twice the outside diameter (O.D.) of the insert pipe, maximum 1 insert pipe per sleeve. All wiring to be in separate sleeves from piping sleeves.
- H. Use Teflon tape on all threaded fittings.
- I. Primer shall be P70 and glue shall be 705 clear or gray on main and laterals.
- J. Provide water-tight "link seal" or equal structural penetration seals where pipes penetrate building floors and walls.

#### 2.4 AUTOMATIC IRRIGATION CONTROLLER ASSEMBLY:

- A. Hybrid type controller that combines electromechanical and microprocessor based circuitry capable of fully automatic and manual operation. Station timing: 1-120 minutes in 1-minute increments, and 2-12 hours in 10-minute increments. Input: 117 volt AC, 60HZ. Output: 26.5 Volt AC, 1.5 amps. Controller shall have an integral circuit breaker or fuse. Controller shall have two master valve/pump start circuits.
  - 1. Duplex receptacle, LEV5280-W.
  - 2. Controller shall include terminal strip for 24-volt wires.
  - 3. Controller: Rainbird ESP-MC Series reference plans for number of stations.
- B. General Conditions:

## SECTION 32 84 00 PLANTING IRRIGATION

1. Controller shall be hard wired in conduit. All conduits are to be UL approved electrical conduit minimum size 1 1/2-inch diameter, 18-inch deep minimum.
2. Conduit size for irrigation control wires shall be minimum 1 1/2-inch diameter.
3. Communication cable shall be the type recommended by the irrigation controller manufacturer. No splices in the communication cable will be allowed unless approved in writing by Engineer.
4. All controllers and sensor decoders shall be grounded with three ground rods to a resistance of less than 10 ohms.

### 2.5 CONTROLLER ENCLOSURE:

- A. Controller will be wall mounted at locations shown on drawings in powder-coated steel cabinet. Confirm location with Engineer prior to installation.

### 2.6 POP-UP SPRINKLER HEADS:

- A. All heads shall have a built-in pressure-regulating device. The device shall regulate nozzle pressure to the design pressure. The pressure-regulating device shall be an internal part of the pop-up stem.
- B. The heads shall have matched precipitation rate nozzles with adjusting screws.
- C. All heads shall have screens under the nozzles.
- D. The heads shall be equipped with check valves to prevent low head drainage. The check valves shall hold back pressures equivalent to 10 feet of head.
- E. The heads shall be of types, manufacture and sizes shown on the Plans and Details and/or the following:
  1. Rotor Heads: Rainbird 1800-SAM Series, 12-inch pop-up
  2. Bubbler: Rainbird 1300A-F Bubbler

### 2.7 AUTOMATIC CONTROL VALVES:

- A. Valves shall be of all brass construction or iron body, bronze-mounted, globe pattern. The valve pressure rating shall be 150 psi min. All connections shall be brass pipe, threaded.
- B. Valves shall be electrically operated, actuated by a solenoid utilizing AC current, 24 volts, and rated at not more than 8.5 VA with an in-rush maximum of 1.0 amp. The solenoid coil is to be sealed in an "Epoxy" material so it is completely waterproof.
- C. Operation of all valves (except the master valve) shall be normally closed solenoid control capable of operating within minimum flow requirements.
- D. Diaphragm operated of one-piece construction. The diaphragm shall be fully pressure balanced in both the open and closed positions.
- E. Solenoid shall be mounted directly on the valve or bonnet. All parts and tubing downstream of the entrance shall be of larger size to permit passage of foreign particles.
- F. A flow adjustment stem with cross handle shall be provided that limits the travel of the valve plug from full closed to full open, allowing manual closure or flow regulation. A manual control shall be provided for operation with or without the control wiring installed.
- G. Construction shall be so that all operating parts are accessible and removable from the top by removing the bonnet without having to disconnect the valve body from the pipeline. The valve shall be capable of being operated in any position.
- H. Valves shall be Rainbird PEB Series, size as noted on plans

### 2.8 CONTROL WIRE FOR AUTOMATIC CONTROL VALVES:

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- A. Control wire shall be double jacketed maxi cable strand copper designed for twenty (20) to fifty (50) volts and UL approved as Type U.F. (Underground Feeder). The UL and U.F. designations shall be clearly marked or indented on the insulation jacket of the wire.
- B. Expansion curls shall be provided within three (3) feet of each wire connection to solenoid and at least every three hundred (300) feet in length of control wire length. Expansion curls are formed by wrapping at least 5 turns of control wire around a rod or pipe 1" or more in diameter. Withdraw the rod or pipe once curls are formed.
- C. White, black and orange colored wires shall be used.
- D. The master valve shall be installed with separate power and common wires which shall be different colors than the other control wires. The wire colors shall be blue (power) and yellow (common).
- E. Copper conductors must meet or exceed ASTM B-3 requirements.
- F. Install spare wires as noted on plans.

### 2.9 QUICK COUPLING VALVES:

- A. Shall be one inch (1"), all brass, and one or two piece bodies, with locking brass tops and have galvanized steel swing joints as shown in the Details. Provide five (5) operating keys and hose swivels on each project.
- B. Quick coupler valve for use of compressed air for winterizing shall be 1" all brass, two piece bodies with locking brass tops. Provide one (1) operating key on each project.
- C. Shall be of the type, manufacture and size shown on the drawings and/or the following:  
Rainbird 44LRC with 1 inch outlet, single lug 2-piece with locking lid and matching key, or approved equal. All quick coupling valves shall be installed in a 10" diameter valve box as shown in the Details.

### 2.10 MANUAL VALVES:

- A. Gate valves 2" and larger shall be flanged, iron body, brass trimmed, resilient double disc wedge, and integral taper seats with non-rising stem and square actuator. All gate valves shall be Class 150 with a minimum 150 psi - 300 WOG.
- B. Curb or Gate Valves one and one half inches (1-1/2") and smaller shall be all bronze construction with 'tee' handle, 175 psi water working pressure, Mueller Oriseal Mark II, or approved equal.
- C. Stop and Waste Valves shall be all bronze construction, 175 psi water working pressure, Mueller Oriseal Mark II, or equal.
- D. Drain valves shall be of types, manufacture and sizes as shown on the Plans and Details and/or the following:
  - 1. Gate Valve: Kennedy, Mueller, or Hammond.
  - 2. Drain Valve: Mueller Mark II Oriseal H-10284 stop and waste.
  - 3. Or approved equal.

### 2.11 MASTER VALVES / FLOW SENSORS:

- A. Master Control Valve:
  - 1. The master control valve shall be a normally open electric solenoid actuated valve. The valve shall have an NPT inlet and outlet. The valve shall be capable of working at pressures of up to 150 psi.
  - 2. The master control valve shall meet all of the requirements for Automatic Control Valves with the exception of that noted above.

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3. The master control valve shall also be of the type, manufacture and size shown on the Drawings and/or the following: Superior No. 3100, or approved equal.
  4. The master control valve shall be installed with separate power and common wires as described in 2.08 (D) above.
- B. Flow Sensor:
1. The thermoplastic flow sensor shall have a six bladed impeller with a proprietary, non-magnetic sensing mechanism. The transmitted signal shall be a low impedance 8 VDC square wave signal. The maximum transmitted signal distance shall be 2000 feet.
  2. The flow sensor shall include a PVC schedule 80 tee fitted with a removable sensor alert.
  3. The flow sensor shall be of the type, manufacture and size as shown on the Drawings and shall be Rainbird FS-200P.
    - a. The Flow Sensor (Maxi) Wire shall only be PE-89 Communication Cable, as manufactured by Regency. The cable shall have 6 wire pairs. The conductors shall be 22 awg solid copper, insulated, filled and metal shielded. The outside diameter of the cable shall be 0.40 inch. No splices in the cable are acceptable. Connection to Flow Sensor shall be made using Super SERVICEAL Closure.
    - b. The Output Transmitter shall be Rainbird PT-1502 (included in controller assembly).

### 2.12 VALVE BOXES:

- A. Automatic control valves shall be enclosed in valve boxes of HDPE or polyolefin and fibrous material (preferably recycled material) with locking lids. The bottom section is to be slotted so as to extend below the pipe. Extensions shall be added as required to meet grades per the Details. Automatic control valves shall read ACV, master valve boxes shall read MV, gate valves shall read GV, etc.
- B. Drain valves and individual gate valves shall be enclosed in a 10" round valve boxes of HDPE or polyolefin and fibrous material with locking lids.
- C. Provide two (2) sets of all keys required for valves, valve box covers, and protective sleeve covers unless otherwise noted.
- D. Valve boxes shall be of the type, manufacture and size shown on the Plans and Details and/or the following:
  1. Ametek or Carson 10 inch diameter round box (for drain valves, quick couplers and gate valves), green color.
  2. Ametek Jumbo Box with Pentagon Lock or Carson 1220-12 with bolt down locking lid and extensions as required (for single valve only) green color.
  3. Ametek Extra Large Utility Box or Carson 1730-18 with bolt down locking lid and extensions as required (use for two valves), green color.
  4. Backflow preventers and pressure reducing valves shall be installed in a Fog tite #25-TA concrete vault as shown on the Plans and Details.
  5. Or, approved equals.

### 2.13 BACKFLOW PREVENTION DEVICES:

Refer to mechanical engineer plans.

### 2.14 SWING JOINTS:

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- A. No pre-fabricated swing joints will be allowed. Use Marlex Sch 80 Nipples PVC TXT 90, Sch 80 risers.

### 2.15 OTHER SUPPLIES:

- A. Electrical tape shall be black plastic, three-quarters inch (3/4") wide and a minimum of 0.007 inches thick and the all-weather type.
- B. Teflon tape shall be used for all threaded connections. Tape shall be set back a minimum of one quarter inch (1/4") into the pipe threading.
- C. Pressure gages for the pressure reducing valve assembly shall be liquid-filled Ashcroft 1009 AL with one quarter inch (1/4") gage cock attached or approved equal.
- D. Encapsulate all splices with approved splice kit with sealant. Wire Splice Kit: DBY 3M splice kit, Or approved equal.

### 2.16 IDENTIFICATION:

- A. Underground - Type Plastic Line Markers: Permanent, bright-colored, continuous-printed plasticized aluminum tape, intended for direct-burial service; not less than 3" wide x 5 mils thick. Provide blue tape with black printing reading "CAUTION IRRIGATION LINE BURIED BELOW". Line Tec. Inc., PO Box 67, Glen Ellyn, IL 60138. Detectable Marking Tape; Allen Systems, P.O. Box 33569, Houston, TX 77233 (713)943-7213, (800) 231-2077; or Magnatec by Thor Enterprises, Inc. P.O. Box 450, Sun Prairie, WI 53590.
- B. Christy's identification tags manufactured from polyurethane Behr Desopan, incorporating an integral attachment neck and reinforced attachment hole and will be capable of withstanding 180 pounds pull force. Tag shall be 2 1/4" x 2 3/4" in size. All lettering shall be hot stamped in black and capable of withstanding outdoor use. Tag color shall be yellow. Marking tag shall be double side stamp with zone valve number.

### 2.17 BACKFILL MATERIAL:

- A. Sand for backfill around all irrigation heads use: common builder's sand.
- B. Suitable bedding material for use around all pipes and equipment as shown on the Details, use: native topsoil with no rocks or other debris more than 1 inch diameter or common builder's sand.

## PART 3 - EXECUTION

### 3.1 LAYOUT OF IRRIGATION SYSTEM:

- A. Stake the sprinkler irrigation system following design shown on the Plans before the construction begins. Alterations and changes in the layout may be expected in order to conform to the ground conditions and to obtain full and adequate coverage of water. It is understood that corrective measures in the system may become necessary, but no changes or alterations in the system as planned shall be made without the prior authorization of the Engineer.
- B. Before starting work, determine that work may proceed without disruption of activities of other trades.
- C. The Contractor shall carefully check grades to ensure that area is ready to begin work.
- D. Contractor is responsible for taking all reasonable investigative actions and precautions when working around all utility systems.

### 3.2 TRENCHING:

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- A. The contractor will save and maintain any sod from the ditches and replace it after sprinkler installation. Sod shall not be displaced for more than 48 hours.
- B. Exercise care when excavating trenches near existing trees. Where roots are two inches (2") and greater in diameter hand excavate and tunnel. When large roots are exposed, wrap with heavy burlap for protection and prevent excessive drying. Trenches dug by machines adjacent to trees having roots two inches (2") and less in diameter shall have the sides hand trimmed making a clean cut of the roots. Trenches having exposed tree roots shall be back-filled within twenty-four (24) hours unless adequately protected with moist burlap or canvas.
- C. The top six inches (6") of soil shall be kept separate from subsoil and shall be replaced as the top layer when backfill is made.
- D. Trenches shall be excavated for all pipe to provide the minimum depth of cover below finish grade of 24" for live lines (mains), and 18" for laterals and all others, no wider at any point than is necessary to lay the pipe or install equipment. Trenches shall be excavated with vertical sides. Locate outside of paved areas wherever possible.
- E. Materials unsuitable for bedding of pipe to be removed to a depth 4" below trench bottom, and replaced with suitable bedding material as directed by the Engineer. Suitable bedding material shall be: excavated trench material, free from rocks, roots, sticks, debris or other sharp objects over one inch in diameter; or sand, as required.
- F. All trenches must be straight, with appropriate pipe-fittings used to allow pipe to be laid without undue bending and not have abrupt changes in grade.
- G. The trench bottom must be free of rocks or sharp-edged objects.
- H. The use of an underground vibratory plow or similar device to pull pipe will not be permitted.

### 3.3 INSTALLATION:

- A. Installation of Pipe
  - 1. All exposed irrigation lines within the parking structure will be copper, type as approved by building codes. Interior piping shall be installed by the project plumbing contractor with coordination by the landscape irrigation contractor. This includes from the mechanical room p.o.c. and all runs and penetrations to the various planters on-structure and the runs through the building structures to the perimeter streetscape planting. The landscape irrigation contractor will install all pipe at the planter pipe transition and the PVC street tree irrigation lines.
- B. PVC Pipe and Fittings:
  - 1. The Contractor shall exercise care in handling, loading, unloading and storing to avoid damage. The pipe and fittings shall be stored under cover, and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat, so as not to be subject to undue bending or concentrated external load at any point. Any pipe that has been dented or damaged shall be discarded until such damage has been cut out and the pipe is rejoined with a coupling.
  - 2. PVC pipe ends shall be cut to ninety (90) degrees to the pipe length and cleaned of all cutting burrs prior to cementing. Use approved reaming tool. Pipe ends shall be wiped clean with a rag and lightly wetted with PVC primer. Cement shall be applied with a light coat on the inside of the fitting and heavier coat on the outside of the pipe. Pipe shall be inserted into the fitting and given a quarter turn to seat the cement. Excess cement shall be wiped from the outside of the pipe. Pipe will be tested as indicated elsewhere in these specifications. No back filling will be permitted other than at the centers of pipe lengths until the pressure test is completed.
  - 3. Appropriate primer shall be used with solvent glue. Solvent welded joints shall be given at least fifteen (15) minutes set-up time before moving or handling. Pipe shall be partially center loaded to prevent arching and slipping. No water shall be

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permitted in pipe until a period of at least ten (10) hours has elapsed for solvent weld setting and curing.

4. Before pressure testing, soluble weld joints shall be given at least twenty-four (24) hours curing time.
5. No PVC pipe may be threaded or connected to a threaded fitting without an adapter. Use Teflon tape on all male threads.
6. Great care must be taken to insure that the inside of the pipe is absolutely clean. Any pipe ends not being worked on must be protected and not left open.

C. Brass Pipe and Fittings:

1. Brass pipe shall be installed in accordance with the local Plumbing Code and as shown on the Plans and Details.
2. Teflon tape all male threads to prevent leaks and corrosion.
3. Wrap all brass pipes with black PVC tape where they pass through grouted openings in concrete vaults.

D. Control Wiring:

1. Control wires are to be taped together at five (5) foot intervals with electrical tape; then this bundle is to be taped to the bottom of the supply line at ten foot (10') intervals with at least three (3) wraps of electrical tape. A bare copper wire #14 or greater, will be installed on top of the PVC supply line for future detection with the wire ends clearly exposed in the valve boxes.
2. Tie a loose 24 inches long loop in all wiring at changes of direction greater than 30 degrees. Untie all loops after all connections have been made.
3. Splices will be permitted only at junction boxes, valve boxes, or at control equipment and never between valves or valve and controller. A minimum of 24 inches of excess conductor shall be left at all splices, terminal and control valves to facilitate inspection and future splicing. All splices must be encapsulated with sealant in approved splice kit.
4. One unconnected spare orange control wire (one spare wire for each 5 valves) is to be run from the controller through each intermediate control valve box. Provide a twenty-four inch (24") long, tight loop in each box. Where control valves run in opposite directions from the controller, run a separate spare wire in each direction.
5. A schedule diagram shall be posted in the controller to facilitate the selection of the valves to be operated.
6. Location and type of monitoring of controllers shall be directed by the Engineer or as shown on the Plans.
7. Minimum size of wire is to be determined strictly by the following chart:

No. of Valves	Maximum Length of Common Wire			
	500'	1000'	2000'	3000'
1	14	14	14	14
2	14	14	14	10
3	14	14	10	8
4	14	14	10	8
5	14	10	8	6
6	14	10	6	6
7	14	8	6	4
8	14	8	6	4
9	14	8	4	4
10	10	6	4	2

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8. The control wires shall be color coded as follows:  
Neutral or common wire - White.  
Lead-in wire - Black.  
Extra wire – Orange
9. Control wires to be installed in 1 1/2 inch minimum PVC schedule 40 sleeve under all paved areas.
10. Flow sensor wire to be computer interface wire between flow sensor and controller. Install computer-interface (Maxi) wire on the underside of the mainline irrigation pipe and attached in the same manner as for controller wires. The computer interface wire shall be continuous with no splices.

E. Sleeves:

Trenches located under areas of existing or new paving shall have sleeves installed. Sleeves shall extend 12" beyond the pavement on each side. Trenches shall be back-filled with sand (6 inches above and 4 inches below the pipe) and compacted in layers to 95% compaction, using manual or mechanical tamping devices. Trenches for piping shall be compacted to equal the compaction of the existing adjacent undisturbed soil and shall be left in firm unyielding condition. All trenches shall be left flush with the adjoining grade. The Contractor shall set in place; cap and pressure test all piping under paving prior to paving work.

F. Risers and Swing Joints:

1. All pop-up sprinkler heads and quick coupler swing joints must be constructed according to the Details.
2. Minimum riser size shall be the pipe size of the sprinkler head.
3. All threaded joints are to have Teflon tape or pipe dope (approved for PVC pipe) applied to male threads only.
4. Risers are to be capped after installation in preparation for pressure testing.
5. All pop-up sprinkler heads and quick couplers shall have swing joints that allow the head to be set perpendicular and flush with finish grades.

G. Pop-up Sprinkler Heads:

1. Install heads as designated on the Plans and Details.
2. Spacing of heads shall not exceed spacing shown on the Plans for any reason.
3. Heads along curbs, walks, paving, etc. shall be placed 1/2 inch above finish grade and no closer than 4 inches from paving edge.
4. All impact sprinkler heads located in athletic turf areas shall be equipped with rubber covers.
5. All heads shall be set perpendicular to finish grade unless otherwise designated on the Plans.
6. Backfill around heads with sand per the Details.

H. Automatic controllers:

1. Install irrigation controllers per manufacturer's specifications and shop drawings.
2. Electrical wiring (120 V.A.C.) shall be installed according to local code. A licensed electrician must perform hard wiring of controller, and the work must be permitted per Ft. Lewis Public Work requirements. The cost of all electrical work necessary to make the automatic equipment operate properly shall be included in this contract.
3. Conduit for power supply wires shall be installed as shown on Plans and Details and controller manufacturers shop drawings. The ends of all conduits, whether shop cut or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true. Conduit bends, except factory bends, shall have a radius of not

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less than six times the inside diameter of the conduit. A 3/16-inch polyethylene pull rope shall be installed in all conduits with two feet of pull rope extended beyond the conduit openings and then secured. All conduit shall be free of debris. All conduit openings shall be sealed with duct tape to prevent fouling.

4. The Engineer shall direct final location and type of mounting of controllers.
5. A diagram of schedule shall be posted in the controller to facilitate the selection of the valves to be operated.
6. Install decoders, transmitter and all control equipment in controller housing per manufacturer's specifications.

### I. Quick Couplers:

All quick coupling valves shall be installed in a 10" diameter valve box as shown in the Details.

### J. Automatic Control Valves:

1. Install as shown on the Plans and Details.
2. Before installation of any automatic valves, the supply line must be thoroughly flushed.
3. All automatic valves shall be enclosed in valve boxes with valve box extensions as required.

### K. Master Valve/Flow Sensors:

1. Install per manufacturer's specifications.
2. Coordinate wiring with control equipment.

### L. Thrust Blocking:

Thrust blocking shall be installed on main lines 3 inches (3") in size as recommended by pipe manufacturer.

### M. Back-filling:

1. Back-filling shall be done when pipe is not in an expanded condition due to heat or pressure. Cooling of the pipe can be accomplished by operating the system for a short time before back-fill, or by back-filling in the early part of the morning before the heat of the day.
2. In refilling the trenches, the fill around, 4 inches below, and 6 inches above the pipe and fittings shall be suitable bedding material or sand, as required, and tamped. The remainder of the backfill shall contain no lumps or rocks larger than three inches. A six inch separation is required between all pipes when more than one pipe occupies the trench. If no sodding is required, the top 6 inch of backfill shall be replaced by topsoil where it exists (free of rocks over one inch, subsoil or trash) or selected fill soil or sand if soil conditions are rocky.
3. All roots, rocks and surplus excavation shall be removed from the site unless otherwise directed. Any turf areas buried under ditch excavation shall be raked clean of any excavated material.
4. Trenches under roads or paved areas shall be back-filled and tamped with a mechanical tamper in successive six inch (6") lifts. Paving shall be replaced to the satisfaction of the Engineer.
5. Prior to completing backfill, place detection tape 12 inch above installed lateral and supply mains for future line detection. Provide extra length to clearly expose ends in the valve boxes.
6. Before complete back-filling, all underground appurtenances including risers, valves, double check valve assembly, drain valves, and joints must remain exposed so that they can be viewed during testing and located "as-built" by the Engineer. It is suggested that the Contractor partially backfill the pipe as it is laid, leaving all joints exposed; then complete back-filling later after flushing, pressure testing, inspection

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and "record drawing" location. The location, inspecting and testing provisions of these specifications will be strictly adhered to. If, for any reason, any part of the sprinkler system is back-filled before approved location, testing, or inspection is authorized, it must be completely uncovered and exposed until approved for back-filling by the Engineer.

### 3.4 CLEAN-UP:

Upon completion of operations and prior to watering, clean all adjoining areas such as paving, curbs, and lawns of debris caused by the work on this project, or any part of this project. All hard surfaced areas shall be washed clean. Daily clean up shall be required on all areas used for circulation, parking, or other daily use.

### 3.5 TESTING AND INSPECTIONS:

#### A. Pressure Testing:

1. Make hydrostatic tests only in the presence of the Engineer. No pipe shall be backfilled until it has been inspected, tested and approved.
2. Furnish necessary pump, gauges and all other test equipment.
3. All PVC main lines with valves installed and closed shall be flushed and pressure tested with all joints exposed to one hundred fifty (150) psi until watertight. Maximum psi loss in a thirty (30) minute test period shall be five (5) PSI.
4. Similarly, all PVC lateral lines with risers installed and capped shall be flushed and pressure tested with all joints exposed to service line pressure required for design for 30 minutes. Maximum PSI loss allowed shall be five (5) PSI. The Engineer shall visually inspect all lateral lines, joints, and swing joints for leakage.
5. To be valid, all tests must be witnessed and approved by the Engineer. The contractor must give the Engineer forty eight (48) hours notice prior to the anticipated date of inspection.
6. All gauges used in the testing of water pressures shall be certified correct by an independent testing laboratory immediately prior to use on the project. Gauges shall be re-tested when directed by the Engineer.
7. All testing shall be approved prior to installation of valves or irrigation heads.

#### B. Equipment Surveying:

Upon the Engineer's approval of the Pressure Test, the Engineer will locate main lines and lateral lines. If surveying is not required, backfilling of trenches can be completed.

#### C. Coverage Test:

1. Before the irrigation system will be accepted, the Contractor, in the presence of the Engineer, shall perform a water coverage test for each zone of the system. Contractor to be responsible to change nozzles, etc. at discretion of Engineer in order to obtain full coverage with minimum over spray. Contractor will be required to adjust and/or replace nozzles, etc. to meet this requirement. Prior to arrival of Engineer, the Contractor shall accomplish the following: complete all work including balancing, adjusting the system (pressure reducing valves, flow adjustment keys, nozzles, etc.) to provide optimum coverage without fogging.
2. Notify the Engineer at least forty eight (48) hours in advance of coverage test.

#### D. Complete System Inspection (Punch List):

1. Upon approved completion of the Coverage Test, trenching and installation of all equipment, the Contractor shall request a Complete System Inspection of the entire irrigation system including: backfilling, irrigation heads, valves, valve boxes, controller and all other equipment.

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2. From this inspection, a punch list shall be prepared by the Engineer and presented to the Contractor for completion. The Engineer shall give a date for completion of the punch list, not to exceed two weeks.
  3. Notify the Engineer at least forty-eight (48) hours in advance of Complete System Inspection. The Contractor shall be responsible for having a two-way communication system or sufficient personnel so that directions from the inspection areas to the controller of the system can be readily accomplished.
- E. Substantial Completion:
1. Contractor shall write a letter to the Engineer requesting substantial completion of the irrigation system.
- F. System Operations Orientation:
1. System Operation Training Session:
    - a. Prior to the training and orientation session. The date and time of the session shall be subject to approval of the Engineer.
    - b. The "As-Built" plans shall be reviewed and all features explained. The "As-Built" plans shall consist of red-lined corrections, notes, comments, etc. on a clean bond copy print. All critical dimensions shall be shown to the nearest inch. The Consultant shall review and approve the "As-Built" plans submitted and prepare "As-Built" Drawings on Mylar for archive storage.
    - c. A complete maintenance and operations manual shall be prepared by the Contractor and three copies of the manual shall be turned over to the Engineer at the final inspection. The manuals shall consist of three ring binders containing: (1) catalogs of all materials used, (2) a complete parts list of all materials, (3) a written summary of all operations data including spring start-up and winterization techniques, controller programming, valve cleaning, irrigation adjustments, backflow preventer operation and any other information required to operate and maintain system, (4) two local distributors.
    - d. The controller station timing shall be set by the Engineer.
  2. Controller Charts:
    - a. As-Built drawings shall be approved by the Engineer before charts are prepared. The chart shall be a reduction of the actual As-Built Drawing prepared by the Consultant.
    - b. Provide one controller chart per controller. Controller chart shall fit in behind controller door.
    - c. Chart shall be a bond copy print with a different pastel transparent color to show each separate zone. Verify that the zone number as shown on the Controller Chart matches the number on the actual control valve identification tag
    - d. When completed and approved, hermetically seal (lamine) the chart between two pieces of plastic.
    - e. The charts shall be completed before the project can be considered Physically Complete.
  3. The contractor shall provide the Engineer with the necessary keys and/or other tools necessary to operate/drain/activate the system and spend sufficient time with the Engineer to insure that the system operation/maintenance/winterizing can continue after departure of the Contractor. The Contractor shall be liable for all damage or loss resulting from failure to comply with the provisions of this paragraph.
- G. Functional Test:
1. Functional test of the control system shall be performed and demonstrate that all parts of the control system function as specified or intended. The functional test for

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each new system shall consist of not less than 30 days of continuous, satisfactory operation.

2. Any materials determined to be faulty as part of the installation shall be replaced or corrected by the Contractor at his expense in a manner respective to the Plans, Details and other sections of this Specification. In the event of a system failure due to faulty installation or workmanship, the 30 day period will be repeated until testing is complete.

### 3.6 PHYSICAL COMPLETION:

- A. Upon completion and approval of all tests, inspections, training, manuals, as-built drawings, and other requirements of this Section, the Engineer shall write a letter to the Contractor transferring the project to the Owner's Maintenance and Operation's personnel.
- B. Physical Completion of the system will be contingent upon Contractor providing signed and approved irrigation/plumbing/health/electrical permits as may be applicable.

### 3.7 GUARANTEE:

- A. Contractor shall submit a written guarantee, in approved form, stating that all work showing defects in materials or workmanship will be repaired or replaced at no cost to the Engineer for a period of one year from date of Physical Completion.
- B. A final site meeting shall take place eleven months after the date of Physical Completion (minimum of twelve months after Substantial Completion). The system shall be examined by the Engineer to determine if the system requires alterations or replacements covered in the Guarantee.
- C. The sample Guarantee Form following this section may be re-typed on Contractor's letterhead and contain the following information:

END OF SECTION 328400



## SECTION 32 91 13 STRUCTURAL SOIL

### PART 1 - DESCRIPTION

#### 1.1 SCOPE OF WORK:

This section specifies tree planting soil under pavement furnished and installed by the contractor, as shown on the Drawings and specified herein. Work includes furnishing and installation of materials and furnishing sample mixes and testing.

#### 1.2 CODES AND REFERENCE STANDARDS:

Comply with codes and requirements of the authority having jurisdiction. Comply with applicable requirements of the following standards, where these standards are in conflict with specification requirements, the most restrictive requirement shall govern.

- A. ASTM – American Society of Testing Materials.
- B. USDA – United States Department of Agriculture.
- C. AOAC – Association of Official Agricultural Chemists
- D. WSDOT – Washington State Department of Transportation Specification for Road, Bridge, and Municipal Construction.
- E. AASHTO – American Association of State Highway Transportation Officials.

#### 1.3 SUBMITTALS

- A. Product Data: Manufacturer's product literature for polymer soil conditioner.
- B. Tests: Provide sieve analysis of crushed rock and clay loam products, pH test of clay loam.
- C. Component Samples: Provide bagged samples of crushed rock and clay loam in labeled, clean, sealed containers weighing no more than 10 pounds each.
- D. Mix Samples and Compaction Tests: Mix and install on site up to 3 sample areas with varied percentages of crushed rock and clay loam. Each sample area is to be minimum 6 feet square and 1 foot deep. Test samples shall be mixed according to the methods specified and compacted in lifts as specified. Maintain samples areas in a moist condition, protect from contamination and erosion, test each sample for compaction levels and provide for inspection at weekly intervals by Landscape Architect over a period of three weeks. Following the last inspection of the samples, the Landscape Architect will indicate the percentage ratio of clay loam to crushed rock to be used for the project.
- E. Mixing Methods: Submit description of equipment for and method of mixing.

#### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Protect materials during delivery and storage to ensure that the materials remain evenly mixed and moisture levels are maintained to ensure adhesion of clay loam to crushed rock. Do not allow material to become contaminated with debris or other soil materials. Protect soil from erosion. Do not deliver or install materials during freezing conditions or during heavy precipitation.

SECTION 32 91 13 STRUCTURAL SOIL

PART 2 - PRODUCTS

2.1 CRUSHED ROCK

- A. Materials shall be angular base course material ranging in size from ¾" to 1-1/2" meeting WSDOT 9-03 (1)A. Particle size distribution shall be within the range of the following percentages by volume:

Sieve Size	Percent Passing
1-1/2"	90 TO 100%
1"	20 TO 75%
¾"	10 TO 50%
#40	5 TO 10%

2.2 CLAY LOAM

- A. Material shall meet within the 5.5 to 6.5 pH range. Particle distribution shall comply with US Department of Agriculture Soil Conservation Service Soil Survey for clay loam. Clay loam shall be from a commercial processing facility, and shall contain no less than 2% organic matter and no more than 5% organic matter. Clay loam shall be free of debris and roots. Clay loam should be composed of the following percentages by volume:

Sieve Size	Percent Passing
1 mm	100%
.05 mm	70%
.02 mm	40%
.002 mm	10 to 25%

2.3 POLYMER SOIL CONDITIONER

- A. Materials shall be "Soil Moist Fines" with a particle size distribution of 500 to 50 microns, or approved.
1. Suppliers:
    - a. H.D. Fowler Company at phone 425-746-8400.
    - b. JRM Chemical, Inc. at 1-800-962-4010.
    - c. Pacific Topsoils at phone 425-337-2700
    - d. or approved equal.

2.4 WATER

- A. Water shall be available throughout the mixing and placement of the soil. Water shall be clean, potable water.

PART 3 - EXECUTION

3.1 SOIL MIXING

- A. Mixing Ratios:
1. Crushed Rock: 2.5 to 3.5 cubic yards (72% to 78%)
  2. Clay Loam: 1 cubic yard (28% to 22%)
  3. Polymer soil conditioner: 4 lbs.
  4. Water: as needed
- B. Mixing

## SECTION 32 91 13 STRUCTURAL SOIL

1. Mixing should be done at an off-site location. Measure materials accurately to maintain the ratios of the mix.
2. The clay loam component of mix shall be in a friable condition that crumbles easily and will mix uniformly.
3. Maintain sufficient moisture throughout the mixing procedure to ensure adhesion of clay loam to crushed rock surfaces.
4. Spread a 1 foot thick layer of crushed rock over a clean paved surface.
5. Wet the rock evenly.
6. Broadcast spread evenly the proportional amount of dry polymer over the wet rock. Over the polymer, spread a proportional amount of clay loam in an even layer.
7. Turn the materials until materials are evenly mixed.
8. During the mixing process add water at the minimum rate required to ensure that clay loam adheres to the surfaces of the crushed rock and to produce optimum moisture content for compaction. Add amendments for pH adjustment, at the time of mixing at rates recommended by the soil test.

### C. Soil Placement

1. Install soil in lifts of 6 inches or less and compact each lift.
2. Compact materials to peak dry density from a standard AASHTO compaction curve to achieve 95% proctor density. No compaction shall occur when moisture content exceeds maximum. Delay compaction until soil falls within allowable range and protect soil during delays with covering to prevent soil erosion.
3. Notify the Engineer at least 2 days before the installation of soil. The Engineer will regularly inspect the material during installation to ensure consistency with sample mix. Soil which varies significantly from the approved sample, as determined by the Landscape Architect, shall be removed and new soil installed that meets these specifications.
4. Bring soils to sub-grade elevations to support paving as shown on the Drawings. Subgrade surface shall be smooth and slope uniformly. Fill depressions greater than  $\frac{1}{2}$ ". Cover soil surface immediately to protect it from erosion by rain and from contamination by toxic materials, construction waste, trash, debris, water containing cement, or soil materials that will alter the particle size distribution of the mix.

### 3.2 ACCEPTANCE STANDARDS

- A. The Engineer will inspect the work upon the request of the contractor. Request for inspection shall be received at least 2 days before the anticipated date of inspection.

### 3.3 CLEAN UP

- A. Upon completion of the soil installation operation, clean surrounding areas within the limit of work. Remove excess material from the site. Do not wash adjacent areas with water until paving materials covering soil are in place.

End of Section 329113



## SECTION 329200 – GRASS TURF

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sodding.
- B. Related Sections:
  - 1. Division 32 Section "Planting Irrigation" for turf irrigation.
  - 2. Division 32 Section "Plants" for planting soils, soil amendments, and fertilizers.

#### 1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- C. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- D. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- E. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For qualified landscape Installer.
- C. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf and grass paving installation and establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Ten years experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
  - a. Certified Landscape Technician - Exterior, with installation and maintenance specialty area(s), designated CLT-Exterior.
  - b. Certified Turfgrass Professional, designated CTP.
  - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- B. Bulk Materials:
  1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

#### 1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion. Seeding prior to April 1st and after November 1st may proceed only upon approval by Landscape Architect.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.
- C. Coordination with planting areas (trees, shrubs, groundcovers): Plant turf areas after planting trees, shrubs, and other plants unless otherwise indicated.
  1. When planting turf, protect trees, shrubs, and other plants, and promptly repair damage caused by planting operations

#### 1.8 WARRANTY

- A. Acceptance of lawn areas will be based upon growth of a uniform color and dense stand of grass, without bare spots larger than 1' x 1' square. Seeded or sodded areas that fail to produce acceptable growth shall be re-sodded at no change in Contract Amount.

1.9 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
  - 1. Sodded Turf: Thirty days from date of Substantial Completion.

PART 2 – PRODUCTS

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

- B. Turfgrass Species: Sod shall be composed of the following:

50%	Turf-Type Perennial Rye Grass
30%-45%	Kentucky Bluegrass
5%-20%	Fine Fescue

- C. Approved Varieties:

- 1. Turf-Type Perennial Rye Grass: Grass Seed Mix shall consist of two or more varieties listed below:

Brightstar SLT	Hawkeye	Nighthawk	Catalina II
Brightstar II	SR 4420	Elfkin	Pizzazz
Admire	SR 4220	All Star II	Amazing
Charger II	Pentlum	Manhattan 4	Inspire
Promise	Gator 3	Applaud	Repell III
Seville II	Grand Slam	Line Drive	Cathedral II
Kokomo	Mach I	Pennant II	Terradyne

or, approved equals.

- 2. Kentucky Bluegrass: Blend must consist of two or more varieties listed below:

Julius	Julia	Cheri	Merit
Rogale	Bristol	Brooklawn	Chateau
Midnight	Blacksberg	Blueridge	Champagne
Coventry	Fairfax	Shamrock	Blackstone
Asset	Washington	Bariris	Estate
Majestic	or, approved equals.		

3. Fine Fescues: At least one variety shall be selected from the following list:

Salsa	Flyer	Cindy	Salem
Jasper	Longfellow	Proformer	Victory
Weekend	Seabreeze	Dawson E+	Napoli
Barskol	Barcrown	Marker	Tiffany
Bridgeport	Bargreen	Shadow II	Tamara
Shadow w/Endo	Jamestown II	Treazure E	Enjoy
Southport	or, approved equals.		

### PART 3 – EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

#### 3.3 PREPARATION FOR GRASS PAVER MATERIALS

- A. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus ¼ inch of finish elevation. Roll and rake, remove ridges, and fill depressions.

### 3.6 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod across angle of slopes exceeding 1:3.
  - 2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.
- D. Water newly planted areas and keep moist until new turf is established.

### 3.7 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Turf Post Fertilization: Apply fertilizer after initial mowing and when grass is dry.

### 3.8 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

## SECTION 32 93 10 SOIL PREPARATION

### PART 1 - GENERAL

#### 1.1 DESCRIPTION:

The work includes furnishing and installation of soil and/or amendments for lawn areas and landscape planting areas.

#### 1.2 QUALITY ASSURANCE:

All products supplied shall comply with applicable state and local codes.

- A. Washington Department of Ecology, Western Washington Stormwater Manual, BMP T5.13: Post-Construction Soil Quality and Depth
- B. WAC Chapter 173-350, Definitions and Section 220
- C. United States Department of Agriculture (USDA) Soil Texture System of Classification

#### 1.3 REFERENCE SECTIONS:

Section 329330 - Plants  
Section 02950 - Landscape Planting

#### 1.4 SUBMITTALS:

Submit the following samples to the Engineer for approval:

- A. Lawn Soils – 1 Gallon Container with soil analysis test.
- B. Planting Soils – 1 Gallon Container with soil analysis test.
- C. Planter Soils – 1 Gallon Container with soil analysis test.
- D. Compost - 1 Gallon Container with supplier certification.

#### 1.5 PROJECT CONDITIONS:

- A. The site soils shall be amended with either Lawn Soil Mix, Planting Soil Mix (for on-grade Landscape Planting Areas) or Planter Soil Mix (for on-structure planters) as shown on the plans.
- B. Keep streets, sidewalks and site clean, free from debris and affected drains open and free flowing at all times. Protect drains with filter fabric covers during construction. Appropriate erosion control measures shall be employed.

### PART 2 - PRODUCTS

#### 2.1 SOIL MIXES:

- A. Lawn Soil Mix: intended for use in all lawn areas and shall consist of 60% Sand and 40% Compost by volume.
- B. Planting Soil Mix: intended for use in on-grade Landscape Planting (shrub bed) Areas and shall consist of 67% Sandy/Loam Mix component and 33% Compost by volume.
- C. Planter Soil Mix: intended for use in all on-structure Planter Areas and shall consist of the following layered media:
  - 1. Upper 18 inches: 75% sand, 15% fir-bark fines and 10% composted sewage sludge (SoundGRO brand or approved equivalent).
  - 2. Next lower 18 inches: 90% sand and 10% AXIS (or approved equivalent diatomaceous-earth product).
  - 3. All fill below 36 inches: 100% sand.

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2.2 SOIL MIX COMPONENTS:

A. Sand

1. The Sand Component shall meet the following specifications within reasonable variations:

<u>Screen Size</u>	<u>Percent Retained</u>	<u>Percent Passing</u>
6.35mm	5%	95%
#10	15	85
#30	50	50
#60	60	40
#100	80	20
#200	90	10

B. Sandy / Loam Mix

1. The Sandy/Loam Mix component of the Planting Soil Mix shall be soil, based on USDA standards and shall have the following characteristics:

<u>Class</u>	<u>Particle Size Range</u>
Coarse sand	0.5 - 2.0 mm
All sands	0.05 - 2.0 mm
Silt	0.002 - 0.05 mm
Clay	<0.002 mm

2. The Sandy/Loam component shall also meet or exceed the following specifications:

<u>Screen Size</u>	<u>Percent Retained</u>	<u>Percent Passing</u>
6.35mm	5%	95%
#10	15	85
#30	50	50
#60	60	40
#100	80	20
#200	90	10

C. Compost

1. Composted material must be in compliance with WA Department of Ecology's specifications, which appear in WAC Chapter 173-350 Section 220; plus the following additional requirements.
2. Additional Requirements
  - a. The carbon to nitrogen ratio of the compost shall be below 25:1 or below 35:1 if the proposed plantings are composed entirely of plants native to the Puget Sound Lowlands region.
  - b. The compost shall have an organic matter content of 35% to 65%% as determined by "loss on ignition" test method.
3. Alternative organic materials may be used in lieu of the specified compost if they meet the criteria for carbon to nitrogen ratio, contaminants (as defined in WAC Chapter 173-350 Section 220), and when mixed with existing native soil can achieve a calculated organic content of 5% for turf areas or 10% for planting beds.
4. Submit one-gallon sample, source, and letter of certification from the supplier to the Owner and/or Owner's Representative for approval prior to installation.

2.3 SOIL MIX REQUIREMENTS:

A. Each soil mix shall also have the following characteristics:

1. Each soil mix shall have a Saturation Extract Conductivity of less than 4.0 dS/m @ 25 degrees C. as determined in a saturation extract.
2. The pH range shall be from 5.5 to 7.5.

## SECTION 32 93 10 SOIL PREPARATION

3. The Sodium Adsorption Ratio shall be less than 6.0.
  4. The saturation extract concentration of Boron shall be less than 1.0ppm.
  5. The water percolation/infiltration rate of the disturbed soil sample shall be a minimum of 0.4 inches per hour.
  6. The soil structure shall be loose, friable, and not subject to consolidation or compaction.
  7. The soil shall contain less than 100 plant parasitic nematodes per 100 cc of soil.
  8. The soil shall be relatively free of soil-borne plant pathogens.
  9. Minimal weed seed shall be present, based on germination testing of a representative sample.
  10. Non-soil components shall be less than 1% by volume (i.e. plastic, sticks, glass, etc.).
- B. Each soil mix shall contain sufficient quantities of available nitrogen, potassium, phosphorus, calcium, magnesium, sulfate, copper, zinc, manganese, iron and boron to support normal plant growth. In the event of nutrient inadequacies, provisions shall be made to add required materials prior to planting.
- C. The Contractor shall submit soil analysis from a soils testing laboratory to the Engineer. Indicate source and obtain the Engineer's approval before hauling to the site an (analysis test with a 1 gallon sample is required).

### PART 3 - EXECUTION

#### 3.1 PREPARATION OF SUB-GRADE:

- A. Scarify sub-grade soils to depths noted below. Where possible and not in conflict with tree driplines rip sub-grade 12" below surface. Reference tree protection specification and notes when working within and around existing trees. Contact the Owner prior to conducting work in these areas for approval of soil sub-grade preparation methods.
1. For Lawn Areas - Sub-grade elevation 6 inches below finished grade.
  2. For Landscape Planting Areas - Sub-grade elevation 12 inches below finished grade.

#### 3.2 PLACING AMENDMENTS:

- A. Lawns Areas: Place 6 inches of planting soil and rototill soil thoroughly into top 9 inches of prepared sub-grade.
- B. Landscape Planting Areas On-Grade: Place a minimum of 12 inches of planting soil and thoroughly rototill soil into top 9 inches of prepared sub-grade. For on structure planters, fill entire planter the full depth to the structure below.
- C. Landscape Planters On-Structure: Place soil the full depth of the planters and in the layers as described in 2.1, C.

#### 3.3 FINE GRADING:

- A. Perform fine grading to attain finish grades as shown on the Plans.
- B. Rake out all rocks, roots, sticks and other debris larger than 1-inch diameter or sticks longer than 3 inches long. Leave surface even and readily able to accommodate lawn or planting installation. Compaction level shall be between 85 to 95 percent density. Adjust grades and add soil as necessary as settlement occurs.

SECTION 32 93 10 SOIL PREPARATION

3.4 INSPECTION:

The Contractor shall notify the Engineer least 48 hours in advance of the time of inspection required for completion of soil preparation before seeding of lawn and planting of shrubs and groundcover can occur.

END OF SECTION 329310

## SECTION 32 93 30 PLANTS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION:

Provide planted trees, shrubs and ground covers as shown and specified. The work includes:

- A. Preparation of subsoil
- B. Plants and planting
- C. Specified planting soils
- D. Mulch and fertilizer
- E. Staking
- F. Maintenance

#### 1.2 QUALITY ASSURANCE:

- A. Comply with sizing and grading standards of the 2000 edition of "American Standard for Nursery Stock."
- B. Nomenclature shall conform to Hortus Third compiled by the L. H. Bailey Arboretum, Cornell University, 1976.
- C. All plants shall be nursery grown or collected materials that has been held in a nursery for at least one year. Nursery climatic conditions must be similar to those in the locality of the project. All plants shall be weed free at the time of planting.
- D. Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable at no additional cost, and providing that the larger plants will not be cut back to size indicated. Provide plants indicated by two (2) measurements so that only a maximum of twenty-five percent (25%) are of the minimum size indicated and seventy-five percent (75%) are of the maximum size indicated.

#### 1.3 REFERENCES:

Section 32 93 10 - Soil Preparation

#### 1.4 SUBMITTALS:

- A. Submit the following material samples:
  - 1. Fertilizer
  - 2. Mulch
- B. Submit the following material certification:
  - 1. Plant material sources.

#### 1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver fertilizer materials in original, unopened, and undamaged containers showing weight, analysis, and name of manufacturer. Store in such a manner as to prevent wetting and deterioration of the fertilizer.
- B. Dig, pack, transport, and handle plants with care to ensure protection against injury. Inspection certificates required by law shall accompany each shipment invoice or order to stock. On arrival, the certificate shall be filed with the Engineer. Protect all plants from desiccation. Wiltproof or another antidesiccant shall be applied only with approval of the Engineer. If plants cannot be planted immediately upon delivery, properly protect them with soil, wet peat moss, or in a manner acceptable to the Engineer. Water heeled-in plantings daily. No plant shall be bound with rope or wire in a manner that could damage or break the branches.

## SECTION 32 93 30 PLANTS

- C. Cover plants transported on open vehicles with a protective covering to prevent wind-burn.
- D. Provide dry, loose soils for planting. Frozen or muddy soil is not acceptable.
- E. Stock shall be handled by root ball only, not the trunks, stems or tops.

### 1.6 PROJECT CONDITIONS:

- A. Work notification: Notify the Engineer at least five (5) working days prior to the installation of plant material.
- B. Protect existing utilities, paving, and other facilities from damage caused by planting operations.
- C. Do not install plant material when ambient temperatures may drop below 35<sup>o</sup>F or above 80<sup>o</sup>F.
- D. Do not install plants when wind velocity exceeds thirty (30) MPH.
- E. Confine work to designated areas. Do not disturb existing vegetation outside project limits and protect all trees, shrubs and ground covers within project limits not designated to be removed. Do not permit vehicular traffic or materials storage under or around new or existing trees.

### 1.7 WARRANTY:

- A. Warrant plant material to remain alive and be in healthy, vigorous condition for a period of one (1) year after the date of Physical Completion. Inspection of plants will be made by the Engineer at the completion of planting.
- B. Replace, in accordance with the drawings and specifications, all plants that are dead or, as determined by the Engineer, are in an unhealthy or unsightly condition, and have lost their natural shape due to dead branches, or other causes due to the Contractor's negligence. The cost of such replacement(s) is at the Contractor's expense. Warrant all replacement plants for one (1) year after Physical Completion, unless otherwise specified.
- C. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, freezing rains, lightning storms, or winds over seventy-five (75) MPH, winter kill caused by extreme cold and severe winter conditions not typical of planting area; acts of vandalism or negligence on the part of the Owner.
- D. Remove and immediately replace all plants, as determined by the Engineer, to be unsatisfactory during the initial planting installation.
- E. This warranty also applies to existing trees, shrubs and ground covers that are to be removed and heeled-in for later replanting on-site.

## PART 2 - PRODUCTS

### 2.1 PLANT MATERIALS:

- A. Plants: Provide plants typical of their species or variety; with normal, densely developed branches and vigorous, fibrous root systems. Provide only sound, healthy, vigorous plants free from weeds, defects, disfiguring knots, sunscald injuries, and abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation. All plants shall have a fully developed form without voids, open spaces, broken branches, flush cuts or stubs.
  - 1. Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and absorbing root system necessary for full recovery of the plant. Provide ball sizes complying with the

SECTION 32 93 30 PLANTS

latest edition of the "American Standard for Nursery Stock." Cracked or mushroomed balls are not acceptable.

2. Bare-root plants: Dug with adequate fibrous roots, covered with a uniformly thick coating of mud by being puddled immediately after they are dug, or packed in moist straw, sawdust or peat moss.
3. Container-grown stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.
  - a. No plants shall be loose in the container.
  - b. Container stock shall not be pot bound.
4. No pruning wounds shall be present with a diameter of more than one (1) inch and such wounds must show vigorous callous on all edges. Trees shall not be pruned within six (6) months prior to delivery.

2.2 SOILS:

Refer to Section 32 93 10 Soil Preparation.

2.3 FERTILIZERS:

A. Description

1. 15-22-15
2. Fertilizer shall be as manufactured by Lilly Miller (or approved equal).

B. Analysis:

Total Nitrogen (N)	15%
Ammoniacal Nitrogen	4.6%
Urea Nitrogen	3.2%
Coated Slow Release Urea Nitrogen	3.3%
Slowly Available Water Soluble Nitrogen*	2.3%
Water Insoluble Nitrogen	1.6%
Available Phosphoric Acid (P <sub>2</sub> O <sub>5</sub> )	22%
Soluble Potash (K <sub>2</sub> O)	15%
Sulfur (S)	4%
Boron (B)	0.06%
Copper (Cu)	0.06%
Iron (Fe)	1%
Manganese (Mn)	0.15%
Zinc (Zn)	0.14%

Derived from Urea, Sulfur-Coated Urea, Methylene Ureas, Ammonium Phosphate, Sulfate of Potash, Muriate of Potash, Iron Sulfate, Calcium and Sodium Borate, Copper Oxide and Sulfate, Iron Oxide Sulfate and Frit, Manganese Oxide and Sulfate, Zinc Oxide and Sulfate.

\* Slowly Available Water Soluble Nitrogen from Methylene Ureas.

2.4 MULCHES:

## SECTION 32 93 30 PLANTS

A. Fine ground fir or hemlock bark, free from weed seeds, sawdust, splinters or other debris. Bark mulch shall not contain resin, tannin, wood fiber, or other compounds detrimental to plant life.

B. Ground bark shall meet the following gradation requirements:

Percent Passing	Sieve Sizes
95% - 100%	1/4 inch
80% - 100%	No. 8
0% - 80%	No. 35

### PART 3 - EXECUTION

#### 3.1 INSPECTION:

- A. Finish grading shall be inspected and approved by the Engineer prior to planting.
- B. Plant material shall be inspected and approved by the Engineer at the nursery, with pictures or site prior to installation. Remove unsatisfactory material from the site immediately.

#### 3.2 PREPARATION:

Contractor shall locate plants by staking with stakes and flags as indicated on the Drawings or as approved in the field. If obstructions are encountered that are not shown on the drawings, do not proceed until Engineer has selected alternate plant locations.

#### 3.3 INSTALLATION:

- A. Plants brought to the planting site shall be bare root, balled and burlapped, or in containers, depending on how specified in the planting schedule in the Contract for the particular type of planting Material. Plants shall not be planted during freezing weather or when the ground is frozen. Plants shall not be planted during excessively wet conditions. Plants shall not be placed on any day in which temperatures are forecast to exceed 80 degrees unless the Engineer approves otherwise. Plants shall not be placed in areas that are below finished grade.
- B. Dates to plant: Planting trees, shrubs, and groundcovers within shall be performed during the period between October 1 and April 30. Planting at other times shall only be done by written permission by the Engineer and only if an automatic irrigation system is available at the site at the time of planting.
- C. Plants shall be removed from containers in a manner that prevents damage to the root system. Containers may require vertical cuts down the full depth of the container to accommodate removal. All circling roots shall be loosened to ensure natural directional growth after planting.
- D. Excavate circular plant pits with scarified vertical sides, except for plants specifically indicated to be planted in beds. Provide planting pits at least twice the diameter of the root system or container. Depth of pit shall accommodate the entire root system. Scarify the bottom and sides of the pit to a depth of four inches. If groundwater is encountered upon excavation of planting holes, the Contractor shall promptly notify the Engineer.
- E. Place specified planting soil for use around the balls and roots of the plants.
- F. Broadcast fertilizer at a rate of one-half pound (1/2#) of nitrogen per 1,000 square feet after completion of planting around shrubs and ground covers only.
- G. Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set crown of plant material at the finish grade. No filling will be permitted around trunks or stems or above grafts on grafted trees. Backfill the planting pit with

## SECTION 32 93 30 PLANTS

specified soil or amendment. Do not use frozen or muddy mixtures for backfilling. Form a ring of soil around the edge of each planting pit to retain water.

- H. After balled and burlapped plants are set, water in soil mixture around bases of balls and fill all voids. Remove all burlap, or plastic wrapping materials, twine, and wires, and wire baskets from root balls.
- I. Space ground cover plants using triangular spacing in accordance with indicated dimensions. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants. Plant to within eighteen inches (18") of the trunks of trees and shrubs within planting bed and to within twelve inches (12") of edge of bed.
- J. Spread and arrange roots of bare-rooted plants in their natural position. Work in specified planting soil. Do not mat roots together. Cut all broken and frayed roots before backfilling with remaining specified planting soil.
- K. Mulching:
  - 1. Mulch tree and shrub planting pits and shrub beds with required mulching material three inches (3") deep immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.
- L. Staking: Stake all deciduous and coniferous trees immediately after planting. Within planters, guy trees using specified Duckbill system or by guying trees to sides or bottom of planters. Submit proposed system to Engineer prior to installation. Coordinate final guying system with Owner for coordination of waterproof membrane system. Damage to existing waterproof membrane systems will be the responsibility of the contractor.
- M. Pruning: Prune all trees only to remove broken or damaged branches, or for aesthetic purposes as directed by the Engineer. Branches will be pruned at the branch collar. Neither stubs nor flush cuts will be acceptable.

### 3.4 MAINTENANCE:

- A. Maintain plantings for a period of at least thirty (30) days after substantial completion of planting operations or until all plants are sufficiently recovered from transplanting and in a healthy growing condition acceptable to the Engineer.
- B. Maintenance shall include regular (at least twice weekly) cultivating, weeding, watering, pruning (only as directed), and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease.
  - 1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
  - 2. Straighten, repair and adjust guy wires and stakes as required.
  - 3. Correct defective work, as soon as possible, after deficiencies become apparent and weather and season permit.
  - 4. Water trees, plants, and ground cover beds within the first twenty-four (24) hours of initial planting, and not less than twice per week (including rain) until Physical Completion.

### 3.5 PHYSICAL COMPLETION:

- A. Inspection to determine Physical Completion of planted areas will be made by the Engineer, upon Contractor's request. Provide notification at least ten (10) working days before requested inspection date.
  - 1. Planted areas will be accepted provided all requirements, including the maintenance period have been complied with and plant materials are alive and in a healthy, vigorous condition.
- B. Upon Physical Completion, the Owner will assume plant maintenance.

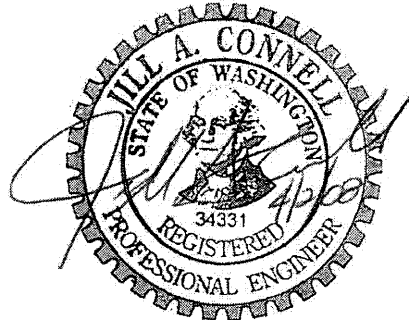
SECTION 32 93 30 PLANTS

3.6 CLEANING:

Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from planting operations.

END OF SECTION 32 93 30

PROJECT:  
MultiCare  
Tacoma General Hospital  
Emergency Department and  
Cancer Center Expansion



EXPIRES 06/30/08

**Mechanical Engineer of Record:**

CDi Engineers  
4200 194th Street SW, Suite 200  
Lynnwood, WA 98036  
425-672-1071, Fax 425-778-8769

Mechanical Engineer of Record

04/03/08  
Date



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## SECTION 21 10 00 WATER-BASED FIRE SUPPRESSION SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods."
  - 2. Section 23 05 53 "Identification for Mechanical Piping and Equipment."
  - 3. Section 21 31 13 "Fire Pumps."
  - 4. Section 28 31 00 "Fire Detection and Alarm" for alarm devices not in this Section.

#### 1.2 SUMMARY

- A. This Section includes fire-suppression piping and equipment for the following building systems:
  - 1. Dedicated and Combined Class II fire-suppression standpipes.
  - 2. Wet-pipe fire-suppression system, including piping, valves, specialties, automatic sprinklers and accessories.
  - 3. Dry-pipe fire-suppression system, including piping, valves, specialties, automatic sprinklers, air compressor(s) and accessories.
  - 4. Pre-action fire-suppression system, including piping, valves, specialties, automatic sprinklers, air compressor(s) and accessories operated by fire-detection system.

#### 1.3 DEFINITIONS

- A. Hose Connection: Valve with threaded outlet matching fire hose coupling thread for attaching fire hose.
- B. Hose Station: Hose connection.
- C. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13, NFPA 14, and FM Global for obtaining approval from authorities having jurisdiction.

#### 1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Design standpipe and sprinkler systems according to the following and obtain approval from authorities having jurisdiction.
  - 1. Perform a flow test as described in the Preparation Article in Part 3 of this specification section. Use results for system design calculations.
  - 2. Include 10 psi margin of safety for available water flow and pressure.
  - 3. Include losses through water-service piping, valves, and backflow preventers.
  - 4. Sprinkler Occupancy Hazard Classifications: As follows unless indicated otherwise:
    - a. Building Service Areas: Ordinary Hazard, Group 1.
    - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
    - c. General Storage Areas: Ordinary Hazard, Group 1.
    - d. Clean Storage: Ordinary Hazard, Group 2
    - e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
    - f. Office and Public Areas: Light Hazard.
    - g. Patient Care Rooms: Light Hazard.
    - h. Exam Rooms and Treatment Rooms: Light Hazard.
    - i. Garages-Dry System: Ordinary Hazard, Group 1.
    - j. Laboratories/Pharmacies: Ordinary Hazard, Group 1.
    - k. Hospital Patient Care Areas: Light Hazard.
    - l. Church Worship Areas: Light Hazard.
    - m. Exterior Canopies-Dry System: Ordinary Hazard, Group 1
  - 5. Minimum Flow Density (per square foot) for Closed Head Automatic-Sprinkler Piping Design, wet system unless noted otherwise, as follows:
    - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
    - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 2500- sq. ft. area.
    - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 2500- sq. ft. area.

## SECTION 21 10 00 WATER-BASED FIRE SUPPRESSION SYSTEMS

- d. Dry System, Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 3,500-sq.ft. area.
- 6. The area of operation reduction allowed by NFPA Standard 13 will not be permitted where quick response sprinkler heads are used in accordance with the provisions of this specification section.
- 7. Maximum Protection Area per Sprinkler: As follows:
  - a. Light Hazard: 225 sq. ft.
  - b. Ordinary Hazard: 130 sq. ft.
  - c. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
- B. Components and Installation: Capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.

### 1.5 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of submittals.
- B. Submit product data, flow test report and drawings with hydraulic calculations in one single package prior to installation.
- C. Product Data: For the following:
  - 1. Pipe and fitting materials and methods of joining for standpipe piping.
  - 2. Pipe and fitting materials and methods of joining for sprinkler piping.
  - 3. Pipe hangers and supports.
  - 4. Piping seismic restraints.
  - 5. Valves, including specialty valves, accessories, and devices.
  - 6. Backflow Preventers: Include pressure drop curve and maintenance and testing information.
  - 7. Alarm devices. Include electrical data.
  - 8. Air compressors. Include electrical data.
  - 9. Fire department connections. Include type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
  - 10. Hose connections. Include size, type, and finish.
  - 11. Cabinets. Include dimensions, material, and finishes.
  - 12. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
- D. Fire-Hydrant Flow Test Report: As specified in "Preparation" Article.
- E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13 and FM Global, that have been approved by authorities having jurisdiction and FM Global. Include hydraulic calculations, if applicable. Include specific locations for sprinkler, escutcheon, and cover finishes, and colors on drawings.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- G. Maintenance Data: For each type of standpipe and sprinkler specialty to include in maintenance manuals specified in Section 01 78 23 "Operation & Maintenance Data."

### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction. The field installation shall be supervised at all times by a journeyman sprinkler fitter.
- B. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer. Base calculations on requirements of "System Performance Requirements" article.
- C. The system shall be designed by a NICET Level 3 certified sprinkler designer.
- D. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those per-

## SECTION 21 10 00 WATER-BASED FIRE SUPPRESSION SYSTEMS

formed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.

- E. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.
- F. Standpipe and Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- H. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems." See also FM requirements.
  - 2. NFPA 14, "Standpipe and Hose Systems."
- I. FM Global Loss Prevention Data Sheets:
  - 1. Earthquake Protection of Water-based Fire Protection Systems.
  - 2. Fire Protection Water Demand for Nonstorage Sprinklered Properties.
  - 3. NFPA 13 Standard for the Installation of Sprinkler Systems (with FM requirements).

### 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Sprinkler Cabinets: Finished, wall-mounting steel cabinet and hinged cover, with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Specialty Valves and Devices:
    - a. Grinnell Corp.
    - b. Reliable Automatic Sprinkler Co., Inc.
    - c. Tyco Fire Products.
    - d. Viking Corp.
    - e. Victaulic Co. of America.
  - 2. Water-Flow Indicators and Supervisory Switches:
    - a. Potter Electric Signal Co.
    - b. Reliable Automatic Sprinkler Co., Inc.
    - c. Viking Corp.
    - d. Watts Industries, Inc.; Water Products Div.
  - 3. Sprinkler, Drain and Alarm Test Fittings:
    - a. Fire-End and Croker Corp.
    - b. Grinnell Corp.
    - c. Victaulic Co. of America.
  - 4. Sprinkler, Branch-Line Test Fittings:
    - a. Elkhart Brass Mfg. Co., Inc.
    - b. Fire-End and Croker Corp.
    - c. Smith Industries, Inc.; Potter-Roemer Div.
  - 5. Sprinkler, Inspector's Test Fittings:
    - a. Fire-End and Croker Corp.
    - b. G/J Innovations, Inc.
    - c. Triple R Specialty of Ajax, Inc.
  - 6. Fire Department Connections:
    - a. Elkhart Brass Mfg. Co., Inc.
    - b. Grinnell Corp.

## SECTION 21 10 00 WATER-BASED FIRE SUPPRESSION SYSTEMS

- c. Reliable Automatic Sprinkler Co., Inc.
- d. Smith Industries, Inc.; Potter-Roemer Div.
- 7. Sprinklers:
  - a. Globe Fire Sprinkler Corp.
  - b. Reliable Automatic Sprinkler Co., Inc.
  - c. Tyco Fire Products.
  - d. Viking Corp.
  - e. Victaulic Co. of America.
- 8. Hose Connections:
  - a. Fire-End and Croker Corp.
  - b. Guardian Fire Equipment, Inc.
  - c. Smith Industries, Inc.; Potter-Roemer Div.
- 9. Indicator Valves:
  - a. Grinnell Corp.
  - b. Milwaukee Valve Co., Inc.
  - c. Nibco, Inc.
  - d. Victaulic Co. of America.
- 10. Fire-Protection-Service Valves:
  - a. Grinnell Corp.
  - b. Nibco, Inc.
  - c. Victaulic Co. of America.
- 11. Backflow Preventers:
  - a. Ames Co., Inc.
  - b. Mueller Co.; Hersey Meters Div.
  - c. Watts Industries, Inc.; Water Products Div.
- 12. Couplings for Steel Piping:
  - a. Grinnell Corp.
  - b. Star Pipe Products, Inc.; Star Fittings Div.
  - c. Victaulic Co. of America.
- 13. Couplings for Ductile-Iron Piping:
  - a. Victaulic Co. of America.
- 14. Couplings for Copper Tubing:
  - a. Grinnell Corp.
  - b. Victaulic Co. of America.
- 15. Flexible Sprinkler Connection
  - a. FlexHead Industries Inc.
  - b. Panew Company Limited.
  - c. Paradise Industry Co Ltd.
- 16. Air Pressure Maintenance Devices:
  - a. Grinnell Corp.
  - b. Reliable Automatic Sprinkler Co Inc.
- 17. Water Flow Meter:
  - a. Badger Meter Inc.
  - b. Hersey Meters, Division of Mueller Group Inc.
  - c. Metron-Farnier LLC.
- 18. Hose Cabinets
  - a. Smith Industries, Inc.; Potter-Roemer Div.
- 19. Specialty Recessed Cabinets
  - a. Smith Industries, Inc.; Potter-Roemer Div.
  - b. Custom fabricated to fit application.

### 2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

### 2.3 PIPES AND TUBES

- A. Ductile-Iron Pipe: AWWA C151, mechanical-joint type; with cement-mortar lining and seal coat according to AWWA C104. Include gland, rubber gasket, and bolts and nuts according to AWWA C111.

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- B. Standard-Weight Steel Pipe: ASTM A 53, ASTM A 135, or ASTM A 795; Schedule 40 in NPS 6 and smaller, and Schedule 30 in NPS 8 and larger.
- C. Copper Tube: ASTM B 88, water tube, drawn temper.

### 2.4 PIPE AND TUBE FITTINGS

- A. Ductile-Iron Fittings: ASTM A 536, ductile-iron casting complying with AWWA pipe size; with ends factory grooved according to AWWA C606. Include cement-mortar lining and seal coat according to AWWA C104 or epoxy, interior coating according to AWWA C550.
- B. Cast-Iron Threaded Flanges: ASME B16.1.
- C. Cast-Iron Threaded Fittings: ASME B16.4.
- D. Steel, Threaded Couplings: ASTM A 865.
- E. Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.
- F. Steel Flanges and Flanged Fittings: ASME B16.5.
- G. Steel, Grooved-End Fittings: UL-listed and FM-approved, ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606.
- H. Copper, Grooved-End Fittings: ASTM B 75, copper tube or ASTM B 584, bronze castings.

### 2.5 JOINING MATERIALS

- A. Refer to Section 23 05 00 "Common Mechanical Materials and Methods" for pipe-flange gasket materials and welding filler metals.
- B. Ductile-Iron, Keyed Couplings: UL 213 and AWWA C606, for ductile-iron pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts.
- C. Ductile-Iron, Flanged Joints: AWWA C115, ductile-iron or gray-iron pipe flanges, rubber gaskets, and steel bolts and nuts.
- D. Steel, Keyed Couplings: UL 213 and AWWA C606, for steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts. Include listing for dry-pipe service for couplings for dry piping.
- E. Copper, Keyed Couplings: UL 213 and equivalent to AWWA C606, for copper-tube dimensions. Include ASTM A 536, ductile-iron housing with copper-colored enamel finish, rubber gaskets, and steel bolts and nuts.
- F. Transition Couplings: AWWA C219, sleeve type, or other manufactured fitting the same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

### 2.6 POLYETHYLENE ENCASEMENT

- A. Polyethylene Encasement for Ductile-Iron Piping: ASTM A 674 or AWWA C105, film, 0.008-inch minimum thickness, tube or sheet.

### 2.7 GENERAL-DUTY VALVES

- A. Refer to Section 23 05 23 "General-Duty Valves for Mechanical Piping" for gate, ball, butterfly, globe, and check valves not required to be UL listed and FM approved.

### 2.8 FIRE-PROTECTION-SERVICE VALVES

- A. General: UL listed and FM approved, with minimum 175-psig nonshock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.
- B. Gate Valves, NPS 2 and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.
- C. Indicating Valves, NPS 2-1/2 and Smaller: UL 1091; butterfly or ball-type, bronze body with threaded ends; and integral indicating device.
  - 1. Indicator: Electrical 115-V AC, prewired, two-circuit, supervisory switch.
- D. Gate Valves, NPS 2-1/2 and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.
- E. Indicator-Post, Gate Valves: UL 262, iron body, bronze mounted, solid-wedge disc, and nonrising stem with operating nut and flanged ends.

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- F. Wall Indicator Posts: UL 789, FM approved, horizontal, wall type, cast-iron body, with windows for target plates that indicate valve position, extension rod and coupling, locking device, hand wheel operator, and red enamel finish.
  - 1. Operation: Operating wrench.
- G. Swing Check Valves, NPS 2 and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.
- H. Swing Check Valves, NPS 2-1/2 and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.

### 2.9 SPECIALTY VALVES

- A. Alarm Check Valves: UL 193, 175-psig working pressure; designed for horizontal or vertical installation, with cast-iron flanged inlet and outlet, bronze grooved seat with O-ring seals, and single-hinge pin and latch design. Include trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
  - 1. Option: Grooved-end connections for use with keyed couplings.
  - 2. Drip Cup Assembly: Pipe drain without valves, and separate from main drain piping.
- B. Dry-Pipe Valves: UL 260; differential type; 175-psig working pressure; with cast-iron flanged inlet and outlet, bronze seat with O-ring seals, and single-hinge pin and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
  - 1. Option: Grooved-end connections for use with keyed couplings.
  - 2. Air Compressor: Fractional horsepower, 120-V ac, 60 Hz, single phase.
- C. Pre-Action Valves: UL 260, cast-iron body, 175-psig working pressure; hydraulically operated, differential-pressure type. Include flanged inlet and outlet, bronze seat with O-ring seals, trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
  - 1. Option: Grooved-end connections for use with grooved-end piping.
  - 2. Air Compressor: Fractional horsepower, 120-V ac, 60 Hz, single phase.
- D. Pressure-Regulating Valves: UL 1468, 400-psig minimum rating, brass. Include NPS 1-1/2 or NPS 2-1/2, female NPS inlet and outlet; adjustable setting feature; and straight or 90-degree angle pattern design as indicated.
- E. Ball Drip Valves: UL 1726, automatic drain valve, NPS 3/4, ball check device with threaded ends.

### 2.10 SPRINKLERS

- A. Automatic Sprinklers: With heat-responsive glass-bulb element complying with the following:
  - 1. UL 199, for applications except residential.
  - 2. UL 1767, for early suppression, fast-response applications.
  - 3. FM Global Approved.
- B. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, quick response, glass-bulb type, unless otherwise indicated or required by application.
  - 1. Open Sprinklers: UL 199, without heat-responsive element.
    - a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
    - b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.
- C. Sprinkler types, features, and options include the following:
  - 1. Concealed ceiling sprinklers, including cover plate.
  - 2. Extended-coverage sprinklers.
  - 3. Flush ceiling sprinklers, including escutcheon.
  - 4. Institution sprinklers, made with small, breakaway projection.
  - 5. Open sprinklers.
  - 6. Pendent sprinklers.
  - 7. Pendent, dry-type sprinklers.
  - 8. Recessed sprinklers, including escutcheon.
  - 9. Sidewall sprinklers.

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10. Sidewall, dry-type sprinklers.
  11. Upright sprinklers.
  - D. Sprinkler Finishes: White at suspended white acoustical ceilings. Chrome-plated, and rough bronze at all other locations.
  - E. Special Coatings: Wax and corrosion-resistant paint.
  - F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
    1. Ceiling Mounting:
      - a. Factory painted or approved equal, two piece, with 1/2-inch to 3/4-inch vertical adjustment.
      - b. Chrome-plated steel, two piece, with 1/2-inch to 3/4-inch vertical adjustment.
    2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
  - G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.
- 2.11 SPECIALTY SPRINKLER FITTINGS
- A. Specialty Fittings: UL listed and FM approved; made of steel, ductile iron, or other materials compatible with piping.
  - B. Pre-Action and Dry-Pipe System Fittings: UL listed for dry-pipe service.
  - C. Press-Seal Fittings: UL 213, steel housing with butylene O-rings and pipe stop.
  - D. Locking-Lug Fittings: UL 213, ductile-iron body with locking-lug ends.
  - E. Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.
  - F. Sprinkler, Drain and Alarm Test Fittings: UL-listed, cast- or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.
  - G. Sprinkler, Branch-Line Test Fittings: UL-listed, brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.
  - H. Sprinkler, Inspector's Test Fittings: UL-listed, cast- or ductile-iron housing; with threaded inlet and drain outlet and sight glass.
- 2.12 FLEXIBLE SPRINKLER CONNECTION
- A. Maximum temperature rating of flexible connection shall be 300°F. Maximum working pressure of flexible connection shall be no greater than 200 psi. Test pressure of flexible connection is 1000 psi. Flexible connection shall have a 1" NPT male thread. Minimum bend radius shall be 3". Maximum bends per hose shall not exceed 3 bends. Flexible sprinkler connection shall be provided with sprinkler support and bracket & Clip Assembly.
- 2.13 HOSE CONNECTIONS
- A. Description: UL 668, 300-psig minimum pressure rating, brass, hose valve for connecting fire hose. Include 90-degree angle pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include NPS 2-1/2 as required by authority having jurisdiction, and hose valve threads according to NFPA 1963 and matching local fire department threads.
    1. Valve Operation: Nonadjustable type, unless pressure-regulating type is indicated.
    2. Finish: Rough chrome-plated.
    3. Mountings: Pipe escutcheon for cabinet-mounted units.
    4. Cabinet: Recessed, 20 gauge steel construction with steel reinforcement, white glossy polyester coated, 20 gauge tubular steel door with 18 gauge frame with continuous steel hinge with brass pin, and, glass insert. Provide pipe escutcheons for pipe penetrations of cabinet.
- 2.14 RECESSED CABINETS
- A. Recessed, 20 gauge steel construction with steel reinforcement, white glossy polyester coated, and 20 gauge tubular steel door with 18 gauge frame, continuous steel hinge with brass pin, and glass insert. Size of cabinet to accommodate sprinkler zone valve assembly, and hose connection where indicated. Provide pipe escutcheons for pipe penetrations of cabinet.

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### 2.15 FIRE DEPARTMENT CONNECTIONS

- A. Exposed, Freestanding, Fire Department Connections: UL 405, cast-brass body, inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, and bottom outlet with pipe threads. Include brass, lugged caps, gaskets, and brass chains; brass, lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round, floor, brass, escutcheon plate with marking "AUTO SPKR & STANDPIPE."
  - 1. Finish Including Sleeve: Polished chrome-plated.
- B. Wall, Fire Department Connections: UL 405; cast-brass body with brass, wall, escutcheon plate; brass, lugged caps with gaskets and brass chains; and brass, lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking "AUTO SPKR & STANDPIPE."
  - 1. Type: Exposed; projecting mounting.
  - 2. Escutcheon Plates: Rectangular.
  - 3. Finish: Polished chrome-plated.

### 2.16 ALARM DEVICES

- A. General: Types matching piping and equipment connections.
- B. Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 250-psig pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- C. Pressure Switches: UL 753; electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
- D. Valve Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
- E. Indicator-Post Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

### 2.17 PRESSURE GAGES

- A. Pressure Gages: UL 393, 3-1/2- to 4-1/2-inch- diameter dial with dial range of 0 to 250 psig.

### 2.18 BACKFLOW PREVENTERS

- A. General: ASSE standard, backflow preventers.
  - 1. NPS 2-1/2 (DN 65) and Larger: Bronze, cast-iron, steel, or stainless steel body with flanged ends.
    - a. Interior Lining: AWWA C550 or FDA approved, epoxy coating for back-flow preventers having cast-iron or steel body.
  - 2. Interior Components: Corrosion-resistant materials.
  - 3. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
  - 4. Strainer: On inlet, if indicated.
- B. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article in Part 1 of this Section.
- B. Report test results promptly and in writing.

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### 3.2 EARTHWORK

- A. Refer to Division 31 for excavating, trenching, and backfilling.

### 3.3 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.4 PIPING APPLICATIONS

- A. Do not use welded joints with galvanized steel pipe.
- B. Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- C. Piping between Fire Department Connections and Check Valves: Use galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
- D. Underground Service-Entrance Piping: Use ductile-iron, grooved-end pipe and fittings; ductile-iron, keyed couplings; and grooved joints.
- E. Service-Entrance Piping Inside Building: If backflow preventer is not within 5 feet of underground service-entrance piping, use Type K hard drawn copper tubing upstream of backflow preventer. Do not use steel pipe on municipal water system upstream of backflow preventer.
- F. Wet Standpipes: Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
- G. Wet-Pipe Sprinklers: Use the following:
  - 1. NPS 1-1/2 and Smaller: Standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints.
  - 2. NPS 2: Standard-weight steel pipe with plain ends, locking-lug fittings, and twist-locked joints.
  - 3. NPS 2: Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
  - 4. NPS 2-1/2 and Larger: Galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
- H. Dry-Pipe Sprinklers: Use the following:
  - 1. NPS 1-1/2 and Smaller: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.
  - 2. NPS 2 and Larger: Galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
- I. Dry-Pipe, and Preaction Sprinklers: Use the following:
  - 1. NPS 1-1/2 and Smaller: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.
  - 2. NPS 2: Galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
  - 3. NPS 2-1/2 and Larger: Galvanized, standard weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

### 3.5 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13 and NFPA 14.
    - a. Shutoff Duty: Use gate valves.
  - 2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13 and NFPA 14.
    - a. Shutoff Duty: Use gate, ball, or butterfly valves.

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### 3.6 JOINT CONSTRUCTION

- A. Refer to Section 23 05 00 "Common Mechanical Materials and Methods" for basic piping joint construction.
- B. Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
- C. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.
- D. Copper-Tubing, Grooved Joints: Use copper tube with roll-grooved ends; copper, grooved-end fittings; and copper, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.
- E. Twist-Locked Joints: Follow fitting manufacturer's written instructions.
- F. Dissimilar-Piping-Material Joints: Construct joints using adapters or couplings compatible with both piping materials. Use dielectric fittings if both piping materials are metal. Refer to Section 23 05 00 "Common Mechanical Materials and Methods" for dielectric fittings.

### 3.7 SERVICE-ENTRANCE PIPING

- A. Connect standpipe and sprinkler piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 33 for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

### 3.8 PIPING INSTALLATION

- A. Refer to Section 23 05 00 "Common Mechanical Materials and Methods" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Install underground service-entrance piping according to FM Global and NFPA 24 and with restrained joints.
- D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- G. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to FM Global and NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install drain valves on standpipes.
- K. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- L. Install alarm devices in piping systems.
- M. Hangers and Supports: Comply with FM Global and NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping and to FM Global and NFPA 14 for standpipes.
- N. Earthquake Protection: Install piping according to FM Global and NFPA 13 to protect from earthquake damage.
- O. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.

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- P. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- 3.9 FLEXIBLE SPRINKLER CONNECTION
- A. Flexible sprinkler connections shall not be used above non-accessible ceilings.
  - B. Maximum bends per hose shall not exceed 3 bends.
  - C. Attach sprinkler support and bracket & clip assembly per manufacturer's installation instructions.
- 3.10 SPECIALTY SPRINKLER FITTING INSTALLATION
- A. Install specialty sprinkler fittings according to manufacturer's written instructions.
- 3.11 VALVE INSTALLATION
- A. Refer to Section 23 05 23 "General-Duty Valves for Mechanical Piping" for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to FM Global, NFPA 13 and NFPA 14, manufacturer's written instructions, and authorities having jurisdiction.
  - B. Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.
  - C. Valves for Wall Fire Hydrants: Install gate valve with nonrising stem in supply pipe.
  - D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
  - E. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain-line connection.
  - F. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
    - 1. Air-Pressure Maintenance Devices for Dry-Pipe Systems: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
    - 2. Install air compressor and compressed-air supply piping.
  - G. Pre-Action Valves: Install in vertical position, in proper direction of flow, in main supply to deluge system.
- 3.12 SPRINKLER APPLICATIONS
- A. General: Use sprinklers according to the following applications:
    - 1. Rooms without Ceilings: Upright sprinklers or as indicated. Provide head guards on sprinkler heads installed below ductwork, and within 8 feet of finished floor.
    - 2. Rooms with Suspended Ceilings: Recessed sprinklers or as indicated.
    - 3. Wall Mounting: Recessed horizontal sidewall sprinklers or as indicated.
    - 4. Spaces Subject to Freezing Served by Wet-Pipe System: Dry-pendent type and/or dry-sidewall type sprinklers.
    - 5. Sprinkler Finishes: Use sprinklers with the following finishes:
      - a. Upright, Pendent, and Sidewall Sprinklers: Chrome-plated heads in finished spaces exposed to view; rough bronze heads in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
      - b. Concealed Sprinklers: Rough brass heads, with factory-painted or approved equal, cover plate to match adjacent surface color. Refer to architectural reflected ceiling plans and specifications.
      - c. Recessed Sprinklers: White heads at suspended white acoustical ceiling. Bright chrome heads, with white or special color, factory-painted or approved equal, escutcheon to match adjacent surface or ceiling grid color. Refer to architectural reflected ceiling plans and specifications.

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### 3.13 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space or dry sprinkler system.

### 3.14 HOSE-CONNECTION INSTALLATION

- A. Install hose connections adjacent to standpipes in recessed cabinets, unless otherwise indicated. Pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose.

### 3.15 SPRINKLER ZONE VALVE ASSEMBLY INSTALLATION

- A. Install sprinkler zone valve and test assembly adjacent to combination standpipe and drain pipe in recessed cabinets, unless otherwise indicated. Pipe escutcheons, with finish matching valves, inside cabinet where water-supply and drain piping penetrates cabinet. Cabinet will also include fire hose connection. Install valves at angle required for connection of fire hose.

### 3.16 CONNECTIONS

- A. Connect water-supply piping and standpipes and sprinklers to fire pumps. Include back-flow preventers.
- B. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- C. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- D. Electrical Connections: Power wiring is specified in Division 26.
- E. Connect alarm devices to fire alarm.
- F. Connect compressed-air supply to dry-pipe sprinkler and preaction sprinkler piping.
- G. Connect air compressor to the following piping and wiring:
  - 1. Pressure gages and controls.
  - 2. Electrical power system.
  - 3. Fire alarm system devices, including low-pressure alarm.

### 3.17 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 and in Section 23 05 53 "Identification for Mechanical Piping and Equipment."

### 3.18 FIELD QUALITY CONTROL

- A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.
- B. Flush, test, and inspect standpipes according to NFPA 14, "Tests and Inspection" Chapter.
- C. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- D. Report test results promptly and in writing to Architect and Authorities Having Jurisdiction.

### 3.19 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers having paint other than factory finish.

### 3.20 PROTECTION

- A. Protect sprinklers from damage until Substantial Completion.

### 3.21 START-UP PROCEDURES

- A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that air compressors and their accessories are installed and operate correctly.
- C. Verify that specified tests of piping are complete.

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- D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application and location.
- F. Verify that potable-water supplies have correct types of backflow preventers.
- G. Drain dry-pipe and pre-action sprinkler piping.
- H. Pressurize and check dry-pipe sprinkler piping air-pressure maintenance devices and air compressors.
- I. Verify that hose connections and fire department connections have threads compatible with local fire department equipment.
- J. Fill wet-pipe sprinkler piping with water.
- K. Fill standpipes with water.
- L. Verify that hose connections are correct type and size.
- M. Energize circuits to electrical equipment and devices.
- N. Start and run air compressors.
- O. Adjust operating controls and pressure settings.
- P. Coordinate with fire alarm tests. Operate as required.

### 3.22 DEMONSTRATION

- A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.
- B. Schedule demonstration with Owner with at least seven days' advance notice.

END OF SECTION



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 21 10 00 Section "Water-Based Fire-Suppression Systems" for feed-main, fire-suppression piping at fire pumps.
  - 2. Section 28 31 00 "Fire Detection and Alarm" for connection to alarm panel.
  - 3. Division 26 Sections for power and connections to fire-pump and pressure-maintenance-pump controllers.

1.2 SUMMARY

- A. This Section includes electric-drive, centrifugal fire pumps for building fire-suppression systems and the following:
  - 1. In-line fire pumps.
  - 2. Pressure-maintenance pumps.
  - 3. Full-service, fire-pump controllers.
  - 4. Automatic transfer switches.
  - 5. Pressure-maintenance-pump controllers.
  - 6. Fire-pump specialties and accessories.
  - 7. Pressure-maintenance-pump specialties and accessories.
  - 8. Alarm panels.
  - 9. Flow-measuring systems.

1.3 DEFINITIONS

- A. Fire Pump: Horizontal-type fire pump used to supply water at rated capacity and total head required for fire-suppression service.
- B. Fire-Pump Unit: Assembly with fire pump, driver, controller, and related accessories.
- C. In-Line Fire Pump: Radially split-case, horizontal fire pump with drive unit supported by pump, suction and discharge flanges on same centerline, and pump shaft in vertical position.
- D. Pressure-Maintenance Pump: Electric-drive pump used to maintain water pressure in fire-suppression piping system.
- E. Pressure-Maintenance-Pump Unit: Assembly with pressure-maintenance pump, driver, controller, and related accessories.
- F. Split-Case Fire Pump: Axially split-case, horizontal fire pump with its housing split parallel to shaft.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Fire-Pump Systems: Fire-pump and pressure-maintenance-pump units that comply with performance requirements specified and are compatible with building fire-suppression systems.
- B. Pump, Equipment, Accessory, and Piping Pressure Rating: 175-psig minimum working-pressure rating, unless higher rating is indicated.

1.5 SUBMITTALS

- A. General: See Section 01 33 00 "Submittal Procedures" for general requirements of submittals. Product data, shop drawings, and product certificates shall also be submitted to FM Global for review and approval.
- B. Product Data: Provide submittals of the following:
  - 1. Fire Pump Unit.
  - 2. In-line fire pumps.
  - 3. Pressure-maintenance pumps.
  - 4. Full-service, fire-pump controllers.
  - 5. Automatic transfer switches.
  - 6. Pressure-maintenance-pump controllers.
  - 7. Fire-pump specialties and accessories.

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8. Pressure-maintenance-pump specialties and accessories.
9. Alarm panels.
10. Flow-measuring systems.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection for each fire-pump and pressure-maintenance-pump unit.
  1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
  2. Shop Drawings may be incorporated into other Section 21 10 00 fire-suppression piping system Shop Drawings.
- D. Product Certificates: Signed by manufacturers of fire pumps and fire-pump controllers certifying that products furnished comply with requirements.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. Maintenance Data: For each fire-pump and pressure-maintenance-pump unit to include in maintenance manuals specified in Section 01 77 00 "Closeout Procedures."

### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms whose fire pumps, pressure-maintenance pumps, drivers, controllers, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with requirements indicated.
- B. Source Limitations: Obtain fire-pump and pressure-maintenance-pump units through one source with responsibility and accountability to respond to and resolve problems regarding compatibility, installation, performance, and acceptance of units. Pumps shall be accepted by FM Global.
- C. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of fire-pump and pressure-maintenance-pump units and are based on specific models indicated. Other manufacturers' pump units with equal performance characteristics may be considered.
- D. Provide listing/approval stamp, label, or other marking on equipment made to specified standards.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- F. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.
- G. Comply with NFPA 20, "Centrifugal Fire Pumps," for fire pumps, drivers, controllers, accessories, and installation.
- H. Comply with FM Global:
  1. FM 3-7n Data Sheet – Stationary Pumps for Fire Protection.
  2. FM 3-7 Operating Standard Fire Protection Pumps.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Shipping: After assembling and testing fire pumps and pressure-maintenance pumps, protect flanges and exposed machined metal surfaces, pipe openings, and nozzles.
- B. Retain shipping flange protective covers and protective coatings during storage.
- C. Protect bearings and couplings against damage from sand, grit, or other foreign matter.

## 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Single-Stage, Vertically Mounted, Split-Case Fire Pumps:
    - a.

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- b. Armstrong Inc.
- c. Fairbanks Morse Pump Corp.
- d. General Signal Pump Group; Aurora Pump Unit.
- e. ITT Fluid Technology Corp.; ITT A-C Pump Unit.
- f. Patterson Pump Co.
- g. Reddy-Buffaloes Pump, Inc.
2. Fire-Pump Controllers:
  - a. Cutler Hammer Inc.
  - b. Firetrol, Inc.
  - c. Hubbell Industrial Controls, Inc.
  - d. Joslyn Clark Controls, Inc.
  - e. Master Control Systems, Inc.
  - f. Metron, Inc.
3. Pressure-Maintenance-Pump Controllers:
  - a. Cutler Hammer Inc.
  - b. Firetrol, Inc.
  - c. Hubbell Industrial Controls, Inc.
  - d. Joslyn Clark Controls, Inc.
  - e. Master Control Systems, Inc.
  - f. Metron, Inc.
4. Alarm Panels:
  - a. Firetrol, Inc.
  - b. Hubbell Industrial Controls, Inc.
  - c. Joslyn Clark Controls, Inc.
  - d. Master Control Systems, Inc.
  - e. Metron, Inc.
5. Flow-Measuring Systems:
  - a. Dieterich Standard Corp.
  - b. Gerand Engineering Co.
  - c. Hyspan Precision Products, Inc.
  - d. Preso Industries, Ltd.
  - e. Reddy-Buffaloes Pump, Inc.
  - f. Scott Fetzer Co.; Meriam Instrument Div.
  - g. Victaulic Company of America.

2.2 FIRE PUMP UNITS

- A. Description: FM Global accepted and UL rated pump package mounted on structural steel frame. Unit includes fire pump, fire pump controller and transfer switch, pressure maintenance pump (Jockey Pump), pressure maintenance pump controller, gauges, fire pump accessories and specialties.

2.3 SPLIT-CASE FIRE PUMPS

- A. Single-Stage, Vertically Mounted, Split-Case Fire Pumps: FM Global and UL 448, factory-assembled and -tested, electric-drive, double-suction, vertical type. Include pump mounted on baseplate and connected to driver with coupling.
  1. Characteristics: Capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head. Shutoff head is limited to 140 percent of total rated head.
  2. Casing: Axially split cast iron with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless Class 250 flanges are indicated.
  3. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
  4. Wear Rings: Replaceable, bronze.
  5. Shaft and Sleeve: Steel shaft with bronze sleeve.
  6. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
  7. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

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8. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
9. Driver: Electric motor.
10. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
11. Nameplate: Complete with capacities, characteristics, and other pertinent data.

### 2.4 PUMP DRIVERS

- A. Description: NEMA MG 1, open-dripproof, squirrel-cage, induction motor. Include construction complying with NFPA 20 and NFPA 70, and include wiring compatible with controller used.
  1. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
  2. Nameplate: Complete with motor horsepower, characteristics, and other pertinent data.

### 2.5 PUMP CONTROLLERS, GENERAL

- A. Description: Combined automatic and nonautomatic operation; factory assembled and wired; factory tested for capacities and electrical characteristics; and with the following features:
  1. Enclosure: UL 50, Type 2, dripproof, indoor, unless special-purpose enclosure is indicated.
  2. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed for each controller type.
  3. Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.
  4. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous-metal sensing piping, NPS 1/2, with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32-inch orifice in clapper or ground-face union with noncorrosive diaphragm having 3/32-inch orifice.

### 2.6 FULL-SERVICE, FIRE-PUMP CONTROLLERS

- A. Description: FM Global, UL 218, and NFPA 20; listed for electric-drive, fire-pump service and service entrance.
  1. Type Starting: Across the line.
- B. Rate controllers for scheduled horsepower. Include short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.
- C. Automatic Transfer Switches: UL 218 and UL 1008 and requirements for and attached to fire-pump controllers. Include enclosure complying with UL 50, Type 2, with automatic transfer switch with rating at least equal to fire-pump driver-motor horsepower. Include ampere rating not less than 115 percent of motor full-load current and suitable for switching motor-locked rotor current.
- D. Controllers: As follows:
  1. Isolating means and circuit breaker.
  2. "Power on" pilot lamp.
  3. Fire alarm system connections for indicating motor running condition, loss-of-line power, and line-power phase reversal.
  4. Automatic and manual operation, and minimum run-time relay to prevent short cycling.
  5. Water-pressure-actuated switch with independent high and low calibrated adjustments responsive to water pressure in fire-suppression system.
  6. Automatic and manual shutdown.
  7. System pressure recorder, electric ac driven with spring backup.
  8. Mounting: Wall type for field electrical connections.
  9. Mounting: Floor-stand type for field electrical connections.

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10. Enclosure Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.

### 2.7 PRESSURE-MAINTENANCE-PUMP CONTROLLERS

- A. Description: UL 508; factory-assembled, -wired, and -tested across-the-line type for combined automatic and nonautomatic operation.
  1. Enclosure: UL 508 and NEMA 250, Type 2, wall-mounting type for field electrical wiring.
- B. Rate controller for scheduled horsepower and include the following:
  1. Fusible disconnect switch.
  2. Pressure switch.
  3. Hand-off-auto selector switch.
  4. Pilot light.
  5. Running period timer.
  6. Enclosure Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.

### 2.8 FIRE-PUMP SPECIALTIES AND ACCESSORIES

- A. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:
  1. Automatic air-release valve.
  2. Circulation relief valve.
  3. Suction and discharge pressure gages.
  4. Eccentric-tapered reducer at suction inlet.
  5. Concentric-tapered reducer at discharge outlet.
  6. Test-Header Manifold: Exposed, Freestanding, ductile-iron or brass body for hose valves. Include nozzle outlets arranged in single line; horizontal and rectangular, brass escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
    - a. Escutcheon Plate Finish: Polished chrome-plated.
  7. Hose Valves: UL 668, straightway pattern, bronze with cap and chain. Include NFPA 1963 hose thread that complies with local fire department standards and finish same as for test-header-manifold escutcheon plate.
  8. Ball Drip Valve: UL 1726.
  9. Main Relief Valve: UL 1478, pilot operated.
  10. Discharge Cone: Closed.
  11. Finish: Manufacturer's standard factory-applied red paint, unless brass or other finish is specified.

### 2.9 PRESSURE-MAINTENANCE-PUMP SPECIALTIES AND ACCESSORIES

- A. Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:
  1. Circulation relief valve.
  2. Suction and discharge pressure gages.

### 2.10 ALARM PANELS

- A. Description: Factory-assembled and -wired remote panel complying with UL 508 and requirements in NFPA 20. Include audible and visible alarms matching controller type.
  1. Enclosure: NEMA 250, Type 2, remote wall-mounting type.
  2. Enclosure Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
- B. Features: Include manufacturer's standard features and the following:
  1. Motor-operating condition.
  2. Loss-of-line power.
  3. Phase reversal.

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### 2.11 FLOW-MEASURING SYSTEMS

- A. Description: FM-approved, fire-pump, flow-measuring systems that indicate flow to not less than 175 percent of fire-pump rated capacity. Include sensor of size to match pipe, tubing, flow meter, and fittings.
  - 1. Pressure Rating: 175 psig minimum.
  - 2. Sensor: Venturi, annular probe, or orifice plate, unless otherwise indicated.
  - 3. Flow Meter: Compatible with flow sensor with dial not less than 4-1/2 inches in diameter or manufacturer's equivalent size.
  - 4. Permanently Mounted: Flow meter suitable for wall mounting with copper tubing to connect to flow sensor.
  - 5. Include complete operating instructions.

### 2.12 SOURCE QUALITY CONTROL

- A. Factory Tests: Hydrostatically test and test run fire pumps before shipping. Test at 150 percent of shutoff head plus suction head, but not less than 250 psig. Produce certified test curves showing head capacity and brake horsepower of each pump.

### 2.13 GROUT

- A. Description: ASTM C 1107, Grade B, factory-mixed and -packaged nonshrink and non-metallic grout; suitable for interior and exterior applications.
- B. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout.
- C. Properties: Nonstaining, noncorrosive, and nongaseous.
- D. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting fire-pump performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine roughing-in of fire-suppression piping systems. Verify actual locations of piping connections before pump installation.

### 3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for fire pump unit, fire pumps, pressure-maintenance pumps, and controllers. Refer to Section 03 30 00 "Cast-in-Place Concrete" and Section 23 05 00 "Common Mechanical Materials and Methods."

### 3.3 INSTALLATION

- A. Comply with fire-pump, pressure-maintenance-pump, and controller manufacturers' written installation and alignment instructions, FM Global and with NFPA 20.
- B. Install pumps and controllers to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Set base-mounting-type pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
  - 1. Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near foundation bolts to provide 3/4- to 1-1/2-inch gap between pump base and foundation for grouting.
  - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and pump suction and discharge flanges to verify that they are level and plumb.
- D. Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles.
- E. Install valves that are the same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.
- F. Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.
- G. Support pumps and piping separately so weight of piping does not rest on pumps.

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- H. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.
- I. Install flow meters and sensors where indicated. Install flow-measuring-system components and make connections according to manufacturer's written instructions.
- J. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram Submittals to electrical Installer.
  - 1. Verify that electrical wiring is installed according to manufacturers' submittal and installation requirements in Division 26 Sections. Proceed with equipment start-up only after wiring installation is satisfactory.

### 3.4 ALIGNMENT

- A. Align fire-pump and driver shafts after complete unit has been leveled on foundation, grout has set, and foundation bolts have been tightened.
- B. After alignment is correct, tighten foundation bolts evenly but not too firmly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten foundation bolts after grout has hardened. Check alignment and make required corrections.
- C. Make piping connections, check alignment, and make required corrections.
  - 1. Adjust alignment of pump and driver shafts for angular and parallel alignment by one method in HI 1.1-1.5, Section 1.4, "Installation, Operation and Maintenance."
  - 2. Alignment Tolerances: Comply with manufacturer's written instructions.
- D. Align vertically mounted, split-case pump and driver shafts after complete unit has been made plumb on foundation, grout has set, and foundation bolts have been tightened. Follow pump manufacturer's written instructions.

### 3.5 CONNECTIONS

- A. Piping installation requirements are specified in Section 21 10 00. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
  - 1. Install piping adjacent to fire and pressure-maintenance pumps to allow service and maintenance.
  - 2. Connect water supply to fire and pressure-maintenance pumps.
  - 3. Connect fire-pump and pressure-maintenance-pump discharge piping to building fire-suppression piping.
  - 4. Connect relief-valve discharge to point of disposal.
- B. Connect flow-measuring-system meters and sensors according to manufacturer's written instructions.
- C. Connect fire-pump controllers to building fire alarm system. Refer to Section 28 31 00 "Fire Detection and Alarm."
- D. Connect controllers to pumps.
- E. Electrical wiring and connections are specified in Division 26 Sections.
- F. Ground equipment.
  - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including fire-pump and pressure-maintenance-pump units, piping, and electrical connections. Report results in writing.
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Check suction line connections for tightness so no air gets into pumps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

SECTION 21 31 13 ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

5. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Fire hoses are for field-acceptance tests only and are not property of Owner.
  6. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:
    - a. Lubricate oil-lubrication-type bearings.
    - b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
    - c. Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
    - d. Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.
  7. Starting procedure for pumps is as follows:
    - a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.
    - b. Open sealing liquid supply valves if pump is so fitted.
    - c. Start motor.
    - d. Open discharge valve slowly.
    - e. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately but let packing run in before reducing leakage through stuffing boxes.
    - f. Check general mechanical operation of pump and motor.
- B. Perform field tests for each fire-pump unit and system piping when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire-pump unit performs as indicated. Report test results in writing.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units as specified below:
  1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining units.
  2. Review data in maintenance manuals. Refer to Section 01 78 23 "Operation & Maintenance Data."
  3. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION

## SECTION 22 11 16 WATER DISTRIBUTION PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 33 for exterior water service piping and water meters.
  - 2. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hangers and seismic restraints.
  - 3. Section 23 07 13 "Pipe Insulation for Mechanical Systems" for pipe insulation requirements.
  - 4. Section 23 05 19 "Meters and Gages for Mechanical Piping" for thermometers, pressure gages, and fittings.
  - 5. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for seismic restraint of pipe.
  - 6. Section 22 11 19 "Water Distribution Piping Specialties" for water distribution piping specialties.
  - 7. Section 22 11 23 "Plumbing Pumps" for connections.
  - 8. Section 22 33 00 "Domestic Water Heaters" for connections to water heater.

#### 1.2 SUMMARY

- A. This Section includes water distribution piping from locations indicated to fixtures and equipment inside building.

#### 1.3 DEFINITIONS

- A. Service Entrance Piping: Water piping at entry into building between facility water distribution piping and domestic water piping.
- B. Domestic Water Piping: Water piping inside building that conveys potable water to fixtures and equipment throughout the building.
- C. Non-Potable Water Piping: Water piping inside building that conveys non-potable water to fixtures and equipment throughout the building.

#### 1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
  - 1. Water Distribution Piping: 125 psig.

#### 1.5 SUBMITTALS

- A. General: See Section 23 05 00 "Common Mechanical Materials and Methods for Mechanical" for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals for the following:
  - 1. Soft copper tubing.
  - 2. Hard copper tubing.
  - 3. Ductile-iron pipe.
  - 4. Pipe and tube fittings.
- C. Reports and Certificates: Provide submittals of the following:
  - 1. Test Reports specified in "Field Quality Control."
- D. Shop Drawings: None required.

#### 1.6 QUALITY ASSURANCE

- A. Provide listing/approval stamp, label, or other marking on piping made to specified standards.
- B. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
- C. Comply with ANSI/NSF 61, "Drinking Water System Components--Health Effects," Sections 1 through 9 for potable-water piping and components.

## SECTION 22 11 16 WATER DISTRIBUTION PIPING

### PART 2 - PRODUCTS

#### 2.1 PIPE AND TUBE MATERIALS

- A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.
- B. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
- C. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
- D. Ductile-Iron Pipe: AWWA C151, 250-psig minimum pressure rating with mechanical-joint bell, plain spigot end, and AWWA C104 cement-mortar lining. Include AWWA C111 ductile-iron gland, rubber gasket, and steel bolts.

#### 2.2 PIPE AND TUBE FITTINGS

- A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.
- B. Copper, Solder-Joint Pressure Fittings: ASME B16.18 cast-copper alloy or ASME B16.22 wrought copper.
- C. Copper, Grooved-End Fittings shall be Victaulic full flow copper fittings with grooved ends. Standard fittings shall be copper per ASTM B-75 alloy C12200; bronze and cast per ASTM B-584 copper alloy CDA 836 per ANSI B16.18.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- E. Copper Unions: ASME B16.18, cast-copper-alloy, hexagonal-stock body with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends. Include threads conforming to ASME B1.20.1 on threaded ends.
- F. Ductile-Iron, Mechanical-Joint Fittings: AWWA C110, ductile- or gray-iron standard pattern; with 250-psig minimum pressure rating and AWWA C104 cement-mortar lining. Include AWWA C111 ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- G. Ductile-Iron Flanged Fittings: AWWA C110, ductile- or gray-iron standard pattern; with 250-psig minimum pressure rating and AWWA C104 cement-mortar lining.

#### 2.3 JOINING MATERIALS

- A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.
- B. Refer to Section 23 05 00 "Common Mechanical Materials and Methods for Mechanical" for commonly used joining materials.
- C. Solder: ASTM B 32, Alloy Sn95, Sn94, or E; lead free.
- D. Brazing Filler Metal: AWS A5.8, BCuP, copper phosphorus or BA9, silver classification.
- E. Copper keyed couplings shall have angle bolt pads and shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12 with a copper color alkyd enamel paint coating, Style 606 as manufactured by Victaulic Company of America. Couplings rated to 300 psi. Gaskets shall be flush-seal style Grade 'F'. FPDM compound molded of materials conforming to ASTM B-2000, UL/ULC classified to ANSI/NSF 61 for cold and hot potable water service.
- F. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

#### 2.4 POLYETHYLENE ENCASUREMENT

- A. Polyethylene Encasement for Piping: ASTM A 674 or AWWA C105 polyethylene film, 0.008-inch minimum thickness, tube or sheet.

#### 2.5 VALVES

- A. Refer to Section 23 05 23 "General-Duty Valves for Mechanical Piping" for general-duty valves.
- B. Refer to Section 22 13 19 "Drainage Piping Specialties" for special-duty valves.

### PART 3 - EXECUTION

#### 3.1 EXCAVATION

- A. Refer to Division 31 Section for excavating, trenching, and backfilling.

## SECTION 22 11 16 WATER DISTRIBUTION PIPING

### 3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Underground, Service Entrance Piping: Do not use valves underground. Use the following:
  - 1. 4-Inch NPS and Smaller: Soft copper tube, Type K; copper, solder-joint pressure fittings; and brazed joints.
  - 2. 6- to 12-Inch NPS: Ductile-iron pipe and fittings, and mechanical joints.
- D. Aboveground, Domestic Water Piping: Use the following:
  - 1. 4-Inch NPS and Smaller: Hard copper tube, Type L; copper, solder-joint fittings; and soldered joints.
  - 2. The Victaulic Copper Groove Piping System may be used on 2-1/2 – 4-inch Type L copper. System consists of mechanical couplings with angular bolt pads with flush-seal style gaskets, UL classified in accordance with ANSI/NSF 61, copper or cast bronze fittings with grooved ends. Install per latest edition of the Manufacturer's Installation Instruction Handbook.
  - 3. 6 to 12-Inch NPS: Hard copper tube, Type L with grooved ends; copper, grooved-end fittings. Install per manufacturers recommendations.
- E. Underground, Domestic Water Piping: Do not use flanges or valves underground. Use the following:
  - 1. 2-Inch NPS and Smaller: Soft copper tube, Type K; wrought-copper, solder-joint pressure fittings; and brazed joints.
- F. Non-Potable-Water Piping: Use the following:
  - 1. 4-Inch NPS and Smaller: Hard copper tube, Type L; solder-joint pressure fittings; and brazed joints.
  - 2. 6 to 12-Inch NPS: Hard copper tube, Type L with grooved ends; copper, grooved-end fittings; and copper, keyed couplings.

### 3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Shutoff Duty: Use gate, ball, or butterfly valves. Grooved-end butterfly valves may be used with grooved-end piping.
  - 2. Balancing: Use circuit balancing valve.

### 3.4 PIPING INSTALLATION, GENERAL

- A. Refer to Section 23 05 00 " Common Mechanical Materials and Methods for Mechanical " for basic piping installation.

### 3.5 SERVICE ENTRANCE PIPING INSTALLATION

- A. Extend service entrance piping to exterior water service piping five feet outside the building in sizes and locations indicated for service entrances into building.
- B. Install shutoff valve, hose-end drain valve, strainer and pressure gage inside building at first accessible point for each service entrance pipe.
- C. Ductile-Iron, Service Entrance Piping: Comply with AWWA C600. Install buried piping between shutoff valve and connection to water service piping with restrained joints. Anchor pipe to wall or floor at entrance. Include thrust-block supports at vertical and horizontal offsets.
  - 1. Encase piping with polyethylene film according to ASTM A 674 or AWWA C105.
- D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service entrance pipe penetration through exterior wall. Select number of interlocking rubber links required to make installation watertight. Refer to Section 23 05 00 " Common Mechanical Materials and Methods for Mechanical " for sleeves and mechanical sleeve seals.

### 3.6 DOMESTIC WATER PIPING INSTALLATION

- A. Install piping with 0.25 percent slope downward toward drain.

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3.7 JOINT CONSTRUCTION

- A. Refer to Section 23 05 00 " Common Mechanical Materials and Methods for Mechanical " for basic piping joint construction.
- B. Grooved Joints: Assemble joints with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.8 VALVE INSTALLATION

- A. Sectional Valves: Install sectional valves close to main on each branch and riser serving plumbing fixtures or equipment, and where indicated. Use gate or ball valves for piping 2-inch NPS and smaller. Use gate or butterfly valves for piping 2-1/2-inch NPS and larger.
- B. Shutoff Valves: Install shutoff valves on each water supply to equipment, close to main, on each plumbing fixture without supply stops, and where indicated. Use ball valves for piping 2-inch NPS and smaller. Use gate or butterfly valves for piping 2-1/2-inch NPS and larger.
- C. Drain Valves: Install hose end drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
  - 1. Install hose-end drain valves at low points in water mains, risers, and branches.
  - 2. Install stop-and-waste drain valves where indicated.
- D. Circuit Balancing Valves: Install in each hot-water circulation return branch, discharge side of each pump and circulator, and where indicated. Refer to Section 22 11 19 "Domestic Water Piping Specialties" for circuit balancing valves.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Support pipe in accordance with Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment." Install the following:
  - 1. Riser clamps, MSS Type 8 or Type 42, for vertical runs.
  - 2. Adjustable steel clevis hangers, MSS Type 1, for individual, straight, horizontal runs of cold water and hot water 100 feet and less.
  - 3. Adjustable roller hangers, MSS Type 43, for individual, straight, horizontal runs of hot water longer than 100 feet.
  - 4. Pipe rolls, MSS Type 44, for multiple, straight, horizontal runs of hot water 100 feet or longer. Support pipe rolls on trapeze.
  - 5. Spring hangers, MSS Type 52, for supporting base of vertical runs.
- B. Install supports according to Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment."
- C. Install seismic restraints according to Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor and at maximum distance of 15 feet (whichever is less).
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Horizontal pipe hanger spacing and rod diameters:

Nom. Pipe Size (inches)	Steel Pipe Max. Span (Feet)	Copper Tube Max. Span (Feet)	Min. Rod Diameter (Inches)
Up to 1	7	5	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	3/8
2-1/2	11	9	1/2
3	12	10	1/2
4	14	12	5/8, 1/2 for copper
5	16	13	5/8, 1/2 for copper
6	17	14	3/4, 5/8 for copper

- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

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### 3.10 CONNECTIONS

- A. Connect service entrance piping to exterior water service piping. Use transition fitting to join dissimilar piping materials.
- B. Connect water distribution piping to service entrance piping at shutoff valve, and extend to and connect to the following:
  - 1. Booster Systems: Connect cold-water suction and discharge piping.
  - 2. Water Heaters: Connect cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Connect hot- and cold-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Section 22 40 00 "Plumbing Fixtures."
  - 4. Equipment: Connect hot- and cold-water supply piping as indicated. Provide shutoff valve and union for each connection. Use flanges instead of unions for connections 2-1/2-inch NPS and larger.

### 3.11 FIELD QUALITY CONTROL

- A. Inspect service entrance piping and water distribution piping as follows:
  - 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
  - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
    - a. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    - b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
  - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
  - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test service entrance piping and water distribution piping as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  - 3. Cap and subject piping to static water pressure of 150 psig or 1-1/2 times the operating pressure, whichever is greater, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 24 hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - 4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
  - 5. Prepare and submit reports for tests and required corrective action.

### 3.12 CLEANING

- A. Clean and disinfect potable-water distribution piping as follows:
  - 1. Purge new piping and parts of existing water piping that have been altered, extended, or repaired before using.
  - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, procedure described in either AWWA C651 or AWWA C652 or as described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

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- 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for 3 hours.
  - c. Flush system with clean, potable water until chlorine is no longer in water coming from system after the standing time.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows contamination.
- B. Prepare and submit reports for purging and disinfecting activities.
  - C. Clean interior of piping system. Remove dirt and debris as work progresses.

### 3.13 START-UP PROCEDURES

- A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- B. Perform the following steps before putting into operation:
  1. Close drain valves, hydrants, and hose bibbs.
  2. Open shutoff valves to fully open position.
  3. Open throttling valves to proper setting.
  4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
  5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.
- C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- D. Check plumbing specialties and verify proper settings, adjustments, and operation.
  1. Water-Pressure Regulators: Set outlet pressure at 80 psig maximum, unless otherwise indicated.
- E. Energize pumps and verify proper operation.

END OF SECTION

## SECTION 22 11 19 WATER DISTRIBUTION PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods" for piping joining materials, joint construction, basic installation requirements, and labeling and identifying requirements; and escutcheons, dielectric fittings, sleeves, and sleeve seals that are not in this Section.
  - 2. Section 23 05 23 "General-Duty Valves for Mechanical Piping" for general-duty ball, butterfly, check, gate, and globe valves.
  - 3. Section 23 05 53 "Identification for Mechanical Piping and Equipment" for labeling and identifying requirements.
  - 4. Section 22 11 16 "Water Distribution Piping" for water-supply piping and connections.
  - 5. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hangers and seismic restraints.
  - 6. Division 26 sections for power-supply wiring, field installed disconnects, electrical devices, and motor controllers.

#### 1.2 SUMMARY

- A. This Section includes water distribution piping specialties for the following:
  - 1. Water distribution systems.

#### 1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
  - 1. Water Distribution Piping: 125 psig.

#### 1.4 SUBMITTALS

- A. Product Data: For each plumbing specialty indicated. Include rated capacities of selected equipment and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following plumbing specialty products:
  - 1. Backflow preventers.
  - 2. Balancing valves.
  - 3. Water filters.
  - 4. Strainers.
  - 5. Trap seal primer valves.
  - 6. Hydrants.
  - 7. Outlet boxes.
  - 8. Washer supply outlets.
  - 9. Miscellaneous water distribution piping specialties.
- B. Reports: None required.
- C. Maintenance Data: For specialties to include in the maintenance manuals specified in Section 01 77 00 "Closeout Procedures." Include the following:
  - 1. Backflow preventers.
  - 2. Thermostatic water mixing valves.
  - 3. Water tempering valves.
  - 4. Trap seal primer valves.
  - 5. Miscellaneous water distribution piping specialties.

#### 1.5 QUALITY ASSURANCE

- A. Provide listing/approval stamp, label, or other marking on water distribution piping specialties made to specified standards.
- B. Listing and Labeling: Provide electrically operated water distribution piping specialties specified in this Section that are listed and labeled.

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1. Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
- D. Comply with NFPA 70, "National Electrical Code," for electrical components.
- E. Comply with Washington State Department of Health Publication 331-137 "Backflow Prevention Assemblies Approved for Installation in Washington State."

### 1.6 EXTRA MATERIALS

- A. Deliver extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
  1. Operating Key Handles: Furnish one extra key for each key-operated hose bibb and hydrant installed.
  2. Water Filter Cartridges: Furnish quantity not less than 200 percent of amount of each type and size installed.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Backflow Preventers (Models listed by State of Washington for Cross-Connection Control):
    - a. CMB Industries; Febco Div.
    - b. Conbraco Industries, Inc.
    - c. Zurn Industries, Inc.; Wilkins Div.
  2. Balancing Valves:
    - a. Armstrong Pumps, Inc.
    - b. Griswold Controls Inc.
    - c. ITT Fluid Technology Corp.; ITT Bell & Gossett Div.
    - d. Tour & Anderson, Inc.; Valve Div.
  3. Water Filters:
    - a. AMETEK, Inc.; Plymouth Products Div.
    - b. CUNO, Inc.
    - c. Eagle Spring Filtration, Inc.
    - d. Manitowoc Co., Inc.
    - e. Met-Pro Corp.; Keystone Filter Div.
    - f. Pura, Inc.
    - g. Service Filtration Corp.; Filterspun Div.
  4. Strainers:
    - a. Ames Co., Inc.
    - b. Cla-Val Co.
    - c. CMB Industries; Febco Div.
    - d. Conbraco Industries, Inc.
    - e. FLOMATIC Corp.
    - f. Grinnell Corp.; Mueller Co. Marketing Group for Hersey Products Div.
    - g. IMI Cash Valve.
    - h. Watts Industries, Inc.; Water Products Div.
    - i. Zurn Industries, Inc.; Wilkins Div.
  5. Trap Seal Primer Valves:
    - a. Josam Co.
    - b. Jay R. Smith Mfg. Co.
    - c. Precision Plumbing Products, Inc.
    - d. Tyler Pipe; Wade Div.
    - e. Zurn Industries, Inc.; Hydromechanics Div.
  6. Trap Seal Primer Systems:

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- a. Precision Plumbing Products, Inc., or approved equivalent.
7. Hydrants:
  - a. Josam Co.
  - b. Jay R. Smith Mfg. Co.
  - c. Tyler Pipe; Wade Div.
  - d. Zurn Industries, Inc.; Hydromechanics Div.
8. Outlet Boxes:
  - a. Acorn Engineering Co.
  - b. Guy Gray Manufacturing Co., Inc.
  - c. Symmons Industries, Inc.
9. Washer-Supply Outlets:
  - a. IMI Cash Valve.
  - b. Symmons Industries, Inc.
  - c. Watts Industries, Inc.; Water Products Div.
10. Miscellaneous Water Distribution Piping Specialties:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Co.
  - c. Tyler Pipe, Wade Div.
  - d. Zurn Industries, Inc.

### 2.2 BACKFLOW PREVENTERS

- A. General: ASSE standard, backflow preventers, of size indicated for maximum flow rate and maximum pressure loss indicated.
  1. Interior Components: Corrosion-resistant materials.
  2. Exterior Finish: Polished chrome-plate if used in chrome-plated piping system.
- B. Reduced Pressure Backflow Assemblies (RPBA): ASSE 1013, suitable for continuous pressure application.
  1. 2-Inch NPS and Smaller:
    - a. Bronze body with threaded ends.
    - b. Full port ball valves on inlet and outlet, strainer on inlet, test cocks, and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.
    - c. Pressure Loss: 15 psig maximum, through middle one-third of flow range.
  2. 2-1/2-Inch NPS and Larger:
    - a. Bronze, cast-iron, steel, or stainless steel body with flanged ends.
    - b. Interior Lining: AWWA C550 or FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.
    - c. Full port gate valves on inlet and outlet, strainer on inlet, test cocks, and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.
    - d. Pressure Loss: 15 psig maximum, through middle one-third of flow range.
- C. Double Check Backflow Assemblies (DCBA): ASSE 1015, suitable for continuous pressure application
  1. 2-Inch NPS and Smaller:
    - a. Bronze body with threaded ends.
    - b. Full port ball valves on inlet and outlet, strainer on inlet, and test cocks with two positive-seating check valves.
    - c. Pressure Loss: 7 psig maximum, through middle one-third of flow range.
  2. 2-1/2-Inch NPS and Larger:
    - a. Bronze, cast-iron, steel, or stainless steel body with flanged ends.
    - b. Interior Lining: AWWA C550 or FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.
    - c. Full port gate valves on inlet and outlet, strainer on inlet, and test cocks with two positive-seating check valves.
    - d. Pressure Loss: 7 psig maximum, through middle one-third of flow range.

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- D. Anti-siphon Pressure Type Vacuum Breakers: ASSE 1020, suitable for continuous pressure application. Include shutoff valves, spring-loaded check valve, spring-loaded floating disc, test cocks, and atmospheric vent.
  - 1. Bronze body with threaded ends.
  - 2. Full port ball valves on inlet and outlet, spring-loaded check valve, spring-loaded floating disc, test cocks, and atmospheric vent.
  - 3. Pressure Loss: 5 psig maximum, through middle one-third of flow range.
- E. Pipe Applied, Atmospheric-Type Vacuum Breakers: ASSE 1001, bronze body with floating disc and atmospheric vent.
- F. Hose Connection Vacuum Breakers: ASE 1011, brass body with non-removable and manual drain features, and ASME B1.20.7 garden-hose threads on outlet.

### 2.3 BALANCING VALVES

- A. Circuit Balancing Valves: Adjustable, with 2 readout ports and memory setting indicator. Include manufacturer's standard hoses, fittings, valves, differential pressure meter, and carrying case.
  - 1. 2-Inch NPS and Smaller: Bronze body with brass ball, adjustment knob, calibrated nameplate, and threaded or solder-joint ends.
  - 2. 2-Inch NPS and Smaller: Bronze, Y-pattern body with adjustment knob and threaded ends.
  - 3. 2-1/2-Inch NPS and Larger: Cast-iron, Y-pattern body with bronze disc and flanged or grooved ends.

### 2.4 WATER FILTERS

- A. General: Cartridge-type assemblies suitable for potable water of size and at flow rate and pressure loss indicated. Include housing, fittings, filter cartridges, and cartridge end caps.
- B. Wall-Mounting Type: Housing head section with threaded inlet and outlet, mounting bracket, and removable lower section for 10-inch-long filter cartridge.
  - 1. Housing Material: Stainless steel, 150-psig minimum operating pressure.
  - 2. Cartridge: Wound- or molded-fiber filter media, or pleated-polypropylene filter media, 5-micron-particulate removable rating.

### 2.5 STRAINERS

- A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.
  - 1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.
  - 2. 2-Inch NPS and Smaller: Bronze body, with female threaded ends.
  - 3. 2-1/2-Inch NPS and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved epoxy coating and flanged ends.
  - 4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.
    - a. Drain: Factory- or field-installed, hose-end drain valve.
  - 5. T-Pattern Strainers: Malleable-iron or ductile-iron body with grooved ends; access end cap with drain plug and access coupling with rubber gasket.
  - 6. Basket Strainers: Bolted flange or clamp cover, and basket with lift-out handle.
    - a. Simplex Type: Single unit, with one basket.
    - b. Drain: Factory- or field-installed, hose-end drain valve.
- B. Drainage Basket Strainers: Non-pressure-rated, cast-iron or coated-steel body; with bolted flange or clamp cover and drain with plug.
  - 1. Basket: Bronze or stainless steel with 1/8- or 3/16-inch-diameter holes and lift-out handle.
  - 2. Female threaded ends for 2-inch NPS and smaller, and flanged ends for 2-1/2-inch NPS and larger.

## SECTION 22 11 19 WATER DISTRIBUTION PIPING SPECIALTIES

### 2.6 TRAP SEAL PRIMER VALVES

- A. Trap Seal Primer Valves: ASSE 1018, water-supply-fed type, with the following characteristics:
  - 1. 125-psig minimum working pressure.
  - 2. Bronze body with atmospheric-vented drain chamber.
  - 3. Inlet and Outlet Connections: 1/2-inch NPS threaded, union, or solder joint.
  - 4. Gravity Drain Outlet Connection: 1/2-inch NPS threaded or solder joint.
  - 5. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
- B. Trap Seal Primer System: Factory-fabricated, automatic-operation assembly for wall mounting with the following:
  - 1. Piping: 3/4-inch NPS, ASTM B 88, Type L; copper, water tubing inlet and manifold with number of 1/2-inch NPS outlets as indicated.
  - 2. Cabinet: Steel box with stainless-steel cover.
  - 3. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V, ac power.
  - 4. Water Hammer Arrester: ASSE 1010.
  - 5. Vacuum Breaker: ASSE 1001.

### 2.7 HYDRANTS

- A. Wall Hydrants: ASME A112.21.3M or ASSE 1019, nonfreeze, automatic draining, anti-backflow type, key operation, with 3/4- or 1-inch NPS threaded or solder-joint inlet, and ASME B1.20.7 garden-hose threads on outlet. Include operating key for each hydrant.
  - 1. Type: Recessed.
  - 2. Finish: Polished brass.
- B. Post Hydrant: Exposed, non-freeze post hydrant, complete with bronze casing, all bronze interior parts, vacuum breaker, bronze seat, replaceable seat washer, and non-turning operating rod with free-floating compression closure valve and 3/4" connection. Hydrant is equipped with 1/4" drain port in valve housing.

### 2.8 OUTLET BOXES

- A. General: Recessed-mounting outlet boxes with fittings complying with ASME A112.18.1M. Include box with faceplate, services indicated for equipment connections, and wood-blocking reinforcement.
- B. Clothes Washer Outlet Boxes: With hose connections, drain, and the following:
  - 1. Shutoff Fittings: 2 hose bibbs.
  - 2. Shutoff Fittings: Combination, single lever.
  - 3. Drain Fitting: 2-inch NPS drainage piping P-trap with 2-inch NPS standpipe extending from floor to outlet box and 2-inch NPS waste.

### 2.9 WASHER-SUPPLY OUTLETS

- A. Description: Surface-mounting, washer-supply outlet fittings complying with ASME A112.18.1M and reinforcement. Include the following:
  - 1. Shutoff Fitting: Combination, single lever.
  - 2. Supply Fittings: Two 1/2-inch NPS gate, globe, or ball valves and 1/2-inch NPS copper, water tubing.

### 2.10 MISCELLANEOUS WATER DISTRIBUTION PIPING SPECIALTIES

- A. Water Hammer Arresters: ASME A112.26.1M, ASSE 1010, or PDI-WH 201, bellows or piston type with pressurized cushioning chamber. Sizes are based on water-supply fixture units, ASME A112.26.1M sizes A through F and PDI-WH 201 sizes A through F.
- B. Hose Bibbs: Bronze body, with renewable composition disc, 1/2- or 3/4-inch NPS threaded or solder-joint inlet. Provide ASME B1.20.7 garden-hose threads on outlet and integral or field-installed, nonremovable, drainable, hose-connection vacuum breaker.
  - 1. Finish: Rough brass.
  - 2. Operation: Operating-key (handle) type. Include operation key.

## PART 3 - EXECUTION

## 3.1 WATER DISTRIBUTION PIPING SPECIALTY INSTALLATION

- A. General: Install water distribution piping specialty components, connections, and devices according to manufacturer's written instructions.
- B. Install backflow preventers of type, size, and capacity indicated, at each water-supply connection to mechanical equipment and systems, and to other equipment and water systems as indicated. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment. Install air-gap fitting on units with atmospheric-vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.
- C. Install strainers on supply side of each control valve, and solenoid valve, and where indicated.
- D. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of one percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- E. Fasten wall-hanging water distribution piping specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- F. Fasten recessed, wall-mounting water distribution piping specialties to reinforcement built into walls.
- G. Secure supplies to supports or substrate.
- H. Install individual stop valve in each water supply to water distribution piping specialties. Use ball, gate, or globe valve if specific valve is not indicated.
- I. Install water-supply stop valves in accessible locations.
- J. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- K. Include wood-blocking reinforcement for recessed and wall-mounting water distribution piping specialties.
- L. Include access for trap primers.
- M. Install hose bibbs with integral or field installed vacuum breaker.
- N. Install wall hydrants with integral or field installed vacuum breaker.
- O. Route post hydrant drain to nearest indirect drain.
- P. Install water hammer arrestors near quick acting valves at the end of pipe runs and batteries of fixtures, including flush valves, and as indicated. Provide access.

## 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping connections between water distribution piping specialties and piping specified in other Division 22 Sections.
  - 2. Install piping connections indicated between appliances and equipment specified in other Sections; connect directly to plumbing piping systems.
  - 3. Install piping connections indicated as indirect wastes from appliances and equipment specified in other Sections, to spill over receptors connected to plumbing piping systems.
- B. Install hoses between water distribution piping specialties and appliances as required for connections.
- C. Arrange for electric-power connections to water distribution piping specialties and devices that require power. Electric power is specified in Division 26 Sections.
- D. Supply Runouts to water distribution piping specialties: Install hot- and cold-water-supply piping of sizes indicated, but not smaller than required by authorities having jurisdiction.
- E. Ground electric-powered water distribution piping specialties.
  - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

## SECTION 22 11 19 WATER DISTRIBUTION PIPING SPECIALTIES

- F. Arrange for electric-power connections to water distribution piping specialties and devices that require power. Electric power, wiring, and disconnect switches are specified in Division 26 Sections.

### 3.3 START-UP PROCEDURES

- A. Before startup, perform the following checks:
  - 1. System tests are complete.
  - 2. Damaged and defective specialties and accessories have been replaced or repaired.
  - 3. Clear space is provided for servicing specialties.
- B. Before operating systems, perform the following steps:
  - 1. Close drain valves, hydrants, and hose bibbs.
  - 2. Open general-duty valves to fully open position.
  - 3. Remove and clean strainers.
  - 4. Verify that drainage and vent piping are clear of obstructions. Flush with water until clear.
- C. Startup Procedures: Follow manufacturer's written instructions. If no procedures are prescribed by manufacturer, proceed as follows:
  - 1. Energize circuits for electrically operated units. Start and run units through complete sequence of operations.

### 3.4 DEMONSTRATION

- A. Startup Services: Engage a factory-authorized service representative to perform startup services and train Owner's maintenance personnel as specified below:
  - 1. Train Owner's maintenance personnel on procedures and schedules related to startup of and servicing trap seal primer systems.
  - 2. Review data in the maintenance manuals. Refer to Division 01.
  - 3. Schedule training with Owner with at least 7 days' advance notice.

### 3.5 PROTECTION

- A. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION



## SECTION 22 11 23 PLUMBING PUMPS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods" for flexible pipe connectors.
  - 2. Section 23 05 53 "Identification for Mechanical Piping and Equipment" for labeling.
  - 3. Section 23 05 23 "General-Duty Valves for Mechanical Piping" for general duty valves.
  - 4. Section 23 05 19 "Meters and Gages for Mechanical Piping" for pressure gages and gage connectors.
  - 5. Section 23 05 13 "Common Motor Requirements for Mechanical Equipment" for general motor requirements.
  - 6. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for pump supports.
  - 7. Section 22 11 16 "Water Distribution Piping" and Section 22 13 16 "Drainage and Vent Piping" for pipe materials.
  - 8. Section 22 13 19 "Drainage Piping Specialties" for strainers.
  - 9. Section 23 05 63 "Variable Frequency Drives" for user interface.
  - 10. Division 26 Sections for power-supply wiring, field-installed disconnects, electrical devices, and motor controllers.

#### 1.2 SUMMARY

- A. This Section includes pumps for the building plumbing systems.

#### 1.3 SUBMITTALS

- A. General: See Section 01 33 00 for general requirements of submittals.
- B. Product Data: Provide submittals of the following:
  - 1. In-line circulators.
  - 2. Constant-Speed Drive, Packaged Booster Pumps.
  - 3. Variable-speed-drive, packaged booster pumps.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of pumps through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.

### 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. In-Line Circulators:
    - a. Armstrong Pumps, Inc.
    - b. ITT Fluid Technology Corp.; ITT Bell & Gossett Div.
    - c. Taco, Inc.
  - 2. Constant-Speed-Drive, Packaged Booster Pumps:
    - a. Armstrong Darling, Inc.
    - b. Canariis.

## SECTION 22 11 23 PLUMBING PUMPS

- c. ITT Fluid Technology Corp.; ITT Bell & Gossett Div.
- d. PACO Pumps, Inc.
- e. SynchroFlo, Inc.

### 2.2 PUMPS, GENERAL

- A. Description: Factory-assembled and -tested, single-stage, centrifugal pump units; complying with UL 778; suitable for potable-water service; with all-bronze or stainless steel construction and components in contact with water made of corrosion-resistant materials.
- B. Motors: Provide with built-in thermal-overload protection appropriate for motor size and duty.
- C. End Connections for NPS 2 and Smaller: Threaded. Pumps available only with flanged ends may be furnished with threaded companion flanges.
- D. End Connections for NPS 2-1/2 and Larger: Flanged.
- E. Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.
- F. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles.

### 2.3 IN-LINE CIRCULATORS

- A. Description: Horizontal or vertical, in-line circulator, close coupled, rated for 175-psig minimum working pressure and minimum continuous water temperature of 225 deg F.
  - 1. Construction: Radially split, all-bronze casing.
  - 2. Impeller: ASTM B 584, cast bronze; overhung, single suction, and keyed or taper fit to shaft.
  - 3. Seal: Mechanical.
  - 4. Shaft and Sleeve: Steel shaft, with copper sleeve.
  - 5. Motor Bearings: Oil-lubricated, bronze-journal or permanently lubricated ball bearing.
  - 6. Motor: Single speed and rigid mounted to pump casing.
    - a. Motor Size: For motors larger than 1/2 hp, select motor size that will not overload through full range of pump performance curve.

### 2.4 PACKAGED BOOSTER PUMPS, GENERAL

- A. Description: Factory-assembled and -tested, packaged booster pump units; complying with UL 778; suitable for potable-water service.
- B. Piping: ASME B31.9 for piping materials and installation.
  - 1. NPS 4 and Smaller: ASTM B 88, Type L, drawn, copper, water tube with copper, solder-joint, pressure fittings and brazed joints.
  - 2. Header End Connections NPS 2 and Smaller: Threaded.
  - 3. Header End Connections NPS 2-1/2 and Larger: Flanged.
- C. Piping Option: Piping, including valves and other components, may have grooved ends for grooved joints.
- D. Shutoff Valves, NPS 2 and Smaller: MSS SP-80, Class 125, bronze, rising-stem gate valve or MSS SP-110, 600-psig minimum CWP, bronze ball valve with ends matching piping.
- E. Shutoff Valves, NPS 2-1/2 and Larger: MSS SP-70, Class 125, bronze-trim, OS&Y, cast-iron gate valve with flanged ends or MSS SP-67, Type I for tight shutoff, 175-psig CWP, single-flanged, cast-iron butterfly valve.
- F. Check Valves, NPS 2 and Smaller: MSS SP-80, Class 125, bronze, swing check valve.
- G. Check Valves, NPS 2-1/2 and Larger: MSS SP-71, Class 125, bronze-trim, cast-iron, swing check valve.
- H. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and to stop corrosion.
  - 1. NPS 2 and Smaller: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
  - 2. NPS 2-1/2 and Larger: Factory-fabricated, companion-flange assembly; for 150- or 300-psig minimum working pressure as required to suit system pressures.
- I. Sensors: Pressure switches.

## SECTION 22 11 23 PLUMBING PUMPS

- J. Draw Down Tank: Sized as scheduled included in package.
- K. Control Panel: Automatic, with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
  - 1. Mounting and Wiring: Factory installed and connected as an integral part of unit for single power supply connection.
  - 2. Enclosure: NEMA ICS 6, Type 12.
  - 3. Motor Controller: Full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.
    - a. Control Voltage: 120-V ac, using integral control power transformer.
    - b. Programmable logic controller.
    - c. Remote signaling and alarm contacts for the building DDC system.
  - 4. Motor Overload Protection: Overload relay in each phase.
    - a. Individual pump thermal protection.
  - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
  - 6. Individual pump running light.
  - 7. Triplex, Automatic Alternating Starter: Switches lead pump to lag main pump and to three-pump operation.
  - 8. Staging: Triplex units with 4 step staging.
  - 9. Instrumentation: Unit suction and discharge pressure gages.
  - 10. Alarm Signal Device: Sounds alarm when backup pumps are operating.
  - 11. Instrumentation: Unit suction and discharge pressure gages.
- L. Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.
- M. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and nozzles.

### 2.5 CONSTANT-SPEED-DRIVE, PACKAGED BOOSTER PUMPS

- A. Description: Multiplex packaged unit, with pumps, piping, valves, sensors, and controls for constant-speed operation.
  - 1. Minimum Pressure Rating: 175 psig.
  - 2. Pump Arrangement: Triplex, with three equal size pumps.
  - 3. Pumps: Comply with HI 1.1-1.5, "Centrifugal Pumps," for close-coupled, in-line centrifugal pumps.
    - a. Construction: Single stage, radially split, all bronze construction.
    - b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
  - 4. Pumps: Comply with HI 2.1-2.5, "Vertical Pumps," for multistage barrel pumps.
    - a. Construction: Multistage, bronze fitted.
    - b. Impellers: ASTM B 584, cast bronze; statically and dynamically balanced, closed or semiopen, and keyed to shaft.
  - 5. Control Valve: Adjustable, automatic, direct-acting, pressure regulator for each pump discharge.
  - 6. Control Valve: Adjustable, automatic, pilot-operated, pressure regulator for each pump discharge.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of plumbing piping systems to verify actual locations of connections before pump installation.

### 3.2 WATER DISTRIBUTION PUMPS INSTALLATION

- A. Install pumps according to manufacturer's written instructions and with access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- B. Support pumps and piping so weight of piping is not supported by pumps.

## SECTION 22 11 23 PLUMBING PUMPS

- C. Suspend vertical in-line pumps independent of piping. Use continuous-thread hanger rods and vibration isolation hangers of sufficient size to support pump weight.

### 3.3 PACKAGED BOOSTER PUMPS INSTALLATION

- A. Install packaged booster pumps according to manufacturer's written instructions and with access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- B. Support packaged booster pumps using the following vibration-control devices, unless otherwise indicated.
  - 1. Install units with total of 7.5 hp or less, with rubber-isolator mount or spring-isolator vibration isolators.
- C. Support connected piping so weight of water distribution piping is not supported by packaged booster pumps.

### 3.4 WATER DISTRIBUTION PUMP CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
  - 1. Connect water distribution piping to pumps. Install suction and discharge pipe equal to or greater than size of pump nozzles.
  - 2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping.
  - 3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps.

### 3.5 PACKAGED BOOSTER PUMP CONNECTIONS

- A. Piping installation requirements are specified in Section 22 11 16 "Water Distribution Piping." Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
  - 1. Connect water distribution piping to pumps. Install suction and discharge pipe equal to or greater than size of unit suction and discharge headers.
  - 2. Install flexible pipe connectors on piping connections to unit suction and discharge headers. Install flexible pipe connectors same size as piping.
  - 3. Install shutoff valves on piping connections to unit suction and discharge headers. Install valves same size as unit suction and discharge headers.

### 3.6 START-UP PROCEDURES

- A. Check suction piping connections for tightness.
- B. Clean strainers on suction piping.
- C. Controls: Set for automatic starting and stopping operation.
- D. Final Checks before Starting: Perform the following preventive maintenance operations:
  - 1. Lubricate oil-lubricated-type bearings.
  - 2. Verify that pump is free to rotate by hand and that pump for handling hot liquids is free to rotate with pump hot and cold. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.
  - 3. Verify that pump controls are correct for required application.
- E. Starting procedure for pumps is as follows:
  - 1. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 2. Open circulating line valve if pump should not be operated against dead shutoff.
  - 3. Start motor.
  - 4. Open discharge valve slowly.
  - 5. Check general mechanical operation of pump and motor.
  - 6. Close circulating line valve once there is sufficient flow through pump to prevent overheating.

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3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain pumps as specified below:
1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
  2. Review data in maintenance manuals.
  3. Schedule 8-hours of training with Owner with at least seven days' advance notice.

END OF SECTION



## SECTION 22 13 16 DRAINAGE AND VENT PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 31 for foundation drains.
  - 2. Division 31 for excavating, trenching, and backfilling.
  - 3. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for support installation.
  - 4. Section 23 07 13 "Pipe Insulation for Mechanical Systems" for drainage piping insulation.
  - 5. Section 23 05 23 "General-Duty Valves for Mechanical Piping" for valves used in drainage piping.
  - 6. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for pipe seismic restraints.
  - 7. Section 22 13 19 "Drainage Piping Specialties" for drainage and vent piping system specialties.

#### 1.2 SUMMARY

- A. This Section includes sanitary drainage and vent piping, and storm drainage piping inside building and to locations indicated.

#### 1.3 SUBMITTALS

- A. General: See Section 01 33 00 "Submittal Procedures." See Section 23 05 00 "Common Mechanical Materials and Methods for Mechanical" for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals for the following:
  - 1. Cast-iron soil piping.
  - 2. Galvanized steel piping.
  - 3. Copper tubing.
- C. Reports and Certificates: Provide submittals of the following:
  - 1. Test Reports specified in "Field Quality Control."
- D. Shop Drawings: None required.

#### 1.4 DEFINITIONS

- A. Service Entrance Piping: Drainage piping at entry into building between outside building sewer piping and inside drainage piping.
- B. Soil, Waste, and Vent Piping: Piping inside building that conveys wastewater and vapors from fixtures and equipment throughout the building.
- C. Rainwater Piping: Piping inside building that conveys storm drainage from building.
- D. Force-Main Piping: Drainage piping, under pressure.

#### 1.5 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
  - 1. Soil, Waste, and Vent Systems: 10-foot head of water.
  - 2. Storm Drainage Systems: 10-foot head of water.
  - 3. Sewage, Force-Main Piping Systems: 50 psig.

#### 1.6 QUALITY ASSURANCE

- A. Provide listing/approval stamp, label, or other marking on piping made to specified standards.
- B. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
- C. Comply with the latest version of CISPI 301-04a and ASTM 888-04a.

## SECTION 22 13 16 DRAINAGE AND VENT PIPING

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.
- C. Transition Couplings for Underground Pressure Piping: AWWA C219 metal, sleeve-type coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

#### 2.2 CAST-IRON SOIL PIPING

- A. Hubless Pipe and Fittings: CISPI 301, ASTM A 888, pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.
  - 1. Couplings: Assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 neoprene rubber sleeve with integral, center pipe stop.
    - a. Standard Duty Couplings: Complying with CISPI 310, Type 301 stainless steel, minimum 0.0075-inch (36 gage) stainless steel corrugated shield, and stainless steel bands.
    - b. Heavy-Duty Couplings: Complying with FM 1680 Class 1, Type 304 stainless steel, minimum 0.016-inch (28 gage) stainless steel shield, and stainless steel bands.

#### 2.3 GALVANIZED STEEL PIPING

- A. Steel Pipe: ASTM A 53, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.
  - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
  - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
  - 3. Cast-Iron, Threaded, Drainage Fittings: ASME B16.12, galvanized.

#### 2.4 COPPER TUBING

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
  - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

#### 2.5 VALVES

- A. Refer to Section 23 05 23 "General-Duty Valves for Mechanical Piping" for general-duty valves. Use valves specified for "Domestic Water Systems" applications.

#### 2.6 ENCASUREMENT FOR UNDERGROUND METAL PIPING

- A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
- B. Form: Sheet or tube.
- C. Color: Black.

### PART 3 - EXECUTION

#### 3.1 EXCAVATION

- A. Refer to Division 31 for excavating, trenching, and backfilling.

#### 3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Aboveground, Soil, Waste, and Vent Piping: Use the following:

## SECTION 22 13 16 DRAINAGE AND VENT PIPING

1. Hubless, cast-iron soil pipe and fittings:
    - a. Couplings: Heavy-duty couplings.
  2. 1-1/4- and 1-1/2-Inch NPS: Copper drainage tube; wrought copper, solder-joint drainage fittings; and soldered joints.
- D. Underground, Soil, Waste, and Vent Piping: Use the following:
1. Hubless, cast-iron soil pipe and fittings:
    - a. Couplings: Heavy-duty couplings.
- E. Above and Belowground Rainwater and Overflow Rainwater Piping: Use the following:
1. Hubless, cast-iron soil pipe and fittings:
    - a. Couplings: Heavy-duty couplings.
- F. Aboveground, Sewage Force Mains: Use the following:
1. Galvanized steel pipe and cast-iron, threaded fittings.
- G. Indirect Drain Piping: Use the following:
1. Copper drainage tube; wrought copper, solder-joint drainage fittings; and soldered joints.
- 3.3 VALVE APPLICATIONS
- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use gate or ball valves.
- 3.4 PIPING INSTALLATION, GENERAL
- A. Refer to Section 23 05 00 "Common Mechanical Materials and Methods for Mechanical" for basic piping installation.
- 3.5 SERVICE ENTRANCE PIPING INSTALLATION
- A. Extend building sanitary drain piping five feet outside building and connect to sanitary sewer piping in sizes and locations indicated. Install cleanout and extension to grade at connections of building sanitary drains with building sanitary sewers.
- B. Extend building storm drain piping five feet outside of building and connect to storm sewer piping in sizes and locations indicated. Install cleanout and extension to grade at connections of building storm drains and building storm sewers.
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service entrance pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Section 23 05 00 "Common Mechanical Materials and Methods for Mechanical" for sleeves and mechanical sleeve seals.
- 3.6 DRAINAGE AND VENT PIPING INSTALLATION
- A. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- B. Make changes in direction for drainage piping using appropriate branches, bends, and sanitary tees. Make changes in direction for vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not make change in direction of flow greater than 90 degrees. Use proper size of standard increasers and reducers if different sizes of piping are connected. Reducing size of drainage piping in direction of flow is prohibited.
- C. Install drainage and vent piping at the following minimum slopes, unless otherwise indicated:
1. All building drainage systems at 1/4 per foot downward in direction of flow.
  2. Vent Piping: 1/8-inch per foot down toward vertical fixture vent.
- D. Install force mains at elevations indicated.
- E. Install engineered, sanitary drainage and vent systems in locations indicated and as follows:
1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

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- F. Install engineered, controlled-flow, storm drainage systems in locations indicated. Comply with standards of authorities having jurisdiction.
- G. Sleeves are not required for cast-iron soil piping passing through concrete slab on grade if slab is without membrane waterproofing.

3.7 JOINT CONSTRUCTION

- A. Refer to Section 23 05 00 "Common Mechanical Materials and Methods for Mechanical" for basic piping joint construction.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

3.8 VALVE INSTALLATION

- A. Shutoff Valves: Install shutoff valve on each pump discharge and where indicated. Use gate or ball valves for piping 2-inch NPS and smaller. Use gate valves for piping 2-1/2-inch NPS and larger.
- B. Check Valves: Install swing check valve on each pump discharge, downstream from shutoff valve.
- C. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
  - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
  - 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
  - 3. Install backwater valves in accessible locations.
  - 4. Backwater valves are specified in Section 22 13 19 "Drainage Piping Specialties."

3.9 HANGER AND SUPPORT INSTALLATION

- A. Refer to Section 23 05 23 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hanger and support devices. Install the following:
  - 1. Riser clamps, MSS Type 8 or Type 42, for vertical runs.
  - 2. Adjustable steel clevis hangers, MSS Type 1, for individual, straight, horizontal runs 100 feet and less.
  - 3. Adjustable roller hangers, MSS Type 43, for individual, straight, horizontal runs longer than 100 feet.
  - 4. Spring cushion rolls, MSS Type 49, if indicated, for individual, straight, horizontal runs longer than 100 feet.
  - 5. Pipe rolls, MSS Type 44, for multiple, straight, horizontal runs 100 feet or longer. Support pipe rolls on trapeze.
  - 6. Spring hangers, MSS Type 52, for supporting base of vertical runs.
- B. Install supports and seismic restraints according to Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" and "Mechanical Vibration Controls and Seismic Restraints."
- C. Support vertical piping and tubing at base and at each floor (15-ft. maximum).
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for horizontal piping with following maximum spacing and minimum rod sizes:

Nom. Pipe Size (Inches)	Cast-Iron Pipe Max. Span (Feet)	Copper DWVMax. Span (Feet)	Min. Rod Diameter (Inches)
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	6	3/8
1-1/2	9	6	3/8
2	10	8	3/8
2-1/2	11	9	1/2
3	12	10	1/2
4	14	12	5/8

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Nom. Pipe Size (Inches)	Cast-Iron Pipe Max. Span (Feet)	Copper DWVMax. Span (Feet)	Min. Rod Diameter (Inches)
6	17	14	5/8
1.	Support vertical cast-iron pipe and copper tube at each floor, not to exceed 15-feet.		
2.	Support horizontal hubless cast iron pipe at every other joint, unless over four feet, then support at every joint not to exceed 10-feet.		
3.	Support horizontal ABS pipe at every four feet. Allow for expansion every 30-feet.		
F.	Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.		

3.10 CONNECTIONS

- A. Connect service entrance piping to exterior sewage and drainage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect drainage piping to service entrance piping, and extend to and connect to the following:
  - 1. Plumbing Fixtures: Connect soil, waste, and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Section 22 40 00 "Plumbing Fixtures."
  - 2. Plumbing Specialties: Connect soil, waste, and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Section 22 11 19 Water Distribution Piping Specialties."
  - 3. Equipment: Connect waste piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections 2-1/2-inch NPS and larger.
- C. Connect force-main piping as indicated on drawings, and extend to and connect to the following:
  - 1. Sewage Pumps: Connect force-main piping to sewage-pump discharge.
  - 2. Sump Pumps: Connect force main piping to sump pump discharge.

3.11 FIELD QUALITY CONTROL

- A. Inspect soil, waste, and vent piping as follows:
  - 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
  - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
    - a. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    - b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
  - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
  - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedure, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  - 3. Roughing-In Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10 feet of head. Water

## SECTION 22 13 16 DRAINAGE AND VENT PIPING

level must not drop from 15 minutes before inspection starts through completion of inspection (24 hours). Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
  5. Repair leaks and defects using new materials and retest piping or portion thereof until satisfactory results are obtained.
  6. Prepare and submit reports for tests and required corrective action.
- C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedure, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
  3. Repair leaks and defects using new materials and retest piping or portion thereof until satisfactory results are obtained.
  4. Prepare and submit reports for tests and required corrective action.

### 3.12 CLEANING AND PROTECTING

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

## SECTION 22 13 19 DRAINAGE PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods" for piping joining materials, joint construction, basic installation requirements, and labeling and identifying requirements; and escutcheons, dielectric fittings, sleeves, and sleeve seals that are not in this Section.
  - 2. Section 23 05 23 "General-Duty Valves for Mechanical Piping" for general-duty ball, butterfly, check, gate, and globe valves.
  - 3. Section 23 05 53 "Identification for Mechanical Piping and Equipment" for labeling and identifying requirements.
  - 4. Section 22 13 16 "Drainage and Vent Piping" for drainage and vent piping and connections.
  - 5. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hangers and seismic restraints.
  - 6. Division 26 Sections for power-supply wiring, field installed disconnects, electrical devices, and motor controllers.

#### 1.2 SUMMARY

- A. This Section includes drainage piping specialties for the following:
  - 1. Soil, waste, and vent systems.
  - 2. Storm drainage systems.

#### 1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
  - 2. Storm Drainage Piping: 10-foot head of water.
  - 3. Force-Main Piping: 50 psig.

#### 1.4 SUBMITTALS

- A. Product Data: For each plumbing specialty indicated. Include rated capacities of selected equipment and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following plumbing specialty products:
  - 1. Cleanouts.
  - 2. Drains.
  - 3. Miscellaneous drainage piping specialties.
- B. Reports: Specified in "Field Quality Control" Article.

#### 1.5 QUALITY ASSURANCE

- A. Provide listing/approval stamp, label, or other marking on plumbing specialties made to specified standards.
- B. Listing and Labeling: Provide electrically operated plumbing specialties specified in this Section that are listed and labeled.
  - 1. Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.
  - 2. Listing and Labeling Agency Qualifications: "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
- D. Comply with NFPA 70, "National Electrical Code," for electrical components.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cleanouts:
    - a. Josam Co.
    - b. Jay R. Smith Mfg. Co.
    - c. Tyler Pipe, Wade Div.
    - d. Zurn Industries, Inc.; Hydromechanics Div.
  2. Drains:
    - a. Josam Co.
    - b. Jay R. Smith Mfg. Co.
    - c. Tyler Pipe, Wade Div.
    - d. Zurn Industries, Inc.
  3. Miscellaneous Drainage Piping Specialties:
    - a. Jay R. Smith Mfg. Co.
    - b. Josam Co.
    - c. Tyler Pipe, Wade Div.
    - d. Zurn Industries, Inc.

## 2.2 CLEANOUTS

- A. General: Size cleanouts as indicated on drawings, or where not indicated, same size as connected drainage piping.
1. Provide wall cleanouts on each end of water closet ends and one over main drops in addition, provide all cleanouts required per code.
- B. Cleanouts: ASME A1122.36.2M, cast-iron body with straight threads and gasket seal or tapered threads for plug, flashing flange and clamping ring, and a brass closure plug. Cleanouts for installation in floors not having membrane waterproofing may be furnished without clamping ring.
1. Tiled Areas: Round cleanout top with tile recess top.
  2. Quarry Tiled Areas: Square nickel-bronze cleanout cover.
  3. Walls: Round cleanout cover with stainless steel finish.
  4. All Other Areas: Round cleanout top with nickel-bronze finish.

## 2.3 DRAINS

- A. General: Size outlets as indicated on drawings.
- B. Floor Drains: ASME A112.21.1M, cast-iron body, with seepage flange and clamping device, and trap seal primer valve connection. Floor drains for installation in floors not having membrane waterproofing may have seepage flange with clamping device. Floor drains for use as area drains in exterior slab on grade may be furnished with anchor flange instead of seepage flange and clamping device. Provide the following options as indicated:
1. Trap primer connection.
  2. Round strainer with integral funnel.
  3. Polished nickel bronze top.
  4. Slotted top.
- C. Roof Drains: ASME A112.21.2M, cast-iron body, with combination flashing ring and gravel stop, cast-iron dome except where other dome material is specified, extension collars, underdeck clamp, and sump receiver. Roof drains for installation in cast-in-place concrete decks may be furnished without underdeck clamp and sump receiver.
- D. Trench Drains: Pre-sloped trench drainage system, polyethylene plastic drain channel with 0.75% bottom slope, modular sections with interlocking ends, standard cast grating, complete with the straps and mounting accessories.
- E. Planter Drains: Cast-iron body, with combination flashing ring and gravel stop, low-silhouette cast-iron dome except where other dome material is specified, interior dome, underdeck clamp, and stainless steel mesh screen over dome.

## SECTION 22 13 19 DRAINAGE PIPING SPECIALTIES

- F. Floor Sinks: Cast iron body, 12-inch square by 8-inch deep sump, 3-inch bottom outlet, square slotted medium duty grate, with polished nickel bronze top, with interior dome strainer.

### 2.4 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

- A. Roof Flashing Assemblies: Manufactured assembly made of 4-lb/sq. ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.
  - 1. Vent Cap: Open-top, without cap.
- B. Open Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section of length to provide depth indicated; and where indicated, increaser fitting of size indicated, joined with ASTM C 564 rubber gaskets. Size P-trap as indicated.
- C. Deep-Seal Traps: Cast iron or bronze, with inlet and outlet matching connected piping, cleanout where indicated, and trap seal primer valve connection where indicated.
  - 1. 2-Inch NPS: 4-inch- minimum water seal.
  - 2. 2-1/2 Inch NPS and Larger: 5-inch- minimum water seal.
- D. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.
- E. Air-Gap Fittings: ASME A112.1.2, cast iron or cast bronze, with fixed air gap, inlet for drain pipe or tube, and threaded or spigot outlet.
- F. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
- G. Downspout Nozzle: Nickel bronze body, threaded inlet, wall flange and outlet hinged flap.
- H. Hose-End Drain Valves: MSS SP-110, 3/4-inch NPS ball valve, rated for 400-psig minimum CWP. Include 2-piece, ASTM B 62 bronze body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.
  - 1. Inlet: Threaded or solder joint.
  - 2. Outlet: Short-threaded nipple with ASME B1.20.7 garden-hose thread and cap.
- I. Stop-and-Waste Drain Valves: MSS SP-110, ball valve, rated for 200-psig minimum CWP or MSS SP-80, Class 125, gate valve, ASTM B 62 bronze body, with 1/8-inch NPS side drain outlet and cap.
- J. Horizontal Backwater Valves: ASME A112.14.1, cast-iron body, with removable bronze swing-check valve and threaded or bolted cover.
  - 1. Open-Position Check Valve: Factory assembled or field modified to hang open unless subject to backflow condition.
  - 2. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor, instead of cover.

### 2.5 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
  - 1. General Use: 4 lb/sq. ft. or 0.0625-inch thickness.
  - 2. Vent Pipe Flashing: 3 lb/sq. ft. or 0.0469-inch thickness.
  - 3. Burning: 6 lb/sq. ft. or 0.0937-inch thickness.
- B. Copper Sheet: ASTM B 152, of the following minimum weights and thicknesses, unless otherwise indicated:
  - 1. General Applications: 12 oz./sq. ft.
  - 2. Vent Pipe Flashing: 8 oz./sq. ft.
- C. Zinc-Coated Steel Sheet: ASTM A 653, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

## SECTION 22 13 19 DRAINAGE PIPING SPECIALTIES

- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

### PART 3 - EXECUTION

#### 3.1 DRAINAGE PIPING SPECIALTY INSTALLATION

- A. General: Install drainage piping specialty components, connections, and devices according to manufacturer's written instructions.
- B. Install backwater valves in building drain piping as indicated. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install expansion joints on vertical risers, stacks, and conductors as indicated.
- D. Install cleanouts in aboveground piping and building drain piping as indicated, and where not indicated, according to the following:
  - 1. Size same as drainage piping up to 4-inch NPS. Use 4-inch NPS for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet for piping 4-inch NPS and smaller and 100 feet for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- E. Install cleanout deck plates, of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.
- F. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- G. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- H. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- I. Install floor drains according to manufacturer's written instructions, in locations indicated.
- J. Install floor drains at low points of surface areas to be drained as indicated. Set grates of drains flush with finished floor or as indicated. Size outlets as indicated.
- K. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- L. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
- M. Position floor drains for easy access and maintenance.
- N. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions and size outlets as indicated.
- O. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
- P. Position roof drains for easy access and maintenance.
- Q. Fasten wall-hanging drainage piping specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- R. Fasten recessed, wall-mounting drainage piping specialties to reinforcement built into walls.
- S. Install traps on drainage piping specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- T. Locate drainage piping as close as possible to bottom of floor slab supporting fixtures and drains.
- U. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- V. Include wood-blocking reinforcement for recessed and wall-mounting drainage piping specialties.

## SECTION 22 13 19 DRAINAGE PIPING SPECIALTIES

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping connections between drainage piping specialties and piping specified in other Division 22 Sections.
  - 2. Install piping connections indicated as indirect wastes from appliances and equipment specified in other Sections, to spill over receptors connected to plumbing piping systems.
- B. Install hoses between drainage piping specialties and appliances as required for connections.
- C. Arrange for electric-power connections to plumbing specialties and devices that require power. Electric power is specified in Division 26 Sections.
- D. Drainage Runouts to Drainage Piping Specialties: Install drainage and vent piping, with approved trap, of sizes indicated, but not smaller than required by authorities having jurisdiction.

### 3.3 FLASHING INSTALLATION

- A. Fabricate flashing manufactured from single piece unless large pans, sumps, or other drainage shapes are required.
- B. Burn joints of lead sheets where required.
- C. Solder joints of copper sheets where required.
- D. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- E. Set flashing on floors and roofs in solid coating of bituminous cement.
- F. Secure flashing into sleeve and specialty clamping ring or device.
- G. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00.
- H. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- I. Fabricate and install flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection if indicated.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of factory-authorized service representative to supervise the field assembly of components and installation of grease recovery units, including piping and electrical connections, and to report results in writing.
  - 1. Test and adjust drainage piping specialty controls and safeties. Replace damaged and malfunctioning controls and components.

### 3.5 START-UP PROCEDURES

- A. Before startup, perform the following checks:
  - 1. System tests are complete.
  - 2. Damaged and defective specialties and accessories have been replaced or repaired.
  - 3. Clear space is provided for servicing specialties.
- B. Before operating systems, perform the following steps:
  - 1. Close drain valves, hydrants, and hose bibbs.
  - 2. Open general-duty valves to fully open position.
  - 3. Remove and clean strainers.
  - 4. Verify that drainage and vent piping are clear of obstructions. Flush with water until clear.
  - 5. Fill grease interceptors with clean water.

## SECTION 22 13 19 DRAINAGE PIPING SPECIALTIES

- C. Startup Procedures: Follow manufacturer's written instructions. If no procedures are prescribed by manufacturer, proceed as follows:
  - 1. Energize circuits for electrically operated units. Start and run units through complete sequence of operations.

### 3.6 DEMONSTRATION

- A. Startup Services: Engage a factory-authorized service representative to perform startup services and train Owner's maintenance personnel as specified below:
  - 1. Train Owner's maintenance personnel on procedures and schedules related to startup of and servicing interceptors.
  - 2. Train Owner's maintenance personnel on procedures and schedules related to startup of and servicing grease recovery units.
  - 3. Review data in the maintenance manuals. Refer to Division 01.
  - 4. Schedule training with Owner with at least 7 days' advance notice.

### 3.7 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

## SECTION 22 33 00 DOMESTIC WATER HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following sections contain requirements that relate to this section.
  - 1. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hangers and pipe seismic restraints.
  - 2. Section 23 05 53 "Identification for Mechanical Piping and Equipment" for equipment tags and nameplates.
  - 3. Section 23 05 19 "Meters and Gages for Mechanical Piping" for temperature and pressure gages.
  - 4. Section 23 05 23 "General-Duty Valves for Mechanical Piping" for general duty valves.
  - 5. Section 23 07 13 "Pipe Insulation for Mechanical Systems."
  - 6. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for seismic restraint requirements.
  - 7. Section 22 11 16 "Water Distribution Piping."
  - 8. Section 22 11 23 "Plumbing Pumps" for circulating pumps.
  - 9. Section 23 22 13 "Steam and Condensate Heating Piping."
  - 10. Section 23 09 00 "Instrumentation and Controls for HVAC."
  - 11. Division 26 for electrical connections.

#### 1.2 SUMMARY

- A. This Section includes the following for domestic water systems:
  - 1. Semi-Instantaneous, steam water heaters.
  - 2. Expansion tanks.
  - 3. Accessories.

#### 1.3 SUBMITTALS

- A. General: See Section 01 33 00 "Submittal Procedures" for requirements. See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Semi-Instantaneous, steam water heaters.
  - 2. Expansion tanks.
  - 3. Accessories.
- C. Maintenance Data: For water heaters and heat exchangers to include in maintenance manuals specified in Section 01 78 23 "Operation & Maintenance Data."
- D. Warranties: Special warranties specified in this Section.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters and heat exchangers through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASME Compliance: Fabricate and label heat exchangers, water heaters, and hot-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
- D. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:
  - 1. ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," for commercial water heaters.

#### 1.5 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall

## SECTION 22 33 00 DOMESTIC WATER HEATERS

be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1. Warranty Period: From date of Substantial Completion:
  - a. Steam Water Heater Pressure Vessels and Anticipators: Ten years.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Semi-Instantaneous Steam Water Heaters:
    - a. Aerco International, Inc.
    - b. Cemline Corp.
    - c. Leslie Controls, Inc.
    - d. Patterson-Kelley Co.
    - e. PVI Industries, Inc.
    - f. RECO Industries, Inc.
    - g. Sellers Engineering Co.
  2. Expansion Tanks:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Taco, Inc.
    - d. Zurn Industries, Inc.; Wilkins Div.
    - e. Bell & Gossett.
  3. Water Heater Stand and Drain Pan Units:
    - a. Safety: W. H. Safety Products, Inc.

#### 2.2 SEMI-INSTANTANEOUS STEAM WATER HEATERS

- A. Description: Packaged, commercial, ASME labeled, indirect-fired, vertical U-tube, double-wall water heater with negligible storage capacity; and heat exchanger for heating water with steam. Semi-instantaneous design with service water in the shell and steam in the tubes. The ratio of hot water volume to steam volume shall be a minimum of 5:1.
- B. Pressure Vessel: ASME code, with 185-psig- minimum working-pressure rating at 400-degrees F. Include nozzle or other arrangement for heat exchanger. The water vessel shall be designed for an average water velocity of 5 feet per second, maximum. Maximum allowable water pressure drop shall not exceed 10 psi at design flow.
- C. U-Tube Coils: Double-wall copper tube bundle for steam, with atmospherically-vented, clearly labeled, visible leak detection port.
  1. Pressure Rating: ASME, 250-psig- minimum working-pressure rating at 400-degrees F.
  2. Tappings: Factory fabricated of materials compatible with water heater shell for piping connections, relief valve, pressure gage, thermometer, blowdown, vent, and controls as required. Attach tappings to shell before testing and labeling.
    - a. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1, pipe threads.
    - b. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
- D. Materials of Construction: All surfaces in contact with water shall be non-ferrous alloy.
  1. Shell: Type 304 stainless steel.
  2. Tubes: Outer wall 0.049" minimum copper and Inner wall 0.025" minimum copper.
  3. Upper Tubesheet: Passivated type 304 stainless steel.
  4. Lower Tubesheet: Carbon steel.
  5. Top Head: Bronze.
- E. Temperature Control: Adjustable anticipator thermostat that operates steam-control valve and that is capable of maintaining outlet-water temperature within 4 deg F of setting at all load conditions.

## SECTION 22 33 00 DOMESTIC WATER HEATERS

- F. Safety Control: Automatic, dual solenoid valve high-temperature-limit cutoff device system. Provide control panel with on/tripped status lights, thermometer for domestic water temperature indication, and compound steam pressure gauge. Provide dry contacts for high limit status indication for DDC system.
- G. Miscellaneous Components: Provide the following:
  - 1. Electronic steam control valve for 125-psig maximum steam pressure.
  - 2. Bronze T&P relief valve, 125-psig, conforming to ANSI Z21.22.
  - 3. Minimum 1-1/2" thick resilient insulation kit in accordance with ASHRAE 90.1 and local energy code requirements.
- H. Stand: Factory fabricated for floor mounting.

### 2.3 EXPANSION TANKS

- A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm and poly-propylene liner. Include air precharge to minimum system-operating pressure at tank.
- B. Construction: 150-psig working-pressure rating.
- C. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread, brass or stainless steel.
- D. Tank Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
- E. Tank Exterior Finish: Manufacturer's standard, unless finish is indicated.
- F. Air-Charging Valve: Factory installed, brass with plastic cap.
- G. Floor Mounting Stand: Provide integral floor mounting stand and bottom elbow system connection where vertical, floor-mounted tanks are indicated.

### 2.4 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: According to the following:
  - 1. Steam Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.
  - 2. Option: Separate temperature and pressure relief valves are acceptable instead of combination relief valve.
  - 3. Exception: Omit combination temperature and pressure relief valve for tankless water heater, and furnish pressure relief valve for installation in piping.
- B. Pressure Relief Valves: According to the following:
  - 1. Steam Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than heat-exchanger working-pressure rating.
- C. Vacuum Relief Valves: According to the following:
  - 1. Steam Water Heaters: Comply with ASME PTC 25.3. Furnish for installation in piping.
  - 2. Exception: Omit if water heater has integral vacuum-relieving device.
- D. Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
- E. Water Heater Stands: Water heater manufacturer's factory-fabricated, steel stand for floor mounting and capable of supporting water heater and water.
- F. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.
- G. Hose and Drain Valve: Provide with water heater.
- H. Install restraints as required for seismic zone.
- I. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE 90.1 or ASHRAE 90.2.

## PART 3 - EXECUTION

### 3.1 WATER HEATER AND HEAT EXCHANGER INSTALLATION

- A. Install water heaters and heat exchangers on concrete bases.

## SECTION 22 33 00 DOMESTIC WATER HEATERS

- B. Install water heaters and heat exchangers, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Anchor water heaters and heat exchangers to substrate.
- D. Install seismic restraints for water heaters and heat exchangers. Anchor to substrate.
- E. Install pressure relief valves in water piping for water heaters without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.
- F. Install water heater drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains.
- G. Install thermometers on heat exchanger inlet and outlet piping.
- H. Install pressure gages on water heater and heat exchanger piping.
- I. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet.
- J. Arrange for insulation on equipment and piping not furnished with factory-applied insulation.
- K. Fill water heaters and heat exchangers with water prior to activation.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 21, 22, and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union.
- D. Make connections with dielectric fittings where piping is made of dissimilar metal.
- E. Electrical Connections: Power wiring and disconnect switches are specified in Division 26 Sections. Arrange wiring to allow unit service. Ground equipment.

### 3.3 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.
- B. In addition to manufacturer's written installation and startup checks, perform the following:
  - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.
  - 2. Verify that piping system tests are complete.
  - 3. Check for piping connection leaks.
  - 4. Check for clear relief valve inlets, outlets, and drain piping.
  - 5. Check operation of circulators.
  - 6. Test operation of safety controls, relief valves, and devices.
  - 7. Energize electric circuits.
  - 8. Adjust operating controls.
  - 9. Adjust hot-water-outlet temperature settings. Do not set above 120 deg F unless piping system application requires higher temperature.
  - 10. Balance water flow through manifolds of multiple-unit installations.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water heaters and heat exchangers.
  - 1. Train Owner's maintenance personnel on procedures for starting and stopping troubleshooting, servicing, and maintaining equipment.
  - 2. Review data in maintenance manuals. Refer to Section 01 77 00 "Closeout Procedures."

SECTION 22 33 00 DOMESTIC WATER HEATERS

3. Schedule 8 hours of training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION



## SECTION 22 40 00 PLUMBING FIXTURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Section 23 05 23 "General-Duty Valves for Mechanical Piping" for general-duty valves used as supply stops.
  - 2. Section 22 11 19 "Water Distribution Piping Specialties" for backflow preventers and other specialties not specified in this Section.
  - 3. Section 23 07 13 "Pipe Insulation for Mechanical Systems" for piping.
  - 4. Section 22 13 16 "Drainage and Vent Piping" for pipe and fittings.
  - 5. Section 22 11 16 "Water Distribution Piping" for pipe and fittings.
  - 6. Division 26 "Electrical" for wiring for electrical appurtenances.

#### 1.2 SUMMARY

- A. This Section includes plumbing fixtures and trim, faucets, other fittings, and related components.

#### 1.3 DEFINITIONS

- A. Accessible: Plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped, disabled, and elderly people.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, showerheads and tub spouts, drains and tailpieces, traps and waste pipes. Pipe fittings, tube fittings, and general-duty valves are included where indicated.

#### 1.4 SUBMITTALS

- A. General: Submit each item in this Article according to Specification Section 01 33 00 "Submittal Procedure."
- B. Product Data for each plumbing fixture category and type specified. Include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- C. Wiring diagrams from manufacturer for electrically operated units.
- D. Maintenance data for plumbing fixtures and components to include in the operation and maintenance manuals specified in Section 01 78 23 "Operation & Maintenance Data."

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category from one source and by a single manufacturer.
  - 1. Exception: Where fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for this category.
- B. Regulatory Requirements: Comply with requirements of CABO/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; regarding plumbing fixtures for physically handicapped people.
- C. Energy Policy Act Requirements: Comply with requirements of Public Law 102-486, "Energy Policy Act," regarding water flow rate and water consumption of plumbing fixtures.
- D. Backflow Prevention Requirements: Comply with the requirements of Washington State Department of Health regulation for "Backflow Prevention Assemblies Approved for Installation in Washington State".
- E. Listing and Labeling: Provide electrically operated fixtures and components specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

## SECTION 22 40 00 PLUMBING FIXTURES

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
  - F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- 1.6 DELIVERY, STORAGE, AND HANDLING
    - A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.
    - B. Store plumbing fixtures on elevated platforms in dry location.
  - 1.7 PROJECT CONDITIONS
    - A. Field Measurements: Coordinate roughing-in and final fixture locations and verify that plumbing fixtures can be installed to comply with original design and referenced standards.

### PART 2 - PRODUCTS

#### 2.1 PLUMBING FIXTURE STANDARDS

- A. Comply with applicable standards below and other requirements specified.
  1. Electric Water Coolers: ARI 1010 and UL 399.
  2. Emergency Equipment: ANSI Z358.1.
  3. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
  4. National Sanitation Foundation Construction: NSF 2.
  5. Stainless-Steel Fixtures Other than Service Sinks: ASME A112.19.3M.
  6. Vitreous-China Fixtures: ASME A112.19.2M.
  7. Water-Closet, Flush Valve: ASME A112.19.5.

#### 2.2 LAVATORY/SINK FAUCET STANDARDS

- A. Comply with ASME A112.18.1M and other requirements specified for lavatory, sink, and similar-type-fixture faucet fittings. Include hot- and cold-water indicators; 2.5-gpm- maximum flow rate; and polished, chrome-plated finish; except where otherwise indicated. Coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.
  1. Faucet Hose: ASTM D 3901.
  2. Hose-Connection Vacuum Breakers: ASSE 1011.
  3. Hose-Coupling Threads: ASME B1.20.7.
  4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
  5. Pipe Threads: ASME B1.20.1.
  6. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

#### 2.3 SHOWER FAUCET STANDARDS

- A. Comply with ASME A112.18.1M and other requirements specified for bathtub and shower faucet fittings. Include hot- and cold-water indicators; 2.5-gpm- maximum flow rate; and polished, chrome-plated finish; except where otherwise indicated. Coordinate faucet inlets with supplies and outlet with diverter valve; tub spout; and shower head, arm, and flange.
  1. Combination, Pressure-Equalizing- and Thermostatic-Control, Antiscald Faucets: ASSE 1016.
  2. Hand-Held Showers: ASSE 1014.
  3. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
  4. Hose-Coupling Threads: ASME B1.20.1 or ASME B1.20.7.
  5. Manual-Control Antiscald Faucets: ASTM F 444.
  6. Pipe Threads: ASME B1.20.1.

#### 2.4 MISCELLANEOUS FITTING STANDARDS

- A. Comply with ASME A112.18.1M and other requirements specified for fittings, other than faucets. Include polished, chrome-plated finish, except where otherwise indicated. Coordinate fittings with other components and connectors.
  1. Atmospheric Vacuum Breakers: ASSE 1001.

## SECTION 22 40 00 PLUMBING FIXTURES

2. Automatic Flow Restrictors: ASSE 1028.
3. Brass and Copper, Supplies and Tubular Brass: ASME A112.18.1M.
4. Fixed Flow Restrictors: ASSE 1034.

### 2.5 MISCELLANEOUS COMPONENT STANDARDS

- A. Comply with applicable standards below and other requirements specified for components for plumbing fixtures, equipment, and appliances.
1. Hose-Coupling Threads: ASME B1.20.7.
  2. Hot-Water Dispensers: ASSE 1023 and UL 499.
  3. Pipe Threads: ASME B1.20.1.
  4. Plastic Toilet Seats: ANSI Z124.5.
  5. Supply and Drain Insulation Kits: CABO/ANSI A117.1.
  6. Supports: ASME A112.6.1M.

### 2.6 FITTINGS

- A. Fittings for Equipment Specified in Other Sections: Fittings include the following:
1. Supply Inlets: Brass pipe or copper tube, size required for final connection.
  2. Supply Stops: Chrome-plated brass, angle or straight; compression, loose-key type, same size as supply inlet and with outlet matching supply riser.
  3. Supply Risers: flexible copper tube with knob end. Use chrome-plated tube for exposed applications.
  4. Traps: 0.045-inch thick tubular brass, slip-joint inlet, cleanout, wall flange, escutcheons, and size to match equipment. Use chrome-plated tube for exposed applications.
  5. Continuous Waste: Tubular brass with slip-joint inlet, and size to match equipment.
  6. Indirect Waste: Tubular brass size to match equipment.

### 2.7 FIXTURE LISTING

- A. Refer to attached plumbing fixture data sheets for fixture and trim callouts.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and locations and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Include supports for plumbing fixtures according to the following:
1. For wall hung water closets, urinals, lavatories, sinks, drinking fountains, and electric water coolers where indicated.
  2. Reinforcement: For floor-mounted lavatories and sinks that require securing to wall and recessed, box-mounted, electric water coolers.
  3. Fabricate reinforcement from 2-by-4-inch or 1/4-by-6-inch steel plates attached to studs, in wall construction, to secure fixtures to wall. Include length that will extend beyond ends of fixture mounting bracket and attach to at least 2 studs.
- B. Include fitting insulation kits for accessible fixtures according to the following:
1. Lavatories: Cover hot- and cold-water, and tempered water supplies, stops and handles, drain, trap, and waste to wall.
  2. Sinks: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.
  3. Fixtures with Offset Drain: Cover hot- and cold-water supplies, offset drain, trap, and waste to wall.
  4. Other Fixtures: Cover exposed fittings below fixture.

SECTION 22 40 00 PLUMBING FIXTURES

3.3 PLUMBING FIXTURE INSTALLATION

- A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.
- B. Install fixtures level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.
- C. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gage.
- D. Install toilet seats on water closets.
- E. Install wall-hanging, back-outlet urinals with gasket seals.
- F. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for handicapped people to reach.
- G. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- H. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- I. Fasten recessed, wall-mounted fittings to reinforcement built into walls.
- J. Fasten wall-mounted fittings to reinforcement built into walls.
- K. Fasten counter-mounting plumbing fixtures to casework.
- L. Secure supplies to supports or substrate within pipe space behind fixture.
- M. Set shower receptors and mop basins in leveling bed of cement grout.
- N. Install individual stop valve in each water supply to fixture. Use gate or globe valve where specific stop valve is not specified.
  - 1. Exception: Omit stop valves on supplies to emergency equipment, except when permitted by authorities having jurisdiction. When permitted, install valve chained and locked in OPEN position.
- O. Install water-supply stop valves in accessible locations.
- P. Install faucet, laminar-flow fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.
- Q. Install supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- R. Aerators are not allowed.
- S. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.
- T. Install shower, flow-control fittings with specified maximum flow rates in shower arms. Install in-line check valves on the water supplies to the mixing valve. Check valve size shall match rough-in size.
- U. Install in-line check valves on the water supplies to electronic faucet mixing valve. Check valve size shall match rough-in size.
- V. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.
- W. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.
- X. Install hose bibs with integral or field-installed vacuum breaker.
- Y. Install wall hydrants with integral or field-installed vacuum breaker.
- Z. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.
- AA. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant according to sealing requirements specified in Division Section "Joint Sealants." Match sealant color to fixture color.
- BB. Coordinate exact location and mounting height of all fixtures with the architectural drawings.
- CC. Caulk around the top joint of all wall mounted fixtures to prevent water from getting between the fixture and the wall.

## SECTION 22 40 00 PLUMBING FIXTURES

### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other Division 22 Sections.
- B. Supply and Waste Connections to Plumbing Fixtures: Refer to plumbing fixture schedule on drawings for fitting sizes and connection requirements for each plumbing fixture.
- C. Supply and Waste Connections to Equipment Specified in Other Sections: Connect equipment with supply inlets, supply stops, supply risers, and traps specified in this Section. Use fitting sizes required to match connected equipment. Connect fittings to plumbing piping.
- D. Ground equipment.
  - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Arrange for electric-power connections to fixtures and devices that require power. Electric power is specified in Division 26 Sections.

### 3.5 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized and demonstrate proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

### 3.6 ADJUSTING AND CLEANING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust hot-water dispensers, and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at electric water coolers, faucets, shower valves, and flush valves having controls, to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Include the following:
  - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
  - 2. Remove sediment and debris from drains.

### 3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities, except when approved in writing by Owner.

### 3.8 PLUMBING FIXTURE SCHEDULE

- A. Refer to Plumbing Fixture Data Sheets at the end of this section.
- B. Provide all options and accessories as indicated.

END OF SECTION



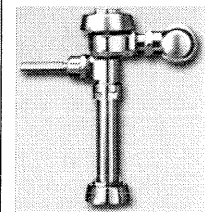
<b>Plumbing Fixture Data Sheet</b>	<b>Water Closet – Wall Mounted</b>	<b>P1A</b>
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**Manufacturer:** Kohler Model K-4330.  
**Material:** Vitreous china.  
**Type:** 1-1/2-inch top spud, elongated bowl, 1.6 gpf down, 1.0 gpf up, siphon jet.  
**Mounting:** Wall mounted.

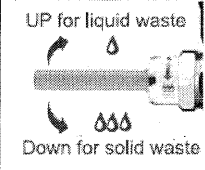


**Accessories:**

**Flushometer**

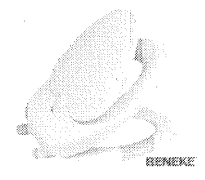


Quiet, exposed, diaphragm type, chrome plated, vandal resistant stop cap, adjustable tailpiece, high back pressure vacuum breaker flush connection, 1.6 gpf. Sloan WES Model 111.



Provide with antimicrobial coated dual flush handle. Provide manufacturer's etched metal instruction plates. Sloan Uppercut.

**Toilet Seat**



Combination juvenile/adult seat by Beneke for elongated toilets

**Support**

Adjustable fixture support for siphon jet water closets, no-hub horizontal fitting, extra heavy duty. Jay R. Smith Model 0210Y-M45-XX.

Plumbing Fixture Data Sheet	Water Closet – Wall Mounted	P1B
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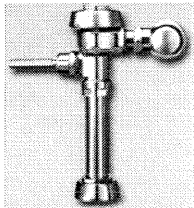
**Manufacturer:** Kohler Model K-4330.  
**Material:** Vitreous china.  
**Type:** 1-1/2-inch top spud, elongated bowl, 1.6 gpf down, 1.0 gpf up, siphon jet.  
**Mounting:** Wall mounted.



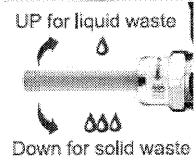
*Picture shown may not include all options and accessories indicated*

**Accessories:**

**Flushometer**



Quiet, exposed, diaphragm type, chrome plated, vandal resistant stop cap, adjustable tailpiece, high back pressure vacuum breaker flush connection, 1.6 gpf. Sloan WES Model 111.



Provide with antimicrobial coated dual flush handle. Provide manufacturer's etched metal instruction plates. Sloan Uppercut.

**Toilet Seat**

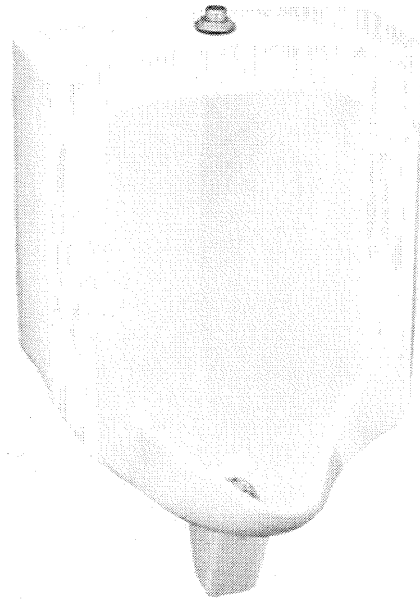
Elongated open front seat (with anti-microbial agent), less cover, check hinges. Bemis Model 3155C.

**Support**

Adjustable fixture support for siphon jet water closets, no-hub horizontal fitting, extra heavy duty. Jay R. Smith Model 0210Y-M45-XX.

Plumbing Fixture Data Sheet	Urinal – Wall Mounted	P2A
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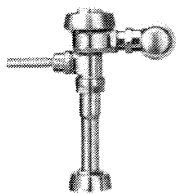
**Manufacturer:** Kohler Model K-4960-ET.  
**Material:** Vitreous china.  
**Bowl Type:** Washout, 3/4" top spud, 0.5 gpf, 14" extended rim, 2" outlet spud, strainer, two hangers.  
**Mounting:** Wall mounted.  
**Options:** White.



*Picture shown may not include all options and accessories indicated*

**Accessories:**

**Flush Valve**

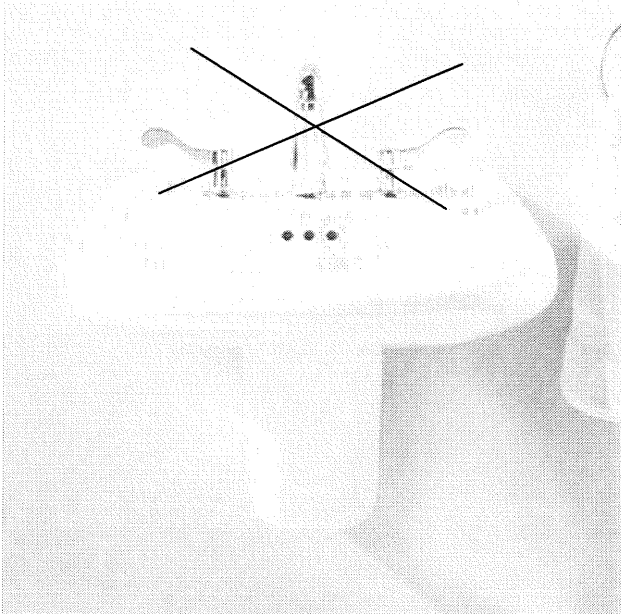


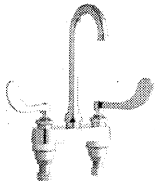
Quiet, exposed, diaphragm type, chrome plated flushometer for 3/4" top spud urinals, free spinning vandal resistant stop cap, adjustable tailpiece, high back pressure vacuum breaker flush connection, spud coupling and flange, non-hold-open handle, fixed metering bypass and no external volume adjustment to ensure water conservation, 3/4" I.P.S. Screwdriver Bak-Chek™ angle stop. Sloan Valve Royal II Model 186-0.5.

**Support**

Labor saver urinal supports for off-the-floor urinals with plate for blowout and washout urinals with wall hangers. Jay R. Smith Model No. 0617.

Plumbing Fixture Data Sheet	Lavatory – Wall Mounted	P3A
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<p><b>Manufacturer:</b> American Standard Model 0954.000.</p> <p><b>Material:</b> Vitreous china.</p> <p><b>Type:</b> Barrier free, rear overflow, recessed self-draining deck, 4" centers, 22"x21-1/4", ADA compliant.</p> <p><b>Mounting:</b> Wall mounted.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>
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**Accessories:****Faucet**

Deck mounted lavatory faucet, rigid/swing gooseneck spout, 317 indexed wristblade handles, chrome plate finish, 1.6 gpm, laminar flow spout base, plain end 5-3/8" spout. Chicago Faucet Model 895-317FC-GN2JKCP. Provide with plain end spout ring, fits spouts with 13/16" – 24 male outlet threads, 13/16" – 24 female inlet thread. Chicago Faucet Model 1-159JKCP.

**Drain**

Standard lavatory chrome plate finish grid strainer.

**P-Trap**

1-1/4" trap.

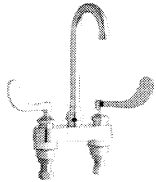
**Supply Cover**

Waste and water piping covers, vitreous china shroud/knee contact guard. American Standard Model 0059.020.

**Support**

Lavatory support with concealed arms, wall mounted. Jay R. Smith Model 0722.

Contractor to coordinate with GC. Refer to Architectural for sink type and installation.

**Accessories:****Faucet**

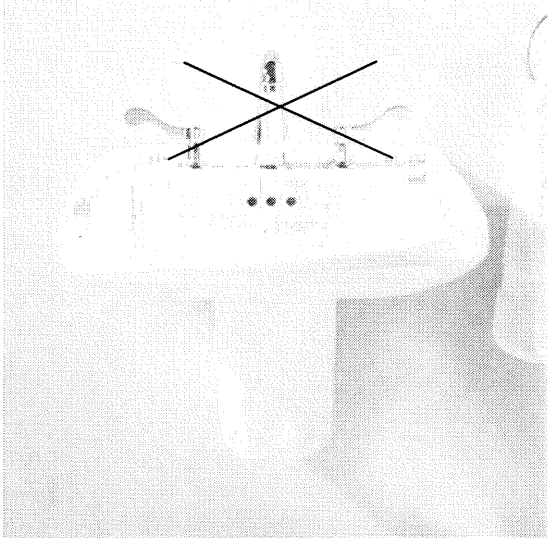
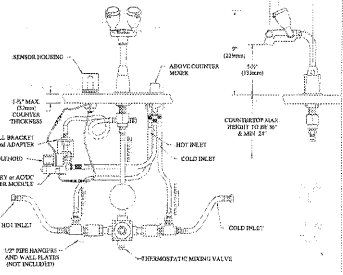
Deck mounted lavatory faucet, rigid/swing gooseneck spout, 317 indexed wristblade handles, chrome plate finish, 1.6 gpm, laminar flow spout base, plain end 5-3/8" spout. Chicago Faucet Model 895-317FC-GN2JKCP. Provide with plain end spout ring, fits spouts with 13/16" – 24 male outlet threads, 13/16" – 24 female inlet thread. Chicago Faucet Model 1-159JKCP.

**Drain**

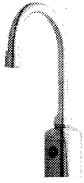
Standard chrome plate finish lavatory grid strainer, coordinate size with Architectural sink.

**P-Trap**

Kohler Model K-8998.

Plumbing Fixture Data Sheet	Lavatory – Wall Mounted	P3C
<p><b>Manufacturer:</b> American Standard Model 0955.000</p> <p><b>Material:</b> Vitreous china.</p> <p><b>Type:</b> Barrier free, rear overflow, recessed self-draining deck, 8" centers, 22"x21-1/4", ADA compliant.</p> <p><b>Mounting:</b> Wall mounted.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	
<p><b>Accessories:</b></p> <p><b>Faucet, Eye/Face Wash, and Mixing Valve</b></p> <p>8" Gooseneck faucet with an independently operated eyewash, infrared sensor, twin aerated sprays and flip-top dust covers, AD/DC adapter, addition of SE-370 thermostic mixing valve with check valves. Speakman Model SEF-1824-TW. Sensor shall include transformer for line-voltage connection. Provide spring back check valves on hot and cold inlets, Sloan Valve Model 3365001.</p>  <p><b>Drain</b></p> <p>Standard lavatory grid strainer.</p> <p><b>P-Trap</b></p> <p>Kohler Model K-8998.</p> <p><b>Supply Cover</b></p> <p>Waste and water piping covers, vitreous china shroud/knee contact guard. American Standard Model 0059.020.</p> <p><b>Support</b></p> <p>Lavatory support with concealed arms, wall mounted. Jay R. Smith Model 0722.</p>		

Contractor to coordinate with GC. Refer to Architectural for sink type and installation

**Accessories:****Faucet**

Single hole, gooseneck deck mount, electronic sink fitting with dual beam infrared sensor, cast brass 5-3/8" spout, 12 Volt AC transformer required, single supply for tempered water, chrome plate finish, multiple field adjustable modes and ranges, 0.5 gpm vandal resistant spray outlet, without aerator option. Chicago Faucet Model 116.103.21.1. Provide spring back check valves on hot and cold inlets, Sloan Valve Model 3365001.

**Drain**

Standard chrome plate finish lavatory grid strainer, coordinate size with Architectural sink.

**P-Trap**

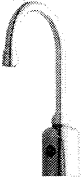
Kohler Model K-8998.

**Supply Cover**

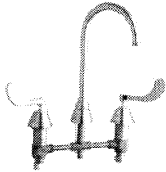
Waste and supply piping covers. Truebro Model Lav Guard 2.

**Support**

Lavatory support with concealed arms, wall mounted. Jay R. Smith Model 0722.

Plumbing Fixture Data Sheet	Lavatory – Wall Mounted	P3E
Contractor to coordinate with GC. Refer to Architectural for sink type and installation		
<p><b>Accessories:</b></p> <p><b>Faucet</b></p>  <p>Single hole, gooseneck deck mount, electronic sink fitting with dual beam infrared sensor, cast brass 5-3/8" spout, 12 Volt AC transformer required, single supply for tempered water, chrome plate finish, multiple field adjustable modes and ranges, 0.5 gpm vandal resistant spray outlet, without aerator option. Chicago Faucet Model 116.103.21.1. Provide spring back check valves on hot and cold inlets, Sloan Valve Model 3365001.</p> <p><b>Drain</b></p> <p>Standard chrome plate finish lavatory grid strainer, coordinate size with Architectural sink.</p> <p><b>P-Trap</b></p> <p>Kohler Model K-8998.</p> <p><b>Supply Cover</b></p> <p>Waste and supply piping covers. vitreous china shroud/knee contact guard. American Standard Model 0059.020.</p> <p><b>Support</b></p> <p>Lavatory support with concealed arms, wall mounted. Jay R. Smith Model 0722.</p>		

Contractor to coordinate with GC. Refer to Architectural for sink type and installation  
(11-1/2"x14-3/4"x7" Griform ref # MBRC12157)

**Accessories:****Faucet**

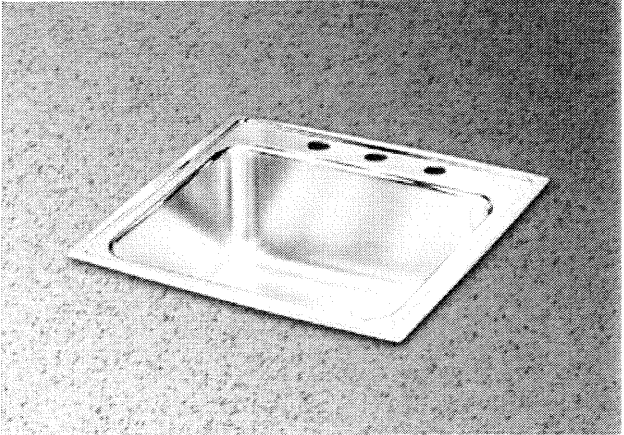
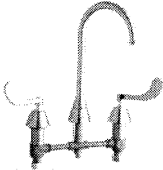
Deck mounted faucet, rigid/swing gooseneck spout, 317 indexed wristblade handles, chrome plate finish, laminar flow spout base, plain end 5-3/8" spout, 1.6 gpm. Chicago Faucet Model 786-GN2FCXK.

**Drain**

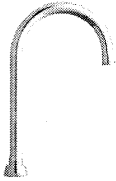
Standard sink strainer. Elkay Model LKS35.

**Supply Cover**

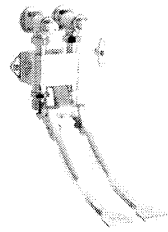
Waste and supply piping covers. Truebro Model Lav Guard 2.

Plumbing Fixture Data Sheet	Sink – Single Compartment	P4B
<p><b>Manufacturer:</b> Elkay Model LR1722.</p> <p><b>Material:</b> 18 gauge, 304 stainless steel.</p> <p><b>Type:</b> Self-rimming, 17" x 22" x 7-5/8" deep.</p> <p><b>Mounting:</b> Counter mounted.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	
<p><b>Accessories:</b></p> <p><b>Faucet</b></p>  <p>Deck mounted faucet, rigid/swing gooseneck spout, 317 indexed wristblade handles, chrome plate finish, laminar flow spout base, plain end 5-3/8" spout, 1.6 gpm, 4" centers. Chicago Faucet Model 786-GN2FCCP.</p> <p><b>Drain</b></p> <p>Standard sink strainer. Elkay Model LKS35.</p>		

Contractor to coordinate with GC. Refer to Architectural for sink type and installation

**Accessories:*****Faucet and Foot Pedals***

Rigid/swing gooseneck spout, laminar flow spout base, plain end, 9 3/4" height to top of spout, 5 1/4" inlet to outlet projection, 6 1/8" height to outlet, accepts 13/16" - 24 female outlet, thread ring cover, chrome plate. Chicago Faucet Model GN2AFCJKCP, include flow at base.



Combination pedal box, adjustable SLO closing cartridge, extended pedals, wall mounted. Chicago Faucet Model 834-EPSLOCP.

***Drain***

Standard sink strainer. Elkay Model LKS35.

***Supply Cover***

Protective undersink pipe covers and plumbing enclosures from Truebro for ADA compliance in handicap-accessible lavatories and sinks.

Contractor to coordinate with GC. Refer to Architectural for sink type and installation.

### Accessories:

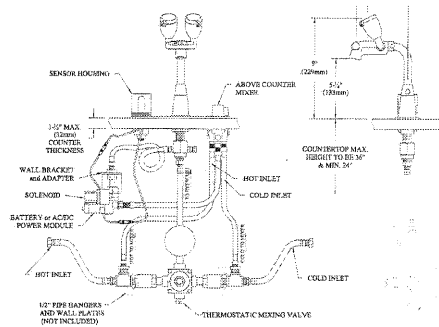
#### **Faucet, Foot Pedals, Eye/Face Wash, and Mixing Valve**



Gooseneck faucet with an independently operated eyewash, twin aerated sprays and flip-top dust covers, vandal resistant 0.5 gpm flow control, addition of SE-370 thermostatic mixing valve with check valves. Speakman Model SEF-1824-TW.



Combination pedal box, adjustable SLO closing cartridge, extended pedals, wall mounted. Chicago Faucet Model 834-EPSLOCP.



#### **Drain**

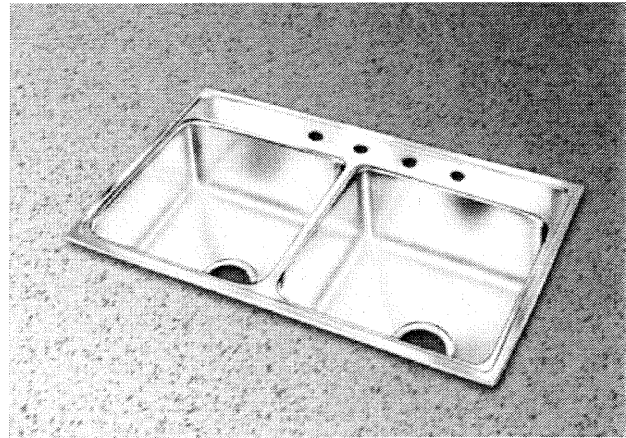
Standard sink strainer. Elkay Model LKS35.

#### **Supply Cover**

Protective undersink pipe covers and plumbing enclosures from Truebro for ADA compliance in handicap-accessible lavatories and sinks.

Plumbing Fixture Data Sheet	Sink – Double Compartment	P4E
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**Manufacturer:** Elkay Model LR3321.  
**Material:** 18 gauge, 304 stainless steel.  
**Type:** Self-rimming, 33" x 21" x 8" deep.  
**Mounting:** Counter mounted.



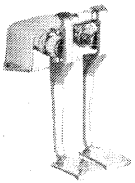
*Picture shown may not include all options and accessories indicated*

**Accessories:**

**Faucet and Foot Pedals**



Rigid/swing gooseneck spout, laminar flow spout base, plain end, 11-1/4" to top of spout, 8" inlet to outlet projection, 6-1/8" height to outlet, chrome plate. Chicago Faucet Model GN8JKCP.



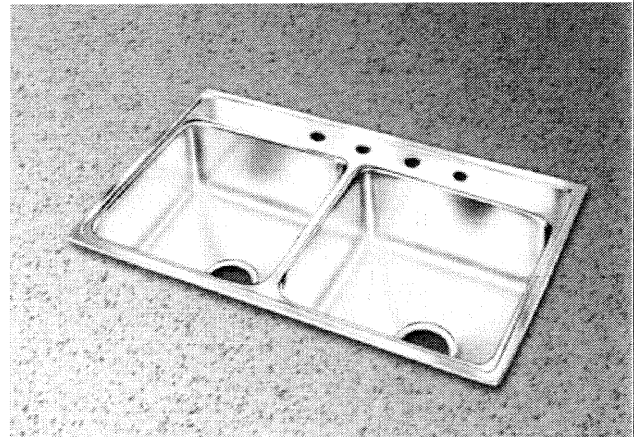
Combination pedal box, extended pedals, adjustable SLO closing cartridge, loose key angle inlet service stops. Chicago Model 625-LPSLO.

**Drain**

Standard sink strainer. Elkay Model LKS35.

Plumbing Fixture Data Sheet	Sink –Double Compartment	P4F
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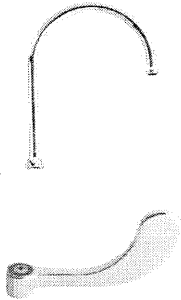
**Manufacturer:** Elkay Model DLR332212.  
**Material:** 18 gauge, 304 stainless steel.  
**Type:** Self-rimming, 33" x 22" x 12" deep.  
**Mounting:** Counter mounted.



*Picture shown may not include all options and accessories indicated*

**Accessories:**

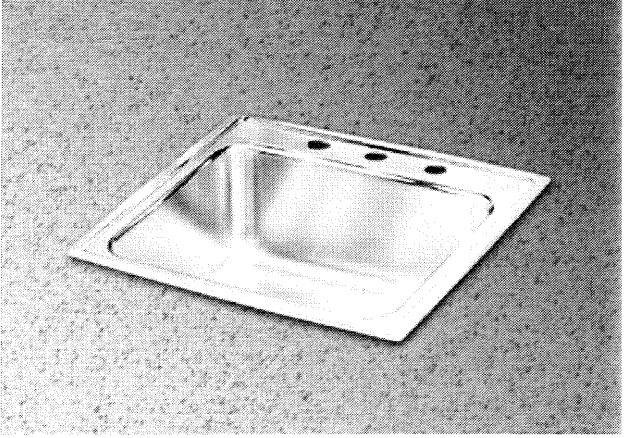
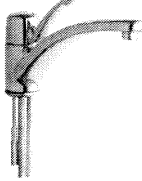
**Faucet**



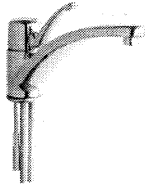
Rigid/swing gooseneck spout, laminar flow spout base, plain end, 11-1/4" to top of spout, 8" inlet to outlet projection, 6-1/8" height to outlet, chrome plate. 317 indexed wristblade handles. Chicago Faucet Model GN8FCJKCP-317.

**Drain**

Standard sink strainer. Elkay Model LKS35.

Plumbing Fixture Data Sheet	Sink – Single Compartment	P4G
<p><b>Manufacturer:</b> Elkay Model LR1722.</p> <p><b>Material:</b> 18 gauge, 304 stainless steel.</p> <p><b>Type:</b> Self-rimming, 17" x 22" x 7-5/8" deep.</p> <p><b>Mounting:</b> Counter mounted.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	
<p><b>Accessories:</b></p> <p><b>Faucet</b></p>  <p>Deck mounted fitting, 10" cast brass spout, metal lever handle, temperature limit stop, volume control, Only in Lounge Areas – E29 laminar flow outlet, otherwise, provide with plain end spout ring, fits spouts with 13/16" – 24 male outlet threads, 13/16" – 24 female inlet thread, Chicago Faucet Model 1-159JKCP. Chicago Faucet Model 2300-CP.</p> <p><b>Drain</b></p> <p>Standard sink strainer. Elkay Model LKS35.</p>		

Contractor to coordinate with GC. Refer to Architectural for sink type and installation.

**Accessories:****Faucet**

Deck mounted fitting, 10" cast brass spout, metal lever handle, temperature limit stop, plain end spout. Chicago Faucet Model 2300-CP.

**Drain**

Standard sink strainer. Elkay Model LKS35.

Contractor to coordinate with GC. Refer to Architectural for sink type and installation.

**Accessories:*****Faucet, Eye/Face Wash, and Mixing Valve***

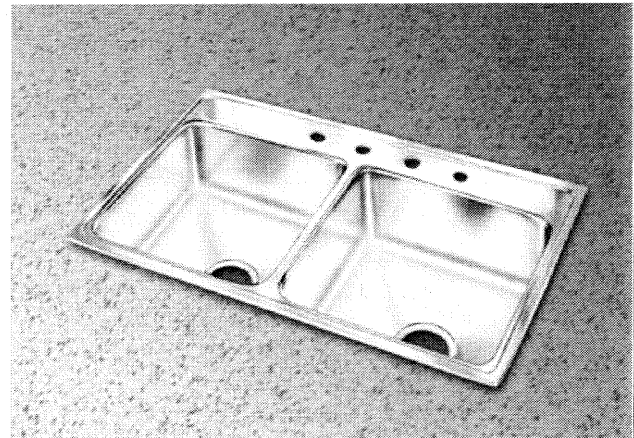
Gooseneck faucet with an independently operated eyewash, twin aerated sprays and flip-top dust covers, 8" gooseneck, vandal resistant 0.5 gpm flow control, vandal resistant 4" wrist blade handles with color-coded indexes, addition of SE-370 thermostic mixing valve with check valves. Speakman Model SEF-1800-BO-TW.

***Drain***

Standard sink strainer. Elkay Model LKS35.

Plumbing Fixture Data Sheet	Sink – Double Compartment	P4K
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**Manufacturer:** Elkay Model DLR332212.  
**Material:** 18 gauge, 304 stainless steel.  
**Type:** Self-rimming, 33" x 22" x 12" deep, 4 hole drilling.  
**Mounting:** Counter mounted.



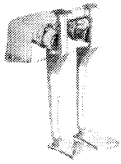
*Picture shown may not include all options and accessories indicated*

#### Accessories:

##### Faucet and Foot Pedals

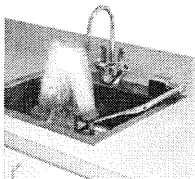


Rigid/swing gooseneck spout, laminar flow spout base, plain end spout, 11-1/4" to top of spout, 8" inlet to outlet projection, 6-1/8" height to outlet, chrome plate. Chicago Faucet Model GN8FCJKCP.



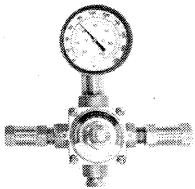
Combination pedal box, extended pedals, adjustable SLO closing cartridge, loose key angle inlet service stops. Chicago Model 625-LPSLO.

##### Eye/Face Wash



Sink or countertop mounted polished chrome-plated brass single action swing-down to activate eye/face wash that features twin ABS Feather-Flo® heads. This model is designed for barrier-free access. Supply: 1/2" O.D. slip joint. Haws Model 7610WC.

##### Thermostatic Mixing Valve



Thermostatic mixing valve that mixes hot and cold water to supply tempered water to fixtures requiring flow up to 7gpm @ 30 psi pressure drop. The unit employs a thermostatic mixing element and includes an outlet temperature gauge. Haws Model 9201EF.

##### Drain

Standard sink strainer. Elkay Model LKS35.

Plumbing Fixture Data Sheet	Service Sink – Wall Mounted	P4L
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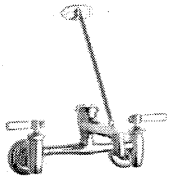
**Manufacturer:** Just Model A18665.  
**Material:** Stainless steel.  
**Type:** 14-gauge, type 304 stainless steel, two stainless steel wall brackets, one stainless steel wall clip.  
**Mounting:** Wall mounted.



*Picture shown may not include all options and accessories indicated*

**Accessories:**

**Faucet**



Wall mounted fitting, vacuum breaker spout with pail hook and wall brace, 3/4" male hose thread outlet, 369 handles, adjustable supply arm, 1/2" NPT female union nut inlets, 5/6" hex. Integral supply stops. Chicago Faucet Model 897-CP.

Mount on wall above sink.

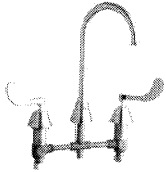
**Support**

Service sink support system, dura-coated rectangular steel uprights with welded feet, adjustable face plate and upper support plate, adjustable corrosion resistant coupling. Zurn Model Z-1218, or equivalent of Josam or Jay R. Smith.

**Drain**

Just Model J-35.

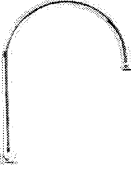
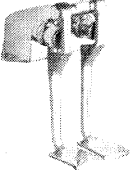
Contractor to coordinate with GC. Refer to Architectural for sink type and installation.

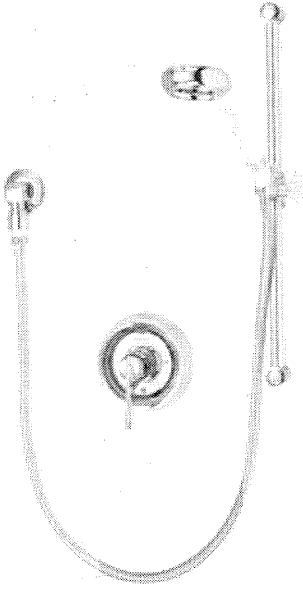
**Accessories:****Faucet**

Deck mounted faucet, rigid/swing gooseneck spout, 317 indexed wristblade handles, chrome plate finish, laminar flow spout base, plain end 5-3/8" spout, 1.6 gpm. Chicago Faucet Model 786-GN2FCXK.

**Drain**

Standard sink strainer. Elkay Model LKS35.

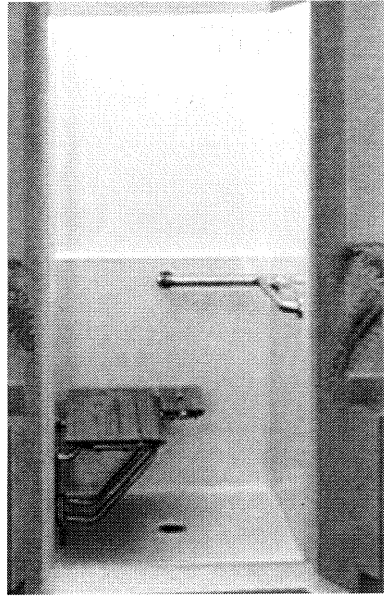
Plumbing Fixture Data Sheet	Sink – Double Compartment	P4N
<p>Contractor to coordinate with GC. Refer to Architectural for sink type and installation</p>		
<p><b>Accessories:</b></p> <p><b><i>Faucet and Foot Pedals</i></b></p> <p> Rigid/swing gooseneck spout, laminar flow spout base, plain end, 11-1/4" to top of spout, 8" inlet to outlet projection, 6-1/8" height to outlet, chrome plate. Chicago Faucet Model GN8JKCP.</p> <p> Combination pedal box, extended pedals, adjustable SLO closing cartridge, loose key angle inlet service stops. Chicago Model 625-LPSLO.</p> <p><b><i>Drain</i></b></p> <p>Standard sink strainer. Elkay Model LKS35.</p>		

Plumbing Fixture Data Sheet	Shower Fittings	P5A
<p><b>Manufacturer:</b> Symmons Model 1-25-FSB.</p> <p><b>Type:</b> Safetymix pressure balancing mixing valve, color coded index, with adjustable stop screw to limit handle turn. All chrome plate finish, wall/hand shower with flexible metal hose, in-line vacuum breaker, wall connection and flange. 30" slide bar for hand shower mounting. Provide spring check valves on inlet, hot and cold water back check valves. Sloan Model 3365001.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	

Plumbing Fixture Data Sheet	Shower	P5B
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**Manufacturer:** Fiber Fab Model 38 H1.

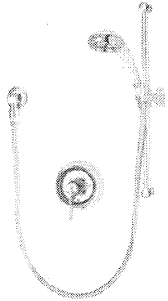
**Type:** One-piece construction, fold-down seat, stainless steel support tubing, 1-1/4" L-shaped stainless steel grab bar, Full-width soap and shampoo ledge across the back wall. Pre-installed curtain rod.



*Picture shown may not include all options and accessories indicated*

**Accessories:**

**Shower Fittings**

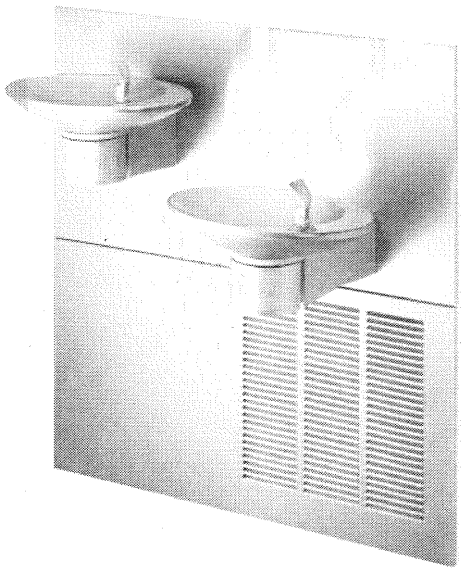


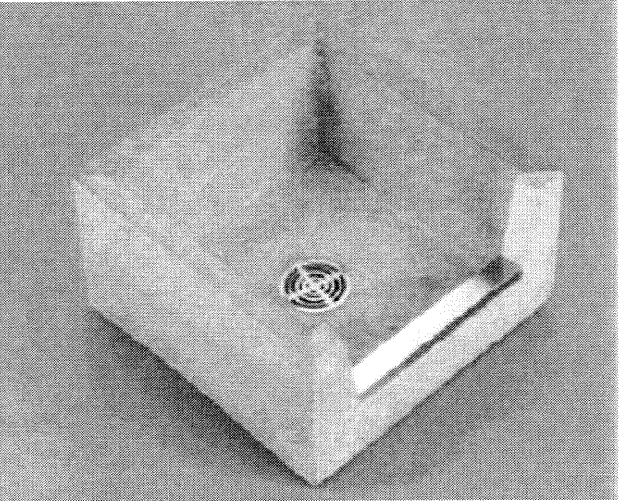
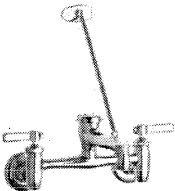
Symmons Model 1-25-FSB. Safetymix pressure balancing mixing valve, color coded index, with adjustable stop screw to limit handle turn. All chrome plate finish, wall/hand shower with flexible metal hose, in-line vacuum breaker, wall connection and flange. 30" slide bar for hand shower mounting. Provide spring check valves on inlet, hot and cold water back check valves. Sloan Model 3365001.

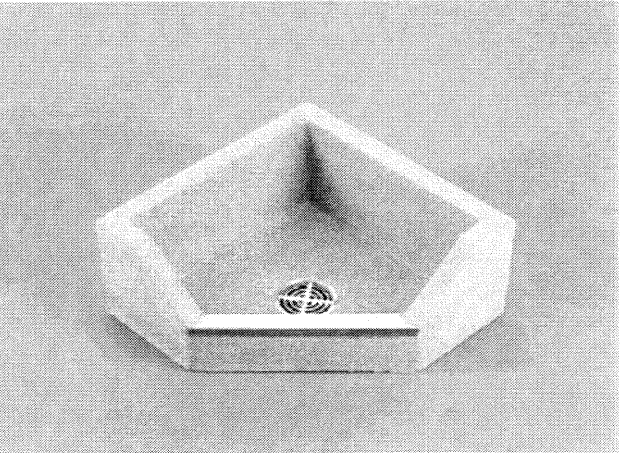
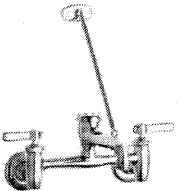
**Drain**

Provide grid strainer for shower.

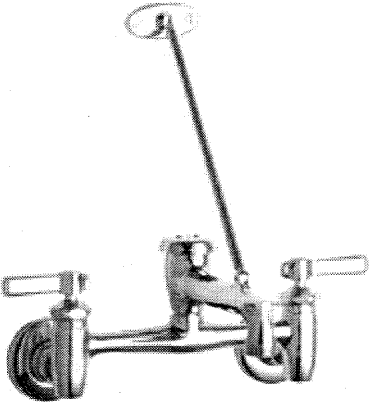
## SECTION 22 40 00 PLUMBING FIXTURES

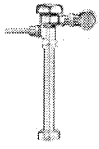
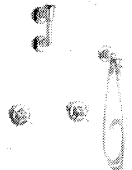
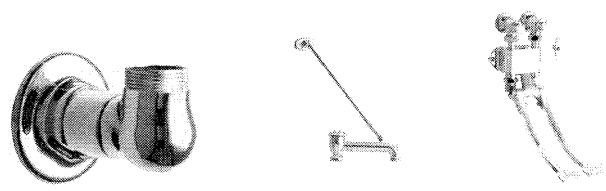
Plumbing Fixture Data Sheet	Drinking Fountain – Dual Level	P6A
<p><b>Manufacturer:</b> Halsey Taylor Model OVL-II SER-Q, with Model 15242 water filter.</p> <p><b>Material:</b> Stainless steel, 300 series, with satin finish.</p> <p><b>Type:</b> Dual level, electric water cooler, round sculpted bowls, ADA Compliant.</p> <p><b>Mounting:</b> Wall mounted.</p> <p><b>Capacity:</b> 7.5 GPH</p> <p><b>Electrical:</b> 120V/60Hz, 370 Watt, 4.0 FLA.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	

Plumbing Fixture Data Sheet	Housekeeping Service Sink	P7A
<p><b>Manufacturer:</b> Fiat Model TSB3012.</p> <p><b>Material:</b> Terrazzo.</p> <p><b>Type:</b> One piece, 12" high, 6" drop front, stainless steel threshold, 36"x36"x12".</p> <p><b>Mounting:</b> Floor mounted.</p> <p><b>Options:</b> Hose and bracket combination 832AA.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	
<p><b>Accessories:</b></p> <p><b>Faucet</b></p>  <p>Wall mounted fitting, vacuum breaker spout with pail hook and wall brace, 3/4" male hose thread outlet, 369 handles, adjustable supply arm, 1/2" NPT female union nut inlets, 5/16" hex. Integral supply stops. Chicago Faucet Model 897-CP.</p> <p><b>Drain</b></p> <p>Stainless steel cast integrally and provide for a caulked lead connection not less than 1" deep to a 3" pipe.</p>		

Plumbing Fixture Data Sheet	Housekeeping Service Sink	P7B
<p><b>Manufacturer:</b> Fiat Model TSBC 1612.</p> <p><b>Material:</b> Terrazzo.</p> <p><b>Type:</b> Neo-Corner, 12" high, 6" drop front, stainless steel threshold, 36"x36"x12".</p> <p><b>Mounting:</b> Floor mounted.</p> <p><b>Options:</b> Hose and bracket combination 832AA.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	
<p><b>Accessories:</b></p> <p><b>Faucet</b></p>  <p>Wall mounted fitting, vacuum breaker spout with pail hook and wall brace, 3/4" male hose thread outlet, 369 handles, adjustable supply arm, 1/2" NPT female union nut inlets, 5/16" hex. Integral supply stops. Chicago Faucet Model 897-CP.</p> <p><b>Drain</b></p> <p>Stainless steel cast integrally and provide for a caulked lead connection not less than 1" deep to a 3" pipe.</p>		

## SECTION 22 40 00 PLUMBING FIXTURES

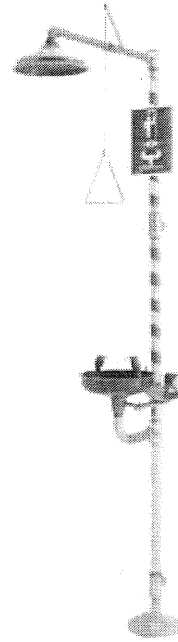
Plumbing Fixture Data Sheet	Housekeeping Service Sink Faucet	P7C
<p><b>Manufacturer:</b> Chicago Faucet Model 897-CP.</p> <p><b>Type:</b> Wall mounted fitting, vacuum breaker spout with pail hook and wall brace, 3/4" male hose thread outlet, 3/69 handles, adjustable supply arm, 1/2" NPT female union nut inlets, 5/16" hex. Integral supply stops.</p> <p>Hose and bracket combination Fiat Model 832AA.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	

Plumbing Fixture Data Sheet	Clinic Sink – Wall Mounted	P8A
<p><b>Manufacturer:</b> Kohler Model K-12867.</p> <p><b>Material:</b> Vitreous china.</p> <p><b>Type:</b> 1-1/2" top spud, blow-out action flushing rim, 21-1/2" x 25".</p> <p><b>Mounting:</b> Wall mounted.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	
<p><b>Accessories:</b></p> <p><b>Flushometer</b></p>  <p>Quiet, exposed, diaphragm type, chrome plated service sink flushometer, 1.6 GPF. Sloan Valve Model 117.</p> <p><b>Bedpan Washer</b></p> <p>Wall mounted spray, E21 rubber bound spray outlet, 633 cross handles, slow compression cartridge, 4' white vinyl hose, 1/2" NPT female stops, no vacuum breaker. Chicago Model 778-CP.</p>  <p><b>Faucet and Foot Pedal</b></p> <p>Chicago 629 spout base, Chicago 897-SJKCP rigid vacuum breaker spout with brace. Faucet – offset center to right of flush valve. Adjust spout angle to center of bowl. Wall mounted pedal valve with push button cartridges, extended pedals, slow closing units, loose key stops with wall flanges, chrome plated finish. Chicago Model No. 834-EP-SLO. Mount HW/CW foot pedals on the side with the greatest clearance (right if same), center 6" from edge of sink. Provide fitting to go around flush valve.</p>  <p><b>Support</b></p> <p>Service sink support system, dura-coated rectangular steel uprights with welded feet, adjustable face plate and upper support plate, adjustable corrosion resistant coupling. Zurn Model Z-1218, or equivalent of Josam or Jay R. Smith.</p> <p><b>Drain</b></p> <p>Loose sink strainer. Kohler Model K-13864.</p> <p><b>Rim Guard</b></p> <p>Stainless steel rim guard. Kohler Model K-8935.</p>		

Plumbing Fixture Data Sheet	Combination Shower/Eyewash	P9A
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**Manufacturer:** Haws Model 8320.

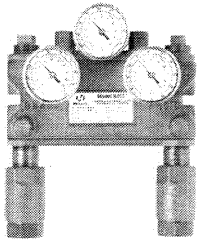
**Type:** Combination shower and eyewash features a 10-5/8" ABS plastic showerhead and an ABS plastic eyewash receptor with twin Soft-Flo ABS plastic anti-surge eyewash heads. A pull rod activates shower. Push flag activates eyewash. Pipe and fitting: 1-1/4" Schedule 40 hot-dipped galvanized steel. Supply and waste: 1-1/4" IPS.



*Picture shown may not include all options and accessories indicated*

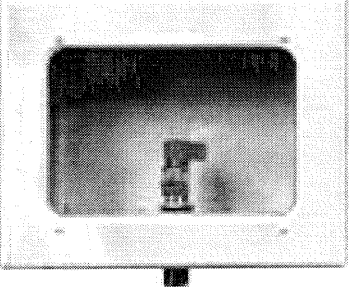
**Accessories:**

***Tempered Water Blending Valve***

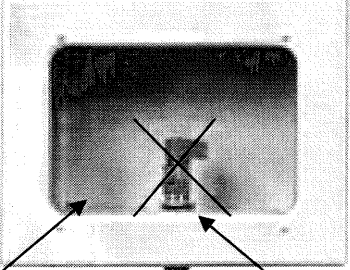


Thermostatic mixing valve that mixes hot and cold water for the tempering of water for eyewash and showers, maximum flow rate is 40 gpm, with isolation check valves. Haws Model 9202.

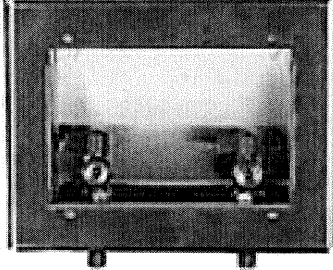
## SECTION 22 40 00 PLUMBING FIXTURES

Plumbing Fixture Data Sheet	Valve Box	P10
<p><b>Manufacturer:</b> Guy Gray Mfg. Model SSIB 1.</p> <p><b>Type:</b> 304 stainless steel box and faceplate, 1/2" F/P inlet x 1/4" O.D. outlet compression angle valve.</p> <p><b>Mounting:</b> Wall mounted.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	

SECTION 22 40 00 PLUMBING FIXTURES

Plumbing Fixture Data Sheet	Valve Box and Drain	P11
<p><b>Manufacturer:</b> Guy Gray Mfg. Model SSIB 1 (similar to).</p> <p><b>Type:</b> 304 stainless steel box and faceplate, 1/2" F/P inlet x 1/4" O.D. outlet compression angle valve with 1-1/2" drain connection.</p> <p><b>Mounting:</b> Wall mounted.</p>	 <p>Valve</p> <p>Drain</p> <p><i>Picture shown may not include all options and accessories indicated</i></p>	

## SECTION 22 40 00 PLUMBING FIXTURES

Plumbing Fixture Data Sheet	Hot and Cold Water Hose Bibb	P12
<p><b>Manufacturer:</b> Guy Gray Mfg. Model BB200TS.</p> <p><b>Type:</b> 18 gauge stainless steel box and faceplate, 1/2" NPT inlet, 3/4" hose.</p> <p><b>Mounting:</b> Wall mounted.</p> <p><b>Note:</b> Drain not required. Either do not provide drain or cap the drain.</p>	 <p><i>Picture shown may not include all options and accessories indicated</i></p>	

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 12 32 16 "Plastic Laminate-Clad Casework" for compressed-air outlets in medical casework.
  - 2. Section 22 61 13 "Compressed-Air Piping for Healthcare Facilities" for general-service compressed-air piping.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Medical air piping and specialties, designated "medical air," operating at 50 to 55 psig.

1.3 DEFINITIONS

- A. D.I.S.S.: Diameter-index safety system.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. Medical Compressed-Air Piping Systems: Include medical air piping systems.

1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Medical compressed-air tubes and fittings.
  - 2. Medical Compressed-air valves and valve boxes.
  - 3. Medical compressed-air service connections.
  - 4. Medical compressed-air alarm system components.
- B. Shop Drawings: Include diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
  - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 22 Section "Gas Piping for Healthcare Facilities."
- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Medical Compressed-Air Service(s): Do not interrupt medical compressed-air service to facilities occupied by Owner or others unless permitted under

## SECTION 22 61 13 COMPRESSED-AIR PIPING FOR HEALTHCARE FACILITIES

the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect and Construction Manager no fewer than seven days in advance of proposed interruption of medical compressed-air service(s).
2. Do not proceed with interruption of medical compressed-air service(s) without Construction Manager's written permission.

### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate medical compressed-air service connections with other service connections. Medical vacuum service connections are specified in Division 22 Section "Vacuum Piping for Healthcare Facilities," and medical gas service connections are specified in Division 22 Section "Gas Piping for Healthcare Facilities."

### 1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Quick-Coupler Service Connections: Furnish complete non-interchangeable medical compressed-air pressure outlets.
    - a. Medical Compressed-Air Service Connections: Equal to 5 percent of amount installed, but no fewer than 5 units.

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Type K, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube.
  1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
  2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
  3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

### 2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

### 2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves-Service: MSS SP-110, 3-piece body, brass or bronze.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Pressure Rating: 300 psig minimum.
  3. Ball: Full-port, chrome-plated brass.
  4. Seats: PTFE or TFE.
  5. Handle: Lever type with locking device.
  6. Stem: Blowout proof with PTFE or TFE seal.
  7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Pressure Rating: 300 psig minimum.

## SECTION 22 61 13 COMPRESSED-AIR PIPING FOR HEALTHCARE FACILITIES

3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Pressure Rating: 300 psig minimum.
  3. Ball: Full-port, chrome-plated brass.
  4. Seats: PTFE or TFE.
  5. Handle: Lever type.
  6. Stem: Blowout proof with PTFE or TFE seal.
  7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
  8. Pressure Gage: Manufacturer installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Interior Finish: Factory-applied white enamel.
  3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
  4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

### 2.4 MEDICAL COMPRESSED-AIR SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. BeaconMedaes.
- B. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
  1. Roughing-in Assembly:
    - a. Steel outlet box for recessed mounting and concealed piping.
    - b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
    - c. Double seals that will prevent air leakage.
    - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
  2. Finishing Assembly:
    - a. Brass housing with primary check valve.
    - b. Double seals that will prevent air leakage.
    - c. Cover plate with gas-service label.
  3. Quick-Coupler Service Connections: Pressure outlet with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
  4. Cover Plates: One piece, white finish, and permanent, color-coded, identifying label matching corresponding service.

### 2.5 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. BeaconMedaes.
- B. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.

## SECTION 22 61 13 COMPRESSED-AIR PIPING FOR HEALTHCARE FACILITIES

- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
  - 1. Low-Pressure Operating Range: 0- to 100-psig.
  - 2. High-Pressure Operating Range: Up to 250-psig.
- E. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
  - 1. Mounting: Recessed installation.
  - 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inch- thick aluminum, with knockouts for electrical and piping connections.
- F. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
  - 1. Include alarm signals when the following condition exists:
    - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.
    - b. Dental-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators.

### 2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.

### 2.7 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if pre-cleaned fittings or tubing must be re-cleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
  - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
  - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
    - a. Scrub to ensure complete cleaning.
    - b. Rinse with clean, hot water to remove cleaning solution.

### 3.2 PIPING APPLICATIONS

- A. Connect new tubing to existing tubing with memory-metal couplings.
- B. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

### 3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of compressed-air piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

## SECTION 22 61 13 COMPRESSED-AIR PIPING FOR HEALTHCARE FACILITIES

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install air and drain piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install piping to permit valve servicing.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install medical compressed-air piping to existing medical compressed-air service manifold connection, to medical compressed-air service connections in equipment specified in Section 22 63 13 "Gas Piping for Healthcare Facilities," and to equipment specified in other Sections requiring medical compressed-air service.
- O. Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
- P. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- Q. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- R. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

### 3.4 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.
- F. Install pressure regulators on compressed-air piping where reduced pressure is required.
- G. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.

### 3.5 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- D. Soldered Joints (Drain Piping Only): Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
- E. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

## 3.6 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.
- B. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.
- C. Install area and master alarm panels for medical compressed-air piping system where indicated.

## 3.7 SLEEVE INSTALLATION

- A. Sleeves are not required for core-drilled holes.
- B. Permanent sleeves are not required for holes formed by removable PE sleeves.
- C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using sleeve fittings.
  - 1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
  - 2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- D. Install sleeves in new walls and slabs as new walls and slabs are constructed.
- E. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
  - 1. Steel Pipe Sleeves: For pipes smaller than NPS 6.
  - 2. Steel Sheet Sleeves: For pipes NPS 6 and larger penetrating gypsum board partitions.
  - 3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim" for flashing.
    - a. Seal space outside of sleeve fittings with grout.
- F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

## 3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
  - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
  - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within 12 inches of each fitting and coupling.
- H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1/4: 60 inches with 3/8-inch rod.
  - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
  - 3. NPS 3/4: 84 inches with 3/8-inch rod.
  - 4. NPS 1: 96 inches with 3/8-inch rod.
  - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
  - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
  - 7. NPS 2: 11 feet with 3/8-inch rod.
  - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.

## SECTION 22 61 13 COMPRESSED-AIR PIPING FOR HEALTHCARE FACILITIES

9. NPS 3: 14 feet with 1/2-inch rod.
  10. NPS 3-1/2: 15 feet with 1/2-inch rod.
  11. NPS 4: 16 feet with 1/2-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.

### 3.9 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for compressed-air piping, valves, and specialties. Comply with requirements in Section 23 05 53 "Identification for Mechanical Piping and Equipment."
- B. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
  1. Medical Air: Black letters on yellow background.

### 3.10 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.
- B. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.
- C. Tests and Inspections:
  1. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
  2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
    - a. Initial blowdown.
    - b. Initial pressure test.
    - c. Cross-connection test.
    - d. Piping purge test.
    - e. Standing pressure test for positive-pressure medical compressed-air piping.
    - f. Repair leaks and retest until no leaks exist.
  3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
    - a. Standing pressure test.
    - b. Individual-pressurization or pressure-differential cross-connection test.
    - c. Valve test.
    - d. Area alarm tests.
    - e. Piping purge test.
    - f. Piping particulate test.
    - g. Piping purity test.
    - h. Final tie-in test.
    - i. Operational pressure test.
    - j. Medical air purity test.
    - k. Verify correct labeling of equipment and components.
  4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
    - a. Inspections performed.
    - b. Procedures, materials, and gases used.
    - c. Test methods used.
    - d. Results of tests.
- D. Remove and replace components that do not pass tests and inspections and retest as specified above.

SECTION 22 61 13 COMPRESSED-AIR PIPING FOR HEALTHCARE FACILITIES

3.11 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION

## SECTION 22 62 13 VACUUM PIPING FOR HEALTHCARE FACILITIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 12 32 16 "Plastic Laminate-Clad Casework" for vacuum outlets in metal medical casework.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 15 inches mercury.

#### 1.3 DEFINITIONS

- A. D.I.S.S.: Diameter-index safety system.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. WAGD: Waste anesthetic gas disposal.
- D. Medical vacuum piping systems include medical vacuum piping systems.

#### 1.4 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Vacuum pipes and fittings.
  - 2. Vacuum valves and valve boxes.
  - 3. Vacuum service connections and vacuum-bottle brackets.
- C. Shop Drawings: In addition to requirements set forth in Section 23 05 00, shop drawings for the listed systems shall also include detailing of pipe anchors, special pipe support assemblies, alignment guides, and expansion joints and loops. Provide submittals of the following piping systems within mechanical equipment rooms.
  - 1. Vacuum system.
- D. Reports and Certificates: Provide submittals of the following:
  - 1. Qualification Data: For qualified installer.
  - 2. Field quality-control test reports.
  - 3. Brazing certificates.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
  - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Section 22 63 13 "Gas Piping for Healthcare Facilities."
- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

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- F. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

### 1.6 PROJECT CONDITIONS

- A. Interruption of Existing Medical Vacuum Service(s): Do not interrupt medical vacuum service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
  - 1. Notify Architect and Construction Manager no fewer than seven days in advance of proposed interruption of medical vacuum service(s).
  - 2. Do not proceed with interruption of medical vacuum service(s) Construction Manager's written permission.

### 1.7 COORDINATION

- A. Coordinate medical vacuum service connections with other service connections. Medical compressed-air service connections are specified in Section 22 61 13 "Compressed-Air Piping for Healthcare Facilities," and medical gas service connections are specified in Section 22 63 13 "Gas Piping for Healthcare Facilities."

### 1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical vacuum suction inlets.
    - a. Medical Vacuum Service Connections: Equal to 5 percent of amount installed, but no fewer than 5 units.
  - 2. Medical Vacuum Bottle Brackets: Equal to 5 percent of amount installed, but no fewer than 5 units.

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
  - 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
  - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
  - 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
- B. Extruded-Tee Outlets: ASTM F 2014 procedure for making branch outlets in copper tube.
  - 1. Manufacturers: Subject to compliance with requirements, provide procedure according to one of the following:
    - a. T-DRILL Industries Inc.

### 2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

### 2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.

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2. Pressure Rating: 300 psig minimum.
  3. Ball: Full-port, chrome-plated brass.
  4. Seats: PTFE or TFE.
  5. Handle: Lever type with locking device.
  6. Stem: Blowout proof with PTFE or TFE seal.
  7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Bronze Check Valves: In-line pattern.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Pressure Rating: 300 psig minimum.
  3. Operation: Spring loaded.
  4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Pressure Rating: 300 psig minimum.
  3. Ball: Full-port, chrome-plated brass.
  4. Seats: PTFE or TFE.
  5. Handle: Lever type.
  6. Stem: Blowout proof with PTFE or TFE seal.
  7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
  8. Vacuum Gage: Manufacturer installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Interior Finish: Factory-applied white enamel.
  3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
  4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

### 2.4 MEDICAL VACUUM SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. BeaconMedaes.
- B. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
1. Roughing-in Assembly:
    - a. Steel outlet box for recessed mounting and concealed piping.
    - b. Brass-body inlet block.
    - c. Seals that will prevent vacuum leakage.
    - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
  2. Finishing Assembly:
    - a. Brass housing with primary check valve.
    - b. Seals that will prevent vacuum leakage.
    - c. Cover plate with gas-service label.
  3. Quick-Coupler Service Connections: Suction inlets for medical vacuum service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

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4. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
5. Cover Plates: One piece, white finish, and permanent, color-coded, identifying label matching corresponding service.

### 2.5 MEDICAL VACUUM PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. BeaconMedaes.
- B. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
  1. Vacuum Operating Range: 0- to 30-in. Hg.
- E. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
  1. Mounting: Recessed installation.
  2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inch- thick aluminum, with knockouts for electrical and piping connections.
- F. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
  1. Include alarm signals when the following condition exists:
    - a. Medical Vacuum: Vacuum drops below 12-in. Hg.

### 2.6 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
  1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
  2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
    - a. Scrub to ensure complete cleaning.
    - b. Rinse with clean, hot water to remove cleaning solution.

### 3.2 PIPING APPLICATIONS

- A. Connect new copper tubing to existing tubing with memory-metal couplings.
- B. Medical Vacuum Piping: Use one of the following piping materials for each size range:
  1. NPS 4, 4-inch and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
  2. NPS 5 to NPS 8, 6-inch to 8-inch: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- C. Drain Piping: Use one of the following piping materials:
  1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

### 3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calcu-

## SECTION 22 62 13 VACUUM PIPING FOR HEALTHCARE FACILITIES

late friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- B. Comply with ASSE Standard #6010 for installation of vacuum piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install vacuum and drain piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
- I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install piping to permit valve servicing.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
- N. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.
- O. Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
- P. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- Q. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- R. Connect vacuum piping to existing vacuum producer header and to medical vacuum connections.
- S. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

### 3.4 VALVE APPLICATIONS

- A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

### 3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
- B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

### 3.6 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Apply appropriate tape to external pipe threads.
- E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

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- G. Flanged Joints:
    - 1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
  - H. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
- 3.7 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION
- A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.
  - B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.
  - C. Install medical vacuum piping system area and master alarm panels where indicated.
- 3.8 SLEEVE INSTALLATION
- A. Comply with requirements in Section 23 05 00 "Common Mechanical Materials and Methods."
- 3.9 HANGER AND SUPPORT INSTALLATION
- A. Comply with requirements in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hanger and support devices.
  - B. Vertical Piping: MSS Type 8 or 42, clamps.
  - C. Individual, Straight, Horizontal Piping Runs:
    - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
    - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
  - D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for trapeze hangers.
  - E. Base of Vertical Piping: MSS Type 52, spring hangers.
  - F. Support horizontal piping within 12 inches of each fitting and coupling.
  - G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
  - H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
    - 1. NPS 1/4: 60 inches with 3/8-inch rod.
    - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
    - 3. NPS 3/4: 84 inches with 3/8-inch rod.
    - 4. NPS 1: 96 inches with 3/8-inch rod.
    - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
    - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
    - 7. NPS 2: 11 feet with 3/8-inch rod.
    - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
    - 9. NPS 3: 14 feet with 1/2-inch rod.
    - 10. NPS 3-1/2: 15 feet with 1/2-inch rod.
    - 11. NPS 4: 16 feet with 1/2-inch rod.
  - I. Install supports for vertical copper tubing every 10 feet.
- 3.10 LABELING AND IDENTIFICATION
- A. Install identifying labels and devices for medical vacuum piping, valves, and specialties. Comply with requirements in Section 23 05 53 "Identification for Mechanical Piping and Equipment."
  - B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
    - 1. Medical Vacuum: Black letters on white background.

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3.11 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
- B. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
- C. Tests and Inspections:
  - 1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
  - 2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
    - a. Initial blow down.
    - b. Initial pressure test.
    - c. Cross-connection test.
    - d. Piping purge test.
    - e. Standing pressure test for vacuum systems.
    - f. Repair leaks and retest until no leaks exist.
  - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
    - a. Standing pressure test.
    - b. Individual-pressurization or pressure-differential cross-connection test.
    - c. Valve test.
    - d. Area alarm tests.
    - e. Piping purge test.
    - f. Final tie-in test.
    - g. Operational vacuum test.
    - h. Verify correct labeling of equipment and components.
  - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
    - a. Inspections performed.
    - b. Procedures, materials, and gases used.
    - c. Test methods used.
    - d. Results of tests.
- D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION



## SECTION 22 63 13 GAS PIPING FOR HEALTHCARE FACILITIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 12 32 16 "Plastic Laminate-Clad Casework" for gas outlets in metal medical casework.
  - 2. Section 22 61 13 "Compressed-Air Piping for Healthcare Facilities" for compressed-air piping systems for healthcare facilities.
  - 3. Section 22 62 13 "Vacuum Piping for Healthcare Facilities" for vacuum piping systems for healthcare facilities.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig.
- B. Owner-Furnished Material:
  - 1. Ceiling columns.

#### 1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. D.I.S.S.: Diameter-index safety system.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Medical gas piping systems include medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Equipment specified in this section shall withstand the effects of earthquake motions determined according to ASCE-7 and as described in Sections 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."

#### 1.5 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Tubes and fittings.
  - 2. Valve and valve boxes.
  - 3. Medical gas service connections.
  - 4. Medical gas alarm system components.
- C. Shop Drawings: In addition to requirements set forth in Section 23 05 00, shop drawings for the listed systems shall also include detailing of pipe anchors, special pipe support assemblies, alignment guides, and expansion joints and loops. Provide submittals of the following piping systems within mechanical equipment rooms.
  - 1. Medical Gas Systems.
- D. Reports and Certificates: Provide submittals of the following:
  - 1. Qualification Data: For qualified Installer
  - 2. Field quality-control reports.
  - 3. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
  - 4. Brazing certificates.
  - 5. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.

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- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
    - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
  - C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
  - D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - E. NFPA Compliance:
    - 1. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.
  - F. UL Compliance:
    - 1. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
    - 2. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.
- 1.7 PROJECT CONDITIONS
- A. Interruption of Existing Medical Gas Service(s): Do not interrupt medical gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
    - 1. Notify Architect and Construction Manager no fewer than seven days in advance of proposed interruption of medical gas service(s).
    - 2. Do not proceed with interruption of medical gas service(s) without Construction Manager's written permission.
- 1.8 COORDINATION
- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
  - B. Coordinate medical gas service connections with other service connections. Compressed-air service connections are specified in Sections 22 61 13 "Compressed-Air Piping for Healthcare Facilities" and 22 62 13 "Vacuum Piping for Healthcare Facilities."
- 1.9 EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    - 1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets.
      - a. Medical Oxygen: Equal to 5 percent of amount installed, but no fewer than 5 units.

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Types K, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
  - 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
  - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.

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3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

### 2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

### 2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves-Service: MSS SP-110, 3-piece body, brass or bronze.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Pressure Rating: 300 psig minimum.
  3. Ball: Full-port, chrome-plated brass.
  4. Seats: PTFE or TFE.
  5. Handle: Lever type with locking device.
  6. Stem: Blowout proof with PTFE or TFE seal.
  7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Pressure Rating: 300 psig minimum.
  3. Operation: Spring loaded.
  4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Pressure Rating: 300 psig minimum.
  3. Ball: Full-port, chrome-plated brass.
  4. Seats: PTFE or TFE.
  5. Handle: Lever type.
  6. Stem: Blowout proof with PTFE or TFE seal.
  7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
  8. Pressure Gage: Manufacturer-installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BeaconMedaes.
  2. Interior Finish: Factory-applied white enamel.
  3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
  4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

### 2.4 MEDICAL GAS SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. BeaconMedaes.
- B. General Requirements for Medical Gas Service Connections,: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
  1. Roughing-in Assembly:

## SECTION 22 63 13 GAS PIPING FOR HEALTHCARE FACILITIES

- a. Steel outlet box for recessed mounting and concealed piping.
  - b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
  - c. Double seals that will prevent gas leakage.
  - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
2. Finishing Assembly:
    - a. Brass housing with primary check valve.
    - b. Double seals that will prevent gas leakage.
    - c. Cover plate with gas-service label.
  3. Quick-Coupler Service Connections: Pressure outlets for oxygen service connections with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
  4. Cover Plates: One piece, white finish, and permanent, color-coded, identifying label matching corresponding service.

### 2.5 CEILING COLUMNS

- A. General Requirements for Ceiling Columns: Ceiling-mounting units with medical gas service connections as specified in "Medical Gas Service Connections". Include labels indicating services, and the following:
  1. Service Connections: quick-coupler type.

### 2.6 MEDICAL GAS PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. BeaconMedaes.
- B. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
  1. Low-Pressure Operating Range: 0- to 100-psig.
  2. High-Pressure Operating Range: Up to 250-psig.
- E. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
  1. Mounting: Recessed installation.
  2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inch- thick aluminum, with knockouts for electrical and piping connections.
- F. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
  1. Include alarm signals when the following conditions exist:
    - a. Oxygen: Pressure drops below 40 psig or rises above 60 psig.

### 2.7 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:

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1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
  - a. Scrub to ensure complete cleaning.
  - b. Rinse with clean, hot water to remove cleaning solution.

### 3.2 PIPING APPLICATIONS

- A. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.

### 3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of medical gas piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install medical gas piping existing medical gas service, to medical gas service connections specified in this Section, and to equipment specified in other Sections requiring medical gas service.
- L. Install seismic restraints on gas piping. Seismic-restraint devices are specified in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
- M. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- N. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- O. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

### 3.4 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas healthcare equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from healthcare gas supplies.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

### 3.5 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.

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- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
  - D. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
  - E. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
    - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    - 2. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.
- 3.6 GAS SERVICE COMPONENT INSTALLATION
- A. Assemble patient service console with service connections. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.
  - B. Install nitrogen pressure-control panels in walls. Attach to substrate.
  - C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
  - D. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
  - E. Install gas manifolds[ on concrete base] anchored to substrate.
  - F. Install gas cylinders and connect to manifold piping.
  - G. Install gas manifolds with seismic restraints as indicated.
  - H. Install bulk gas storage tanks and reserve supply tanks level on concrete bases. Set tanks and connect gas piping to tanks[ according to applicable requirements in NFPA 50 for bulk oxygen storage systems]. Install tanks level and plumb, firmly anchored to concrete bases; maintain NFPA 50 and tank manufacturer's recommended clearances. Orient tanks so controls and devices are accessible for servicing.
  - I. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.
- 3.7 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION
- A. Install medical gas alarm system components in locations required by and according to NFPA 99.
  - B. Install medical gas area and master alarm panels where indicated.
- 3.8 SLEEVE INSTALLATION
- A. Comply with requirements in Section 23 05 00 "Common Mechanical Materials and Methods."
- 3.9 ESCUTCHEON INSTALLATION
- A. Comply with requirements in Section 23 05 00 "Common Mechanical Materials and Methods."
- 3.10 HANGER AND SUPPORT INSTALLATION
- A. Comply with requirements in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for seismic-restraint devices.
  - B. Comply with requirements in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hanger and support devices.
  - C. Vertical Piping: MSS Type 8 or 42, clamps.
  - D. Individual, Straight, Horizontal Piping Runs:
    - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
    - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
  - E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for trapeze hangers.
  - F. Base of Vertical Piping: MSS Type 52, spring hangers.

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- G. Support horizontal piping within 12 inches of each fitting and coupling.
- H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1/4: 60 inches with 3/8-inch rod.
  - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
  - 3. NPS 3/4: 84 inches with 3/8-inch rod.
  - 4. NPS 1: 96 inches with 3/8-inch rod.
  - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
  - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
  - 7. NPS 2: 11 feet with 3/8-inch rod.
  - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.

### 3.11 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 23 05 53 "Identification for Mechanical Piping and Equipment."
- B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
  - 1. Oxygen: White letters on green background or green letters on white background.

### 3.12 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- B. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- C. Tests and Inspections:
  - 1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
  - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
    - a. Initial blow down.
    - b. Initial pressure test.
    - c. Cross-connection test.
    - d. Piping purge test.
    - e. Standing pressure test for positive pressure medical gas piping.
    - f. Standing pressure test for vacuum systems.
    - g. Repair leaks and retest until no leaks exist.
  - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
    - a. Standing pressure test.
    - b. Individual-pressurization or pressure-differential cross-connection test.
    - c. Valve test.
    - d. Master and area alarm tests.
    - e. Piping purge test.
    - f. Piping particulate test.
    - g. Piping purity test.
    - h. Final tie-in test.
    - i. Operational pressure test.
    - j. Medical gas concentration test.
    - k. Medical air purity test.
    - l. Verify correct labeling of equipment and components.

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- m. Verify the following source equipment:
  - 1) Medical gas supply sources.
- 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
  - a. Inspections performed.
  - b. Procedures, materials, and gases used.
  - c. Test methods used.
  - d. Results of tests.
- D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.13 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes general and supplementary conditions specifically applicable to Division 23, in addition to Division 01, Division 21, and Division 22.
- B. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.
  - 1. Submittals.
  - 2. Coordination Drawings.
  - 3. Record Documents.
  - 4. Maintenance Manuals.
  - 5. Piping materials and installation instructions common to most piping systems.
  - 6. Concrete base construction requirements.
  - 7. Escutcheons.
  - 8. Dielectric fittings.
  - 9. Flexible connectors.
  - 10. Mechanical sleeve seals.
  - 11. Nonshrink grout for equipment installations.
  - 12. Field-fabricated metal equipment supports.
  - 13. Installation requirements common to equipment specification sections.
  - 14. Rough-ins.
  - 15. Mechanical demolition.
  - 16. Mechanical Installations.
  - 17. Cutting and patching.
  - 18. Touchup painting and finishing.

1.3 GENERAL REQUIREMENTS

- A. Intent:
  - 1. The intent of the Contract Documents is for the Contractor to include all work necessary for the complete mechanical systems, tested and ready for operation.
  - 2. By submitting a proposal, the Contractor represents that it has made a thorough examination of the site, of the work, and all existing conditions and limitations, and that it has examined the Contract Documents in complete detail and has determined beyond doubt that the drawings, specifications, and existing conditions are sufficient, adequate and satisfactory for the construction of the work under the Contract.
  - 3. Where minor adjustments of the work are necessary for purposes of fabrication or installation of items, or resolution of conflicts between items within the intent of the Contract Documents, the Contractor shall make such adjustments with no added compensation. Where such adjustments affect functional or aesthetic design of the work, they shall first be submitted to the Architect for review and approval.
- B. Conditions:
  - 1. Conform to all Bidding Requirements, General Conditions and Amendments to the General Conditions, Supplementary Conditions and Special Conditions and General Requirements, Division 01, which govern the work specified herein.
  - 2. The Contractor is obligated to comply with the above in addition to the requirements of this Section.
  - 3. Modifications by this Section do not nullify any other portions of the above referenced conditions.
- C. Make complete mechanical installation, connecting to all equipment shown on the plans, or called for in the specifications. Mechanical contractor to provide any additional extra dampers and valves not shown on plans to obtain design criteria as required by the balancing contractor.

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- D. Plans and Specifications: Plans and specifications shall be taken together.
1. Contractor shall provide all equipment, materials and work shown on the plans and/or called for in these specifications.
  2. Provide work specified and not indicated on plans, or work indicated on plans and not specified, as though mentioned in both.
  3. When discrepancies or conflicts occur within the documents, the Architect shall determine which takes precedence and the Contractor shall perform the selected requirement without additional cost.
- E. Mechanical Drawings:
1. Mechanical drawings do not attempt to show all aspects of building construction, which will affect the installation of mechanical systems. The mechanical drawings are diagrammatic and do not intend to show all offsets and fittings that may be required for a complete installation. Locations of equipment, pipes, valves, traps, ductwork, etc. shown on the drawings, shall be followed as closely as conditions will permit. Review all project drawings, including, but not limited to, architectural, structural and electrical drawings; and coordinate with all trades involved so there is no conflict with work of other trades and so Owner secures best arrangement of work consistent with use of space.
  2. Verify exact distances between points shown of drawings by actual measurement at site, as no extra cost will be allowed for differences between actual measurements and scaled measurements.
  3. Changes in design, configuration, or location of equipment, piping, or ductwork, advisable in the opinion of Contractor, shall be submitted to Architect for approval before proceeding with work, with written assurance from other trades that such changes will not interfere with their installation, nor cause any extra cost on their part. Such changes shall be made at no additional cost to Owner.
  4. Check location of all work of all trades and avoid interferences. Special attention is called to the following items; conflicts shall be reported to Architect for decision and direction:
    - a. Exact location of outlets shown on architectural details.
    - b. Location of suspended ceilings.
    - c. Location of ducts, grilles, pipes, and other mechanical equipment so electrical outlets are clear of these items and in proper relation to same.

1.4 DEFINITIONS AND ABBREVIATIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include spaces above hard or lay-in type ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The word "provide," as used in Division 23, means "furnish and install."
- G. The word "approved," as used in these specifications, means acceptance by the Architect.
- H. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the drawings, or other paragraphs or schedules in the specifications, and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the reader locate the reference. Location is not limited.
- I. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted," mean directed by the Architect, requested by the Architect, and similar phrases.
- J. Mechanical Systems - Including but not limited to:

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1. Heating, Ventilation and Air Conditioning Systems.
  2. Temperature Controls System.
- K. Abbreviations:
1. AMCA Air Moving and Conditioning Association
  2. ANSI American National Standards Institute
  3. ARI Air Conditioning and Refrigeration Institute
  4. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
  5. ASME American Society of Mechanical Engineers
  6. ASTM American Society of Testing Materials
  7. AWWA American Water Works Association
  8. AWS American Welding Society
  9. CISPI Cast Iron Soil Pipe Institute
  10. FM Factory Mutual Engineering Corporation
  11. IBC International Building Code
  12. IMC International Mechanical Code
  13. NEBB National Environmental Balancing Bureau
  14. NEC National Electric Code
  15. NEMA National Electrical Manufacturers Association
  16. NFPA National Fire Protection Association
  17. NREC Washington State Non-Residential Energy Code
  18. OSHA Occupational Safety and Health Administration
  19. SMACNA Sheet Metal and Air Conditioning Contractors National Association, Inc.
  20. UPC Uniform Plumbing Code
  21. UL Underwriters Laboratories

### 1.5 CODES, PERMITS AND INSPECTIONS

- A. Codes: Work shall be installed as a minimum in conformity with applicable local ordinances and statutes. Standards and sizes, which exceed preceding requirements, shall be installed as drawn or specified. Nothing in the specifications shall be construed to permit deviation to less than the requirements of governing codes. Contractor is not relieved from furnishing and installing work shown or specified which may be beyond requirements of ordinances, laws, regulations, and codes.
- B. Codes and Standards: Applicable codes and standards shall include, but not necessarily be limited to:
1. Uniform Plumbing Code, by International Association of Plumbing and Mechanical Officials as amended by the State of Washington.
  2. International Mechanical Code, by International Code Council as amended by the State of Washington.
  3. International Building Code, by International Code Council as amended by the State of Washington.
  4. Requirements of OSHA, EPA and WISHA.
  5. National Fire Protection Association Codes.
  6. ASME codes for boiler and pressure vessels.
  7. SMACNA HVAC Duct Construction Standards, latest edition.
  8. All local and state amendments.
  9. Requirements of all agencies have jurisdictional authority over installation of mechanical systems.
- C. Permits, Fees and Inspections:
1. Contractor shall arrange and pay for all permits, fees and inspections required in connection with this installation. The Contractor shall present the Owner with properly signed certificates of final inspection before the work will be accepted.
  2. Contractor shall call for all inspections by local building official(s) when they become due, and shall not cover any work until approved by these governing authorities.
  3. Contractor shall make all arrangements with utility companies for water, steam, gas and drainage services, etc., associated with the work and include required payments for meters, piping, services, connection charges and materials fur-

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nished and installed by utility companies. Work and materials shall be in strict accordance with rules of respective authorities.

- D. Underwriters Laboratory Approval: Where Underwriters Laboratories (UL) standards exist, all items of electrical equipment or items partially composed of electrical equipment shall carry Underwriters Laboratories (UL) label either for the entire unit or for the electrical portion of the equipment. If UL standards do not exist, equipment shall be provided that has been labeled by an independent testing agency that is recognized by the authority having jurisdiction.
- E. ASME Code Stamp: ASME code stamp required on all pressure vessels and relief valves. Certificate required from the Boiler Inspector showing approval of the equipment and its installation.

### 1.6 WORK INCLUDED

- A. Work under this division shall include providing all materials, labor, equipment, tools, appliances, hoisting, scaffolding, supervision and overhead for the proper execution and completion of the mechanical work.
- B. Should these specifications or references made therein fail to specify adequately an item of equipment or material required for proper completion of the work in accordance with present day practice, this deficiency shall not relieve Contractor from furnishing and installing same. Call such omissions to attention of Architect and use such equipment or material as approved by Architect.
- C. All new equipment and products as noted in Part 2 of each section shall be installed as per manufacturer's recommendations.
- D. Provide all additional piping, ducts, caps and valves not shown on drawings, to maintain fully operational systems during the project at no additional cost to the owner.

### 1.7 WORKMANSHIP

- A. This Contractor shall provide completed systems with a neat and finished appearance. If, in the judgment of the Architect, any portion of the work has not been performed in a workmanlike manner or is left in a rough, unfinished state, this Contractor will be required to remove, reinstall or replace same and patch and paint surrounding surfaces in a manner acceptable to the Architect, without increase in cost to the Owner.

### 1.8 SUBMITTALS, GENERAL REQUIREMENTS

- A. General: Submit in accordance with the provisions of Section 01 33 00 and the following.
- B. General Requirements for Division 23 Submittals: Provide the following submittals as indicated in each Division 23 section. Additional submittal requirements may be included in the individual sections.
  - 1. Product Data: Submit manufacturer's product data for the items listed in the individual Division 23 sections. Product data shall demonstrate compliance with all specified features and requirements. Submittals for equipment shall include, but not be limited to, data indicating equipment capacity meets the indicated values at specified conditions, equipment drawings indicating all dimensions, connection information, service space requirements, recommended piping and/or wiring diagrams, installation details and extended warranties either offered by equipment manufacturer or required by specifications.
  - 2. Shop Drawings: Submit Contractor prepared drawings of Contractor fabricated mechanical systems. Drawings shall be prepared at  $\frac{1}{4}$ " scale using Computer Aided Design (CAD) software unless indicated otherwise. Drawings shall show exact location of equipment, piping and ductwork, each section of shop fabricated duct or pipe and location of field joints, supports and building attachments, and seismic restraint locations.
  - 3. Reports and Certificates: Indicate and interpret test results for compliance with performance requirements. Provide performance certificates.
  - 4. Operation and Maintenance Data: Submit proposed Division 23 Operation and Maintenance materials for approval prior to inclusion in the comprehensive final bound edition. See Article in this section on Operation and Maintenance Manuals for materials required to be included.
- C. Number of Copies: As specified in Section 01 78 23.

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- D. Format to be as specified under Section 01 78 23 and as follows: All product data shall be submitted complete by system, partial submittals are not acceptable and may be returned unreviewed. Systems are defined here as plumbing systems (Division 22), fire suppression system (Division 21), HVAC system, and HVAC control system (Division 23). Reference submittals, including title and location of project, Architect, Contractor, submission date, and specification paragraph number to indicate clearly the location, service, equipment identification numbers as shown on drawings, and function of each particular item. Where manufacturers' catalogs, pamphlets, or data sheets are submitted in lieu of prepared shop drawings, such submissions shall indicate specifically the item for which approval is required in red ink, and submissions showing general information only are not acceptable.
- E. Submittals not in conformance to above paragraphs will be returned unreviewed.

### 1.9 SUBMITTALS, BASIC MECHANICAL MATERIALS

- A. General: See Article in this section, Submittals, General Requirements for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Dielectric Unions
  - 2. Dielectric Flanges
  - 3. Dielectric Couplings
  - 4. Dielectric Nipples
  - 5. Braided Flexible Hose Connectors
  - 6. Rubber Flexible Connectors
  - 7. Flexible Expansion Loops
- C. Shop Drawings: None required.
- D. Reports and Certificates: None required.

### 1.10 COORDINATION DRAWINGS

- A. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
  - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
  - 2. Planned duct layout, including fan, coil, filter, duct silencer, and damper location.
  - 3. Clearances for installing and maintaining insulation.
  - 4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
  - 5. Equipment and accessory service connections and support details.
  - 6. Other systems installed in same space as mechanical systems.
  - 7. Exterior wall and foundation penetrations.
  - 8. Fire-rated wall and floor penetrations.
  - 9. Ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
  - 10. Sizes and location of required concrete pads and bases.
  - 11. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
  - 12. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
  - 13. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

### 1.11 SUBSTITUTIONS

- A. For substitution procedures see the provisions of Section 01 25 13.

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### 1.12 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:
1. Ductwork mains and branches, size and location, for both exterior and interior, locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
  2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
  3. Record drawings shall incorporate all accepted change orders and RFIs; reference number on drawings is not acceptable.
  4. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
  5. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
  6. Contract Modifications, actual equipment and materials installed.
  7. Record the locations and invert elevations of underground installations.

### 1.13 OPERATION AND MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Section 07 78 23 and the following requirements. Division 23 manuals shall be indexed by systems. Pages shall be same size, with exception of allowable foldout pages for control and flow diagrams. In addition to the requirements specified in Section 01 78 23, include the following information in Division 23 materials:
1. Product Data of all Division 23 equipment provided by the project as indicated in submittal requirements.
  2. Manufacturer's Equipment Installation and Start-Up Manuals for all equipment provided by the project. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  3. Manufacturer's Equipment Service Manuals for all equipment provided by the project, including parts list, troubleshooting list and maintenance procedures for routine preventative maintenance. Include disassembly, repair, and reassembly; aligning and adjusting instructions; servicing instructions and lubrication charts and schedules
  4. Reports and Certificates of all Division 23 systems and equipment as required by specifications.
  5. Material Safety Data Sheets (MSDS) for all applicable materials used for Division 23 installations.
  6. Warranty Certificates for all equipment where extended warranties are either offered or required; provide supplier contact information.

### 1.14 QUALITY ASSURANCE

- A. Equipment Selection: Equipment allowed by the specifications but with different electrical characteristics, physical dimensions, capacities, and/or ratings than what is shown on the drawings may be furnished, provided such proposed equipment is approved in writing and connecting mechanical and electrical services, such as pipe and/or duct connection sizes, circuit breakers, conduit, motors, bases, and equipment spaces are revised to accommodate such equipment. All expenses shall be borne by the Contractor. Specified minimum energy ratings and/or equipment efficiencies must meet design and commissioning requirements.

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1.15 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored mechanical equipment, ducts, pipes and tubes and other materials from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Pipes, ducts, mechanical equipment, and other materials that are damaged due to improper storage shall be replaced at the Contractor's expense.

1.16 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Some equipment may require temporary installation during one phase and require relocation to final location under another phase. Provide all associated labor and materials to accommodate this phasing.
- F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- G. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Section 08 31 13.
- H. Use of the building HVAC systems, including those being provided under this contract, for temporary heating, ventilation or cooling during construction is prohibited. When system installation is complete and ready for start-up, approval to operate the system shall be obtained from the Owner or designated Owner's representative.

1.17 COMMISSIONING SUPPORT

- A. Provide the following support for project commissioning:
  - 1. Attend commissioning scoping meetings. At a minimum, the Mechanical, TAB, and Controls Contractors shall participate. Equipment vendor representatives shall also attend upon request of the Commissioning Agent and Test Engineer. These meetings shall further define the testing requirements and participation of each contractor and sub-contractors for each commissioning activity.
  - 2. Provide Commissioning Authority and Test Engineer additional requested data, prior to normal O&M Manual submittal, in a timely manner for the development of the startup plan and the functional performance testing procedures.
  - 3. Provide startup forms and clearly document all completed startup activities. The DDC system startup forms shall include detailed checkout forms with descriptions for each controlled device. All forms shall be submitted for review by the Test Engineer and Commissioning Authority prior to use.
  - 4. During the normal submittal processes, provide an additional copy of all equipment submittals, startup forms, field static testing reports (duct static pressure test reports, pipe static pressure test reports, chemical treatment reports, etc.), and TAB reports to the Commissioning Authority and Test Engineer for review.
  - 5. Provide skilled technicians, including equipment vendor representatives, equipment, and materials to perform startup and execute functional performance tests. DDC system sub-contractor shall provide skilled technicians, familiar with the project, for both startup (Owner-witnessed point-to-point testing) and functional performance testing. Commissioning functional performance testing participation from the controls contractor shall be required in addition to the point-to-point testing.

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6. Submit startup documentation to General Contractor, Test Engineer, and Commissioning Authority to verify functional testing prerequisite requirements are fulfilled before functional testing for the associated equipment or system is scheduled to start. Refer to Section 23 08 00 – Commissioning of HVAC Systems, for commissioning procedure. Startup documentation (point-to-point testing) shall also be required from the controls contractor as a prerequisite to functional performance testing.
7. Correct deficiencies found during startup and functional performance testing in a timely manner to facilitate retesting activities within the commissioning schedule.
8. TAB sub-contractor shall report any deficiencies found in a timely manner. These deficiencies shall be corrected in a timely manner to facilitate functional performance testing within the commissioning schedule.
9. TAB sub-contractor shall coordinate all setpoint value requirements for input into the controls system, including minimum outside air damper positions, return/supply fan VFD speed mapping, pumping loop differential pressure setpoints, duct system static pressure setpoints, air terminal unit flow sensor calibration factors, etc.

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. Dielectric Unions:
    - a. Capitol Manufacturing Co.
    - b. Eclipse, Inc.; Rockford-Eclipse Div.
    - c. Epco Sales Inc.
    - d. Hart Industries International, Inc.
    - e. Watts Industries, Inc.; Water Products Div.
    - f. Zurn Industries, Inc.; Wilkins Div.
  2. Dielectric Flanges:
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Co.
    - c. Epco Sales Inc.
    - d. Watts Industries, Inc.; Water Products Div.
  3. Dielectric Couplings:
    - a. Calpico, Inc.
    - b. Lochinvar Corp.
  4. Dielectric Nipples:
    - a. Grinnell Corp.; Grinnell Supply Sales Co.
    - b. Victaulic Co. of America.
  5. Braided Hose Flexible Connectors:
    - a. Flex-Hose Co, Inc.
    - b. Hyspan Precision Products, Inc.
    - c. Mason.
    - d. Mercer Rubber Co.
    - e. Metraflex Co.
  6. Rubber Flexible Connectors:
    - a. General Rubber Corp.
    - b. Flex-Hose Co., Inc.
    - c. Mercer Rubber Co.
    - d. Metraflex Co.
    - e. Mason.
  7. Flexible Expansion Loops:
    - a. Metraflex Co.
    - b. Flex-Hose.
  8. Mechanical Sleeve Seals:
    - a. Calpico, Inc.

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- b. Metraflex Co.
- c. Thunderline/Link-Seal.
- d. Innerlynx

### 2.2 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for fluid type, temperature and pressure of piping system.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, unless indicated otherwise.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32.
  - 1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
  - 2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
- D. Brazing Filler Metals: AWS A5.8.
  - 1. BCuP Series: Copper-phosphorus alloys.
  - 2. BAg1: Silver alloy.
- E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.
- G. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
  - 1. Sleeve: ASTM A 126, Class B, gray iron.
  - 2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
  - 3. Gaskets: Rubber.
  - 4. Bolts and Nuts: AWWA C111.
  - 5. Finish: Enamel paint.

### 2.4 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

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2.5 FLEXIBLE CONNECTORS

- A. Braided Hose Flexible Connectors: Stainless steel bellows with woven, flexible, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment. Bronze braiding for copper tubing applications and stainless steel braiding for steel pipe applications.
- B. Rubber Flexible Connectors: Mason SFU for 3/4 to 2-inch NPS or equal by other specified manufacturers; Mason SFDEJ for 2-1/2-inch NPS and larger or equal by other specified manufacturers. Fiber-reinforced EPDM rubber body; capable of handling operating temperatures up to 250 deg F and pressures up to 150 psig. Joint type to match system specification.
- C. Flexible Expansion Loops: Three equal length sections of annular corrugated stainless steel hose and braid, Provide with four 90 degree elbows and support per manufacturer's recommendations. Ends flanged, screwed, welded, sweat, or grooved. Suitable for operating temperatures up to 850 F. Designed for pressure testing to 1.5 times their maximum rated working pressure with a minimum 4 to 1 (burst to working) safety factor. Factory tested using air-under-water and hydrostatic pressure. Manufacturer: Flex-Hose Company.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular design, with interlocking EPDM rubber links shaped to continuously fill annular space between pipe and sleeve. Stainless steel connecting bolts and composite pressure plates.

2.7 PIPING SPECIALTIES

- A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
  - 1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
  - 2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
  - 3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
  - 4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
    - a. Underdeck Clamp: Clamping ring with set screws.
- B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
  - 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
  - 2. OD: Completely cover opening.
  - 3. Cast Brass: One piece, with set screw.
    - a. Finish: Rough brass.
    - b. Finish: Polished chrome-plate.
  - 4. Cast-Iron Floor Plate: One-piece casting.

2.8 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
  - 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psig, 28-day compressive strength.

PART 3 - EXECUTION

3.1 GENERAL MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
  - 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
  - 2. Verify all dimensions by field measurements.

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3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
  4. 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.
  5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
  6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
  7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
  8. 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 conflict to the Architect.
  9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
  10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
  11. Install access panel or doors where units are concealed behind finished surfaces. Notify General Contractor on the number, location and size of access panels or doors.
  12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
  13. Replace all air filters with new filters upon Owner taking occupancy of the building or at a time mutually agreed upon between the Owner and Contractor.
  14. Do not install ductwork in elevator machine rooms, electrical and/or communication rooms unless it directly services that room.
- B. Locate wall, floor and ceiling fire ratings from architectural drawings for appropriate hourly rating of combination fire/smoke dampers or fire dampers shown on mechanical drawings.

### 3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install piping at indicated slope.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping free of sags and bends.
- G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

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- K. Install flexible connectors according to manufacturer's written instructions where indicated and specified in other Division 23 sections.
- L. Install flexible expansion loops according to manufacturer's written instructions where indicated and specified in other Division 23 sections.
- M. Install fittings for changes in direction and branch connections.
- N. Install couplings according to manufacturer's written instructions.
- O. Install Portable Instrument Connections in all piping systems where DDC temperature and/or pressure sensors and thermometers and/or pressure gauges are located.
- P. Do not route piping through elevator equipment rooms, unless specifically allowed by local authority.
- Q. Do not route piping over electrical panels, transformers, switchgear or other electrical equipment.
- R. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
  - 1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
- S. Sleeves are not required for core drilled holes.
- T. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Build sleeves into new walls and slabs as work progresses.
  - 3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
    - b. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
    - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Section 07 62 00 "Sheet Metal Flashing and Trim" for flashing.
      - 1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
  - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- U. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
  - 3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- V. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for manufacturer's recommended clear space between pipe and sleeve.
  - 1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
  - 2. Caulk exterior side of annular space once the mechanical sleeve seal is in place using an elastomeric joint sealant.

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- W. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Section 07 84 00 "Penetration Firestopping" for materials.
- X. Verify final equipment locations for roughing-in.
- Y. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- Z. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
  - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  - 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
  - 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
    - c. Align threads at point of assembly.
    - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    - e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
  - 6. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators.
  - 7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench to recommended torque values.
- AA. Piping Connections: Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
  - 2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
  - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.3 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

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- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
  - E. Install equipment giving right of way to piping installed at required slope.
- 3.4 PAINTING AND FINISHING
- A. Refer to Section 09 91 00 for paint materials, surface preparation, and application of paint.
  - B. Apply paint to exposed piping, ductwork and supports according to the following, unless otherwise indicated:
    - 1. Exterior, Ferrous Piping and ductwork: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
    - 2. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
  - C. Do not paint piping specialties with factory-applied finish.
  - D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- 3.5 CONCRETE BASES
- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions for all floor-supported units. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Concrete and reinforcement as specified in Division 03.
- 3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE
- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
  - B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."
- 3.7 DEMOLITION
- A. Perform all demolition or interface work required in the existing building for the removal of, or interface with, existing mechanical equipment, ductwork, tubing, or piping. Relocate or modify the existing piping, tubing and ductwork as required by any general construction alterations or by the installation of new ductwork, tubing, or piping in the existing building.
  - B. Existing Materials, Removal and Disposition:
    - 1. Scope: For mechanical items that remain the property of the Owner, refer to drawings.
    - 2. In coordination with the Owner's Representatives, these materials shall be made available for their inspection and decision as to whether the Owner will retain possession. Items selected for retention shall be delivered to a location on the premises selected by the Owner and turned over to them. Take reasonable care to avoid damage to this material.
    - 3. All material not selected for retention by the Owner and debris shall be disposed of by the Contractor.
  - C. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
  - D. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
  - E. Reuse of Materials: Reuse of materials is prohibited unless specifically indicated or approved by Architect.
  - F. Notify Architect in discovery of any hazardous materials.
  - G. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- 3.8 CUTTING AND PATCHING
- A. General: Perform cutting and patching in accordance with Section 01 73 29. In addition to the requirements specified in Section 01 73 29, the following requirements apply:

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1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
  1. Uncover Work to provide for installation of ill-timed Work.
  2. Remove and replace defective Work.
  3. Remove and replace Work not conforming to requirements of the Contract Documents.
  4. Remove samples of installed Work as specified for testing.
  5. Install equipment and materials in existing structures.
  6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
- C. Cut, remove and legally dispose off-site of selected mechanical equipment, components, and materials, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- F. Repair cut surfaces to match adjacent surfaces.

### 3.9 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

### 3.10 EARTHWORK

- A. General: Perform earthwork required for installation of mechanical work below grade in accordance with Division 2.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of the pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated. Grade trench bottoms to provide uniform bearing and support for each section of pipe. Form holes and depressions for joints after trench bottom has been graded. Provide temporary pumping equipment to keep excavation free from water. Install pipe bedding in rock excavation consisting of not less than 6 inch of sand or equivalent material.
- C. Provide bracing and shoring as necessary.
- D. Backfill trenches only after completion of pressure tests and inspection. Carefully compact material under pipe and bring backfill evenly up on both sides and along the full length of piping or conduit. Cover to 12-inch thickness over top of pipe. Fill and tamp remainder of backfill material in 6-inch layers. Provide backfill materials generally consisting of clean earth or sand relatively free of clods or stones. For sewer and water piping, use pea gravel. For gas piping, use sand. Backfill under, around, and to 6 inch above top of piping.
- E. Compact soil to 6-inch layer (maximum) loose thickness of backfill. Where roadway or parking area surfaces will be placed over backfill, provide moisture conditions, which will produce compacted density of 95 percent of maximum density. Elsewhere, 90 percent. Test in accordance with Divisions 1 and 2.
- F. Take special care in compacting under services where they enter building to prevent settling. Contractor fully responsible for damage to piping and property as a result of settling around service piping.
- G. Dispose surplus materials off-site in a suitable location.

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- H. Place and maintain barricades, construction signs, torches, lanterns, and guards as required during periods of open excavation to protect persons from injury and to avoid property damage.
- I. Leave premises thoroughly clean at completion of earthwork.
- J. Wherever piping is to be installed in areas, which have been excavated below pipe inverts, for any purpose, install piping to prevent subsequent settlement. Do not install piping until backfill is to full compaction, completed to minimum 18 inch above installed pipe. Install piping in re-excavated trenches and backfill as previously specified.

END OF SECTION

## SECTION 23 05 13 COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.
  - 2. Section 23 05 63 "Variable Frequency Drives" for variable frequency, variable speed drives.

#### 1.2 SUMMARY

- A. This Section includes basic requirements for factory-installed motors provided with equipment specified in other sections of Division 23.

#### 1.3 SUBMITTALS

- A. Product Data: Include each piece of motorized equipment: Complete nameplate data and ratings; insulation class, NEMA design, frame size, enclosure type, bearing type, type of lubrication, service factor; mounting arrangements; size and coatings. Motor wiring and connection diagrams for all external connections and drawing showing location of winding termination lugs, conduit entry, and grounding lug.
- B. Manufacturer's Shop Test Reports: Submit only if specifically requested.

#### 1.4 QUALITY ASSURANCE

- A. Comply with latest published edition of NFPA 70, National Electrical Code.
- B. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label. Any NRTL listing/label shall be as accepted by the local authority having jurisdiction.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Motors
    - a. General Electric
    - b. Siemens
    - c. Century
    - d. U.S. Motors
    - e. Reliance
    - f. Baldor

#### 2.2 GENERAL REQUIREMENTS

- A. Design and Construction: Motors and enclosures to conform to requirements of latest publication of NEMA Standard MG 1.
- B. VFD Compatibility: Motors serving equipment that utilizes variable frequency drives shall be compatible with variable frequency drives, as outlined in Section 23 05 63 "Variable Frequency Drives." Motors that are used in conjunction with variable frequency drives shall be labeled by the manufacturer for inverter use.
- C. Motors 1/2 HP and Larger: Three-phase, unless specifically indicated otherwise.
- D. Motors Smaller than 1/2 HP: Single phase.
- E. Efficiency: Premium efficiency as defined by NEMA MG 1, unless otherwise indicated.
- F. Nameplates: Provide motors with stainless steel nameplates, secured with stainless steel fasteners, containing information required in NEMA MG 1; and motor connection diagram if more than three motor leads enter the motor terminal box.
- G. Frequency Rating: 60 Hz.

## SECTION 23 05 13 COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

- H. Voltage Rating: Determined by voltage of circuit to which motor is connected or as indicated. Motor shall be capable of normal operation with voltage variations of plus or minus 10% of nameplate rating.
- I. Service Factor: Provide motors with 1.15 service factor, unless otherwise indicated.
- J. Duty and Torque Characteristics: Rated for continuous duty; sufficient to start, accelerate, and operate connected loads at designated speeds, in environments ranging from -4 to 104 Deg F, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- K. Enclosure Type:
  - 1. Indoor Service: Open Drip-Proof (ODP), unless otherwise indicated. Provide drain plugs at the lowest part of the motor housing.
  - 2. Outdoor Service: Totally Enclosed Fan Cooled (TEFC), unless otherwise indicated. Furnish with drain and breather plugs.
  - 3. Hazardous Environment Duty: Explosion-proof motors where indicated. Furnish with drain and breather plugs.
- L. Vertical Motors: Motors used in vertical configuration shall be specifically designed to operate in vertical installation. Universal position motors are not acceptable. Thrust bearing rating shall be compatible with the loads imposed by the driven equipment.

### 2.3 THREE-PHASE MOTORS

- A. Description: Three-phase, single speed squirrel-cage induction type, 208-230V or 460V as indicated. In addition to requirements listed under General Requirements, provide motors with following:
  - 1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated. Motor torque characteristics must allow the connected load to be accelerated to full load speed and then operate continuously at full load without damaging the motor. Unless otherwise indicated, motors shall be capable of full voltage across-the-line starts per NEMA MG 1, Section III, Part 20 as follows: Two starts in succession, coasting to rest between starts, motor initially at ambient temperature of 104 Deg F (40 Deg C).
  - 2. Insulation: NEMA Class F insulation with Class B temperature rise, unless otherwise indicated.
  - 3. Stator: High conductivity copper windings, cast iron frame and end bells unless otherwise indicated. Multispeed motors have separate winding for each speed.
  - 4. Rotor: Keyed or shrunk to shaft. Rotors welded to shaft are not acceptable. Where aluminum die-cast rotor assemblies are not provided, make rotor bars and conducting end rings of copper with bars brazed to rings.
  - 5. Bearings: Motors equipped with anti-friction bearings to meet the following: Motors serving belt-driven equipment use AFBMA 9 L-10 life, 50,000 hours minimum; direct-drive motors use AFBMA 9 L-10 life, 125,000 hours minimum.
  - 6. Lubrication: Motors shall be grease lubricated, unless otherwise indicated. Bearings shall be externally regreasable via accessible grease fittings without having to disassemble the motor; provide for the elimination of the purged grease through fittings. Provided seals to prevent grease from entering the motor interior. Vertical motor lubrication shall conform to the motor manufacturer's recommendations.
  - 7. Vibration: Test vibration at bearing housing and shaft in accordance with NEMA MG 1, Section I, Part 7. Maximum allowable vibration velocity is 0.08 inches per second (resiliently mounted).
  - 8. Winding Over-Temperature Protection: Imbedded (normally closed contact) thermostats, one per winding, shall be provided for an external thermal alarm or motor cut-out for all motors 40 hp and above, unless indicated otherwise. Thermostat automatically resets when the motor temperature returns to normal range. Thermal cutout leads shall be brought out to the motor terminal connection box.
  - 9. Connections: Conduit or terminal box shall be split construction with threaded hubs, able to rotate in 90-degree increments. Provide ground lug securely attached to motor frame in conduit box for ground connection.
  - 10. Noise Control: Comply with NEMA MG 1, Section I, Part 9.

## SECTION 23 05 13 COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

11. Lifting lugs: Provide lifting lugs on motors weighing over 100 lbs. Drilled and tapped holes for lugs shall not penetrate motor enclosure.
12. Finish: Coat parts with zinc-rich primer prior to final coats of epoxy enamel.
- B. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for indicated controller, with required motor leads brought to motor terminal box to suit control method.
- C. Motors Used with Variable-Frequency (VFD) Drives: Ratings, characteristics, and features coordinated with and approved by variable frequency drive manufacturer.
  1. Motor Operating Frequencies: Critical motor vibration frequencies shall not be within operating range of drive output.
  2. Insulation: NEMA Class H with Class B temperature rise.
  3. Winding Over-Temperature Protection: Provide winding over-temperature thermostat to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermostat automatically resets when the motor temperature returns to normal range. Thermal cutout leads shall be brought out to the motor terminal connection box.
  4. Motor nameplates shall indicate that motors are inverter duty motors capable of operation up to 200% nameplate speed.
  5. Motor shall have shaft grounding system to protect bearings from capacitance discharge through the bearings. The system shall use grounding brushes and shall be designed to reduce shaft voltage levels to less than 3 volts.
- D. Manufacturer Shop Tests: Each three-phase motor shall be given a routine test to determine that is free from electrical and/or mechanical defects and provide assurance that it meets the specifications. The test shall conform to the latest applicable NEMA and IEEE standards and shall be defined as "Standard Commercial Test." Copies of the test report will not be required to be submitted unless the actual operation and installation suggest the motor's performance should be verified, in which case certified copies of the test report shall be submitted upon request.

### 2.4 SINGLE-PHASE MOTORS

- A. Description: Single-phase, single speed, 115/230V or 115-208/230V as indicated, designed for continuous duty. In addition to requirements listed under General Requirements, provide motors with following:
  1. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.
    - a. Permanent-split capacitor.
    - b. Split-phase start, capacitor run.
    - c. Capacitor start, capacitor run.
    - d. Shaded-pole: Do not use, unless motors are smaller than 1/20 hp.
  2. Thermal Protection: Internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range.
  3. Insulation: NEMA Class B insulation, unless otherwise indicated.
  4. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, prelubricated sleeve bearings for other single-phase motors.
  5. Enclosures: Heavy fabricated steel or cast iron.
  6. Finish: Coat parts with zinc-rich primer prior to final coats of epoxy enamel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. The motor installation shall be in conformance with the motor manufacturer's recommendations. Motors shall be factory installed on, aligned and connected to driven equipment, common bases, stands, etc., with the driven equipment. Belt driven equipment shall have belt tension adjusted to manufacturer's recommendations.

SECTION 23 05 13 COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

- B. Electrical Connections: Install electrical connectors and terminals according to manufacturer's recommendations. Verify motor is properly grounded.
- C. Motors for Variable Speed Drives: Install shaft grounding system according to manufacturer's recommendations.

END OF SECTION

## SECTION 23 05 19 METERS AND GAGES FOR MECHANICAL PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 22 13 "Steam and Condensate Heating Piping" for steam and condensate meters.

#### 1.2 SUMMARY

- A. This Section includes the following meters and gages for mechanical systems:
  - 1. Thermometers.
  - 2. Gages.
  - 3. Trumpet valves and gages
  - 4. Portable instrument connections.
  - 5. Flowmeters.

#### 1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermal-energy meters indicating manufacturer's number, scale range, and location for each.
- C. Product Certificates: For each type of thermal-energy meter, signed by product manufacturer.
- D. Operation and Maintenance Data: For flowmeters and thermal-energy meters to include in emergency, operation, and maintenance manuals.

#### 1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of instrumentation on floor plans and diagrams.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Direct-Mounting, Vapor-Actuated Dial Thermometers:
    - a. Marsh Bellofram.
    - b. Terice, H. O. Co.
    - c. Weiss Instruments, Inc.
    - d. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
  - 2. Pressure Gages:
    - a. Marsh Bellofram.
    - b. Terice, H. O. Co.
    - c. Weiss Instruments, Inc.
    - d. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
  - 3. Trumpet Valve and Gage
    - a. Flow Conditioning Corp.
  - 4. Portable Instrument Connections:
    - a. Flow Design, Inc.
    - b. MG Piping Products Co.
    - c. National Meter, Inc.
    - d. Peterson Equipment Co., Inc.
    - e. Sisco Manufacturing Co.
    - f. Terice, H. O. Co.
    - g. Watts Industries, Inc.; Water Products Div.
  - 5. Venturi Flowmeters:

## SECTION 23 05 19 METERS AND GAGES FOR MECHANICAL PIPING

- a. Armstrong Pumps, Inc.
  - b. Badger Meter, Inc.; Industrial Div.
  - c. Flow Design, Inc.
  - d. Victaulic Co. of America.
6. Turbine Flowmeters:
- a. Badger Meter, Inc.; Industrial Div.
  - b. Engineering Measurements Company.
  - c. ONICON Incorporated.
  - d. Sponsler Company, Inc.
  - e. Venture Measurement.

### 2.2 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

- A. Case: Dry or liquid-filled type to suit application, stainless steel or cast aluminum, 4-1/2-inch diameter.
- B. Element: Bourdon tube or other type of pressure element.
- C. Movement: Mechanical, connecting element and pointer.
- D. Dial: White face with black markings.
- E. Pointer: Black metal.
- F. Window: Glass.
- G. Ring: Stainless steel.
- H. Connector: Rigid, bottom or back type to suit application.
- I. Thermal System: Liquid-filled bulb in brass stem for thermowell installation and of length to suit installation.
- J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

### 2.3 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

### 2.4 PRESSURE GAGES

- A. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
  1. Case: Dry or liquid-filled type to suit application, stainless steel or cast aluminum, 4-1/2-inch diameter.
  2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
  3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
  4. Movement: Mechanical, with link to pressure element and connection to pointer.
  5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
  6. Pointer: Black metal.
  7. Window: Glass.
  8. Ring: Stainless steel.
  9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
  10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
  11. Range for Fluids under Pressure: Two times operating pressure.
- B. Pressure-Gage Fittings:
  1. Valves: NPS 1/4 brass or stainless-steel needle type.
  2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
  3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

### 2.5 TRUMPET VALVE AND GAGE

- A. Description: Brass manifold with hydronic indicator gage, spring return pushbutton valves, ports to connect to system, test port, and universal mounting bracket for horizontal or vertical pipe.

## SECTION 23 05 19 METERS AND GAGES FOR MECHANICAL PIPING

- B. Hydronic Indicator Gage: Shall meet ASA Grade A specifications for pressure gages, accurate to 1%. Case shall be 4½" diameter, stem mounted, heavy steel with screwed ring and unbreakable crystal. Indicator shall have recalibrator, compound scale calibrated in both psig and feet W.C. from full vacuum to selected pressure, and quick-set dial for pressure comparison. Maximum indicator pressure shall at least equal pump shut-off head and shall exceed this minimum by no more than 50 psig.

### 2.6 PORTABLE INSTRUMENT CONNECTIONS

- A. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed, and threaded cap, with extended stem for units to be installed in insulated piping.
- B. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- C. Core Inserts: One or two self-sealing rubber valves.
  - 1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
  - 2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.
- D. Test Kit: Furnish one test kit containing one pressure gage and adaptor, two thermometers, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit portable instrument connections and of length to project into piping.
  - 1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be 0 to 200 psig.
  - 2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
  - 3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
  - 4. Carrying case shall have formed instrument padding.

### 2.7 VENTURI FLOWMETERS

- A. Description: Differential-pressure design for installation in piping; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.
- B. Construction: Bronze, brass, or factory-primed steel; with brass fittings and attached tag with flow conversion data.
- C. Pressure Rating: 250 psig.
- D. Temperature Rating: 250 deg F.
- E. End Connections for NPS 2 and Smaller: Threaded.
- F. End Connections for NPS 2-1/2 and Larger: Flanged.
- G. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
- H. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
  - 1. Scale: Gallons per minute.
  - 2. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.
- I. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.
  - 1. Scale: Gallons per minute.
  - 2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.
- J. Operating Instructions: Include complete instructions with each flowmeter.

### 2.8 TURBINE FLOWMETERS

- A. Description: Insertion type for inserting turbine into piping and measuring flow directly in gallons per minute.
- B. Construction: Bronze or stainless-steel body; with plastic turbine or impeller and integral direct-reading scale.
- C. Pressure Rating: 150 psig minimum.

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- D. Temperature Rating: 250 deg F minimum.
- E. Display: Visual instantaneous rate of flow.
- F. Accuracy: Plus or minus 2-1/2 percent.

### PART 3 - EXECUTION

#### 3.1 THERMOMETER APPLICATIONS

- A. Install thermometers in the following locations and where shown on drawings:
  - 1. Inlet and outlet of each hydronic chiller.
  - 2. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
  - 3. Inlet and outlet of each hydronic heat exchanger.
  - 4. Inlet and outlet of each hydronic heat-coils.
  - 5. Inlet and outlet of each thermal storage tank, and domestic water heater.
  - 6. Outside-air, return-air, and mixed-air ducts.
- B. Provide the following temperature ranges for thermometers:
  - 1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
  - 2. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
  - 3. Domestic water: 0 to 160 deg F, with 2-degree scale divisions.
  - 4. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
  - 5. Heat Recovery Water: 0 to 100 deg F, with 2-degree scale divisions.
  - 6. Condensate: 30 to 300 deg F, with 5-degree scale divisions.
  - 7. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

#### 3.2 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve and where shown on drawings.
- B. Install liquid-filled-case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.
- C. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

#### 3.3 TRUMPET VALVE AND GAGE APPLICATIONS

- A. Install trumpet valve and hydronic indicator gage at large circulating pumps as detailed on the drawings. Make connections across pump inlet and discharge, and across suction diffuser or strainer.

#### 3.4 INSTALLATIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports, and portable instrument connections.
- B. Install direct-mounting thermometers and adjust vertical and tilted positions.
- C. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.
- D. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- E. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
- F. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- G. Install remote-mounting pressure gages on panel.
- H. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- I. Install needle-valve and syphon fitting in piping for each pressure gage for steam.
- J. Install portable instrument connections in tees in piping.
- K. Install flow indicators, in accessible positions for easy viewing, in piping systems.
- L. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.
- M. Install flowmeter elements in accessible positions in piping systems.

## SECTION 23 05 19 METERS AND GAGES FOR MECHANICAL PIPING

- N. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.
- O. Install permanent indicators on walls or brackets in accessible and readable positions.
- P. Install connection fittings for attachment to portable indicators in accessible locations.
- Q. Mount meters on wall if accessible; if not, provide brackets to support meters.

### 3.5 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy-meter transmitters to meters.
- E. Ground equipment according to Division 26.
- F. Connect wiring according to Division 26.

### 3.6 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION



## SECTION 23 05 23 GENERAL-DUTY VALVES FOR MECHANICAL PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Special purpose valves are specified in other Division 23 piping system sections.
  - 2. Valve tags and charts are specified in Section 23 05 53 "Identification of Mechanical Piping and Equipment."

#### 1.2 SUMMARY

- A. This Section includes general duty valves common to several mechanical piping systems.

#### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Gate Valves, 2-Inches and Smaller
  - 2. Gate Valves, 2½-Inches and Larger
  - 3. Ball Valves
  - 4. Globe Valves, 2-Inches and Smaller
  - 5. Globe Valves, 2½-Inches and Larger
  - 6. Butterfly Valves
  - 7. Swing Check Valves, 2-Inches and Smaller
  - 8. Swing Check Valves, 2½-Inches and Larger
  - 9. Silent Check Valves, 2-Inches and Smaller
  - 10. Silent Check Valves, 2½-Inches and Larger
- C. Shop Drawings: None required.
- D. Reports and Certificates: Provide submittals of the following:
  - 1. Summary table indicating each type of valve and application required for project.

#### 1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Comply with the requirements specified in Division 01 Section "Materials and Equipment," under "Source Limitations" Paragraph.
- B. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set globe and gate valves closed to prevent rattling.
  - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

SECTION 23 05 23 GENERAL-DUTY VALVES FOR MECHANICAL PIPING

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Gate Valves:
    - a. Crane Company; Valves and Fitting Division
    - b. Hammond Valve Corporation
    - c. Milwaukee Valve Company, Inc.
    - d. Nibco Inc.
  2. Ball Valves:
    - a. Conbraco Industries, Inc.; Apollo Division
    - b. Hammond Valve Corporation
    - c. Nibco Inc.
    - d. Milwaukee Valve Company, Inc.
  3. Globe Valves:
    - a. Crane Company; Valves and Fitting Division
    - b. Hammond Valve Corporation
    - c. Milwaukee Valve Company, Inc.
    - d. Nibco Inc.
  4. Butterfly Valves:
    - a. Demco
    - b. Keystone Valve USA, Inc.
    - c. Dezurik
    - d. Nibco Inc.
    - e. Victaulic
  5. Swing Check Valves:
    - a. Crane Company; Valves and Fitting Division
    - b. Hammond Valve Corporation
    - c. Milwaukee Valve Company, Inc.
    - d. Nibco Inc.
  6. Silent Check Valves:
    - a. Hammond Valve Corporation
    - b. Milwaukee Valve Company, Inc.
    - c. Nibco Inc.

2.2 BASIC, COMMON FEATURES

- A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.
1. Nonrising stem valves may be used only where headroom prevents full extension of rising stems.
- B. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.
- C. Sizes: Same size as upstream pipe, unless otherwise indicated.
- D. Operators: Use specified operators and handwheels, except provide the following special operator features:
1. Handwheels: For valves other than quarter turn.
  2. Lever Handles: For quarter-turn valves 6 inches and smaller, except for plug valves, which shall have square heads. Furnish Owner with one wrench for every 10-plug valves.
  3. Chain-Wheel Operators: For valves 4 inches and larger, installed 96 inches or higher above finished floor elevation.
  4. Gear-Drive Operators: For quarter-turn valves 8 inches and larger.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- G. Threads: ASME B1.20.1.
- H. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.
- I. Solder Joint: ASME B16.18.

## SECTION 23 05 23 GENERAL-DUTY VALVES FOR MECHANICAL PIPING

1. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

### 2.3 GATE VALVES

- A. Gate Valves, 2-Inches and Smaller: MSS SP-80; Class 125, 200-psi cold working pressure (CWP), or Class 150, 300-psi CWP as required in Application Schedule; ASTM B 62 cast-bronze body and bonnet, solid-bronze wedge, dezincification-resistant copper silicon alloy rising stem, union body-bonnet connection, non-asbestos packing, bronze packing nut, malleable-iron handwheel, and threaded or soldered end connections as required in Application Schedule.
- B. Gate Valves, 2½-Inches and Larger: MSS SP-70, Class 125, 200-psi CWP or Class 250, 500-psi CWP, ASTM A 126 cast-iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, bolted body-bonnet connection, teflon-impregnated packing with 2-piece packing gland assembly, flanged end connections; and with cast-iron handwheel.

### 2.4 BALL VALVES

- A. Ball Valves, 2-Inches and Smaller: MSS SP-110, 600-psi CWP, Class 150, ASTM B 584 bronze body and end piece(s), 2-piece or 3-piece construction as required in the Application Schedule; stainless steel ball, full port, blowout proof; stainless steel stem; teflon seats and seals; threaded or soldered end connections as called for in Part 3. Vinyl-covered steel lever handle.
  1. Options:
    - a. Stem Extension: For valves installed in insulated piping (if required in Application Schedule) equip with 2-Inch extended handle of non-thermal material. Provide protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
    - b. Memory Stop: For operator handles (if required in Application Schedule).

### 2.5 GLOBE VALVES

- A. Globe Valves, 2-Inches and Smaller: MSS SP-80; Class 150, 300-psi CWP or Class 300, 600-psi CWP as required in the Application Schedule; ASTM B 62 cast-bronze body and bonnet bronze or teflon seat disc, dezincification-resistant copper silicon alloy rising stem, union body-bonnet connection, bronze packing nut, malleable-iron handwheel, threaded end connections.
- B. Globe Valves, 2½-Inches and Larger: MSS SP-85, Class 125, 200-psi CWP or Class 250, 500-psi CWP; ASTM A 126 cast-iron body and bonnet with bronze fittings, bolted body-bonnet connection, renewable bronze seat and disc, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

### 2.6 BUTTERFLY VALVES

- A. Butterfly Valves: MSS SP-67, 200-psi CWP up to 12-inch and 150-psi for 14-inch and larger, 150-psi maximum pressure differential, ASTM A 536 ductile-iron body, full lug style, extended neck, stainless-steel stem, EPDM liner and stem seals. Suitable for bi-directional dead-end service at valve's rated pressure without need of downstream flange.
  1. Disc Type: Aluminum bronze or elastomer-coated ductile iron as indicated in Application Schedule.
  2. Operator for Sizes 2-Inches to 6-Inches: Standard lever handle with memory stop.
  3. Operator for Sizes 8-Inches to 12-Inches: Gear operator with position indicator.
  4. Operator for Sizes 8-Inches and Larger, 96 Inches or Higher above Floor: Chain-wheel operator.

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### 2.7 CHECK VALVES

- A. Swing Check Valves, 2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP or Class 150, 300-psi CWP as required in the Application Schedule; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with renewable seat and disc, threaded or soldered end connections as required by Application Schedule.
- B. Swing Check Valves, 2½-Inches and Larger: MSS SP-71, Class 125, 200-psi CWP or Class 250, 500-psi CWP as required in the Application Schedule, ASTM A 126 Class B cast-iron body and bolted bonnet, horizontal-swing, bronze disc, flanged connections.
- C. Silent Check Valves, 2-Inches and Smaller: MSS SP-80, Class 125, 250-psig CWP, in-line spring actuated lift type, ASTM B 584 bronze body, stainless steel spring, Buna-N seat, threaded connections.
- D. Silent Check Valves, 2½-Inches and Larger: Class 125, 200-psi CWP, twin disc, spring actuated type, ASTM A 126 Class B case iron body, bronze disc, stainless steel spring, Buna-N seat, wafer, lug or grooved style connections.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

#### 3.2 INSTALLATION

- A. Install valves as indicated, according to manufacturer's written instructions.
- B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with stem a minimum of 30° above horizontal at or above the center of the pipe.
- F. Install valves in a position to allow full stem movement.
- G. For chain-wheel operators, extend chains to 60 inches above finished floor elevation.
- H. Installation of Check Valves: Install for proper direction of flow as follows:
  - 1. Swing Check Valves: Horizontal position with hinge pin level or vertical upflow position.
  - 2. Silent Check Valves: Horizontal or vertical position.

#### 3.3 SOLDERED CONNECTIONS (FOR DOMESTIC WATER SYSTEMS ONLY)

- A. Cut tube square and to exact lengths.
- B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.
- C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.
- D. Open gate and globe valves to fully open position.
- E. Remove the cap and disc holder of swing check valves having composition discs.
- F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.
- G. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve.

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Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

### 3.4 THREADED CONNECTIONS

- A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
- B. Align threads at point of assembly.
- C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
- D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

### 3.5 FLANGED CONNECTIONS

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

### 3.6 VALVE END SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
  - 1. Copper Tube Size, 2-Inches and Smaller: Threaded ends, except solder ends can be used for plumbing cold water, hot water, non-potable water and compressed air systems.
  - 2. Copper Tube Size, 2½-Inches and Larger: Flanged ends. Grooved ends acceptable if specified in Section 22 11 16 "Water Distribution Piping" and/or Section 23 21 13 "Hydronic Piping."
  - 3. Steel Pipe Sizes, 2-Inches and Smaller: Threaded ends.
  - 4. Steel Pipe Sizes, 2½-Inches and Larger: Flanged ends. Grooved ends acceptable if specified in Section 23 21 13 "Hydronic Piping."

### 3.7 APPLICATION SCHEDULE

- A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe for throttling duty as indicated. Refer to piping system Specification Sections for specific valve applications and arrangements.
- B. Domestic Water Systems: Use the following valve types:
  - 1. Ball Valves, 2-inches and Smaller: 3-piece with stem extension.
  - 2. Gate Valves, 2½-Inches and Larger: Class 125, iron body.
  - 3. Globe Valves, 2½-Inches and Larger: Class 125, cast-iron body.
  - 4. Butterfly Valves: Elastomer-coated ductile iron or aluminum bronze disc.
  - 5. Swing Check Valves, 2-Inches and Smaller: Class 125, bronze body, use for all applications except at pump discharge.
  - 6. Swing Check Valves, 2½-Inches and Larger: Class 125, iron body, use for all applications except at pump discharge.
  - 7. Silent Check Valves, 2-Inches and Smaller: Class 125, bronze body; use at pump discharge.
  - 8. Silent Check Valves, 2½-Inches and Larger: Class 125, iron body, use at pump discharge.
- C. Heating Water Systems: Use the following valve types:
  - 1. Ball Valves, 2-Inches and Smaller: 3-piece with stem extension and memory stop.
  - 2. Gate Valves, 2½-Inches and Larger: Class 125, iron body.
  - 3. Globe Valves, 2-Inches and Smaller: Class 150, bronze body.
  - 4. Globe Valves, 2½-Inches and Larger: Class 125, cast-iron body.
  - 5. Butterfly Valves: Aluminum bronze disc.
  - 6. Swing Check Valves, 2-Inches and Smaller: Class 125, bronze body, use for all applications except at pump discharge.

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7. Swing Check Valves, 2½-Inches and Larger: Class 125, iron body, use for all applications except at pump discharge.
  8. Silent Check Valves, 2-Inches and Smaller: Class 125, bronze body; use at pump discharge.
  9. Silent Check Valves, 2½-Inches and Larger: Class 125, iron body, use at pump discharge.
- D. Steam and Condensate Systems: Use the following valve types:
1. Gate Valves, 2-Inches and Smaller: Class 150, bronze body.
  2. Gate Valves, 2-1/2-Inches and Larger: Class 250, iron body.
  3. Globe Valves, 2-Inches and Smaller: Class 150, bronze body.
  4. Globe Valves, 2-1/2-Inches and Larger: Class 250, iron body.
  5. Swing Check Valves, 2-Inches and Smaller: Class 150, bronze body.
  6. Swing Check Valves, 2-1/2-Inches and Larger: Class 250, iron body.
- E. Chilled Water Systems: Use the following valve types:
1. Ball Valves, 2-Inches and Smaller: 3-piece with stem extension and memory stop.
  2. Gate Valves, 2½-Inches and Larger: Class 125, iron body.
  3. Globe Valves, 2-Inches and Smaller: Class 150, bronze body.
  4. Globe Valves, 2½-Inches and Larger: Class 125, cast-iron body.
  5. Butterfly Valves: Aluminum bronze disc.
  6. Swing Check Valves, 2-Inches and Smaller: Class 125, bronze body, use for all applications except at pump discharge.
  7. Swing Check Valves, 2½-Inches and Larger: Class 125, iron body, use for all applications except at pump discharge.
  8. Silent Check Valves, 2-Inches and Smaller: Class 125, bronze body; use at pump discharge.
  9. Silent Check Valves, 2½-Inches and Larger: Class 125, iron body, use at pump discharge.
- F. Condenser Water Systems: Use the following valve types:
1. Globe Valves, 2-Inches and Smaller: Class 150, bronze body.
  2. Globe Valves, 2½-Inches and Larger: Class 125, cast-iron body.
  3. Butterfly Valves: Aluminum bronze disc.
  4. Swing Check Valves, 2-Inches and Smaller: Class 125, bronze body, use for all applications except at pump discharge.
  5. Swing Check Valves, 2½-Inches and Larger: Class 125, iron body, use for all applications except at pump discharge.
  6. Silent Check Valves, 2-Inches and Smaller: Class 125, bronze body; use at pump discharge.
  7. Silent Check Valves, 2½-Inches and Larger: Class 125, iron body, use at pump discharge.

### 3.8 ADJUSTING

- A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for vibration isolation and seismic restraint devices for piping and equipment.

1.2 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems, and/or heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Engineering Responsibility: Design and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.
  - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.
  - 2. Comply with MSS SP-69.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Pipe Hangers:
    - a. B-Line Systems, Inc.
    - b. Tolco.
    - c. Anvil Corp.
    - d. Erico International Corp.
    - e. National Pipe Hanger Corp.
  - 2. Channel Support Systems:
    - a. B-Line Systems, Inc.
    - b. Anvil Corp.
    - c. Tolco.
    - d. Unistrut Corp.

3. Thermal-Hanger Shield Inserts:
  - a. Carpenter & Patterson, Inc.
  - b. PHS Industries, Inc.
  - c. PT&P, Pipe Shields, Inc.
  - d. Rilco Manufacturing Co., Inc.
  - e. Value Engineered Products, Inc.
4. Powder-Actuated Fastener Systems:
  - a. Gunnebo Fastening Corp.
  - b. Hilti, Inc.
  - c. ITW Ramset/Red Head.
  - d. Masterset Fastening Systems, Inc.
5. Composite Metal Deck with Dovetail Ribs:
  - a. Epicore Composite Deck

## 2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
  1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
  2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
  1. Material: Steel, structural quality, ASTM 570.
  2. Coatings: G90 galvanized coating. Threaded hardware, zinc plated.
  3. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
  1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
  2. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
  3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
  4. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
  5. All insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes: ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.
  6. Load tests shall be made on both supporting materials and configurations. All tests shall be performed by an independent testing laboratory. Results of pertinent tests shall be available, on request, to the purchaser.
- D. Epicore Inserts: Concrete has poured in "Epicore" composite metal deck, which features dovetail ribs on the underside. Attachment to this system shall be through wedge-shaped anchors that fit into the dovetail ribs. Refer to Section 01 35 15 "Special Requirements – Penetrations and Anchors."

## 2.3 MISCELLANEOUS MATERIALS

- A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink, and nonmetallic, dry, hydraulic-cement grout.
  1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
  2. Properties: Nonstaining, noncorrosive, and nongaseous.

3. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

## 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
  1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
  3. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  4. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  6. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
  7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
  8. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
  9. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  10. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
  11. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- C. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
- D. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg f piping installations.
  3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg f piping installations.
- E. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  4. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
  - a. Light (MSS Type 31): 750 lb.
  - b. Medium (MSS Type 32): 1500 lb.
  - c. Heavy (MSS Type 33): 3000 lb.
- F. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  1. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
  2. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
  3. Thermal-Hanger Shield Inserts shall be supplied and installed by the mechanical contractor on all insulated pipe and tubing.
- G. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  1. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  2. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
  3. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
  1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
  1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs, Epicore deck, or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- E. If concrete inserts cannot be used, install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

- J. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.9.
  2. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  3. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
  4. Pipes NPS 8 and Larger: Include wood inserts.
  5. Insert Material: Length at least as long as protective shield.
  6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor where indicated.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

### 3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### 3.6 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION



## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Furnish and install a UL listed system of electric self-regulating heating cable and components for maintaining the water temperature in the pipes as indicated on the drawings.

## 1.2 SUBMITTALS

- A. Copy of UL file indicating the heating cable is specifically listed to provide freeze-protection for type of system indicated.
- B. Manufacturer's catalog cuts showing materials and performance data.
- C. Project list of at least 20 projects, installed for at least 5 years, with at least 2000 ft (600m) of heating cable in each project.

## PART 2 - PRODUCTS

## 2.1 CONSTRUCTION

- A. The self-regulating heating cable shall consist of two (2) 16-AWG nickel-coated copper bus wires embedded in a radiation-crosslinked conductive polymer core. It shall be covered by a radiation-crosslinked, polyolefin, dielectric jacket and enclosed in a tinned copper braid of 14 AWG equivalent wire size. The braid shall be covered with a (nominal) 40-mil polyolefin outer jacket, color coded for easy identification. The cable shall be specifically designed, manufactured, and UL listed for freeze-protection.

## 2.2 MECHANICAL

- A. The cable shall have a minimum cut-through resistance of 600 lb per CSA 22.2 0.3. Cutting test 4.14. The cable shall have a minimum impact resistance of 25 ft lb per UL 1588.11. The cable shall withstand a glancing impact of 22 ft lb per UL 1581.590. The cable shall have a minimum abrasion resistance of 7000 cycles per UL 719.19. The cable shall withstand a crush resistance of 4500 N per IEEE 515 Deformation Test 5.1.5.

## 2.3 EXPERIENCE

- A. The manufacturer shall have more than ten years experience with self-regulating heating cables for temperature maintenance of domestic hot water.
- B. The manufacturer's Quality Assurance Program shall be certified to ISO 9001 standard.

## 2.4 ACCEPTABLE MANUFACTURER

- A. Raychem Corporation.
- B. Thermon.
- C. Nelson Heat Tracing Systems.

## PART 3 - EXECUTION

## 3.1 OPERATING TEMPERATURES

- A. The freeze protection system shall not exceed a nominal temperature of 40°F.

## 3.2 MAINTENANCE TEMPERATURE

- A. Each freeze protection system shall be maintained using only one product. Temperatures shall be maintained with straight runs of heating cable on the pipe. The use of a 40°F fixed thermostat shall ensure heating cable is off when pipe temperature is over 40°F.

## 3.3 INSTALLATION

- A. The system shall be installed by factory trained certified installers.
- B. The system shall be installed according to the drawings and the manufacturer's instruction. The installer shall be responsible for providing a functional system, installed in accordance with applicable national and local code requirements. Each circuit shall be protected with a 30-mA ground-fault protection device.
- C. Electrical Connections: The following requirements apply:
  1. Electrical power wiring is specified in Division 26.

SECTION 23 05 33 HEAT TRACE

2. Freeze-protection for the fire line shall be monitored by fire alarm control panel.

3.4 TESTING

- A. Procedure: Measure the heater circuit continuity and the insulation resistance between the braid and bus wires with a 2500-Vdc megohmmeter (megger).
- B. Acceptable Results: The heater circuit shall be continuous and megger readings shall be at least 20 megohms regardless of heater length. Circuits yielding unacceptable readings must be repaired or replaced.
- C. Submittal of Results: Submit records of the test data to the Construction Manager.

END OF SECTION

SECTION 23 05 48 VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
  - 1. This Section includes vibration isolators, vibration isolation bases, vibration isolation roof curbs.
  - 2. This Section includes seismic restraint requirements for suspended pipes, ducts, and mechanical equipment with and without vibration isolation.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. SEI/ASCE 7: American Society of Civil Engineers; Minimum Design Loads for Buildings and Other Structures.

1.4 PERFORMANCE REQUIREMENTS

- A. Design seismic and vibration isolation systems, including drawings, calculations, and material specifications prepared according to current IBC and SEI/ASCE 7 (2005) for obtaining approval from authorities having jurisdiction. Seismic and vibration systems shall be selected for the approved Project equipment, piping and ductwork components.
- B. Wind-Restraint Loading:
  - 1. Basic Wind Speed: 85 mph.
  - 2. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- C. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: C.
  - 2. Assigned Seismic Use Group as Defined in the IBC: III.
    - a. For Seismic Use Group III: use the following:
      - 1) Component Importance Factor: 1.5 for all life safety systems and equipments required to function after an earthquake and all systems, and equipment, needed for continued operation of the facility or whose failure could impair the continued operation of the facility. Refer to Component Importance Factor Schedule in Part 3 of this Section.
  - 3. Component Response Modification Factor (Rp) and Component Amplification Factor (Ap): From SEI/ASCE 7 (2005), Table 13.6-1, Seismic Coefficients for Mechanical and Electrical Components.
  - 4. Seismic Design Category: D.
- D. Reports and Certificates: Equipment manufacturers, provide submittals of the following:
  - 1. Mechanical Seismic Qualification Certificates: For all required equipment specified in Divisions 21, 22, and 23, accessories, and components from manufacturer.
    - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      - 1) For Seismic User Group III: The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
    - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

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1.5 DEFERRED SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by OSHPD.
    - b. Annotate to indicate application of each product submitted and compliance with requirements.
  - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Product Data: Provide submittals of the following:
  - 1. Vibration isolators.
  - 2. Anchor Bolts, Washers, and Bushings
  - 3. Restrained Vibration Isolation Roof Curb Rails.
  - 4. Seismic Restraint Devices
  - 5. Vibration Isolation Equipment Bases.
- C. Shop Drawings: In addition to requirements set forth in Section 23 05 00, shop drawings for the listed systems shall also include detailing of riser supports, vibration isolation base details, seismic-restraint systems, and suspended elements. Provide submittals of the following piping systems within the entire building:
  - 1. For Vibration Isolated Elements:
    - a. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
    - b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
    - c. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate layout, quantity, diameter, anchor depth of embedment and, if mounted on housekeeping pads, indicate anchor minimum edge distance requirements.
    - d. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
  - 2. For Suspended Elements: Prior to installation, submit seismic restraint manufacturer's layout of all required bracing locations on contractor shop drawings. Layout to be signed and sealed by a qualified professional engineer. Layout to include manufacturer's bracing legend indicating:
    - a. Type of braced element.
    - b. Seismic restraint hardware call-out.
    - c. Minimum required vertical support rod diameter.
    - d. Maximum allowable brace spacing.
    - e. Brace reaction at full design load.
    - f. Minimum required seismic restraint anchorage.
    - g. Installation detail drawing number.
    - h. Anchorage installation detail drawing number.
- D. Design Calculations: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

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1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
  - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
  - b. To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
  - c. Pre-approval and Evaluation Documentation: By OSHPD, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 QUALITY ASSURANCE

- A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those indicated for this Project in material, design, and extent. This professional engineer shall develop a Quality Assurance Plan.
- B. Testing Agency Qualifications (Owner may engage): An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- C. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- E. Any device that provides seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, showing maximum seismic-restraint ratings. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.7 FIELD QUALITY CONTROL

- A. Provide a Quality Assurance Plan that complies with SEI/ASCE 7, Appendix 11A for the following mechanical systems or equipment.
  1. Flammable, combustible, or highly toxic piping systems and their associated mechanical units in Seismic Design Categories C, D, E, or F.
  2. Installation of HVAC ductwork that will contain hazardous materials in Seismic Design Categories C, D, E, or F.
  3. Installation of vibration isolation systems where the maximum clearance (air gap) between the equipment support frame and restraint is less than or equal to 1/4-inch.
  4. Installation of seismic restraint systems for Seismic Use Group II and III.
- B. The Contractor shall submit a written Contractor's statement of responsibility to the regulatory authority having jurisdiction and the Owner prior to the commencement of work. The Contractor's statement of responsibility shall contain the following:
  1. Acknowledgement of awareness of the special requirements contained in the Quality Assurance Plan.
  2. Acknowledgement that control will be exercised to obtain conformance with the design documents approved by the authority having jurisdiction.
  3. Procedure for exercising control within the Contractor's organization, the method and frequency of reporting, and the distribution of the reports.
  4. Identification and qualifications of the person exercising such control and their position in the organization.
- C. The Owner shall employ a special inspector to observe the construction of all seismic systems in accordance with the Quality Assurance Plan.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Vibration Isolation: Subject to compliance with requirements, provide products by the manufacturers specified.
  - 1. Amber/Booth Company, Inc.
  - 2. Kinetics Noise Control, Inc.
  - 3. Korfund/Vibration Mountings and Controls, Inc.
  - 4. Mason Industries, Inc.
- B. Seismic Restraint for Suspended Elements: Subject to compliance with requirements, provide products by the manufacturers specified.
  - 1. International Seismic Application Technology (ISAT).
  - 2. Kinetics Noise Control, Inc.
  - 3. Korfund/Vibration Mountings and Controls, Inc.
  - 4. Mason Industries, Inc.
  - 5. Tolco.

2.2 VIBRATION ISOLATORS

- A. Type V-1, Elastomeric Isolator Pads: Oil- and water-resistant neoprene or natural rubber, molded with a nonslip, ribbed or waffle-pattern steel load distribution plates of sufficient stiffness for uniform loading over pad area, factory cut to sizes that match requirements of supported equipment.
  - 1. Basis of Design: Mason Models W and WM.
  - 2. Material: Standard neoprene.
  - 3. Durometer Rating: 40.
  - 4. Thickness: 5/16 inch thick.
  - 5. Isolator shall be loaded to limit surface pressure to a maximum of 50 psi.
- B. Type V-2, Elastomeric Isolator Pads: Oil- and water-resistant neoprene or natural rubbermolded with a nonslip, ribbed or waffle-pattern steel load distribution plates of sufficient stiffness for uniform loading over pad area factory cut to sizes that match requirements of supported equipment.
  - 1. Basis of Design: Mason Model Super W and Super WM.
  - 2. Material: Standard neoprene.
  - 3. Durometer Rating: 50.
  - 4. Thickness: 3/4-inch thick.
  - 5. Isolator shall be loaded to limit surface pressure to a maximum of 50 psi.
- C. Type V-5, Spring Isolators: Freestanding, laterally stable, open-spring isolators.
  - 1. Basis of Design: Mason Model SLF or SLFH.
  - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, neoprene isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psi. Provide resilient isolation washers and bushings at baseplate anchor bolts.
  - 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Type V-6, Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
  - 1. Basis of Design: Mason Model SLR/SLRS.
  - 2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

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3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- E. Type V-7, Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Basis of Design: Mason Model SSLFH.
  2. Housing: Steel housing to provide all-directional seismic restraint.
  3. Base: Factory drilled for bolting to structure with 1/4-inch thick neoprene pad attached to baseplate.
  4. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel before contacting a resilient collar. Snubbing in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum rating of 1.0g.
  5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  7. Isolator to be equipped with leveling bolts that must be rigidly bolted to the equipment with height-saving brackets.
  8. Isolator to be installed with neoprene washers and bushings at baseplate anchor bolts.
- F. Type V-9, Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Basis of Design: Mason Model 30N.
  2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- G. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick, 60 durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psi and for equal resistance in all directions.
1. Basis of Design: Mason Model ADA.
- H. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch-thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
1. Basis of Design: Mason Model VSG.

2.3 ANCHOR BOLTS, WASHERS, AND BUSHINGS

- A. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer rating of 50 with a flat washer face.
1. Basis of Design: Mason Model HG.
  2. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

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3. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
  1. Basis of Design: Hilti Kwik Bolt TZ Mechanical Anchor for seismic restraints.
  2. Basis of Design: Hilti Undercut HDA anchors for direct attachment to equipment 10 hp and greater.

2.4 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

- A. Type RC-1, Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand 125-mph wind impinging laterally against side of equipment. Design restraints to meet seismic requirements of Authorities Having Jurisdiction.
  1. Basis of Design: Mason Model SRSC.
- B. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind and seismic forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
- C. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
  1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
    - a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
    - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    - d. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  2. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
    - a. Material: Standard neoprene.
    - b. Durometer Rating: 50.
    - c. Number of Layers: 1 minimum.
- D. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and

2.5 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in OSHPD pre-approval.
  1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- B. Type S-1, Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
  1. Basis of Design: Mason Model Z-1011.

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2. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and female-wedge or stud-wedge type.
3. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer rating of 50.
- C. Type S-2, Suspended Elements:
  1. Design Requirements: Seismic restraint hardware to be furnished in manufacturer's pre-assembled "kits" labeled for installer cross reference with manufacturer's layout performed on contractor shop drawings. Kits to be labeled as to "kit number," "trade" and "floor." Kits to include:
    - a. All required seismic bracketry correctly sized for attachment to vertical support rods.
    - b. Rod stiffeners as required based on rod diameter and length.
    - c. Correct anchorage hardware for connection to concrete deck, structural steel, or wood structural members.
    - d. Complete installation instructions.
  2. Rigid seismic restraint brace arm assemblies: Designed for strut nut attachment to minimum 12 gage steel channel with pregalvanized zinc finish per ASTM A525, solid, punched or short slot per engineering calculations.
    - a. Basis of Design: Pre-engineered brackets with OSHPD pre-approval. Hinged seismic brackets.
    - b. Assembly: Brackets to be provided from manufacturer with integral 1/2" hex bolts and strut nuts.
  3. Cable seismic restraint brace arm assemblies: Minimum 7 x 19 pre-stretched galvanized steel aircraft cable appropriately sized for the system load.
    - a. Basis of Design: Pre engineered brackets with OSHPD pre-approval.
    - b. Design Requirements: Hinged seismic brackets.
    - c. Assembly: Brackets factory pre-tied to made-to-length aircraft cable, with integral method for length adjustment by installer.
  4. Cast-In Place Deck Inserts: For vertical supports and seismic restraint anchorage.
    - a. Basis of Design: Pre-engineered inserts with OSHPD pre-approval.
    - b. Design Requirements: For form pour slabs, for metal decks with concrete, internally threaded to accept threaded rod diameters, with an OSHPD approval or other enforcement agency approval. Coordinate installation locations with manufacturer's lay out of seismic restraint locations on contractor's shop drawings.

2.6 VIBRATION ISOLATION EQUIPMENT BASES

- A. Type B-1, Steel Base: Factory-fabricated, welded, structural-steel bases with pre-drilled anchor bolt holes.
  1. Basis of Design: Mason Model WF.
  2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Bases shall be sized to accommodate supports for suction and discharge elbows.
  3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  4. Height Saving Brackets: Factory-welded steel L brackets on frame for outrigger isolation mountings.
  5. Frame to be manufactured of beams or channels of minimum section depth equal to 10-percent of the longest span between support isolators, as indicated on the drawings.
  6. Frame to provide a rigid, distortion free mounting base for supported equipment, which allows no excessive differential motion between driving or driven equipment components.
  7. Isolation materials manufacturer to coordinate the isolator locations for each piece of equipment as required.

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- B. Type B-2, Inertia Base: Factory-fabricated, bolted steel bases ready for field-applied, cast-in-place concrete.
    - 1. Basis of Design: Mason Model BMK.
    - 2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor rails. Include supports for suction and discharge elbows for pumps.
    - 3. Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
    - 4. Height Saving Brackets: Factory-welded steel corners bolted to frame for isolation mountings.
    - 5. Frame to be manufactured with a minimum section depth equal to 8-percent of the longest span between support isolators, as indicated on the drawings.
    - 6. Steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete.
    - 7. Base to be equipped with equipment anchor bolts fixed into position and housed in a steel bolt sleeve, allowing minor bolt location adjustment.
    - 8. Base to include reinforced concrete with 1/2 inch reinforcing bars at a maximum of 8 inches on center.
    - 9. Weight of base to be not less than twice that of all the equipment it supports.
- 2.7 FACTORY FINISHES
- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
    - 1. Epoxy Powder coating or electro-galvanized isolation on springs and housings. Zinc plate all bolts, nuts and washers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by OSHPD.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
  - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 3. Install seismic-restraint devices using methods approved by OSHPD.
- C. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.

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2. Space lateral braces a maximum of 40 feet o.c., and longitudinal braces a maximum of 80 feet o.c.
  3. Brace a change of direction longer than 2 feet .
  - D. Ductwork Restraints:
    1. Comply with requirements of SMACNA "Seismic Restraint Manual Guidelines for Mechanical Systems."
    2. Use Seismic Hazard Level A.
  - E. Attachments to Structure:
    1. Install cables so they do not bend across edges of adjacent equipment or building structure.
    2. Install seismic-restraint devices using anchor bolts that meet building code requirements for testing and approval.
    3. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and oversize mounting hole.
    4. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
    5. If specific attachment to structure is not indicated, anchor bracing to structure at flanges of beams at upper chords of bar joists, or at concrete members. Obtain approval of the structural engineer prior to installation.
  - F. Drilled-in Anchors:
    1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
    2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
    3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
    4. Set anchors to manufacturer's recommended torque, using a torque wrench.
- 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION
- A. Install V or U Type flexible loops in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment as indicated on the drawings. Comply with requirements in Section 23 21 13 "Hydronic Piping" for piping flexible connections.
- 3.5 ADJUSTING
- A. Adjust isolators after piping system is at operating weight.
  - B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
  - C. Adjust active height of spring isolators.
  - D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

EQUIPMENT DESCRIPTION	MARK	VIBRATION ISOLATOR TYPE	MINIMUM DEFLECTION (INCHES)	BASE/CURB TYPE	SEISMIC RESTRAINT DEVICE TYPE	NOTES
<b>HYDRONIC AND PLUMBING PUMPS</b>						

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EQUIPMENT DESCRIPTION	MARK	VIBRATION ISOLATOR TYPE	MINIMUM DEFLECTION (INCHES)	BASE/CURB TYPE	SEISMIC RESTRAINT DEVICE TYPE	NOTES
HYDRONIC AND PLUMBING PUMPS	P-14 P-18 P-19	N/A	N/A	N/A	N/A	
HYDRONIC AND PLUMBING PUMPS	P-1 P-2 P-3 P-4 P-5 P-6 P-7 P-8 P-9 P-10 P-11 BWP-1	V-2	0.11	N/A	N/A	
HYDRONIC AND PLUMBING PUMPS	P-12 P-13 P-16 P-17	V-2	0.11	N/A	N/A	
<b>DOMESTIC WATER HEATERS</b>	DWH-1 DWH-2	N/A	N/A	N/A	S-2	
<b>CENTRIFUGAL AND SCREW WATER CHILLERS</b>						
CENTRIFUGAL AND SCREW WATER CHILLERS	CH-1 CH-2 CH-3 CH-4	V-2	0.25	N/A	N/A	
<b>PACKAGED COOLING TOWERS</b>						
PACKAGED COOLING TOWERS	CT-1 CT-2 CT-3 CT-4	V-6	2.5	B-1	N/A	
<b>FLUID COOLERS AND EVAPORATIVE CONDENSERS</b>						
RECIPROCATING WATER CHILLERS	PCH-1	V-6	1.5	N/A	N/A	
<b>AIR-COOLED CONDENSERS</b>						
AIR-COOLED CONDENSERS	ACU-1B ACU-2B ACU-3B	V-1	0.035	N/A	N/A	
AIR-COOLED CONDENSERS	ACU-4B ACU-5B ACU-6B	V-2	0.11	N/A	N/A	
<b>ROOFTOP UNITS</b>						
ROOFTOP UNITS	RTU-1	RC-1	1.5	RC-1	N/A	

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EQUIPMENT DESCRIPTION	MARK	VIBRATION ISOLATOR TYPE	MINIMUM DEFLECTION (INCHES)	BASE/CURB TYPE	SEISMIC RESTRAINT DEVICE TYPE	NOTES
<b>AIR-CONDITIONING UNITS</b>						
AIR-CONDITIONING UNITS	ACU-1A ACU-2A ACU-3A ACU-4A ACU-5A ACU-6A	V-9	1.0	N/A	S-2	
<b>UNIT HEATERS AND CABINET HEATERS</b>						
UNIT HEATERS AND CABINET HEATERS	UH-1 UH-2 UH-3 UH-4	V-9	0.75	N/A	S-2	
<b>AIR TERMINALS</b>						
AIR TERMINALS	-	N/A	N/A	N/A	N/A	
<b>FANS</b>						
ROOFTOP EXHAUST FAN	EF-5 EF-9 EF-10 EF-11 PSF-1 PSF-2 PSF-3	V-6	1.0	N/A	N/A	
FANS	EF-1 EF-4A EF-4B	V-9	0.75	N/A	S-2	
FANS	REF-8 GEF-1	V-9	2.5	B-1	S-2	
<b>AIR HANDLING UNITS</b>						
AIR HANDLING UNITS	AHU-9	V-2	0.25	N/A	N/A	
AIR HANDLING UNITS	AHU-5 AHU-8 AHU-11 AHU-12	V-9	0.75	N/A	S-2	
AIR HANDLING UNITS	AHU-1 AHU-2 AHU-3 AHU-4	V-2	0.25	N/A	N/A	3
AIR HANDLING UNITS	REF-1 EF-2 EF-3 REF-4	V-2	0.25	N/A	N/A	3

SECTION 23 05 48 VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL PIPING AND EQUIPMENT

EQUIPMENT DESCRIPTION	MARK	VIBRATION ISOLATOR TYPE	MINIMUM DEFLECTION (INCHES)	BASE/CURB TYPE	SEISMIC RESTRAINT DEVICE TYPE	NOTES
PIPING ATTACHED TO VIBRATING EQUIPMENT	N/A	V-9	1.0	N/A	N/A	4

A. Vibration Isolator and Seismic Restraint Schedule Notes:

1. Seismic restraints are required for all systems and equipment. Seismic restraints for equipment without scheduled seismic snubbers shall be provided by the anchor bolts, vibration isolators, or devices as specified for suspended elements.
2. Provide vibration isolators and seismic restraints for all equipment as specified, including, but not limited to, the specific equipment marks listed above. Where a piece of equipment is included on the project but is not listed above, provide vibration isolators and seismic restraints as specified and as described for similar equipment.
3. Internal vibration isolators, snubbers, and bases for custom air handling units and custom exhaust fans shall be provided and installed at the fan manufacturer's factory, except concrete for inertia bases will be field installed as specified in this section.
4. Provide vibration isolators as indicated for suspended piping attached to any piece of vibrating equipment 5 horsepower or larger within mechanical rooms or within 50 feet of equipment, whichever provides the greater length. For piping supported from the floor, provide isolators similar to those used on the equipment. Applicable vibrating equipment includes items that are not internally isolated such as chillers, pumps, and air compressors.
5. The indicated equipment will be provided with internal vibration isolators.

3.7 COMPONENT IMPORTANCE FACTOR SCHEDULE

EQUIPMENT DESCRIPTION	MARK	IMPORTANCE FACTOR, IP	NOTES
PLUMBING PUMPS	P-14	1.0	
	P-15 (FUT.)	1.0	
HYDRONIC PUMPS	P-1	1.0	
	P-2	1.0	
	P-3	1.0	
	P-4	1.0	
	P-5	1.0	
	P-6	1.0	
	P-7	1.0	
	P-8	1.0	
	P-9	1.0	
	P-10	1.0	
	P-11	1.0	
	P-12	1.5	
	P-13	1.5	
	P-16	1.5	
P-17	1.5		
DOMESTIC WATER HEATERS	P-18	1.5	
	P-19	1.5	
	DWH-1	1.5	
	DWH-2	1.5	
	DWH-3 (FUT.)	1.5	
	DWH-4 (FUT.)	1.5	

SECTION 23 05 48 VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL PIPING AND EQUIPMENT

EQUIPMENT DESCRIPTION	MARK	IMPORTANCE FACTOR, IP	NOTES
DOMESTIC WATER BOOSTER PUMPS	BWP-1	1.5	
HEAT EXCHANGERS - STEAM TO WATER	HE-1 HE-2	1.0 1.0	
CENTRIFUGAL WATER CHILLERS	CH-1 CH-2 CH-3 CH-4 (FUT.)	1.5 1.5 1.5 1.5	
PACKAGED COOLING TOWERS	CT-1 CT-2 CT-3 CT-4 (FUT.)	1.5 1.5 1.5 1.5	
SAND FILTRATION SYSTEM	CTFS-2 CTFS-3	1.5 1.5	
PROCESS WATER CHILLER	PCH-1	1.5	
FIRE PUMP/JOCKEY PUMP	FP-1 FP-2	1.5 1.5	
CONDENSATE RECEIVER/PUMPS	CP-1 CP-2	1.5 1.5	
AIR HANDLING UNITS-SUPPLY	AHU-1 AHU-2 AHU-3 AHU-4 AHU-5 AHU-8 AHU-9 AHU-10 AHU-11 AHU-12	1.0 1.5 1.5 1.0 1.5 1.5 1.5 1.5 1.5 1.5	
AIR HANDLING UNITS - EXHAUST AND RETURN	REF-1 REF-4 EF-2 EF-3	1.0 1.0 1.5 1.5	
FANS	EF-1 EF-4A EF-4B EF-5 EF-8 EF-9 EF-10 EF-11 PSF-1 PSF-2 PSF-3 GEF-1	1.0 1.0 1.0 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	
ROOFTOP AC UNIT	RTU-1	1.5	

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EQUIPMENT DESCRIPTION	MARK	IMPORTANCE FACTOR, IP	NOTES
SPLIT AIR CONDITIONING UNITS	ACU-1A	1.5	
	ACU-1B	1.5	
	ACU-2A	1.0	
	ACU-2B	1.0	
	ACU-3A	1.0	
	ACU-4B	1.0	
	ACU-3A	1.0	
	ACU-3B	1.0	
	ACU-4A	1.0	
	ACU-4B	1.0	
TERMINAL UNITS	SEE SCHEDULES	1.0	
UNIT HEATERS	UH-1	1.0	
	UH-2		
	UH-3		
	UH-4		
CABINET HEATER	CHU-1	1.5	
DOMESTIC COLD WATER PIPING 1-1/2" & <	LLCW	1.0	
	HLCW		
DOMESTIC COLD WATER PIPING 2" & >	LLCW HLCW	1.5	
DOMESTIC HOT WATER PIPING 1-1/2" & <	LLHW	1.0	
	HLHW		
	LLHWC		
	HLHWC		
DOMESTIC HOT WATER PIPING 2" & >	LLHW	1.5	
	HLHW		
	LLHWC		
	HLHWC		
NON-POTABLE COLD WATER PIPING 1-1/2" & <	NPCW	1.0	
NON-POTABLE COLD WATER PIPING 2" & >	NPCW	1.5	
SANITARY WASTE PIPING 1-1/2" & <	W	1.0	
SANITARY WASTE PIPING 2" & >	W	1.0	
SANITARY VENT PIPING 1-1/2" & <	V	1.0	
SANITARY VENT PIPING 2" & >	V	1.0	
RAIN LEADER PIPING 2" & >	RWL	1.5	
OVERFLOW RAIN LEADER PIPING 2" & >	ORWL	1.5	
MEDICAL OXYGEN PIPING: ALL SIZES	O2	1.5	
MEDICAL AIR PIPING 1" & <	MA	1.0	
MEDICAL AIR PIPING 1-1/4" & 1-1/2"	MA	1.0	

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EQUIPMENT DESCRIPTION	MARK	IMPORTANCE FACTOR, IP	NOTES
MEDICAL AIR PIPING 2" & >	MA	1.5	
MEDICAL VACUUM PIPING 1" & <	MV	1.0	
MEDICAL VACUUM PIPING 1-1/4" & 1-1/2"	MV	1.0	
MEDICAL VACUUM PIPING 2" & >	MV	1.5	
MEDICAL AIR INTAKE PIPING 2" & >	-	1.0	
MEDICAL VACUUM VENT PIPING 2" & >	-	1.0	
CHILLED WATER PIPING 1-1/2" & <	CWS/CWR	1.0	
CHILLED WATER PIPING 2" & >	CWS/CWR	1.5	
PROCESS CHILLED WATER PIPING 1-1/2" & <	PCWS/PCWR	1.5	
PROCESS CHILLED WATER PIPING 2" & >	PCWS/PCWR	1.5	
HEATING HOT WATER PIPING 1-1/2" & <	HWS/HWR	1.0	
HEATING HOT WATER PIPING 2" & >	HWS/HWR	1.5	
HEAT RECOVERY PIPING 1-1/2" & <	HRS/HRR	1.0	
HEAT RECOVERY PIPING 2" & >	HRS/HRR	1.5	
HIGH PRESSURE STEAM PIPING	HPS	1.5	
LOW PRESSURE STEAM PIPING	LPS	1.5	
HIGH PRESSURE CONDENSATE PIPING	HPR	1.5	
MEDIUM PRESSURE CONDENSATE PIPING	MPR	1.5	
LOW PRESSURE CONDENSATE PIPING	LPR	1.5	
CONDENSATE / INDIRECT DRAIN PIPING	ID	1.0	
STEAM RELIEF VENT	-	1.5	
REFRIGERANT RELIEF VENT	-	1.5	
MEDIUM PRESSURE SUPPLY DUCTS	-	1.0	
LOW PRESSURE SUPPLY DUCTS	-	1.0	
LOW PRESSURE RETURN DUCTS	-	1.0	

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EQUIPMENT DESCRIPTION	MARK	IMPORTANCE FACTOR, IP	NOTES
LOW PRESSURE EXHAUST DUCTS- GENERAL	FIRST FLOOR SECOND FLR THIRD FLOOR FOURTH FLR	1.0 1.0 1.0 1.5	
LOW PRESSURE EXHAUST DUCTS- ISOLATION ROOMS	-	1.5	
LOW PRESSURE EXHAUST DUCTS- PHARMACY HOODS	-	1.5	
LOW PRESSURE EXHAUST DUCTS- CHILLER ROOM	-	1.5	

END OF SECTION

## SECTION 23 05 53 IDENTIFICATION FOR MECHANICAL PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related sections include the following:
  - 1. Section 09 91 00 for painting.

#### 1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
  - 1. Equipment nameplates.
  - 2. Equipment markers.
  - 3. Pipe markers.
  - 4. Duct markers.
  - 5. Valve tags.
  - 6. Valve schedules.
  - 7. Warning tags.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Valve numbering scheme.
- C. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

#### 1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
  - 1. Data:
    - a. Manufacturer, product name, model number, and serial number.
    - b. Capacity, operating and power characteristics, and essential data.
    - c. Labels of tested compliances.
  - 2. Location: Accessible and visible.
  - 3. Fasteners: As required to mount on equipment.
- B. Ceiling-mounted Equipment Marker:
  - 1. Terminology: Match mark numbers on equipment schedules as closely as possible.
  - 2. Size: Minimum 3/4 by 2 inches.
  - 3. Thickness: 1/16-inch.
- C. Equipment Markers: Two-ply engraved black plastic with lettering cut through to white background. Include contact-type, permanent adhesive.
  - 1. Terminology: Match mark numbers on equipment schedules as closely as possible.
  - 2. Size: Minimum 1-1/2 by 4 inches.
  - 3. Thickness: 1/16-inch.

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### 2.2 PIPING IDENTIFICATION DEVICES

- A. Self-Adhesive Pipe Markers: Vinyl with pressure-sensitive, permanent type, self-adhesive back. Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
  2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
  3. Full-band pipe markers extending 360 degrees around pipe at each location.
  4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

### 2.3 DUCT IDENTIFICATION DEVICES

- A. Self Adhesive Duct Markers: Vinyl with pressure-sensitive, permanent-type, self-adhesive back. Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
  2. Lettering: Use HVAC system terms and abbreviate only as necessary for each application length.
  3. Arrows: Integral with HVAC system service lettering to accommodate both directions; or as separate unit on each duct marker to indicate direction of flow.

### 2.4 VALVE TAGS

- A. Valve Tags: Two-ply engraved black plastic with lettering cut through to white background.
1. Data: Service and identification number.
  2. 2-inch round, 1/16-inch thick, with 3/16-inch hole.
  3. Fastener: Brass chain or S-hook.

### 2.5 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Assign and tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-Schedule Frame: Mount valve schedule in frame with clear plastic cover, include mounting screws.

### 2.6 WARNING TAGS

- A. Warning Tags: Preprinted plasticized card stock with matte finish.
1. Size: 4 by 7 inches.
  2. Fasteners: Brass grommet and chain.
  3. Nomenclature: Large-size primary caption such as CAUTION: ISOLATION ROOM EXHAUST.
  4. Color: Yellow background with 1/2-inch black lettering.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 23 Sections.

### 3.2 EQUIPMENT IDENTIFICATION

- A. Nameplate Installation: Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
1. Pumps, compressors, chillers, condensers, and similar motor-driven units.
  2. Heat exchangers, electric coils, evaporators, cooling towers, heat recovery units, and similar equipment.
  3. Fans, blowers and air terminals.

## SECTION 23 05 53 IDENTIFICATION FOR MECHANICAL PIPING AND EQUIPMENT

4. Air handling units.
  5. Packaged units.
  6. Variable frequency drives mounted remote from fan.
- B. Ceiling-mounted Equipment Marker: Install and permanently fasten self-adhesive equipment nameplates on the ceiling grid below each piece of ceiling-mounted equipment. Include nameplates for the following general categories of equipment:
1. Constant volume terminal units.
  2. Fire dampers, smoke dampers, combination fire/smoke dampers.
  3. Circuit setter, balancing valves.
  4. Trap primers.
  5. Ceiling-mounted packaged units.
- C. Equipment Marker Installation: Install with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  2. Locate markers where accessible and visible. Include markers for all scheduled equipment.

### 3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows completely around pipe showing direction of flow. Apply to clean surface.
- B. Locate pipe markers where piping is exposed in finished spaces, mechanical spaces; accessible maintenance spaces such as removable accessible ceilings, shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
  4. At access doors, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced markers, minimum one in each space.

### 3.4 DUCT IDENTIFICATION

- A. Install manufactured duct markers indicating service on each duct system. Install with flow arrows showing direction of flow.
- B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and air terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

### 3.6 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

### 3.7 WARNING-TAG INSTALLATION

- A. Attach warning tags to equipment and other items where required.

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3.8 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION

## SECTION 23 05 63 VARIABLE FREQUENCY DRIVES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes variable frequency drives (VFD) for HVAC systems motors.
- B. Related sections include the following:
  - 1. Section 23 05 13 "Common Motor Requirements for Mechanical Equipment."
  - 2. Section 23 09 00 "Instrumentation and Control for HVAC."

#### 1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product data including certified performance data and capacities of selected models, weights, furnished specialties and accessories.
- C. Shop drawings showing layout and connections, wiring diagrams showing detailed wiring for power, signal, and controls systems interfaces, differentiating between manufacturer-installed wiring and field-installed wiring.
- D. Maintenance data for drives including operation and maintenance manuals specified in Section 01 78 23. Include startup instructions.

#### 1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following:
  - 1. UL 508.
  - 2. NEC.
  - 3. CSA.
  - 4. ETL.
- B. The contractor shall coordinate VFDs for pumps and fans to be provided by one manufacturer. Only one brand may be provided for the entire project.

#### 1.4 WARRANTY

- A. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized on-site service.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: subject to compliance with requirements, provide products by one of the following:
  - 1. ABB.

#### 2.2 GENERAL

- A. Furnish complete variable frequency drives as specified herein for the fans and pumps designated on the drawing schedules or specified to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure and shall be equipped with an integral fused disconnect switch.
- B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control.
- C. The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to DC voltage.
- D. The inverter section of the VFD shall invert the DC voltage into a quality output waveform, with variable voltage and frequency for a step-less motor speed control. The VFD shall maintain a constant V/Hz ratio through the specified range of operation. The output phase voltage shall maintain a balance of plus or minus 1-percent.
- E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be listed by a nationally recognized testing agency

## SECTION 23 05 63 VARIABLE FREQUENCY DRIVES

such as UL, CUL, ETL, or CSA. Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-1992, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters." The total voltage distortion shall not exceed 5%.

- F. The VFD shall not emit radiated RFI in excess of the limitations set forth in the FCC Rules and Regulations, Part 15 for a Class A computing device. The VFD shall carry a FCC compliance label. Pulse Width Modulation (PWM) type drives shall include RFI filters.
- G. An advanced sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life.
- H. The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- I. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be listed by a nationally recognized testing agency such as UL, ETL, or CSA.
- J. The VFD shall have a DC link reactor to minimize power line harmonics. VFDs without a DC link reactor shall provide a 3% impedance line reactor.
- K. The VFDs full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 220% of rated current for up to 1 second while starting.
- L. An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall reduce voltages when lightly loaded and provide a 3% to 10% additional energy savings. If the load increases, the drive shall automatically return to normal operation.
- M. Input and output power circuit switching can be done without interlocks or damage to the VFD.
- N. Drive shall be capable of switching motors on output without damage to the drive. This capability shall not require interlocks with the VFD.
- O. Provide output devices as necessary to limit peak output voltage to less than 1,000 volts to ground, at the motor when connected to the VFD by less than 60 feet of wire, and to reduce the VFD output rise time to less than 1,000 volts per microsecond. These output filtering devices shall be designed for constant duty with an inverter type adjustable speed drive output.
- P. The VFD shall have at least 65,000 RMS symmetrical ampere interrupting capacity.
- Q. Protective Features: The following protective features shall be included:
  - 1. Class 20 I<sup>2</sup>t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.
  - 2. Provide a total of 3 percent input reactance in the form of line and DC bus reactor to protect against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.
  - 3. Protect VFD from sustained power or phase loss. The VFD shall incorporate a 5 second control power loss ride through to eliminate nuisance tripping.
  - 4. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
  - 5. The drive shall be fitted with output line reactors to limit the peak output voltage to less than 1000 volts to ground, at the motor when connected to the VFD by less than 60 feet of wire, and to reduce the VFD output rise time (dv/dt) to less than 1000 volts per microsecond, reduce motor operating temperature and RFI and EMI. The supplier shall include with the quotation the dv/dt values of the drive.
  - 6. Drive shall catch a rotating motor operating forward or reverse up to full speed.
  - 7. Installation of VFD located over 300 feet from the motor shall be installed with LC filter for reduced motor stress.
- R. Interface Features: Provide the following interface features:
  - 1. All VFDs shall use one common type of user interface.
  - 2. Provide complete programming software for use in a laptop PC so that changes to the VFD program can be made by directly connecting the laptop to the VFD.

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3. Provide all hardware, software, and connecting cable as necessary to digitally communicate and exchange information with the Direct Digital Control (DDC) System. The exchanged information shall include: Motor speed, Electric load in KW, Volts, Amps, VFD fault, Hand/Off/Auto/Bypass mode and Network point address. The Direct Digital Control system shall be able to start, stop, control motor speed and modify VFD settings including acceleration and deceleration times and skip frequency ranges through this communication system.
  4. Local/Hand, Stop/Reset, and Remote/Auto selector switches shall be provided to start and stop the drive and determine the speed reference.
  5. Provide a 24 V DC, 40 mA max, output signal to indicate that the drive is in Remote/Auto mode.
  6. Digital manual speed control. Potentiometers are not acceptable.
  7. Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away.
  8. Displays shall be available in English.
  9. A red FAULT light and a green POWER-ON light shall be provided.
  10. A quick setup menu with preset parameters shall be provided on the drive.
  11. The drive shall be fitted with an RS 485 serial communications port and be supplied with software to display all monitoring, fault, alarm and status signals The software shall allow parameter changes to be made to the drive settings as well as storage of each controller's operating and setup parameters.
  12. Set point control interface (PID control) shall be standard in the unit.
  13. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.
  14. An elapsed time meter and kWh meter shall be provided.
  15. The following displays shall be accessible from the control panel in actual units: Reference Signal Percent, Output Frequency, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature (% until trip) and Motor Speed in engineering units per application (in percent speed, GPM, CFM,...).
  16. Drive will sense the loss of load and signal a no load/broken belt warning or fault.
  17. The VFD shall store in memory the last 8 faults and record all operational data.
  18. Four programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
  19. Two programmable relay outputs shall be provided for remote indication of drive status.
  20. Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.
  21. Two programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.
  22. Under fire mode conditions, the VFD shall automatically default to a preset speed.
- S. Adjustment Capability: The drive shall be provided with the following adjustment capability:
1. VFD shall have an adjustable carrier frequency of 2 to 14 kHz through 60 HP and 2 to 4.5 kHz above 60 HP.
  2. Automatic variable-torque V/Hz patterns shall be provided with the ability to select a constant torque start pattern for each of them.
  3. A minimum of two preset speeds shall be provided.
  4. Four acceleration and four deceleration ramps shall be provided. The shape of these curves shall be adjustable.
  5. Current limit settings of 0-60 seconds shall be provided.
  6. Primary failure annunciation and control of ON/OFF and speed shall be through hardwire connection to the Environmental Control system (DDC system). Provide the following:
    - a. A dry contact output enunciating VFD failure.
    - b. An ON/OFF input which responds to a remote dry contact closure.

## SECTION 23 05 63 VARIABLE FREQUENCY DRIVES

- c. A speed control input which responds to remote 4-20 mA and 0-10 VDC signals.
7. The Environmental Control system, DDC system, will be used to diagnose VFD conditions and to reconfigure resident VFD software. Provide all hardware, software and connecting cable as necessary to digitally communicate and exchange information with the Environmental Control system. The exchanged information shall include, motor speed, electric load in KW, volts, amps, VFD fault description, hand/off/auto/bypass mode, and network point address. The Environmental Control system shall be able to modify VFD settings including acceleration and deceleration times and skip frequency ranges through this communication system.
8. Fire Alarm Interface:
  - a. Provide an override input so that opening dry contacts will absolutely stop the motor under any operating condition.
  - b. Provide an override input so that closing dry contacts will cause the motor to operate at a speed predetermined by VFD programming.
  - c. Provide a Summary Alarm dry contact, for connection to the Fire Alarm system, indicating that the VFD is not operable.
9. The number of restart attempts shall be selectable from 0 through 10 and the time between attempts shall be adjustable from 0 through 10 seconds.
- T. Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive, so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.
- U. Service Conditions: The drive shall be capable of operating in the following service conditions:
  1. Ambient temperature, 14 to 104°F (-10 to 40°C).
  2. 0 to 95% relative humidity, non-condensing.
  3. Elevation to 3,300 feet without derating.
  4. AC line voltage variation, -10 to +10% of nominal with full output.
  5. No side clearance shall be required for cooling of wall mount units and all power and control wiring shall be done from the bottom.
  6. Drive shall be capable of operating a motor up to 300 feet away without derating or field modification. Install LC filter for drive(s) located over 300 feet away from the motor(s) to provide motor protection.

### 2.3 PERFORMANCE

- A. The VFD shall not create a voltage rate of change greater than 1000 volts/microsecond nor a peak voltage greater than 1000 volts to ground at the motor when the motor is connected to the VFD by less than 60 feet of wire.
- B. The carrier frequency of pulse width modulated VFDs shall be variable and adjusted so motor noise resulting from VFD, measured at 3 feet from the motor, is less than 3 dB greater than the motor noise when operating across the line. Carrier frequency adjustment shall be available such that the average carrier frequency can be maintained at less than 9 KHz while meeting noise requirements.
- C. When turned ON, the VFD shall be able to stop reverse motor rotation, apply a synchronized output to a rotating motor and then drive the motor to control setpoint.
- D. Quality Assurance Provisions:
  1. To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.

## SECTION 23 05 63 VARIABLE FREQUENCY DRIVES

2. All optional features shall be functionally tested at the factory for proper operation.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.
- B. The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

#### 3.2 INSTALLATION

- A. The VFD shall be installed per manufacturer's recommendations.
- B. The VFD shall be sized to continually operate at 105% of nameplate load of the motor to which it is applied.
- C. Installation and Field Wiring: Mounting and Control wiring shall be Division 23. VFD shall be mounted to rigid unistrut type and/or building structures. Power wiring shall be by Division 26.
- D. Training:
  1. Provide on site operation and maintenance training for (2) identical 4-hour sessions. Coordinate training times with the Contracting Officer.
  2. Provide six sets of operating, troubleshooting, repair and maintenance manuals.
- E. Service During the Warranty Period:
  1. The VFD shall be serviced by an agency located within 50 miles of the project site.
  2. Qualified technical support shall be available on site within 24 hours of request.

#### 3.3 MANUFACTURER REPRESENTATIVE STARTUP

- A. The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Start-up shall include customer operator training at the time of the equipment commissioning.
- B. Field Start Up and Testing:
  1. Verify all installation connections and controls.
  2. Field adjust all safety controls.
  3. Field adjust VFD parameters as follows:
    - a. Acceleration time – According to inertia load.
    - b. Deceleration time – According to inertia load.
    - c. Minimum speed –30% of pump motor full load RPM and 20% of fan motor full load RPM.
    - d. Program VFD so that, upon reapplication of power after a power failure, the VFD shall automatically reapply power and drive the motor to control setpoint.
    - e. Program VFD so no more than 3 automatic restart attempts will be made within one hour after shutdown due to input power problems.
    - f. Adjust carrier frequency to provide optimum efficiency while not increasing motor noise more than 3 dB measured at 3 feet from motor.

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4. Demonstrate operation of VFD including control, display of information and programming by the Environmental Control system and a laptop PC, return to operation after a power failure, and the by-pass contactor.

END OF SECTION

SECTION 23 05 94 TESTING, ADJUSTING, AND BALANCING SUPPORT FOR OWNER

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Work includes support services for testing, adjusting, and balancing (TAB) of mechanical systems. TAB is not included; TAB will be performed under a separate contract.
- B. Contract requirements of the General Conditions, the Supplementary Conditions, and Division 01 apply to all work in this Section.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with all applicable city, county, and state codes and ordinances. In case of conflict with drawings or specifications, the codes and ordinances govern.

1.3 SUBMITTALS

- A. Pre-Balance System Check-Out Report: Prior to commencement of TAB work, mechanical contractor shall confirm in writing that equipment and system check-out has been performed.
- B. Prior to [date] submit two copies of all proposed equipment and system pre-functional verification checklist Forms for Architect's review.

1.4 SEQUENCING/SCHEDULING

- A. Phase in properly with Architect reviewed/accepted Construction Schedule.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify installation conditions as satisfactory to commence TAB work.

3.2 PREPARATION

- A. Protect surrounding areas and surfaces to preclude damage from work of this Section.

3.3 PERFORMANCE

- A. Perform the work in accordance with "Quality Assurance" provisions, Specifications, and Manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 WORK BY MECHANICAL CONTRACTOR

- A. System Performance: This contractor is responsible for the performance of the equipment and the system. Do not assume that supplier will ship equipment adjusted to meet the project requirements.
- B. Equipment Operation:
  - 1. Check equipment for proper operation as soon as electrical power is available. Perform adjustments required for proper operation.
  - 2. Report malfunctions to the manufacturer, and take corrective action immediately to prevent delay of the work.
  - 3. Check-out equipment for electrical problems, check rotation of motors, read voltage and current in each leg of each motor, heater, etc., and check the readings against the nameplate. Lubricate per manufacturer's recommendations.
  - 4. Before balancing and testing commences, operate (test run) equipment for a minimum of one week.
- C. Air Distribution System Inspection: Check out the air distribution system to ensure that each fan is properly connected to the branch duct, and that a volume damper exists for each outlet (supply, return and exhaust) and is in the wide-open position; in addition, verify existence and function of all other volume dampers.
- D. Controls Operation: Check out and calibrate all control components under equipment and system operation service; these components include, but are not limited to, thermostats.

## SECTION 23 05 94 TESTING, ADJUSTING, AND BALANCING SUPPORT FOR OWNER

tats to ensure they are connected to the appropriate device, respond to the temperature changes, and are of the correct action to be compatible with the controlled device.

- E. Strainers and Filters: After equipment and system check-out, work has been completed, and prior to commencement of TAB work, perform the following:
  - 1. Clean strainers in hydronic systems.
  - 2. Replace air filters in air distribution equipment and systems with new filters.
- F. Access: Provide scaffolds, staging, and accessories required to allow TAB contractor to gain access to equipment, dampers, valves and other devices located beyond the range of a 6-foot stepladder.
- G. Fan Adjustments and Drive Changes: Provide as directed by TAB contractor, including required sheaves and belts.
- H. Cleaning: Clean equipment and devices after check-out and test run period, prior to TAB work.

### 3.5 WORK BY MECHANICAL CONTRACTOR

- A. System Performance: Mechanical contractor is responsible for the performance of the equipment and the system. Do not assume that supplier will ship equipment adjusted to meet the project requirements.
- B. Equipment Operation:
  - 1. Check equipment for proper operation as soon as electrical power is available. Perform adjustments necessary for proper operation.
  - 2. Report malfunctions to the manufacturer, and take corrective action immediately to prevent delay of the work.
  - 3. Check-out equipment for electrical problems, check rotation of motors, read voltage and current in each leg of each motor, heater, etc., and check the reading against the nameplate. Lubricate per manufacturer's recommendations.
  - 4. Before balancing and testing commences, operate (test run) equipment for a minimum of one week.
- C. Air Distribution System Inspection: Check out the air distribution system to ensure that each outlet is properly connected to the branch duct, and that a volume damper exists for each outlet (supply, return and exhaust) and is in the wide-open position; in addition, verify existence and function of other volume dampers.
- D. Controls Operation: Check out and calibrate control components under equipment and system operation service; these components include, but are not limited to, thermostats to ensure they are connected to the appropriate device, respond to temperature changes, and are of the correct action to be compatible with the controlled device.
- E. Strainers and Filters: After equipment and system check-out work has been completed, and prior to commencement of TAB work, perform the following:
  - 1. Clean strainers in hydronic systems.
  - 2. Replace air filters in air distribution equipment and systems with new filters.
- F. Access: Furnish scaffolds, staging, and accessories required to allow TAB contractor to gain access to equipment, dampers, valves and other devices located beyond the range of a 6-foot stepladder.
- G. Fan Drives: Provide drive changes necessary as directed by TAB contractor, including required sheaves and belts.
- H. Cleaning: Clean equipment and devices after check-out and test run period, prior to TAB work.

### 3.6 WORK BY TAB CONTRACTOR (FOR REFERENCE ONLY)

- A. General: TAB of mechanical systems will be performed in accordance with SMACNA publication "HVAC Systems – Testing, Adjusting, and Balancing", First Edition, 1983. Quantities will be adjusted to within 10% of design values.
- B. System Difficulties: Readings should be taken on each unit or piece of equipment as early as possible, such that any apparent difficulties can be resolved before the anticipated close of the job.

END OF SECTION

## SECTION 23 07 13 PIPE INSULATION FOR MECHANICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 07 for firestopping materials and requirements for penetrations through fire and smoke barriers.
  - 2. Section 09 91 00 for "Painting."
  - 3. Section 23 07 19 "Duct Insulation for Mechanical Systems" for insulation for ducts and plenums.
  - 4. Section 23 07 16 "Equipment Insulation for Mechanical Equipment" for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.
  - 5. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe insulation shields and protection saddles.
  - 6. Section 22 40 00 "Plumbing Fixtures" for lavatory drain and supply insulation.

#### 1.2 SUMMARY

- A. This Section includes preformed, rigid, and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

#### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Mineral Fiber Insulation.
  - 2. Flexible Elastomeric Thermal Insulation.
  - 3. Cellular Glass Insulation.
  - 4. Calcium Silicate Insulation.
  - 5. Prefabricated Thermal Insulating Fitting Covers.
  - 6. Foil and Paper Jacket.
  - 7. PVC Jacket.
  - 8. Standard PVC Fitting Covers.
  - 9. Aluminum Jacket.
  - 10. Stainless Steel Jacket.
  - 11. Thermal Insulated Removable Pads.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- B. Protect insulation and jackets from moisture and dirt.

#### 1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment."

## SECTION 23 07 13 PIPE INSULATION FOR MECHANICAL SYSTEMS

- B. Coordinate clearance requirements with piping Installer for insulation application.
- C. Coordinate installation of electric heat tracing.

### 1.7 SCHEDULING

- A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Mineral-Fiber Insulation:
    - a. Knauf Fiberglass.
    - b. Owens Corning.
    - c. Johns Manville.
  - 2. Flexible Elastomeric Thermal Insulation:
    - a. Armstrong.
    - b. Armacell.
  - 3. Cellular Glass Insulation:
    - a. Pittsburgh Corning.
    - b. Cellufoam.
  - 4. Calcium Silicate Insulation:
    - a. Owens Corning.
    - b. Pabco.
    - c. Johns Manville.

### 2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
  - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
  - 2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
  - 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
    - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
    - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
  - 4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
  - 5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
  - 6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
  - 7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
- B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. Adhesive: As recommended by insulation material manufacturer.
  - 2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
- C. Cellular Glass Insulation: All glass, closed cell structure, comply with ASTM C 552. Fabricate in half sections where possible, curved sidewall segments for larger diameter pipes.
  - 1. Weather Barrier Mastic: Flexible, latex coating, comply with ASTM E 84 and E 96.
  - 2. Asphalt Cutback Mastic: Asphalt coating formulated for cellular glass insulation.

## SECTION 23 07 13 PIPE INSULATION FOR MECHANICAL SYSTEMS

3. Polyester Fabric: Open mesh, synthetic fabric.
4. Joint Sealant: Butyl sealant, comply with MIL-I-24244.
5. Protective Membranes:
  - a. Heat-Sealed Membrane: 125-mil thick heat-sealed high polymer asphalt membrane with an integral glass scrim, integral 1 mil aluminum foil, and mylar film.
  - b. Self-Sealing Membrane: 70-mil thick self-sealing high polymer asphalt membrane with an integral glass scrim and mylar film.
- D. Calcium Silicate Insulation: Preformed pipe sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C 533, Type II.
- E. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

### 2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil, ASTM C 921, Type I.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
  1. Adhesive: As recommended by insulation material manufacturer.
  2. PVC Jacket Color: White.
- D. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC.
  1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers and end caps.
  2. Adhesive: As recommended by insulation material manufacturer.
  3. PVC Jacket Color: White.
- E. Aluminum Jacket: ASTM B 209, 3003 alloy, H-14 temper, factory cut and rolled to indicated sizes or roll stock, ready for shop or field cutting and forming to indicated sizes.
  1. Finish and Thickness: Stucco-embossed finish, 0.016 inch thick.
  2. Moisture Barrier: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  3. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

### 2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8-oz./sq. yd.
  1. Tape Width: 4 inches.
- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
  1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
  2. Galvanized Steel: 0.005 inch thick.
  3. Aluminum: 0.007 inch thick.
  4. Brass: 0.010 inch thick.
  5. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

### 2.5 THERMAL INSULATED REMOVABLE PADS

- A. The inner and outer jacketing on the removable pads shall be silicone impregnated fiberglass.
- B. The insulation material inside the pads shall be fiberglass thermal insulating wool.
- C. Lacing hooks, and washers shall be stainless steel.
- D. Tie wire shall be stainless steel.
- E. Fasteners shall be stainless steel staples STCR 5019-3/8-inch, or equal.
- F. Thickness for all pads: 2-inch.

## SECTION 23 07 13 PIPE INSULATION FOR MECHANICAL SYSTEMS

### 2.6 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
  - 1. Apply insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
  - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
  - 1. Pull jacket tight and smooth.

## SECTION 23 07 13 PIPE INSULATION FOR MECHANICAL SYSTEMS

2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
  3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
  4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
  5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
1. Seal penetrations with vapor-retarder mastic.
  2. Apply insulation for exterior applications tightly joined to interior insulation ends.
  3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
  4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
1. Firestopping and fire-resistive joint sealers are specified in Division 07.
- T. Floor Penetrations: Apply insulation continuously through floor assembly.
1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

### 3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
  2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
  3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
  4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
  4. Cover flanges with standard PVC fitting covers.
- C. Apply insulation to fittings and elbows as follows:
1. Apply preformed insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  2. When preformed insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.

## SECTION 23 07 13 PIPE INSULATION FOR MECHANICAL SYSTEMS

3. Cover fittings and elbows with standard PVC fitting covers.
- D. Apply insulation to valves and specialties as follows:
  1. Apply preformed insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  2. When preformed insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
  3. Apply insulation to flanges as specified for flange insulation application.
  4. Cover valves and specialties with standard PVC fitting covers. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
  5. Provide thermal insulated removable pads for larger sizes where PVC fitting covers are not available.

### 3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
  1. Follow manufacturer's written instructions for applying insulation.
  2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- B. Apply insulation to flanges as follows:
  1. Apply pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- C. Apply insulation to fittings and elbows as follows:
  1. Apply mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- D. Apply insulation to valves and specialties as follows:
  1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
  2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to stainer basket.
  3. Apply insulation to flanges as specified for flange insulation application.
  4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

### 3.6 CELLULAR GLASS INSULATION APPLICATION

- A. Follow manufacturer's written instructions for applying insulation.
- B. Apply insulation to pipes, fittings, and elbows as follows:
  1. Where vapor retarders are indicated, seal all joints full depth with joint sealant, fill tightly with no voids.
  2. Provide protective membranes as indicated. Apply membranes at factory where possible.

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### 3.7 CALCIUM SILICATE INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
  - 1. Secure each layer of insulation to pipe with stainless-steel bands at 12-inch intervals and tighten without deforming insulation materials.
  - 2. Apply two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch, soft-annealed, stainless steel wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
  - 3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to surface of installed insulation. When dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin the finish coat to achieve smooth finish.
- B. Apply insulation to flanges as follows:
  - 1. Apply preformed pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
  - 4. Finish flange insulation the same as pipe insulation.
- C. Apply insulation to fittings and elbows as follows:
  - 1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  - 2. When premolded sections of insulation are not available, apply mitered sections of calcium silicate insulation. Secure insulation materials with stainless-steel wire.
  - 3. Finish insulation of fittings the same as pipe insulation.
- D. Apply insulation to valves and specialties as follows:
  - 1. Apply mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
  - 2. Apply insulation to flanges as specified for flange insulation application.
  - 3. Finish valve and specialty insulation the same as pipe insulation.

### 3.8 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
  - 1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  - 2. Embed glass cloth between two 0.062-inch-thick coats of jacket manufacturer's recommended adhesive.
  - 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
- B. Foil and Paper Jackets:
  - 1. Draw jacket material smooth and tight.
  - 2. Apply lap or joint strips with the same material as jacket.
  - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
  - 4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.
  - 6. Apply foil and paper jackets for the following applications:
    - a. Mineral-fiber blanket.
    - b. Cellular glass where protective membrane is not indicated.
- C. PVC Jackets:
  - 1. Apply 1-inch overlap at longitudinal seams and end joints.
  - 2. Seal with manufacturer's recommended adhesive.

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3. Apply PVC jackets for exposed piping in mechanical rooms up to 8-feet from floor.
- D. Metal Jackets:
  1. Apply 2-inch overlap at longitudinal seams and end joints.
    - a. Overlap longitudinal seams arranged to shed water.
    - b. Seal joints with weatherproof sealant recommended by jacket manufacturer.
  2. Secure jacket with bands 12 inches o.c. and at end joints.
  3. Apply stainless steel jackets for exposed piping in food service areas.
  4. Apply aluminum jackets for exposed exterior installations.

### 3.9 FINISHES

- A. Exterior Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

### 3.10 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
  1. Flexible connectors.
  2. Vibration-control devices.
  3. Fire-suppression piping, unless noted to be heat traced.
  4. Drainage piping located in crawl spaces, unless otherwise indicated.
  5. Below-grade piping, unless otherwise indicated.
  6. Chrome-plated pipes and fittings, unless potential for personnel injury.
  7. Flow regulators.
  8. Meters.
  9. Backflow preventers.
  10. Steam traps.

### 3.11 THERMAL INSULATION REMOVABLE PADS

- A. All flanges and valves including control valves, gate valves and butterfly valves shall be insulated with removable pads for systems that are indicated under the applications schedule.

### 3.12 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, thickness and vapor retarders.

### 3.13 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot and recirculated hot water.
  1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 2-inch: 1-inch.
    - b. Pipe, 2-1/2-inch and above: 1-1/2-inch.
  3. Vapor Retarder Required: No.
  4. Insulation Conductivity Range: 0.24 – 0.28 BTU·in/(hr·ft<sup>2</sup>·°F).
- B. Service: Domestic cold water.
  1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: 1/2-inch.
  3. Vapor Retarder Required: Yes.
  4. Insulation Conductivity Range: 0.23 – 0.27 BTU·in/(hr·ft<sup>2</sup>·°F).
- C. Service: Domestic water, rainwater, and fire-protection, where heat tracing is installed.
  1. Insulation Material: Mineral-fiber, preformed.
  2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 2-inch: 1-inch.
    - b. Pipe, 2-1/2-inch and above: 1-1/2-inch.
  3. Vapor Retarder Required: No.

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- 4. Insulation Conductivity Range: 0.23 – 0.27 BTU·in/(hr·ft<sup>2</sup>·°F).
- D. Service: Rainwater conductors.
  - 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: 1/2-inch.
  - 3. Vapor Retarder Required: Yes.
- E. Service: Roof drain bodies.
  - 1. Insulation Material: Mineral-fiber, blanket.
  - 2. Insulation Thickness: 1/2-inch.
  - 3. Vapor Retarder Required: Yes.
- F. Service: Sanitary waste piping where heat tracing is installed.
  - 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
- G. Service: Sanitary waste drain bodies and p-traps located in unheated spaces..
  - 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
- H. Service: Condensate drain piping.
  - 1. Insulation Material: Flexible elastomeric.
  - 2. Insulation Thickness: 1-inch.
  - 3. Vapor Retarder Required: Yes.
- I. Service: Chilled-water supply and return.
  - 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 1-inch: 1/2-inch.
    - b. Pipe, 1-1/4-inch – 2-inch: 3/4-inch.
    - c. Pipe, 2-1/2-inch and above: 1-inch.
  - 3. Insulation Conductivity Range: 0.23 – 0.27 BTU·in/(hr·ft<sup>2</sup>·°F).
  - 4. Vapor Retarder Required: Yes.
- J. Service: Refrigerant suction and hot-gas piping.
  - 1. Insulation Material: Flexible elastomeric.
  - 2. Insulation Thickness: 1-inch.
  - 3. Vapor Retarder Required: Yes.
- K. Service: Heating hot-water supply and return.
  - 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.25 – 0.29 BTU·in/(hr·ft<sup>2</sup>·°F).
- L. Service: Steam and condensate, 100 psi and below.
  - 1. Insulation Material: Mineral-fiber, preformed.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 2-inch: 2-1/2-inch.
    - b. Pipe, 2-1/2-inch – 4-inch: 3-inch.
    - c. Pipe, 4-1/2-inch and above: 3-1/2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.32 – 0.34 BTU·in/(hr·ft<sup>2</sup>·°F).
- M. Service: Steam and condensate, above 100 psi.
  - 1. Insulation Material: Calcium silicate.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 2-inch: 2-1/2-inch.
    - b. Pipe, 2-1/2-inch – 4-inch: 3-inch.
    - c. Pipe, 4-1/2-inch and above: 3-1/2-inch.
- N. Service: Process cold water.
  - 1. Insulation Material: Mineral fiber, preformed.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 1-inch: 1/2-inch.
    - b. Pipe, 1-1/4-inch – 2-inch: 3/4-inch.

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- c. Pipe, 2-1/2-inch and above: 1-inch.
- 3. Vapor Retarder Required: Yes.
- 4. Insulation Conductivity Range: 0.23 – 0.27 BTU·in/(hr·ft<sup>2</sup>·°F).
- O. Service: Generator-engine exhaust.
  - 1. Insulation Material: Calcium silicate.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Steel Pipe, 6-inch – 8-inch: 4-1/2-inch.
    - b. Steel Pipe, 10-inch and above: 6-inch.
  - 3. Vapor Retarder Required: No.

3.14 EXTERIOR INSULATION APPLICATION SCHEDULE

- A. This application schedule is for aboveground insulation outside the building, in the garage, outside air plenum, or other unconditioned spaces.
- B. Service: Domestic water.
  - 1. Insulation Material: Cellular glass.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
  - 4. Insulation Conductivity Range: 0.23 – 0.27 BTU·in/(hr·ft<sup>2</sup>·°F).
- C. Service: Storm water.
  - 1. Insulation Material: Cellular glass.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
- D. Service: Refrigerant suction.
  - 1. Insulation Material: Flexible elastomeric.
  - 2. Insulation Thickness: 1-inch.
  - 3. Vapor Retarder Required: Yes.
- E. Service: Chilled-water supply and return.
  - 1. Insulation Material: Cellular glass.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
  - 4. Insulation Conductivity Range: 0.23 – 0.25 BTU·in/(hr·ft<sup>2</sup>·°F).
- F. Service: Condenser-water supply and return.
  - 1. Insulation Material: Cellular glass.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: Yes.
- G. Service: Heating hot-water supply and return.
  - 1. Insulation Material: Cellular glass.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.23 – 0.25 BTU·in/(hr·ft<sup>2</sup>·°F).
- H. Service: Steam and condensate, 100 psi and below.
  - 1. Insulation Material: Cellular glass.
  - 2. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Pipe, 1/2-inch – 2-inch: 2-1/2-inch.
    - b. Pipe, 2-1/2-inch – 4-inch: 3-inch.
    - c. Pipe, 4-1/2-inch and above: 3-1/2-inch.
  - 3. Vapor Retarder Required: No.
  - 4. Insulation Conductivity Range: 0.32 – 0.34 BTU·in/(hr·ft<sup>2</sup>·°F).
  - 5.

3.15 UNDERGROUND INSULATION APPLICATION SCHEDULE

- A. Service: Chilled-water supply and return.
  - 1. Insulation Material: Cellular glass with self-sealing membrane.
  - 2. Insulation Thickness: 1-1/2-inch.
  - 3. Vapor Retarder Required: No.

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4. Insulation Conductivity Range: 0.23 – 0.27 BTU·in/(hr·ft<sup>2</sup>·°F).

END OF SECTION



## SECTION 23 07 16 EQUIPMENT INSULATION FOR MECHANICAL EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 09 for insulation painting.
  - 2. Section 23 07 19 "Duct Insulation for Mechanical Systems" for insulation materials and application for ducts and plenums.
  - 3. Section 23 07 13 "Pipe Insulation for Mechanical Systems" for insulation for piping systems.

#### 1.2 SUMMARY

- A. This Section includes blanket and block insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

#### 1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation and jackets from moisture and dirt.

#### 1.6 COORDINATION

- A. Coordinate clearance requirements with equipment Installer for insulation application.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Mineral-Fiber Insulation:
    - a. Knauf Fiberglass.
    - b. Owens Corning.
    - c. Johns Manville.
  - 2. Calcium Silicate Insulation:
    - a. Owens Corning.
    - b. Pabco.
    - c. Johns Manville.
  - 3. Thermal Insulation Removable Pads:
    - a. Knauf Fiberglass.
    - b. Owens Corning.
    - c. Johns Manville.

## SECTION 23 07 16 EQUIPMENT INSULATION FOR MECHANICAL EQUIPMENT

### 2.2 INSULATION MATERIALS

- A. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- B. Calcium Silicate Insulation: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

### 2.3 FIELD-APPLIED JACKETS

- A. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
  - 1. Adhesive: As recommended by insulation material manufacturer.
  - 2. PVC Jacket Color: White.
- B. Aluminum Jacket: ASTM B 209, 3003 alloy, H-14 temper; aluminum roll stock, ready for shop or field cutting and forming.
  - 1. Finish and Thickness: Stucco-embossed finish, 0.016-inch thick.
- C. Stainless-Steel Jacket: ASTM A 666, Type 304 or 316; roll stock ready for shop or field cutting and forming.
  - 1. Thickness: 0.10-inch.

### 2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8-oz./sq. yd.
  - 1. Tape Width: 4 inches.
- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
  - 1. Stainless Steel: ASTM A 666, Type 316.
  - 2. Galvanized Steel: 0.005 inch thick.
  - 3. Aluminum: 0.007 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.
- D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
  - 1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.

### 2.5 THERMAL INSULATED REMOVABLE PADS

- A. The inner and outer jacketing on the removable pads shall be silicone impregnated fiberglass.
- B. The insulation material inside the pads shall be fiberglass thermal insulating wool.
- C. Lacing hooks, and washers shall be stainless steel.
- D. Tie wire shall be stainless steel.
- E. Fasteners shall be stainless steel staples STCR 5019-3/8-inch, or equal.
- F. Thickness for all pads: 2-inch thick thermal insulating wool.

### 2.6 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## SECTION 23 07 16 EQUIPMENT INSULATION FOR MECHANICAL EQUIPMENT

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of equipment.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each equipment system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either the wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Keep insulation materials dry during application and finishing.
- F. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- G. Apply insulation with the least number of joints practical.
- H. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- I. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- J. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- K. Apply insulation with integral jackets as follows:
  - 1. Pull jacket tight and smooth.
  - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
  - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints, and at ends adjacent to flanges and fittings.
- L. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- M. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder. Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal. Install vapor-retarder on the following equipment:
  - 1. Chilled water air separators and compression tanks.
  - 2. Aboveground thermal (ice) storage and low temperature brine tanks.
- N. Insulate the following equipment:
  - 1. Chilled-water air separators.
  - 2. Chilled-water compression tanks.
  - 3. Chilled-water pump housings.
  - 4. Aboveground, thermal (ice) storage tanks, not factory insulated.
  - 5. Domestic hot-water storage tanks, not factory insulated.
  - 6. Heating hot-water air separators.
  - 7. Heating hot-water compression tanks.
  - 8. Steam-to-heating hot-water heat exchangers.
  - 9. Steam-to-water converters, not factory insulated.
  - 10. Condensate receivers, not factory insulated.
  - 11. Deaerators, not factory insulated.
- O. Omit insulation from the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.

## SECTION 23 07 16 EQUIPMENT INSULATION FOR MECHANICAL EQUIPMENT

### 6. Cleanouts.

#### 3.4 TANK AND VESSEL INSULATION APPLICATION

- A. Blankets and Block Applications for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of tank and vessel surfaces.
  2. Groove and score insulation materials to fit as closely as possible to the equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joint. Stagger end joints.
  3. Protect exposed corners with secured corner angles.
  4. Install adhesive-attached or self-adhesive anchor pins and speed washers on sides of tanks and vessels as follows:
    - a. On tank and vessel, 3 inches maximum from insulation end joints, and 16 inches o.c. in both directions.
    - b. Do not overcompress insulation during installation.
    - c. Cut and miter insulation segments to fit curved sides and dome heads of tanks and vessels.
  5. Impale insulation over anchor pins and attach speed washers.
  6. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing
  7. Secure each layer of insulation with stainless-steel bands.
  8. Stagger joints between insulation layers at least 3 inches.
  9. Apply insulation in removable segments on equipment access doors and other elements that require frequent removal for service.
  10. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  11. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

#### 3.5 FIELD-APPLIED JACKET APPLICATION

- A. PVC Jackets: Apply jacket with longitudinal seams along top and bottom of tanks and vessels for horizontal applications. Secure and seal seams and end joints with manufacturer's welding adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along the seam and joint edge.
  2. Apply PVC jackets for exposed equipment in mechanical rooms below 8-feet from floor.
- B. Metal Jackets:
1. Apply 2-inch overlap at longitudinal seams and end joints.
  2. Secure jacket with bands 12 inches o.c. and at end joints.
  3. Apply stainless steel jackets for exposed equipment in food service areas.
  4. Apply aluminum jackets for exposed exterior equipment.
    - a. Overlap longitudinal seams arranged to shed water.
    - b. Seal end joints with weatherproof sealant recommended by insulation manufacturer.

#### 3.6 EQUIPMENT APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

#### 3.7 TANK AND VESSEL INSULATION APPLICATION SCHEDULE

- A. Equipment: Chilled-water air separators and compression tanks.
1. Insulation Material: Mineral-fiber blanket.
  2. Insulation Thickness: 1-inch.
  3. Insulation Conductivity Range: 0.23 – 0.27 BTU·in/(hr·ft<sup>2</sup>·°F).
- B. Equipment: Domestic hot-water storage tanks.
1. Insulation Material: Mineral-fiber blanket.
  2. Insulation Thickness: 1-1/2-inch.

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- 3. Insulation Conductivity Range: 0.24 – 0.28 BTU·in/(hr·ft<sup>2</sup>·°F).
  - C. Equipment: Heating hot-water air separators and compression tanks.
    - 1. Insulation Material: Mineral-fiber blanket.
    - 2. Insulation Thickness: 1-1/2-inch.
  - D. Equipment: Steam to heating hot-water heat exchangers, steam-to-water converters, and deaerators.
    - 1. Insulation Material: Calcium silicate.
    - 2. Insulation Thickness: 4-inch.
    - 3. Insulation Conductivity Range: 0.32 – 0.34 BTU·in/(hr·ft<sup>2</sup>·°F).
- 3.8 INTERIOR FLAT-SURFACE EQUIPMENT INSULATION APPLICATION SCHEDULE
- A. Equipment: Steam condensate receivers.
    - 1. Insulation Material: Calcium silicate.
    - 2. Insulation Thickness: 4-inch.
    - 3. Insulation Conductivity Range: 0.32 – 0.34 BTU·in/(hr·ft<sup>2</sup>·°F).
- 3.9 PUMP INSULATION APPLICATION SCHEDULE
- A. Equipment: Chilled water pumps.
    - 1. Insulation Material: Thermal insulated removable pad.

END OF SECTION



## SECTION 23 07 19 DUCT INSULATION FOR MECHANICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 07 for firestopping materials and requirements for penetrations through fire and smoke barriers.
  - 2. Section 23 07 13 "Pipe Insulation for Mechanical Systems" for insulation for piping systems.
  - 3. Section 23 31 13 "Metal Ducts" for duct liner.
  - 4. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment."
  - 5. Section 23 33 00 "Air Duct Accessories."

#### 1.2 SUMMARY

- A. This Section includes semirigid and flexible duct and plenum, insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

#### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Mineral Fiber Board Insulation.
  - 2. Mineral Fiber Blanket Insulation.
  - 3. Aluminum Jackets.
  - 4. Fire Barrier Duct Wrap with UL classification documentation.
- C. Shop Drawings: None required.
- D. Reports and Certificates: None required.

#### 1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory labeled insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less..
- B. Underwriters Laboratories Inc (UL)
  - 1. UL 723, surface burning characteristic per ASTM E 84
  - 2. UL 1479, Through-Penetration firestop test.
- C. National Fire Code: NFPA 96: Ventilation Control and Fire Protection of Commercial Cooking Operations
- D. American Society for Testing and Materials (ASTM):
  - 1. ASTM E119, Standard Method of Fire Tests of Building Construction and Materials.
  - 2. ASTM E814, Standard Method of Fire Tests of Through-Penetration Fire Stops.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

#### 1.6 COORDINATION

- A. Coordinate clearance requirements with duct Installer for insulation application.

#### 1.7 SCHEDULING

- A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

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### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Mineral-Fiber Insulation:
    - a. CertainTeed Manson.
    - b. Knauf FiberGlass GmbH.
    - c. Owens-Corning Fiberglas Corp.
    - d. Johns Manville.
  - 2. Fire Barrier Duct Wrap:
    - a. 3M Fire Barrier.
    - b. Pyroscat Duct Wrap.
    - c. Unifrax FyreWrap.

#### 2.2 INSULATION MATERIALS

- A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

#### 2.3 FIELD-APPLIED JACKETS

- A. Aluminum Jacket: Sheets manufactured from aluminum alloy complying with ASTM B 209, and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness is scheduled at the end of this Section.
  - 1. Finish: Embossed finish.
  - 2. Thickness: 0.04-inch thick.

#### 2.4 ACCESSORIES AND ATTACHMENTS

- A. Bands: 3/4-inch wide, aluminum band, minimum 0.007-inch thick.
- B. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
  - 1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.

#### 2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates. Perm rating not greater than 0.5 and all joints sealed.

#### 2.6 FIRE BARRIER DUCT WRAP

- A. UL Classified Fire resistant flexible wrap consisting of high temperature, non-asbestos inorganic blanket encapsulated with a scrim-reinforced foil rated for use with commercial stainless steel exhaust ducts. Installed system shall allow for zero clearance to combustibles and provide a 2-hour fire resistive enclosure system.
- B. Insulation Pins: 12 Gauge stainless steel pins with round or square clips.
- C. Banding Straps: Minimum 1/2-inch wide Type 302 Stainless Steel bands
- D. Firestopping Material: UL classified, noncombustible

#### 2.7 FIRE BARRIER WRAP ACCESS DOORS

- A. Fire barrier grease duct access door shall be rated for use with fire barrier wrap complete with extension kit. Coordinate opening sizes and locations with Section 23 31 13 "Metal Ducts" and Section 23 33 00 "Air Duct Accessories." Installed access assembly shall be rated no less than the fire resistive protection rating to that of grease duct fire barrier wrap. Provide extension kit to allow duct wrap layers to mechanically fastened to cover

## SECTION 23 07 19 DUCT INSULATION FOR MECHANICAL SYSTEMS

plate for ease of removal and re-installation without the use of a tool. Label "ACCESS PANEL. DO NOT BLOCK" on exterior of access door assembly.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

#### 3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, jackets, and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
- F. Keep insulation materials dry during application and finishing.
- G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation with the least number of joints practical.
- I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- L. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- M. Install vapor-retarder mastic on supply and outside air ducts and plenums.
  - 1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
  - 2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.
  - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- N. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
  - 1. Seal penetrations with vapor-retarder mastic.
  - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
  - 3. Seal insulation to roof flashing with vapor-retarder mastic.
- O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

## SECTION 23 07 19 DUCT INSULATION FOR MECHANICAL SYSTEMS

- Q. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

### 3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with anchor pins and speed washers.
1. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
  2. Impale insulation over anchors and attach speed washers.
  3. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1-inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
  5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
  6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
  8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
- B. Board Applications for Ducts and Plenums: Secure board insulation with anchor pins and speed washers.
1. Space anchor pins as follows:
    - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
  2. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  3. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps

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to adjacent insulation segment with 1/2-inch staples, 1-inch o.c., and cover with pressure-sensitive tape having same facing as insulation.

4. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
6. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

### 3.5 FIRE BARRIER DUCT WRAP APPLICATION

- A. Install fire barrier duct wrap and components in accordance with manufacturer's instructions.
- B. Coordinate installation and spatial requirements with Sections 23 31 00 "Metal Ducts" and 23 33 00 "Air Duct Accessories."
- C. Install hangers and supports insulation to maintain fire resistive rating.
- D. Install firestopping system at rated penetrations (wall, floors, ceilings, roof).
- E. Verify duct access openings are not obstructed.

### 3.6 FIELD-APPLIED JACKET APPLICATION

- A. Apply jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
  1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  2. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
  3. Seal outdoor jacket watertight.
  4. Round Ducts: Overlap seams 45 degrees from bottom.

### 3.7 DUCT SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.
- C. Insulate the following plenums and duct systems:
  1. Supply-, and outside-air ductwork.
  2. Outside-air ductwork shall be insulated from isolation damper to the exterior of the building.
- D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
  1. Factory-insulated flexible ducts.
  2. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
  3. Flexible connectors.
  4. Vibration-control devices.
  5. Testing agency labels and stamps.
  6. Nameplates and data plates.
  7. Access panels and doors in air-distribution systems.
  8. Toilet exhaust ducts in conditioned spaces.
  9. General exhaust ducts in conditioned spaces.
  10. Exposed ducts within a space that serves that space only.

### 3.8 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

- A. Service: Supply-air ducts, concealed.
  1. Material: Mineral-fiber blanket.
  2. Thickness: 1-1/2-inch.
  3. Minimum Installed Insulation R-Value: 3.3.
- B. Service: Round, supply-air ducts, exposed.
  1. Material: Mineral-fiber blanket.

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- 2. Thickness: 1-1/2-inch.
- 3. Minimum Installed Insulation R-Value: 3.3.
- C. Service: Rectangular, supply-air ducts, exposed.
  - 1. Material: Mineral-fiber board.
  - 2. Thickness: 1 inch.
  - 3. Minimum Installed Insulation R-Value: 3.3.
- D. Service: Round, outside-air ducts, downstream of damper.
  - 1. Material: Mineral-fiber blanket.
  - 2. Thickness: 3-inches.
  - 3. Minimum Installed Insulation R-Value: 7.
- E. Service: Round, outside-air ducts, upstream of damper.
  - 1. Material: Mineral-fiber blanket.
  - 2. Thickness: Layers as required to maintain minimum envelope R-Value.
  - 3. Minimum Installed Insulation R-Value: 11.
- F. Service: Rectangular, outside-air ducts and plenums upstream of damper.
  - 1. Material: Mineral-fiber board.
  - 2. Thickness: Layers as required to maintain minimum envelope R-Value.
  - 3. Minimum Installed Insulation R-Value: 11.
- G. Service: Zero-Clearance Exhaust Duct (where allowed by AHJ).
  - 1. Material: Fire barrier duct wrap system.

3.9 OUTDOOR DUCT AND PLENUM APPLICATION SCHEDULE

- A. Service: Round, supply and return-air ducts.
  - 1. Material: Mineral-fiber blanket.
  - 2. Thickness: 3-inches.
  - 3. Field-Applied Jacket: Aluminum.
  - 4. Minimum Installed Insulation R-Value: 7.
- B. Service: Rectangular, supply and return-air ducts.
  - 1. Material: Mineral-fiber board.
  - 2. Thickness: 2 inches.
  - 3. Field-Applied Jacket: Aluminum.
  - 4. Minimum Installed Insulation R-Value: 7.

END OF SECTION

## PART 1 - GENERAL

## 1.1 SCOPE OF THE WORK

- A. The purpose of this section is to specify Division 21, 22, and 23 responsibilities and participation in the commissioning process.
- B. Commissioning is the responsibility of the Contractor (including subcontractors and vendors). The Contractor is responsible for providing all scheduling, coordination and support required for start-up, testing, and commissioning (see Section 01 91 13). Commissioning Section is intended to provide an indication of the tests which must be performed by the Contractor prior to and including verification by the Owner's Representative. The commissioning process requires Division 21, 22, and 23 participation to ensure all portions of the work have been completed in a satisfactory and fully operational manner.
- C. Work of Division 21, 22, and 23 includes the following:
  - 1. Attend commissioning scoping meetings. At a minimum, the Mechanical, TAB, and Controls Contractors shall participate. Equipment vendor representatives shall also attend upon request of the Commissioning Agent and Test Engineer. These meetings shall further define the testing requirements and participation of each contractor and sub-contractors for each commissioning activity.
  - 2. Attend other meetings as required to facilitate the commissioning process. This shall include bi-monthly meetings during the startup period and weekly meetings starting at the beginning of the Owner-witnessed point to point and Functional Testing period. Other meetings may be required as problems arise, apart from the regularly-scheduled commissioning meetings.
  - 3. Controls Contractor shall be required to attend additional meetings intended to clarify the controls sequences of operation and reconcile any differences with the design intent. This meeting shall take place after the first Controls sequence of operations is submitted and reviewed.
  - 4. Provide Commissioning Authority and Test Engineer additional requested data, prior to normal O&M Manual submittal, in a timely manner for the development of the startup plan and the functional performance testing procedures.
  - 5. During the normal submittal processes, provide an additional copy of all equipment submittals, startup forms, field static testing reports (duct static pressure test reports, pipe static pressure test reports, chemical treatment reports, etc.), and TAB reports to the Commissioning Authority and Test Engineer for review.
  - 6. Mechanical Contractor shall install pressure/temperature test ports (i.e. - Pete's plugs) in all piping systems and at all locations where DDC controls pressure and temperature sensors are located.
  - 7. The Mechanical Prime Contractor shall be responsible for development of a comprehensive startup plan, incorporating the controls contractor point-to-point startup plan. The startup plan shall be developed with the help of the Test Engineer in order to integrate startup activities with the Test Engineer's commissioning plan. Mechanical Sub-Contractors shall assist the Mechanical Prime Contractor in development of the startup plan.
  - 8. The Mechanical Contractor shall provided detailed startup forms and clearly document all completed startup activities. The controls startup forms shall include detailed checkout forms with descriptions for each controlled device. All forms shall be submitted for review by the Test Engineer and Commissioning Authority prior to use.
  - 9. Provide skilled technicians, including equipment vendor representatives, equipment, and materials to perform startup and execute functional performance tests. Controls contractor shall provide skilled technicians, familiar with the project, for both startup (Owner-witnessed point-to-point testing) and functional performance testing. Commissioning functional performance testing participation from the controls contractor shall be required in addition to the point-to-point testing.

## SECTION 23 08 16 COMMISSIONING OF MECHANICAL SYSTEMS SUPPORT

10. Correct deficiencies found during startup and functional performance testing in a timely manner to facilitate retesting activities within the commissioning schedule.
11. Submit startup documentation to General Contractor, Test Engineer, and Commissioning Authority to verify functional testing prerequisite requirements are fulfilled before functional testing for the associated equipment or system is scheduled to start. Refer to Section "General Commissioning Requirements," for commissioning procedure. Startup documentation (point-to-point testing) shall also be required from the controls contractor as a prerequisite to functional performance testing.
12. TAB Contractor shall report any deficiencies found in a timely manner to the Mechanical Contractor. The Mechanical Contractor shall correct these deficiencies in a timely manner to facilitate functional performance testing within the commissioning schedule.
13. TAB Contractor shall coordinate all setpoint value requirements for input into the controls system, including minimum outside air damper positions, return/supply fan VFD speed mapping, pumping loop differential pressure setpoints, duct system static pressure setpoints, air terminal unit flow sensor calibration factors, etc.
14. Maintain and update as-built drawings during construction including controls as-built drawings.
15. Provide final O&M manuals that incorporate all system changes including controls sequence of operations.
16. Providing training, for equipment and systems specified under this section, with coordination by the Contractor and Owner's Representative

### 1.2 RELATED WORK

- A. All start-up and testing procedures and documentation requirements specified within Division 23.
- B. Cooperate with the Testing, Adjusting and Balancing (TAB) firm in the following manner:
  1. Allow sufficient time before final commissioning dates so that testing, adjusting and balancing can be accomplished.
  2. Put all heating, ventilating, and air conditioning equipment and systems into full operation and continue the operation during each working day of testing, adjusting, balancing and commissioning.
  3. Provide labor and material to make corrections when required, without undue delay.
  4. Include the cost of exchange sheaves and belts as may be required by the TAB firm.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. Provide test equipment as necessary for start-up and commissioning of the mechanical equipment and systems. The TAB firm will provide the test equipment required to perform TAB services.
- B. Proprietary test equipment required by the mechanical equipment manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall demonstrate its use and assist the Contractor in the commissioning process.

## PART 3 - EXECUTION

### 3.1 WORK PRIOR TO COMMISSIONING

- A. Complete all phases of work so each system can be started, tested, adjusted, balanced, and otherwise commissioned. Division 23 has primary start-up responsibilities with obligations to complete systems, including all sub-systems, so they are fully functional. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.

## SECTION 23 08 16 COMMISSIONING OF MECHANICAL SYSTEMS SUPPORT

- B. A commissioning plan will be developed by the Test Engineer and approved by the Owner's Representative.
  - 1. Division 23 shall be obligated to assist the Test Engineer in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation, identification of parties responsible for startup activities, and schedule dates for equipment startup activities.
  - 2. If system modifications/clarifications are called for in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner.
  - 3. If Contractor-initiated system changes have been made that alter the commissioning process, the Contractor will notify the Owner's Representative for approval.

### 3.2 PARTICIPATION IN COMMISSIONING

- A. Provide skilled technicians to start up all systems within Division 23.
  - 1. These same technicians shall be made available to assist the Contractor and Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty.
  - 2. Work schedules, time required for testing, etc., will be requested and coordinated by the Contractor.
  - 3. Division 23 will ensure that qualified technician(s) are available and present during the agreed-upon schedules and for sufficient duration to complete the necessary tests, adjustment, and problem resolutions.
- B. System problems and discrepancies may require additional technician time which shall be made available for the subsequent commissioning periods until required system performance is obtained.
- C. The Owner's Representative reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system. Such qualifications include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the Contractor to get the job done.

### 3.3 WORK TO RESOLVE DEFICIENCIES

- A. In some systems, misadjustments, misapplied equipment and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work will be completed under the direction of the Owner's Representative and the Architect, with input from the Contractor and equipment supplier. Whereas all members will have input and the opportunity to discuss the work and resolve problems, the Architect will have final jurisdiction on the work needed to achieve performance.
- B. Corrective work shall be completed in a timely fashion to permit timely completion of the commissioning process.
  - 1. Experimentation to render system performance will be permitted.
    - a. If the Architect deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Architect will notify the Owner indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities.
    - b. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem.
    - c. Costs incurred to solve the problem in an expeditious manner will be the Contractor's responsibility.

### 3.4 SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS

- A. Seasonal commissioning pertains to testing under full-load conditions during peak heating and peak cooling seasons, as well as part-load conditions in the spring and fall.
  - 1. Initial commissioning will be done as soon as contract work is completed regardless of season.
  - 2. Commissioning under conditions representing other than the current season may be undertaken at a later time by the Test Engineer and Commissioning Authority.

## SECTION 23 08 16 COMMISSIONING OF MECHANICAL SYSTEMS SUPPORT

3. Discrepancies discovered with the Contractor's equipment or workmanship will be handled as warranty items.

### 3.5 RETESTING AND RECOMMISSIONING

- A. Any fault in material or in any part of the installation revealed by commissioning tests shall be investigated, replaced, or repaired by the Contractor, and the same test repeated at the Contractor's expense until no fault appears.

### 3.6 TRAINING

- A. Participate in the training of the Owner's engineering and maintenance staff, as required in Divisions 01 and 23, on each system and related components. Training, in part, will be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids.
- B. Training shall be conducted jointly by the Contractor, the Design Engineers, and the equipment vendors. The Contractor will be responsible for highlighting system peculiarities specific to this project.

### 3.7 MISCELLANEOUS SUPPORT

- A. Division 23 shall remove and replace covers of mechanical equipment, open access panels, etc., to permit Contractor, Architect and Owner's Representative to observe equipment and controllers provided. Furnish ladders and flashlights as necessary.

END OF SECTION

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 11 23 "Plumbing Pumps."
  - 2. Section 23 05 00 "Common Mechanical Materials and Methods"
  - 3. Section 23 05 53 "Identification for Mechanical Piping and Equipment"
  - 4. Section 23 05 23 "General-Duty Valves for Mechanical Piping"
  - 5. Section 23 05 19 "Meters and Gages for Mechanical Piping."
  - 6. Section 23 05 63 "Variable Frequency Drives."
  - 7. Section 23 21 23 "Hydronic Pumps."
  - 8. Section 23 21 13 "Hydronic Piping."
  - 9. Section 23 22 13 "Steam and Condensate Heating Piping."
  - 10. Section 23 64 26 "Rotary-Screw Water Chillers – Water Cooled."
  - 11. Section 23 64 29 "Refrigerant Monitoring Equipment."
  - 12. Section 23 65 13 "Packaged Cooling Towers"
  - 13. Section 23 73 13 "Modular Indoor Central-Station Air-Handling Units."
  - 14. Section 23 74 13 "Packaged, Outdoor, Central-Station Air-Handling Units."
  - 15. Section 23 81 26 "Split-System Air-Conditioners."
  - 16. Section 23 33 00 "Air Duct Accessories."
  - 17. Section 23 82 39 "Unit and Cabinet Heaters."
  - 18. Section 23 36 00 "Air Terminal Units."
  - 19. Section 23 34 00 "Fans."
  - 20. Section 23 73 23 "Custom Air-Handling Units."
  - 21. Section 23 05 94 "Testing, Adjusting, and Balancing Support for Owner."
  - 22. Division 26 "Electrical"

## 1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems, including control components, wiring and piping for equipment not directly controlled by the DDC system. Control system consists of DDC controllers, sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories connected to controllers to operate systems according to sequences of operation indicated. System Software shall be updated to the latest version at project completion.
- B. DDC system and components shall be BACnet Data Communications Protocol compliant.
- C. Existing Campus DDC system Siemens will be extended and connected to new DDC system.

## 1.3 SUBMITTALS

- A. General: See Section 23 05 00 "Common Mechanical Materials and Methods" for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
  - 1. Product Data: Include manufacturer's technical Product Data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, and start-up instructions. Hardware: Include technical data for workstations, controllers, transducers/transmitters, sensors, actuators, and components.
  - 2. Software: Include technical data for operating system software, operator interface, graphics, and other third party applications.
- B. Shop Drawings (AutoCAD 2006, AutoCAD 14 or latest version) from manufacturer detailing equipment assemblies, indicating dimensions, weights, loadings, required clearances, and methods of field assembly, components, and location and size of each field connection. Include the following:
  - 1. Schematic flow diagram for each system type showing fans, pumps, boilers, chillers, coils, dampers, valves, and control devices.

## SECTION 23 09 00 INSTRUMENTATION AND CONTROLS FOR HVAC

2. Each control device labeled with setting or adjustable range of control.
  3. Diagrams for all required electrical wiring. Clearly differentiate between factory-installed and field-installed wiring. Label/tag all field installed wiring.
  4. Details of control panel faces, including controls, instruments, and labeling.
  5. Detailed written description of control sequence of operation.
  6. Communication trunk cable schematic showing system architecture, workstations, DDC controllers locations and trunk data conductors.
  7. Listing of connected data points, including connected control unit and input device.
  8. Sample of color system graphics diagrams indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
  9. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- C. Schedules: Valve schedules identifying valve size, fail-safe position, flow, Cv, actual pressure drop and equipment served. Damper schedules identifying damper size, fail-safe position, pressure drop and equipment served.
- D. Field Quality Control and Testing: Test Plans forms which will be used to verify operation of all points and control functions. Provide pre-functional testing prior to commissioning. Commissioning shall be complete as a prerequisite to Substantial Completion.
- E. Certificates: Data Communication Protocol.

### 1.4 COORDINATION

- A. Ensure installation of components is complementary to installation of similar components in other systems.
- B. Coordinate installation of DDC system components, control wiring and piping requirements with installation of mechanical systems equipment.
- C. Coordinate installation of components (dampers, valves, flow measurement, meters, etc) provided under this section and to be installed by other sections.
- D. Ensure each system is completed calibrated, tested and operational prior to commissioning. Coordinate and provide support for Pre-Functional and Functional Performance Testing.
- E. Coordinate and support test/balance contractor for all balancing requirements.
- F. Coordinate and provide compatible components for interface with equipment being furnished.

### 1.5 OPERATION AND MAINTENANCE DATA

- A. Maintenance data for control systems equipment to include in the operation and maintenance manual specified in Section 23 05 00 "Common Mechanical Materials and Methods." Include the following:
  1. Maintenance instructions and spare parts list (including unit cost) for each type of control device.
  2. Interconnection wiring diagrams with identified and numbered system components and devices.
  3. Step-by-step procedures indexed for each operator function.
  4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
  5. Calibration records and list of set points.
- B. Project Record Documents:
  1. Accurately record actual location of control components, including panels, controllers, thermostats, and sensors.
  2. Shop drawings reflecting actual installation and operating sequences.
  3. Include data specified in "Submittals" in final form.
  4. System software flow chart reflecting operating sequences.
  5. Documented results of Field Quality Control and Testing Plan.
  6. Certificate stating that control systems have been tested and adjusted for proper operation.
  7. Software License Agreements

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### 1.6 QUALITY ASSURANCE

- A. Comply with the latest edition of the following codes, regulations and standards:
  - 1. City, county, state and federal regulations and codes including amendments
  - 2. National Fire Code NFPA 70 "National Electric Code."
  - 3. National Fire Code NFPA 90A "Installation of Air-Conditioning and Ventilating Systems."
  - 4. Underwriters Laboratories UL 916 "Energy Management Equipment."
  - 5. ANSI/ASHRAE Standard 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
  - 6. BACnet Testing Laboratories (BTL): Devices and products utilized in the BACnet interface shall be BTL listed and label.

### 1.7 SERVICE AND GUARANTEE

- A. After completion of the system, including software, submit a warranty in accordance with Section 01 77 00. Provide all services, materials and equipment necessary for the successful operation of the DDC hardware and controls during the warranty period. Preventive maintenance shall be included. Software and data shall be revised and updated as necessary during warranty period to maintain system performance.
- B. During the warranty period provide a 24-hour emergency service number where a qualified automation service technician familiar with the installed system may be reached. This service technician shall have the capability of remotely communicating with the system for troubleshooting and program alterations.
- C. Provide inspection for opposite season to test, calibrate, and adjust controls. Submit written report for each inspection.

### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store equipment and materials inside and protected from weather.
- B. Factory Mounted Controls: Where Factory-Mounted Controls are indicated to be factory mounted on equipment, arrange for shipping, packing and labeling of control devices to the equipment manufacturer. Installation requirements, wiring schematics shall be furnished and coordinated directly with respective unit manufacturer. Unless otherwise indicated, all cost associated with factory-mounted controls and wiring shall be included under this section.

### 1.9 EXTRA MATERIALS

- A. Furnish spare materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents. Spare materials used during warranty shall be replaced.
- B. Spare Parts: As a minimum, provide the following spare parts:
  - 1. Space Temperature Sensors with covers: 5 percent of the installed system or minimum quantity of 3.
  - 2. Duct and Pipe Temperature Sensors: 5 percent of the installed system or minimum quantity of 2 of each type.
  - 3. DDC Controller Power Supplies: Minimum quantity of 1 of each type.
  - 4. DDC Controller I/O Boards: Minimum quantity of 1 of each type.
  - 5. Replacement Materials: Provide one replacement diaphragm or relay mechanism for each unique pneumatic damper motor, valve motor, controller, thermostat, and positioning relay.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Approved Manufacturers / Representatives:
    - a. Johnson Controls / Johnson Controls, Inc.
    - b. Siemens / Siemens Building Technologies, Inc.

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2. Manufacturers Qualifications: A minimum of 5 (equivalent size and complexity of this project) operational systems within the last 5 years utilizing similar components located in the same State or within 100 miles of project site. Manufacturer or authorized manufacturer's on-site service support shall also be available within the same location parameters indicated.
3. Technician Qualifications: Direct employee of manufacturer of primary control system with a minimum of 5 years of experience for systems programming, start-up, trouble-shooting and diagnostics.
4. Installer Qualifications: By the District Office of the manufacturer as a subcontract, or by a firm regularly engaged in the installation of building direct digital HVAC control systems for a period of not less than 5 years. The entire control system shall be installed by qualified electricians and mechanics, all of which are properly trained and qualified for the work they perform, and directly supervised by the local representative of the component manufacturer.

### 2.2 BASIC DDC SYSTEM

- A. General: The Direct Digital Control (DDC) System shall be fully integrated and installed as a complete package of controls and instrumentation. The system shall include, but not limited to, all computer software and hardware, operator input/output devices, sensors and controls required for complete operation. Provide all wiring, installation, supervision and labor, including calibration, adjustments, operator training and checkout necessary for a complete and fully operating system.
- B. Integrate this facility with existing Central Operator Workstation(s). Communication network shall be extended connected such that the Operator has access to all facilities via the same log in screen and will utilize the same program commands, control loop software programming languages, and graphics representation as with all other similar systems on the facility wide DDC system. Facility Central Operator Workstation(s) shall be upgraded to the latest software version and any additional software as specified herein will be included. Hardware shall be upgraded or replaced to support software operations. Gateways shall not be used to communicate with existing system without prior approval.

### 2.3 OPERATOR WORKSTATION

- A. Provide a Personal Computer/Server Workstation at project site for command entry, information management, network alarm management, and database management functions. All real-time control functions shall be resident in the Advanced DDC panels. Workstation shall be general purpose, commercially available, personal computer with sufficient memory and processor capacity to perform all functions described in this specification. Provide sufficient hard drive disk storage to accommodate all fully configured point databases, all application databases, all graphics databases, all user-defined reports, and all historical data archives as described in this specification. Provide the capacity for future point expansion. System shall be able to support five times the initial point installation without system performance degeneration. Point shall be defined as individual line items on DDC point list. A cost allowance shall be allocated for each operator workstation to provide the latest technology available. System shall be provided with or upgraded to the latest and fastest processor, configured with standard peripherals and accessories available not more than 30 calendar days prior to the scheduled date to commence the commissioning procedures. As a minimum, system shall be configured as follows:
  1. Dual Core Processor 3.00GHz w/ 4MB L2 Advanced Transfer Cache and 1066MHz FSB. 1GB DDR2 SDRAM Memory. 120GB UATA100 7200RPM Hard Drive. Integrated 48XCD and 48X CD-RW/DVD. One Type II PCMCIA Card slot. (6) USB, Parallel, Serial, (2) Integrated IEEE 1394 (FireWire) and (2) PS/2. Headphone/Speaker, Line-in and Microphone Jacks. Complete with operator workstation software. 17.0" LCD Flat Panel Monitor with adjustable stand. Integrated 256MB Graphics with VGA Out. Keyboard and Optical Mouse. V.92 56K Modem. Integrated 10/100 Ethernet. Surge protection.
  2. Printer: Color laser printer 4800x1200 dpi optimized color resolution, 100-sheet tray with 256MB memory and printer cable.

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- B. Laptop Computer: Provide one laptop computer for operator readout of system variables, override control, servicing, trouble-shooting and adjustment of control parameters. Provide all software and hardware necessary for interface at Advanced DDC panels, application Specific digital controllers, variable air volume terminal unit controllers, and at space temperature sensors. As a minimum, system shall be configured as follows:
  - 1. Dual Core 2.33 GHz, Processor, 1GB SDRAM Memory. 80GBATA Hard Drive. Docking Base with Integrated 24XCD-RW/DVD. One Type II PC Card slot. (2) USB, IEEE 1394 (FireWire) and VGA on Docking Base: (2) USB, IEEE 1394 (FireWire), VGA, Parallel, Serial and PS/2. 12.1" XGA TFT Active Matrix. 256MB Graphics with VGA Out. Full-Sized Keyboard and EZ Pad Pointing Device. 4Minimum 5 hours Battery with AC Adaptor. Integrated V.92 56K Modem. Integrated 10/100 Ethernet. Surge protection and hard carrying case.
- C. Manufacturer's Portable Operator Terminal: Provide [one] portable full function operator terminals for operator readout of system variables, override control, servicing, trouble-shooting and adjustment of control parameters. Provide all software and hardware necessary for interface at advanced DDC panels, Application Specific digital controllers, terminal unit controllers, and at space temperature sensors. If a DDC panel, controller or sensor requires a different portable operator terminal for interface, provide one of each type. Complete with carrying case.

### 2.4 OPERATOR WORKSTATION SOFTWARE

- A. Command Entry/Menu Selection Process: Provide all software for a complete and operational system as described herein. Software shall be multi-tasking, multi-user operating system for operator consoles and controllers, network communication software for dial-up and hard wired trunk applications, operator man-machine interface software, control application software and all other software necessary to provide the functions specified. Operator workstation shall use Microsoft "Windows" operating platform with high speed Internet access. Operator Workstation interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change set points from graphical displays through the use of a mouse or similar pointing device.
- B. Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and database manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
  - 1. Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and down loaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually.
  - 2. A minimum of 10 levels of access with a minimum of 200 user passwords shall be supported..
  - 3. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, and shall be limited to only those items defined for the access level of the password used to log-on.
  - 4. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.
- C. Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:
  - 1. Start-up or shutdown selected equipment.
  - 2. Adjust set points.
  - 3. Add/Modify/Delete time programming.
  - 4. Enable/Disable process execution.
  - 5. Lock/Unlock alarm reporting for each point.
  - 6. Enable/Disable Totalization for each point.

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7. Enable/Disable Trending for each point.
  8. Override PID Loop set points.
  9. Enter temporary override schedules.
  10. Define Holiday Schedules.
  11. Change time/date.
  12. Enter/Modify analog alarm limits.
  13. Enter/Modify analog warning limits.
  14. View limits.
  15. Enable/Disable Demand Limiting for each meter.
  16. Enable/Disable Duty Cycle for each load.
- D. Dynamic Color Graphics Software: System software shall provide user interface through which viewing and commanding may be done using a "mouse" pointing device. The operator shall be able to access to any level of desired system information without being required to enter any commands from the keyboard.
1. Windowing: Windowing user interface shall be provided to allow operator to simultaneously view several different types of system displays at the same time to analyze system operation (i.e. air handling unit equipment graphic display and several trend graph of associated space temperatures simultaneously displayed). The system shall be capable of a graphic display associated with an alarm to be viewed without interrupting work in progress.
  2. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their respective locations, area served, and shall automatically update to represent current conditions without operator interface.
  3. System Selection and Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text based commands. Provide a logical penetration of graphical displays from a site plan on down to each level of digital controllers.
  4. Graphics Generation: Graphics generation software shall be provided to allow the user to add, modify, or delete system graphic displays. A minimum of 15 colors shall be available for use. Provide a library of pre-engineered screens and symbols depicting standard HVAC components (e.g. fans, coils, filters, dampers, terminal units, heat pumps, circulation pumps, cooling towers, etc.).
- E. Logs and Summaries:
1. Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:
    - a. A general listing of all points in the network.
    - b. List all points currently in alarm.
    - c. List of all off-line points.
    - d. List all points currently in override status.
    - e. List of all disabled points.
    - f. List all points currently locked out.
    - g. List of all items defined in a "follow-up" file.
    - h. List all Weekly Schedules.
    - i. List all Holiday Programming.
    - j. List of Limits and Deadbands.
  2. Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.
- F. System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
- G. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:
1. Add/Delete/Modify Advanced DDC Panels.
  2. Add/Delete/Modify Operator Workstations.

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3. Add/Delete/Modify Application Specific Controllers.
  4. Add/Delete/Modify points of any type, and all associated point parameters, and tuning constants.
  5. Add/Delete/Modify alarm reporting definition for each point.
  6. Add/Delete/Modify control loops.
  7. Add/Delete/Modify energy management applications.
  8. Add/Delete/Modify time- and calendar-based programming.
  9. Add/Delete/Modify Totalization for every point.
  10. Add/Delete/Modify Historical Data Trending for every point.
  11. Add/Delete/Modify custom control processes.
  12. Add/Delete/Modify any and all graphic displays, symbols, and cross-references to point data.
  13. Add/Delete/Modify dial-up telecommunication definition.
  14. Add/Delete/Modify all operator passwords.
  15. Add/Delete/Modify Alarm Messages.
- H. Programming Description: The system shall permit an operator to create, modify and document all process control sequences including all DDC application software, energy management software, and alarm processes. Manufacturer latest technology programming methods shall be provided, i.e. modified basic, graphical or block programming format.
- I. Network-Wide Strategy Development: Inputs and outputs for any process shall not be restricted to a single Advanced DDC panel, but shall be able to include data from any Advanced DDC panel to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of the other processes (cascading).
- J. System Definition/Control Sequence Documentation: All portions of system definition shall be documented to provide hard copy printouts of all configuration and application data. Control process and DDC control loop documentation shall be provided in logical, graphical or block flow diagram format to allow control sequences to be easily interpreted and modified at any time in the future.
- K. Database Save/Restore/Back-Up: Back-up copies of all Advanced DDC panel databases shall be stored in at central operator workstation. Continuous supervision of the integrity of all DDC panel data bases shall be provided. In the event that any DDC panel on the network experiences a loss of its data base for any reason, the user shall have the ability to manually execute to download a new copy or any portions of the respective data base to restore proper operation.
- L. Third Party Software Package: Provide the capability and capacity to run specific third party software packages for word processing, spreadsheets and database management programs and shall provide for on-line data transfer from DDC network or from archived historical data. Use of third party software shall operate concurrently with other tasks such as alarm logging, and report data gathering. Provide software package to analyze trended point in graphic format with measured variable on y-axis and time variable on x-axis.
- ### 2.5 LOCAL AREA NETWORK
- A. Operator workstations and Advanced DDC panels shall reside directly on a local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer to peer basis. All points connected to network shall be accessible through any operator workstation on the network. Any point on the network shall be available to any controller on the network for control loop processing.
- B. All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment. Access to system data shall not be restricted by the hardware configuration of the facility management system. The hardware configuration of the network shall be transparent to the user when accessing data or developing control programs.

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- C. Manufacturer's highest available speed data transfer rates shall be provided for all communications, alarm reporting, and quick report generation from controllers, and upload/download efficiency between network devices.
- D. Provide synchronization of the real-time clocks in all DDC panels.
- E. Local Area network communication trunk and software shall be configured to support project system requirements including, but not limited to, Advanced DDC panels, operator workstations, servers, and any other peer-to-peer devices residing on the network. Network shall have a minimum of 25-percent extra capacity of the installed system for future additions.

### 2.6 ADVANCED DDC PANELS

- A. General: Advanced DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Modular in design and consisting of processor board with programmable memory, power supplies, and input/output (I/O) modules with manual override. Advanced DDC panels shall be provided for each primary air system, primary heating and cooling system to perform independent, stand alone system operations. Each Advanced DDC panel shall have sufficient memory to support its own operating system and databases including:
  - 1. Control processes.
  - 2. Energy Management Applications.
  - 3. Alarm Management.
  - 4. Historical/Trend Data for all points.
  - 5. Maintenance Support Applications.
  - 6. Custom Processes.
  - 7. Operator I/O.
  - 8. Dial-Up Communications.
  - 9. Manual Override Monitoring.
- B. Each Advanced DDC panel shall support the following types of point inputs and outputs (Each Digital and Analog Outputs shall be provided with manual override):
  - 1. Digital Inputs for status/alarm contacts.
  - 2. Digital Outputs for on/off equipment control.
  - 3. Analog Inputs for temperature, pressure, humidity, flow, and position measurements.
  - 4. Analog Outputs for valve and damper position control, and speed capacity control of primary equipment.
  - 5. Pulse Inputs for pulsed contact monitoring.
  - 6. Spare points: Provide a minimum of 10% spare points for each Input/Output point type (not including pulse inputs).
- C. Each Advanced DDC panel communication trunk and software be configured to support project requirements, including but not limited to, variable volume terminal unit controllers, and other application specific controllers residing on network. Network shall have a minimum of 25-percent extra capacity of the installed system for future additions. Controllers shall consist of any combination of future application specific controllers and variable air volume terminal unit controllers. Advanced DDC panels shall be provided with at least two serial data communication port for operator I/O devices such as industry standard printers, portable operators terminals or portable lap-top computers. In lieu of above, one serial data communication port and a local operator access and display panel shall be provided.
- D. Each Advanced DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.
- E. In the event of the loss of normal power, there shall be an orderly shutdown of all advanced DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all RAM memory. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention. Should DDC panel memory be lost for any reason, the user

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shall have the capability of reloading the DDC panel via the local area network, via the local RS-232C port, or via telephone line dial-in.

- F. Provide NEMA enclosure rated for installed conditions. A local disconnect shall be provided at each controller to individually disconnect control power without interruption to any other controller.

### 2.7 ADVANCED DDC PANEL SOFTWARE

- A. All necessary software to form a complete operating system as described in this specification shall be provided. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution. Provide multiple copies and licensing agreements as necessary to support the specified quantity of workstations and portable terminals.
- B. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:
  - 1. Two Position Control.
  - 2. Proportional Control.
  - 3. Proportional plus Integral Control.
  - 4. Proportional, Integral, plus Derivative Control.
  - 5. Automatic Control Loop Tuning.
- C. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any given time period.
- D. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- E. Power Failure Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation, including start time delays as described above.
- F. Energy Management and Applications
  - 1. DDC Panels shall have the ability to perform any or all of the following energy management and application routines:
    - a. Time of Day Scheduling.
    - b. Calendar Based Scheduling.
    - c. Holiday Scheduling.
    - d. Temporary Schedule Overrides.
    - e. Optimal Start.
    - f. Optimal Stop.
    - g. Night Setback Control.
    - h. Enthalpy or Dry bulb Switch over (Economizer).
    - i. Peak Demand Limiting.
    - j. Temperature Compensated Load Rolling.
    - k. Fan Speed/CFM Control.
    - l. Heating/Cooling Interlock.
    - m. Hot Water Reset.
    - n. Chilled Water Reset.
    - o. Condenser Water Reset.
    - p. Air Handling Unit Control and Sequencing.
    - q. Chiller Control and Sequencing.
    - r. Cooling Tower Control and Sequencing.
    - s. Fire Alarm, Lighting and Security Controls Interface.
    - t. Power, and Water Utilities Monitoring and Recording.
  - 2. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the sequence of operation.
- G. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
  - 1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:

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- a. Any system-measured point data or status.
  - b. Any calculated data.
  - c. Any results from other processes.
  - d. User-Defined Constants.
  - e. Arithmetic functions (+, -, \*, /, square root, exp., etc.) - Boolean logic operators (and, or, exclusive or, etc.) - On-delay/Off-delay/One-shot timers.
2. Process Triggers: Custom processes may be triggered based on any combination of the following:
- a. Time interval.
  - b. Time of day.
  - c. Date.
  - d. Other processes.
  - e. Time programming.
  - f. Events (e.g., point alarms).
- H. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.
- I. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.
- J. Custom Process Documentation: The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphics flowcharts and English language descriptors.
- K. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.
1. Point Change Report Description: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.
  2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.
  3. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PC's used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
  4. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store an alarm message to more fully describe the alarm condition or direct operator response.
  5. Alarms shall be generated for, but not limited to the following:
    - a. Motor is commanded on or off but motor status input indicates no change.
    - b. Room temperature or static pressure strays outside selectable limits.
    - c. An analog input takes a value indicating sensor failure.
    - d. A module or node is "dead" to the LAN.
    - e. A power outage occurs.
- L. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.

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1. Point Histories: Advanced DDC panels shall continuously and automatically sample the value of all analog inputs on a user defined time or change of state intervals.
  2. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assign able to user-definable trends for the purpose of collecting operator specified performance data over extended periods of time. Sample intervals shall be operator selected change of value based or time based shall be provided. Each advanced DDC panel shall have a dedicated buffer for trend data.
  3. Data Storage and Archiving: Trend data shall be stored at the Advanced DDC panels, and uploaded to hard disk storage when archives is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full.
- M. Runtime Totalization: Advanced DDC panels shall have the capability to automatically accumulate and store runtime hours for all binary input and output points.
1. The totalization routine shall have a sampling resolution of one minute or less.
  2. The user shall have the ability to define a warning limit for runtime totalization. Unique, user-specified messages shall be generated when the limit is reached.
- N. Analog/Pulse Totalization: Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons. etc.).
  2. The totalization routine shall have a sampling resolution of one minute or less.
  3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
- O. Event Totalization: Advanced DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.
1. The event totalization feature shall be able to store the records associated with a user defined minimum before reset.
  2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
- P. Interlocking:
1. Permit events to occur, based on changing condition of one or more associated master points.
  2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.
  3. Operator Commands:
    - a. Define single master/multiple master interlock process.
    - b. Define logic interlock process.
    - c. Lock/unlock program.
    - d. Enable/disable interlock process.
    - e. Execute/terminate interlock process.
    - f. Request interlock type summary.

### 2.8 APPLICATION SPECIFIC CONTROLLERS

- A. Application Specific Controllers shall be fully programmable or pre-programmed to support, but not be limited to, the control of the following configurations of Unitary equipment to address current requirements as described in the sequence of operation, and for future expansion. Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand alone fashion. Application programs and parameter data shall be stored in nonvolatile memory:
1. Air Conditioning Units.
  2. Cabinet Heaters, and Unit Heaters.
- B. The modes of operation supported by the Controllers shall include, but not be limited to, the following:
1. Day/Weekly Schedule.

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2. Comfort/Occupancy Mode.
  3. Economy Mode (Standby Mode, Unoccupied, etc.).
  4. Temporary Override Mode.
- C. The operator interface to any Application Specific controller point data or programs shall be through any network-resident PC workstation, any PC or portable operator's terminal connected to any DDC panel in the network, or through terminal jack at room temperature sensor.
- D. Provide NEMA enclosure rated for installed location.. A local disconnect shall be provided at each Application Specific controller to individually disconnect control power without interruption to any other digital controller.
- 2.9 APPLICATION SPECIFIC VARIABLE VOLUME TERMINAL UNIT CONTROLLERS (VAV)
- A. VAV terminal Unit Controllers be fully programmable or pre-programmed to support, but not be limited to, the control of the following configurations of terminal units to address current requirements as described in the sequence of operation, point schedule, and for future expansion. Application programs and parameter data shall be stored in nonvolatile memory.
1. Single Duct Only (Constant Volume, Cooling Only, or Cooling with Reheat).
- B. VAV Terminal Unit Controllers shall support the following types of input and output points:
1. Proportional Cooling Output.
  2. Proportional Heating Output.
  3. Space Temperature Input.
  4. Supply Air Temperature.
  5. Supply Air Quantity.
  6. Primary Damper Position.
  7. Velocity Sensor Input.
  8. Auxiliary Temperature Input.
  9. Override Push-button.
- C. The modes of operation supported by the VAV Terminal Unit Controllers shall include, but not be limited to, the following:
1. Day/Weekly Schedule.
  2. Comfort/Occupancy Mode.
  3. Economy Mode (Standby Mode, Unoccupied, etc.).
  4. Temporary Override Mode.
- D. The operator interface to any VAV controller point data or programs shall be through any network-resident PC workstation, any PC or portable operator's terminal connected to any DDC panel in the network, or through terminal jack at room temperature sensor.
- E. Provide NEMA enclosure rated for plenum use. A local disconnect shall be provided at each VAV controller to individually disconnect control power without interruption to any other digital controller.
- 2.10 SURGE PROTECTION
- A. Provide Surge and transient protection consisting of devices installed externally to digital controllers and operator workstations.
- B. Power Line Surge Protection Surge suppressers external to digital controller, shall be installed on all incoming AC power. Surge suppresser shall be rated by UL 1449, and have clamping voltage ratings below the following levels:
1. Normal Mode (Line to Neutral): 350 Volts.
  2. Common Mode (Line to Ground): 350 Volts.
- 2.11 WIRING
- A. Provide complete electric wiring for temperature control apparatus, including transformer primaries. Control circuit conductors, which run in the same conduit as power circuit conductors, shall have the same insulation level as power circuit conductors.
- B. AC Control Wiring
1. Control wiring for 24 V circuits shall be insulated copper 18 AWG minimum and shall be rated for 300 VAC service.
  2. Wiring for 120 VAC shall be 14 AWG minimum and shall be rated for 600 VAC service.

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- C. DDC Analog Signal Wiring: Analog signal wiring for analog inputs and analog outputs shall be 18 AWG single or multiple twisted pair. Each pair greater than one shall be 100 percent shielded, and have 20 AWG drain wire. Exception is direct connect RTD wiring, which shall be 18 AWG minimum twisted pair, 100 percent shielded, and with 20 AWG drain wire. Each wire shall have insulation rated to 300 VAC. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned copper cable drain wire, and overall cable insulation rated to 300 VAC.
- D. Plenum Cable: Plenum cable shall be UL approved for use only in accessible ceiling spaces. Plenum cable external to electrical raceway is permissible in the following locations:
  - 1. DDC communication trunk serving application specific controllers within a building.
  - 2. DDC system sensor wire installed above suspended accessible ceilings.

### 2.12 CONTROL COMPONENTS

- A. Temperature Sensors:
  - 1. Duct or Pipe Temperature sensors shall be nickel or platinum type RTD's, factory calibrated within plus or minus 0.1 degrees F.
  - 2. Use insertion elements in ducts not effected by temperature stratification. Use averaging elements in duct prone to stratification with length at least the widest dimension of the duct cross section.
  - 3. Insertion elements for liquids shall be stainless steel encased and matched with the temperature wells installed with a minimum insertion length of 2-1/2 inches.
  - 4. Provide outside air temperature sensors with watertight inlet fitting, shielded from direct rays of sun.
  - 5. Room Temperature Sensors: Analog or thermistor type complete with mounting bracket and cover. Each room temperature sensor shall be provided with an integral terminal jack for laptop or portable operators terminal interface and with the following:
    - a. LCD Display.
    - b. Temperature Set point Adjustment.
  - 6. Room sensors located in areas subjected to damage shall be provided with protective guard.
  - 7. Room Humidity Sensors: Analog with mounting bracket and cover. Each room humidity sensor shall be provided with a LCD Display.
- B. Spans and Ranges:
  - 1. Temperature:
    - a. 50 degrees F span: Room, chilled water, cooling coil discharge air, return air sensors.
    - b. 100 degrees F span: Outside air, hot water, heating coil discharge air, mixed air sensors.
    - c. 200 degrees F span: High temperature hot water, heating hot water, chilled/hot water system sensors.
  - 2. Pressure:
    - a. -0.25 to .25 inches of water differential range: Static pressure of rooms.
    - b. 0 to 4 inches of water differential range: Duct static pressure.
  - 3. Humidity:
    - a. 0-100 percent relative humidity.
- C. Differential Static Pressure Sensors/Transmitters: Integral pressure transducer and transmitter. Output of pressure instrument shall be 4-20 mA signal proportional to the pressure span. Accuracy shall be 1.0-percent, linearity shall be 0.1-percent. Supply voltage shall be 24 V. Unidirectional with range not exceeding 150-percent of maximum expected input.
- D. Dynamic Pressure Sensors/Transmitters:
  - 1. UL listed, microprocessor based with flash memory, bidirectional or unidirectional dynamic pressure and airflow measurement assembly. Complete with sensor, transmitter, enclosure, mounting kit and UL plenum rated cabling. Installed accuracy shall be 2-percent airflow (0-3000 cfm FPM), 4-percent dynamic pressure ( $\pm 0.5$  in w.g.) and repeatability shall be  $\pm 0.25$ -percent of reading. Sensor as-

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- sembly shall consist of hermetically sealed thermistors in weather-proof housing. Transmitter output shall be fused, isolated and linear (4-20 mA or 0-10 VDC). 12 bit A/D converter with 0.1-percent output resolution.
2. Coordinate with Section 23 33 00 "Air Duct Accessories" for installation provisions.]
  3. Manufacturer: Ebtron, Inc., Model STA012 series or approved equal.
- E. Relative Humidity Transmitters: Integral humidity transducer and transmitter. Output of relative humidity instrument shall be a 4 to 20 milliampere signal proportional to 0 to 100 percent relative humidity input. Accuracy shall be 2 percent of full scale within the range 20 to 80 percent relative humidity. Sensing element shall be chilled mirror type, polymer, or thin film polymer type. Supply voltage shall be 24 V dc.
- F. VAV Terminal Box Control Components:
1. Actuator: DDC manufacturer's standard DDC system compatible VAV terminal unit damper actuator for each terminal unit. VAV terminal unit actuator shall be provided to the terminal box manufacturer for factory installation. Coordinate with Section 23 36 00 "Air Terminal Units".
  2. Air Flow Sensor: Sensor shall be provided by VAV terminal unit manufacturer.
  3. Differential Pressure Transducer: DDC manufacturer's standard DDC system compatible VAV terminal unit differential pressure transducer for each VAV terminal unit. VAV terminal unit pressure transducer shall be provided to the terminal box manufacturer for factory installation. Coordinate with Section 23 36 00 "Air Terminal Units". The differential pressure transducer shall accept air flow measurement signal from the terminal box air flow sensor.
- G. Actuators: Provide for all motor-operated dampers, valves and AHU Fan Flow Control Device of sufficient size and type, matched to application and operating temperature/pressures.
1. Electric or Electronic Actuators: Solid state positioner to stop automatically at end of travel. Complete with permanently lubricated gear train. Provide proportional, or 2-position (with adjustable SPDT auxiliary end-switch) actuators. Provide with spring return to normally-open or normally-closed on loss of control power. Power return type actuators shall not be acceptable. Substitution for 3-point floating type actuators suitable for pulse width modulation control in lieu of analog type actuators shall be permitted only for Terminal Units, Unit Heaters, Fan Coil Units, Cabinet Heaters, Finned Tube Radiation, and Convectors. Use of non-analog type actuators for any other applications shall not be allowed without prior approval. Provide position feedback for actuators as indicated in "DDC Point List".
- H. Control Dampers: Low leakage control dampers where not furnished with package units. Damper leakage rate shall not exceed 0.5 percent (of damper based on 2000 fpm duct velocity) when closed against 4-inch water gage static pressure; complete with extruded aluminum, stainless steel or zinc-coated steel blades, with extruded vinyl or rubber edge seals: blade ends sealed with aluminum or stainless steel "arc" seals. External frame of heavy gage welded steel with 1/4-inch plate bearing bars and bronze insert bearings. Coordinate with Section 23 33 00 "Air Duct Accessories" for installation provisions.
- I. Control Valves: Valves shall have stainless steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be 0.01 percent of rated Cv. Unless otherwise specified, bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends; bodies for 2 inch valves shall have threaded ends; and bodies for 2 inches to 3 inches shall be of brass, bronze or iron. Bodies for valves 2-1/2 inches and larger shall be provided with flanged-end connections. Valve Cv shall be within 100 to 125 percent of the calculated Cv. Valves shall provide effective control within pumping system total head pressure with a minimum of 100:1 turndown. Pressure drop not to exceed 5 psig at maximum flow rate for hydronic systems. Coordinate with Section 23 21 13 "Hydronic Piping" for installation provisions.
1. Two-Way Valves: Two-way modulating valves shall have equal-percentage characteristics.

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2. Three-Way Valves: Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.
  3. Valves for Chilled-Water and Condenser-Water: Internal valve trim shall be bronze except that valve stems may be type 316 stainless steel. Valves larger than 4 inches shall be butterfly.
  4. Valves for Hot-Water Service Below 250 degrees F: Internal trim (including seats, seat rings, modulating plugs, and springs) of valves controlling water hotter than 210 degrees F shall be Type 316 stainless steel. Internal trim for valves controlling water 210 degrees F or less shall be brass or bronze. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher.
  5. Valves for Steam Service: Bodies for valves 4 inches and larger shall be iron. Internal valve trim shall be Type 316 stainless steel. Steam valves shall have linear characteristics.
- J. Pressure Independent Flow Control Valves: Control valve shall be pressure independent modulating type configured to maintain a constant differential pressure across the control surfaces. Cast iron, steel or bronze rated for 150-psig minimum working pressures. Valve internal components shall be stainless steel, steel, Teflon, brass, or bronze. 0 to 100-percent design flow modulation with no more than  $\pm 5$ -percent variation. Rangeability shall be 100:1 minimum. Valve flow characteristics shall be able to be changed without removing valve from piping system. Complete with Pressure/temperature ports to measure inlet/outlet/internal pressures and calibrated performance tag. Coordinate with Section 23 21 13 "Hydronic Piping" for installation provisions. Manufacturer: Flow Controls Industries or approved equal.
- K. Control Panels: Panels shall be UL listed, NEMA type rated for application and location, surface or flush mounted panel as indicated with key locked door with continuous hinge and standard baked enamel finish.
- L. Differential Pressure Switches:
1. Filter Status: Diaphragm operated which actuate a SPDT snap action switch. A field adjustable pressure set point with a range suitable for air flow status applications. The switch voltage and current rating shall be double the load requirements. Provide sensing tubes connected to tips with multiple holes and bulkhead fittings specifically designed for air flow sensing. Manufacturer: Dwyer or approved equal.
  2. Air System - Limit Differential Pressure Switch: Pressure switches shall incorporate gauge and switch point indicator(s) for continuous indication of applied pressure and switch settings. Diaphragm operated with switching accomplished by photocell controlled relays. Set point adjustment controlled by knobs. Complete with set point latching circuit and external push-button switch for manual reset. Range 0-8 inches water gauge. Manufacturer: Dwyer or approved equal.
  3. Water System Differential Pressure Switch: Form-C contacts, automatic reset, screw-adjustable trip point, all components non-corrosive; wetted parts shall consist of a Buna-N diaphragm with O-ring seal; complete with NEMA rated enclosure suitable for application. Select operating range to match function. Provide instrument gage valve for each input.
- M. Current Transmitters: Designed to convert monitored AC current to a proportional DC voltage of 0-10 VDC or 4-20 mA output. Range 1 to 10, 50, 100 amps as required. Accuracy 1-percent of full scale. Repeatability plus or minus 2-percent of full scale. Response time 100 milliseconds.
- N. Current Sensing Relay: 100-percent solid state with adjustable range ( $\pm 1$ -percent of range) trip set point to monitor AC current. Provide with contact transfer with no calibration drift, complete with LED status indicator. Limit off-state leakage to 2 mA or less. Rating (200 ampere minimum) shall exceed equipment being monitored.
- O. Control Relays: Relays shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays should be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

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- P. Low Limit Thermostats: DPDT, incremental bulb type; actuates if any 12-inch maximum increment is below its setting; adjustable setting, manual reset. Provide capillary element length of 2.14 equaling 2.14 square feet of coil area per foot capillary element. One DPDT contact shall shut down equipment and the second contact shall signal the DDC system.
- Q. Contactors: Single coil electrically operated. Contacts shall be double break silver to silver. Number of contacts and rating shall be selected for the application intended. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.
- R. Transformers: Transformers shall conform to UL 506. Class 2 current limiting type or over-current protection. Connected load shall be limited to 80-percent of transformer rated capacity.
- S. Nameplates: Nameplates shall be in accordance with Section 23 05 53 "Identification for Mechanical Piping and Equipment." Color shall be black with 0.375-inch white engraved block lettering.

### 2.13 FLOW MEASUREMENT

- A. Air Measuring Unit (AMU):
  - 1. Air measuring unit (AMU) assembly shall be UL listed, true averaging, independent multi-point sensing type, and microprocessor (digital circuitry with FLASH memory) transmitter with 16-character LCD display. Factory calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST). Probes shall be configured to suit installed locations (duct and/or fan inlet). Vortex shedding arrays, pitot tubes, RTD, differential pressure sensing arrays and auto-zeroing sensors are not acceptable.
  - 2. Airflow and Temperature Measurement: Hermetically sealed thermistors mounted in the assembly with marine grade waterproof epoxy. Wiring shall be UL plenum rated, Kynar coated and installed within probe with no exposed wiring to environment. Airflow rate and temperature data of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.
  - 3. Airflow accuracy shall be  $\pm 0.2\%$  over entire operating airflow range. Temperature accuracy shall be  $\pm 0.15$  F over operating temperature range of  $-20$  F to 160 F. Operating humidity range shall be 0-99% RH (non-condensing)
  - 4. Probes: Gold anodized or stainless steel tube suitable for operating environment complete with mounting brackets and installation hardware.
  - 5. Transmitter/DDC Communications Interface: DDC manufacturer shall coordinate proper communications (BACnet, RS-485, Ethernet, ModBus or LonWorks) interface requirements for compatibility with DDC system. Linear analog, 0-10VDC/4-20mA isolated will be allowed only if communication interface protocol is not an available option to the DDC manufacturer.
  - 6. Coordinate with Section 23 33 00 "Air Duct Accessories" and "23 73 23 Custom Air-Handling Units" for installation provisions.
  - 7. Manufacturers:
    - a. Ebtron, Inc., Model GTx116 series.
- B. Water Flow Meter:
  - 1. Dual turbine type meter complete with Hot Tap ball valve and installation hardware assembly suitable for service pressure and temperature. Manufacturer: Onicon F-1210 Series or approved equal.
  - 2. ANSI B 16.5 Class 150 electromagnetic flow meter with integral sensor, counter and transmitter. Output of flow shall be 4-20 mA signal proportional to the span, complete with NEMA 4X Enclosure. Accuracy plus/minus 0.25% of rate. Manufacturer: EMCO Model MAG 3100 sensor, remote wall mounted MAG 3000 Signal Converter or approved equal.
  - 3. Coordinate with Section 23 21 13 "Hydronic Piping" for installation provisions.
- C. Steam Flow Meter:
  - 1. Hot tap insertion turbine flow meter with isolation valve to permit installation and removal without process shutdown. Output of flow shall be 4-20 mA signal proportional to the span. Complete with pressure and temperature transmitters.

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Manufacturer: EMCO Turbo-bar Model TMP 600, G2 rotor (plus 2 spare rotors), with temperature transmitter (range: 212-400 F), pressure transmitter (range: 0-150 psig), complete with full port 150 LB gate valve.

2. Steam Flow Processor: Provide processor for use with steam flow meter, complete with NEMA 4 enclosures. Manufacturer: EMCO FP-100 with Flo-link software, mechanical totalizer, and battery backup. Provide direct communication link to DDC system for monitoring, programming and printing.
3. Coordinate with Section 23 22 13 "Steam and Condensate Heating Piping" for installation provisions.

2.14 VARIABLE FREQUENCY DRIVE INTERFACE

- A. Variable Frequency Drives (VFD) shall be provided under Section 23 05 63 "Variable Frequency Drives." DDC manufacturer shall coordinate proper communications (BACnet, RS-485, Ethernet, ModBus or LonWorks) interface requirements for compatibility with DDC system. Provide all hardware, software and wiring required for DDC system interface.

2.15 REFRIGERANT MONITORING AND SYSTEM INTERFACE

- A. Description: Infrared sensor shall continuously measure and display the specific gas concentration and shall be capable of indicating, alarming, and shutting down equipment, and automatically activating ventilation system.
- B. Performance Requirements:
  1. Refrigerant to Be Monitored: HFC-134a.
  2. Low End Accuracy: 100 to 1000 ppm; plus or minus 5 percent of reading.
  3. High End Accuracy: 100 to 1000 ppm; plus or minus 2 percent of full scale.
  4. Sensitivity: 1 ppm.
  5. Resolution: 1 ppm.
  6. Operating Temperature: 32 to 104 deg F.
  7. Response Time: 90 percent of a step change in 4 minutes.
  8. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range.
- C. Operating Requirements:
  1. Maximum Power Input: 120-V ac; 60 Hz, 30 W.
  2. Alarm Relays: 3 relays at 5- to 8-A resistive load.
  3. Alarm Set Points: Displayed on front of meter.
  4. Audible Output: Sonic alert at 75 to 80 dB at 60 inches.
  5. Analog Output: 0- to 10-V dc or 4- to 20-mA current sourcing.
  6. Serial Output Type: RS 232.
- D. Sensor Configuration: Photoabsorptive IR sensor.
  1. Single-sensing channel.
  2. Expandable to four channels.
- E. Display: 10-character, alphanumeric, vacuum-fluorescent indicating lights for each alarm set point; standard alarm; acknowledge switch and test switch mounted on front panel; and alarm status LEDs and service fault LEDs.
  1. Enclosure: NEMA 4, type as required for ambient condition.
- F. Alarm Output: Indicating light flashes and horn sounds.
  1. Unit-mounting device with single-light beacon.
  2. Remote unit for mounting outside machinery room and having light beacon with double lights.
  3. Field-adjustable alarm set points.
  4. Calibration: Factory calibrated.
- G. Control Tubing:
  1. Sample Tubing Material: Install 1/4-inch O.D. tubing to each monitored zone. The tubing shall be refrigerant-grade copper, 1/4-inch O.D. seamless Type ACR (hard or annealed) complying with ASTM B280 or seamless Type L (drawn or annealed in accordance with ASTM B88).
  2. Poly tubing and other gas absorbing/leaching types are not acceptable due to sample corruption. Nylon non-plasticized 1/4-inch O.D. tubing, similar to Parker

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Hannifin, may be used if pre-approved, installed or bundled in 1/2-inch or 3/4-inch EMT conduit, or larger, 80% free area.

- H. Manufacturers:
  - 1. Vulcain Alarm, Inc.
  - 2. Johnson – Yokogawa.
  - 3. General Analysis Corp.
- I. Switches and Labels:
  - 1. Ventilation System Emergency Control Break Glass Switch: On-only, manual re-set. Upon activation, ventilation system shall operate under the Purge Mode. Locate adjacent to and outside of each Refrigeration Machinery Room exit.
  - 2. Emergency Control Break Glass Switch: Off-only, manual reset. Upon activation, electrically energized equipment (except for emergency ventilation system) and devices within the refrigeration room shall be de-energized. Locate adjacent to and outside of each Refrigeration Machinery Room exit.
  - 3. Ventilation System Central Control Station: 3-position switch (automatic-off-on type), located outside the main entrance of the Refrigeration Machinery Room. Switch shall be NEMA Type 4/13, oil tight selector switch. Provide with colored indicator lamps, one to indicate flow with the other to indicate no flow. Pilot light shall be NEMA Type 4/13 Pilot light, push-to-test, transformer. Switch and indicator lamps shall be provided within enclosure. Enclosure shall be NEMA Type 4 enclosure, keyed lock with glass panel face. 2 spare enclosure keys and 10 spare lamps shall be provided.
  - 4. Labels: Permanent identification labels for each switch, panel and indicator lamp.

2.16 CARBON MONOXIDE CO MONITORING AND SYSTEM INTERFACE

- A. Self-contained carbon monoxide detection system. Complete portable gas generator for calibration.
- B. Single or multi-channel, dual level detectors, using solid state sensors with 3-year minimum life, suitable over temperature range of 23 to 130 deg F, calibrated for 35 ppm and 100 ppm with maximum 2-minute response time.
- C. Manufacturers:
  - 1. Quatrosense Environmental Limited (QEL) Series 1000.
  - 2. MSA Instruments.

2.17 ROOM PRESSURE MONITORS

- A. Provide room pressure transmitters and monitors. Monitor shall be capable of interfacing with the Building DDC system, communicating alarms, differential pressure valves, and status point information. Monitor shall include LCD display of pressure monitoring mode, high and low pressure alarm, general failure, status of door switch, audible horn with silence button, status lights, and if applicable, Anteroom status. Monitor shall also include 2-position keyed switch to disable alarms for space cleaning and maintenance.

2.18 FIRE ALARM SYSTEM INTERFACE

- A. Fire Alarm System Interface:
  - 1. Fire alarm system and air handling equipment smoke detectors shall be provided under Division 26. Provide all hardware, software and wiring required for DDC system interface. Coordinate DDC requirements with Fire Alarm System Contractor.
  - 2. Fire alarm system and pressurization fans shall be interfaced. Coordinate DDC requirements with Fire Alarm System Contractor. Provide all hardware, software and wiring required for DDC system interface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

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- B. Notify the Owner Representative in writing of conditions detrimental to the proper and timely completion of the work.

### 3.2 INSTALLATION (GENERAL)

- A. Install in accordance with manufacturer's instructions.
- B. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to insure a complete operating system in accordance with the sequences of operation and point schedules.

### 3.3 LOCATION AND INSTALLATION OF COMPONENTS

- A. Locate and install components for easy accessibility; in general, mount 60-inches (panels measured from top edge) above floor with minimum 3'-0" clear access space in front of units.
- B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration and high temperature.
- C. Identification: Provide permanently mounted tags to all instruments with point address designation, system reference and description. Label all wiring, tubing at each end to match control diagrams.
- D. Control Panels
  - 1. Provide for controls and instruments at equipment and in mechanical room.
  - 2. Install temperature gages and pilot lights flush on the cabinet door. Install controllers, switches, timers, transformers, and relays in the interior of the cabinet; mount on a steel or aluminum subpanel or on the back panel of the cabinet. Provide and label control parameters and test points within the panel for total evaluation of system operation. Electrical controls shall be wired to numbered screw type terminal strips.
- E. Digital Controllers:
  - 1. Provide DDC controllers configured to control a single mechanical system such as an air handling unit, terminal unit, chilled water system, heating water system, etc., to operate a system in a complete standalone mode. DDC controllers shall be able to operate and control respective system upon loss of DDC system network communication.
  - 2. Provide digital control cabinets that protect digital controller electronics from dust, at locations shown on the drawings.
  - 3. Provide a disconnect power switch and surge protector for each digital controller.
- F. Temperature Sensors: Provide temperature sensors in locations to sense the appropriate condition. Provide sensor where they are easy to access and service without special tools. Calibrate sensors to accuracy specified. In no case will sensors designed for one application be installed for another application.
  - 1. Room Temperature Sensors: Provide on interior walls to sense average room temperature conditions. Avoid locations which may be covered by office furniture. Room temperature sensors should not be mounted on exterior walls when other locations are available. Unless otherwise indicated, mount centerline of sensor at 5 feet above finished floor.
  - 2. Duct Temperature Sensors:
    - a. Select specific sensor location within duct to accurately sense appropriate air temperatures. Do not locate sensors in dead air spaces or positions obstructed by ducts or equipment. Install gaskets between the sensor housing and duct wall. Seal duct and insulation penetrations.
    - b. Install duct averaging sensors, freeze protection sensors, between two rigid supports in a serpentine position to sense average conditions. Thermally isolate temperature-sensing elements from supports. Provide duct access doors to averaging sensors.
  - 3. Immersion Temperature Sensors: Provide thermowells for sensors measuring temperatures in liquid applications or pressure vessels. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to effect proper flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of the pipe area. Increase piping size as

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required to avoid restriction. Provide thermowells with thermal transmission material within the well to speed the response of temperature measurement. Provide wells with sealing nuts to contain the thermal transmission material.

4. Outside Air Temperature Sensors: Provide outside air temperature sensor on north side of the building, away from exhaust hoods, air intakes and other areas that may affect temperature readings. Provide sunshields to protect outside air sensor from direct sunlight.
- G. Room Humidity Sensors: Provide on interior walls to sense average room humidity conditions. Avoid locations which may be covered by office furniture. Unless otherwise indicated, mount centerline of sensor at 5 feet above finished floor.
- H. Damper Actuators: Actuators shall not be mounted in the air stream.
- I. Pressure Sensors:
  1. General: Install pressure sensing tips in locations to sense appropriate pressure conditions.
  2. Duct Static Pressure Sensing: Unless otherwise indicated, locate duct static pressure tip approximately two-thirds of distance from supply fan to end of duct with the greatest pressure drop.
  3. Pumping Proof with Differential Pressure Switches: Install high pressure side between pump discharge and check valve.
  4. Steam Pressure Sensing: Install snubbers and isolation valves on steam pressure sensing applications.
- J. Flow Measurement: Install and locate per manufacturer's instructions.
- K. Variable Pumping Application: Differential pressure sensor/transmitter shall be hard-wired directly to respective pumping system DDC controller. Utilization of network for data transfer will not be allowed. Unless otherwise indicated, locate hydronic differential pressure sensor/transmitter at the furthest distance from pumping discharge.

### 3.4 REFRIGERANT MONITORING

- A. Install per manufacturer's instructions. Examine machinery layout for proper location of monitoring device. Verify refrigerant contained in machinery(s) to ensure compatibility of refrigerant monitor.
- B. Sample Tubing: The tubing should be shipped sealed to the site, installed in good workmanship manner, field-assembled with compression fittings. Soldered or brazed connections are not acceptable due to foreign gases and contaminants. Tubing shall be field-assembled with compression fittings, terminated 12-18-inches from the ceiling with 0.1 micron particulate/coalescent filters furnished by the monitor manufacturer. Locate the sensing terminations in areas not subject to damage and downwind in the direction of convection airflow of the device to be monitored and where shown on the drawings. Identify each sample tube, both ends, with stamped (nonferrous) metal tags labeling zone/chiller monitored.
- C. Engage a factory-authorized service representative to inspect, test and adjust components, equipment installation, and electrical connections for compliance with requirements.

### 3.5 CARBON MONOXIDE MONITORING

- A. Install per manufacturer's instructions. Refer to Project Drawings for mounting locations. Engage a factory-authorized service representative to inspect, test and adjust components, equipment installation, and electrical connections for compliance with requirements.

### 3.6 ISOLATION ROOM PRESSURE MONITORING.

- A. Install per manufacturer's instructions.
- B. Install pressure transmitters over doors, below the ceilings, as indicated on the plans.
- C. Install the room pressure monitors in the corridors as indicated. Unless otherwise indicated, mount centerline of sensor at 5 feet above finished floor.

### 3.7 CONTROL WIRING AND CONDUIT

- A. All control wiring, all conduit for control wiring, and all miscellaneous accessory equipment for control wiring systems shall be provided by the Control Subcontractor as part of

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- the control system. Conform to Division 26 requirements, NFPA 70, and all local code requirements.
- B. All wiring in or through mechanical, electrical rooms, finished spaces, on roofs, in walls, below grade and inside equipment (except within control wiring compartments or control panels) shall be installed in conduit and properly supported. Label wire groups to match corresponding wiring diagrams.
  - C. Plenum Cable: Plenum cable type, installation methods and use shall be subject to City and State Codes and Regulations. Within ceiling space, attach directly to wall or slab on 4-foot centers, or support from ceiling suspension wires on 4-foot centers. Do not attach cables to pipes or ducts, or lay on ceilings. Cables shall be routed as high as possible without interference to equipment, ceiling, lighting access and removal.
  - D. Instrumentation and communication cable shall not be run together in the same conduit or raceway as power wiring.
  - E. Communication Cable: Provide all communication wiring between operator workstation and Advanced DDC panels, between Advanced DDC panels and application specific controllers and VAV digital controllers. All communication cable shall be checked for continuity, grounding, and shielding. Local area network communication wiring between operator workstations and Advanced DDC panels shall be in conduit.
  - F. Network Communications: Coordinate with Owner for Internet, Ethernet availability, connection regulations and restrictions.
  - G. Grounding: Ground controllers and cabinets to a good earth ground. Grounding of the green AC ground wire, at the breaker panel, alone is not adequate. Run metal conduit from controller panels to adequate building grounds. Ground sensor drain wire shields at controller end. All associated ground loop problems shall be corrected.
  - H. Power provisions for the DDC system shall be provided by Division 26 to the locations indicated. If not indicated, provide power from nearest electrical panel with additional circuit breakers rated and labeled for service. Unless approved by the Electrical Engineer, spare breakers shall not be used. Coordinate with Electrical Contractor.
  - I. Provide interface control wiring for equipment with remote sensors, panels, limits, and components, etc., furnished (shipped loose) by the manufacturer and to be field installed. Materials, wiring and termination shall be provided and installed in accordance with manufacturer's instruction, including , but not limited to the following:
    - 1. Chillers: Flow switches, differential pressure and temperature sensors.
    - 2. Cooling Towers: Sump heater temperature sensor, level switches, and controls.
    - 3. Pumping Package: Flow sensors and differential pressure sensors.
    - 4. Indoor/Outdoor Split Unit: Evaporation/condenser sections.
    - 5. AC Unit: Temperature, and control panels.

### 3.8 DDC POINT SUMMARY

- A. Provide all Database generation.
- B. Dynamic Color Display: Provide all dynamic graphic displays at each operator workstation System graphical displays shall be color-coded. Include outside air temperature indication on each primary air and water systems displays. As a minimum, the following shall be provided:
  - 1. Site Plan: Overall site plan, including all associated buildings.
  - 2. Building Floor Plan: Each floor plan graphic shall contain all graphical displays, equipment with area served, and locations associated with that building floor plan.
  - 3. Detailed Dynamic Color and data system graphics shall be provided for each piece of mechanical equipment including, but not limited to, air and water systems. Provide equipment run status, alarms, and analog variables for each system.
  - 4. Details, colors, and graphics shall be approved by the Owner prior to generation.
- C. Runtime Totalization: At a minimum, runtime totalization shall be incorporated, but not limited to, each monitored equipment, fans, and pumps. Warning limits for each point shall be entered with owner defined messages.
- D. Trend Log: Each input/output points shall be trended. Historical archiving of owner-selected points shall be provided at the operator workstation with the capability of transfer to graphic format representation.

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- E. Alarm Points: All analog inputs (High/Low Limits) and selected digital inputs alarm points shall be prioritized, printed, routed, with alarm message per owner's requirements. Loss of communication network shall also initiate an alarm. Provide all software timers necessary to prevent false alarms.
- F. Heavy Equipment Delays and Power Fail Restart Software: Each advanced DDC panel shall be provided with heavy equipment and power fail restart application software. Each advanced DDC panel shall start respective equipment in sequence and shall be time based and not dependent on prior system start-up.
- G. Database Save: Provide back-up database for all advanced DDC panels at the operator workstation computer hard disk. Provide additional back-up database for each Advanced DDC panel on Compact Disc (CD).

### 3.9 FIELD QUALITY CONTROL AND TESTING

- A. Demonstrate compliance of the HVAC control system with the contract documents. Calibrate instrumentation and controls and verify the specified accuracy using calibrated test equipment. Adjust controls and equipment to maintain conditions indicated, to perform functions indicated, and to operate in the sequence specified. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Ensure that tests are performed by competent employees of the DDC system installer or the DDC system manufacturer regularly employed in the testing and calibration of DDC systems. Calibrate field equipment and verify equipment and system operation before placing the system on-line. Field-testing will be witnessed by the Owner, Owner's representative or Commissioning Agent and shall include the following:
  - 1. System Inspection: Observe the HVAC system in its shutdown condition. Provide end-to-end wiring checkout. Check dampers and valves for proper normal positions. Document each position for the test report.
  - 2. Calibration Accuracy and Operation of Inputs Test: Check for proper calibration and operation of each input instrument. For each sensor (temperature), record the reading at the sensor, and using traceable test equipment, and record the reading at the digital controller. Document each reading for the test report.
  - 3. Operation of Outputs Test: Check the operation of each output to verify correct operation. Command analog outputs to minimum range, such as 4 mA, and maximum range, such as 20 mA, measure and record commanded and actual output values. Document each command and result for the test report.
  - 4. Actuator Range Adjustment Test: With the digital controller, apply a control signal to each actuator and verify that the actuator operates properly from its normal position to full range of stroke position. Record actual spring ranges and normal positions for all modulating control valves and dampers. Include documentation in the test report.
  - 5. Digital Controller Start-up and Memory Test: Demonstrate that programming is not lost after a power failure, and digital controllers automatically resume proper control after a power failure.
  - 6. Surge Protection: Show that surge protection, meeting the requirements of this specification, has been installed on incoming power to the digital controllers and on communication lines.
  - 7. Application Software Operation Test: Test compliance of the application for:
    - a. Ability to communicate with the digital controllers, uploading and downloading of programs
    - b. Text editing program: Demonstrate the ability to edit the control program off line
    - c. Reporting of alarm conditions: Cause alarm conditions for each alarm, and ensure that workstation receives alarms
    - d. Reporting trend and status reports: Demonstrate ability of software to receive and save trend and status reports
    - e. Execution of Sequence of Operation: Furnish graphic trends to show the sequence of operation is executed in correct order. Demonstrate the HVAC system operates properly through the complete sequence of operation, for example seasonal, optimal start/warm-up, and occupied/unoccupied modes of operation. Demonstrate proper control sys-

tem response for abnormal conditions for which there is a specified response by simulating these conditions. Demonstrate hardware interlocks and safeties work. Demonstrate the control system performs the correct sequence of control after a loss of power

- f. Control Loop Stability and Accuracy: Furnish graphic trends of control loops to demonstrate the control loop is stable and that set point is maintained. Control loop response shall respond to set point changes and stabilize within 1 minute
- g. Opposite Season Test: Testing shall be repeated for opposite season.
- B. Document all tests with detailed results. Provide statement that all corrective action taken. Include test report in Operation and Maintenance Manuals.

### 3.10 TRAINING

- A. Upon substantial completion of the mechanical system work, furnish the services of a competent technician regularly employed by the DDC manufacturer for the instruction of facility personnel in the operation and maintenance of each DDC system at project site. Provide a minimum of 40 hours for training. Coordinate with Owner for number of personnel, date, time, and location. Multiple training times may be necessary to accommodate different working shifts.
- B. Furnish a written test plan and training schedule for approval 15 days prior to instructing operating personnel including the following:
  - 1. Recommended training schedule for operators workstation, standalone DDC controllers, Application specific digital controllers and field components.
  - 2. List of all training materials, aids, etc.
  - 3. List of customer training schools offered by the DDC manufacturer.
- C. Provide all training and materials necessary for each facility personnel, including:
  - 1. Operations and Maintenance Manual
  - 2. As-Built control diagrams
  - 3. Detailed description of the system
  - 4. Complete listing, graphical logic diagrams of all software programs required to perform the sequence of operation
  - 5. Commands, operating and trouble shooting instruction and routine maintenance procedures.
  - 6. Theory of operations
  - 7. Hardware architecture
  - 8. Operation of system
  - 9. Operator Commands
  - 10. Control sequence programming
  - 11. Data base entry
  - 12. Reports and logs
  - 13. Alarm reports
  - 14. Diagnostics.
  - 15. Physical layout of each piece of hardware
  - 16. Troubleshooting and diagnostics procedures
  - 17. Repair instructions
  - 18. Preventive maintenance procedures and schedules
  - 19. Calibration procedures.
- D. Provide 8 hours of additional training 3 and 6 months after project completion. Training to address specific topics that the facility personnel need to discuss and to answer questions concerning operation of the system.

### PART 4 - SEQUENCE OF OPERATION AND DDC POINT LIST

- A. Sequence of operations and point list are indicated on drawings.
- B. Controls shall be by the DDC system unless indicated to be by local controls.
- C. DDC system shall schedule each system or zone independently per owner's operating schedule. Operating schedules shall be confirmed with Owner and adjusted as necessary
- D. Additional points shall be provided to execute the sequence of operations.

END OF SECTION

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  1. Section 07 84 13 for materials and methods for sealing pipe penetrations through fire and smoke barriers.
  2. Section 07 84 13 for materials and methods for sealing pipe penetrations through exterior walls.
  3. Section 23 05 00 "Common Mechanical Materials and Methods" for general piping materials and installation methods; flexible connectors and flexible expansion joints.
  4. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe supports.
  5. Section 23 05 53 "Identification for Mechanical Piping and Equipment" for labeling and identifying hydronic systems.
  6. Section 23 05 23 "General-Duty Valves for Mechanical Piping" for gate, globe, ball, butterfly, and check valves.
  7. Section 23 05 19 "Meters and Gages for Mechanical Piping" for thermometers, flow meters, thermal energy meters, and pressure gages.
  8. Section 23 21 23 "Hydronic Pumps" for pumps and suction diffusers.
  9. Section 23 25 00 "HVAC Water Treatment" for chemical treatment of chilled water, heating water, and condenser water.
  10. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for vibration isolated pipe supports and pipe seismic restraint.
  11. Section 22 13 16 "Drainage and Vent Piping" for condensate drain lines.
  12. Section 23 09 00 "Instrumentation and Control for HVAC" for temperature-control valves, actuators to control valves specified in this section, and sensors.
  13. Section 23 05 94 "Testing, Adjusting, and Balancing Support for Owner" for hydronic system adjusting and balancing.

## 1.2 SUMMARY

- A. This Section includes complete installation of the following piping systems:
  1. Heating Water
  2. Chilled Water
  3. Condenser Water
  4. Heat Recovery Water
  5. Process Cooling Water
  6. Refrigerant Relief Vent

## 1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  1. Grooved Mechanical Joint Piping System
  2. Circuit Balancing Valves
  3. Pressure-Reducing Valves
  4. Safety Relief Valves
  5. Automatic Flow-Control Valves
  6. Automatic Flow-Control Coil Piping Package
  7. Pressure Independent Flow Control Valves
  8. Expansion Tanks
  9. Air Separators
  10. Chemical Feeders
  11. Bypass Filter/Chemical Feeder
  12. Y-Pattern Strainers
  13. Basket Strainers

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14. Braided Hose Flexible Connectors (specified in 15050)
  15. Rubber Flexible Connectors (specified in 15050)
  16. Flexible Expansion Joints (specified in 15050)
  17. Glycol Solution Feed Packaged System
  18. Glycol
  19. Water Treatment Chemicals
- C. Shop Drawings: In addition to requirements set forth in Section 230500, shop drawings for the listed systems shall also include detailing of pipe anchors, special pipe support assemblies, alignment guides, and expansion joints and loops. Provide submittals of the following piping systems within the entire building:
1. Heating Water
  2. Chilled Water
  3. Condenser Water
  4. Heat Recovery Water
  5. Process Cooling Water
  6. Refrigerant Relief Vent
- D. Reports and Certificates: Provide submittals of the following:
1. Hydrostatic Pressure Test Report
  2. Pipe Flushing and Cleaning Report
  3. Chemical Treatment Analysis

### 1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with the following provisions:
1. ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
  2. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 01.
  3. Welding Standards: Qualify welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

### 1.5 COORDINATION

- A. Coordinate layout and installation of piping with equipment and with other installations.
- B. Coordinate pipe sleeve installation for foundation wall penetrations.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete housekeeping pads. Cast anchor-bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.
- F. Coordinate installation of pipe sleeves for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Section 07 84 13 for firestopping.

### 1.6 EXTRA MATERIALS

- A. Maintenance Stock: Furnish a sufficient quantity of chemicals and glycol for initial system startup and for preventive maintenance for one year from Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Grooved Mechanical-Joint Pipe Fitting System:
    - a. Victaulic Company of America.
  2. Circuit Balancing Valves:
    - a. Tour & Andersson.
    - b. Armstrong Pumps, Inc.
    - c. Nibco.

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3. Pressure-Reducing Valves:
  - a. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Conbraco Industries, Inc.
  - d. ITT Bell & Gossett; ITT Fluid Technology Co.
  - e. Watts Regulators.
  - f. Spence Engineering Co.
4. Safety Relief Valves:
  - a. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Conbraco Industries, Inc.
  - d. ITT Fluid Technology Corp.; ITT McDonnell & Miller.
  - e. Kunkel Valves.
  - f. Spence Engineering Co.
5. Automatic Flow-Control Valves:
  - a. Griswold Controls.
6. Pressure Independent Flow Control Valves:
  - a. Flow Control Industries, Inc.
7. Automatic Air Vents:
  - a. Armstrong Machine Works.
  - b. ITT Fluid Technology Corp.; ITT Bell and Gossett Flow Design, Inc.
  - c. Hoffman Specialty ITT; Fluid Handling Div.
  - d. Spirax Sarco.
8. Expansion Tanks:
  - a. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Taco, Inc.
  - d. John Wood.
  - e. ITT Fluid Technology Corp.; ITT Bell and Gossett.
  - f. Wessels.
9. Air Separators:
  - a. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. ITT Fluid Technology Corp.; ITT Bell & Gossett.
  - d. Taco, Inc.
10. Y-Pattern Strainers:
  - a. Hoffman Specialty ITT; Fluid Handling Div.
  - b. Spirax Sarco.
  - c. Victaulic Co. of America.
  - d. Watts Regulator Co.
11. Basket Strainers:
  - a. Crane Co.
  - b. Metraflex Co.
  - c. Spirax Sarco.
  - d. Victaulic Company of America.
12. Glycol Solution Feed Packaged System:
  - a. Ace Tank & Equipment.
  - b. Armstrong.
  - c. Morr Control.
  - d. IAT Construction Service, Inc.
  - e. Wessels.
13. Glycol:
  - a. Dow Chemical Company.

### 2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

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### 2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- E. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

### 2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless), Grade B, Schedule 40, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 through NPS 10: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.
- C. Steel Pipe, NPS 12 through NPS 18: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, standard weight, 0.375-inch wall thickness, black steel, plain ends.
- D. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.
- E. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- F. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- G. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- H. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- I. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 and 250, Material Group 1.1, welding neck, raised face type; include nuts and bolts.
- J. Grooved Mechanical Joint Piping System:
  - 1. General: Grooved mechanical joint pipe couplings, fittings, and other specified grooved components may be used as an option to welding, threading, or flanged methods. All grooved components shall be of one manufacturer, and conform to local code approval and/or as listed by ANSI-B-31.1, B-31.9 and ASME.
  - 2. Class: Provide ANSI pipe class 150.
  - 3. Type: Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with manufacturer's current listed standards conforming to ANSI/AWWA C-606.
  - 4. Gaskets: Grade "E" EPDM compound conforming to ASTM D-2000. Temperature operating range -30 degrees F to 230 degrees F. Gaskets suitable for operation under negative pressure or suction side of pumps in open systems.
  - 5. Mechanical Couplings: Mechanical couplings shall be cast of ductile iron conforming to ASTM A-536, with bolts/nuts conforming to ASTM A-183.
    - a. Rigid Coupling: Victaulic Style 07, with angle bolt pad design.
    - b. Flexible Coupling: Victaulic Style 77,
  - 6. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
  - 7. Flange Adapters: For connection to ANSI class flanged components. Cast of ductile iron conforming to ASTM A-536.
- K. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- L. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

### 2.5 VALVES

- A. Gate, globe, check, ball, and butterfly valves are specified in Section 23 05 23 "General-Duty Valves for Mechanical Piping."
- B. Refer to Part 3 "Valve Applications" for specific uses and applications for each valve specified.
- C. Circuit Balancing Valves: 250-psig working pressure, 230 deg F maximum operating temperature. Valves 2-inch and below shall be bronze body; 2-1/2-inch and above shall

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be ductile iron body. Provide with portable instrument connections for portable differential pressure meter with integral check valves and seals. Valves shall be multi-turn 360° adjustment with micrometer type indications located on the handwheel. Valves shall have hidden memory feature to lock valve position after system balancing. Valves 2-inch NPS and smaller shall have threaded connections and 2-1/2-inch NPS valves shall have flanged connections. Valves shall be sized for 1-psi pressure drop at design flow rate unless noted otherwise.

- D. Pressure-Reducing Valves: Diaphragm-operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shutdown, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.
- E. Safety Relief Valves: Brass or bronze body with brass and rubber, wetted, internal working parts; to suit system pressure and heat capacity; according to ASME Boiler and Pressure Vessel Code, Section IV.
- F. Automatic Flow-Control Valves, 1-1/2-inch NPS and Smaller: Griswold Flowcon Y or K accessible cartridge device with integral ball valve, 20-mesh stainless steel strainer and portable instrument connections. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating-pressure differential. Certified flow test performed by independent laboratory shall be available upon request.
  - 1. Minimum Temperature/Pressure Rating: 250-Degrees F and 300-psig.
  - 2. Construction Materials: Forged brass body, stainless steel flow limiting cartridge, EPDM seals, reinforced Teflon ball seals and glass-filled polymer flow control element.
  - 3. Connection Type: Threaded.
  - 4. Accessories: drain valve with hose end connection, metal identification tag with chain for each valve, factory marked with the zone identification, valve model number and flow rate.
- G. Automatic Flow-Control Valves, 2-inch to 20-inch NPS: automatic flow control device with integral portable instrument connections. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating-pressure differential. Certified flow test performed by independent laboratory shall be available upon request.
  - 1. Minimum Temperature/Pressure Rating: 200-Degrees F and 300-psig.
  - 2. Construction Materials: Steel body and stainless steel flow limiting cartridge.
  - 3. Connection Type: Grooved-end or Flanged.
  - 4. Accessories: Metal identification tag with chain for each valve, factory marked with the zone identification, valve model number and flow rate.
- H. Pressure Independent Flow Control Valves:
  - 1. The valves shall be pressure independent. The flow through the valve shall not vary more than +/-5% due to system pressure fluctuations across the valve in the selected operating range. The control valves shall accurately control the flow from 0 to 100% full rated flow.
  - 2. The rangeability of the control valves shall be 100:1 minimum. The close off pressure of all control valves shall be the full body rating of the valve.
  - 3. The valve bodies shall be of cast iron, steel or bronze and rated for 150-PSI working pressure. All internal parts shall be stainless steel, steel, teflon, brass, or bronze. Valve flow characteristics shall be able to be changed without removing the valve from the piping system.
  - 4. The actuator for the valves shall modulate the control valve from 0 to 100% design flow while rotating a maximum of 90 degrees. The actuator shall be furnished under Section 23 09 00 "Instrumentation and Control for HVAC." Factory mounting of actuators is required.
  - 5. The control valve stem shall extend up from the control valve. The control valve shall have mounting holes tapped into it for mounting the control actuator bracket. This valve stem is rotated by the actuator, range of 90 degrees, to provide the required flow. Torque requirements for job conditions shall be coordinated with the actuator supplier.

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6. Three portable instrument connection ports shall be installed at the factory in each valve. Two ports shall be used to measure inlet and outlet pressure to the valve. The third port is used to measure internal pressure within the valve.

### 2.6 HYDRONIC SPECIALTIES

- A. Manual Air Vents: Bronze body and nonferrous internal parts; 150-psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with 1/8-inch NPS discharge connection and 1/2-inch NPS inlet connection.
- B. Automatic Air Vents: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure, 240 deg F operating temperature; with 1/4-inch NPS discharge connection and 1/2-inch NPS inlet connection.
- C. Expansion Tanks: Welded carbon steel for 125-psig working pressure, 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by a flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air-charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Fabricate and test tank with taps and supports, and label according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 01. Pre-charge to pressure indicated.
- D. Air Separator: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for 2-inch NPS and smaller; flanged connections for 2-1/2-inch NPS and larger; threaded blow-down, air vent and system make-up water connections. Provide units in sizes for full-line size capacity.
- E. Bypass Filter/Chemical Feeder: Bypass-type combination filter and chemical feeder; 5-gallon capacity, welded steel construction with steel support legs. Cartridge type pleated 20-micron filter; 1/4 turn positive seal closure and quick release cap; minimum 125-psig working pressure. Provide inlet, outlet, and drain valve assemblies.
- F. Y-Pattern Strainers: 125-psig working pressure, 350°F maximum operating temperature; cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2-inch NPS and larger, threaded connections for 2-inch NPS and smaller, bolted cover, perforated Type 304 stainless-steel screen, and blowdown drain connection.
  1. 2-Inch and Smaller: Screen size openings 0.032-inches maximum.
  2. 2-1/2-Inch to 4-Inch: Screen size openings 0.062-inches maximum.
  3. 6-Inches and Larger: Screen size openings 0.125-inches maximum.
- G. Basket Strainers: 125-psig working pressure 350°F maximum operating temperature; high-tensile cast-iron body (ASTM A 126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless-steel basket, and bottom drain connection.
  1. 2-Inches to 3-Inches: Screen size openings 0.045-inches maximum.
  2. 4-Inches and Larger: Screen size openings 0.125-inches maximum.
- H. Portable Instrument Connections: For insertable type pressure or temperature gauges, 500 psig working pressure; 275 degrees F maximum temperature; brass body and cap, 1/2-inch NPT connection size; Nordel valve core. Length suitable to provide suitable access outside of pipe insulation. Provide cap restraining strap.
- I. Glycol Solution Feed Packaged System:
  1. Tank: 50 gallon polyethylene tank with a 1/3 hinge polyethylene cover. Tank fully supported and restrained by painted steel bottom mount stand.
  2. Control Panel: NEMA 4X control panel with 115V power cord. The panel includes two-position main power switch and light, three-position (hand-off-auto) switch and light for feed pump, red low level light, audible alarm, contacts for DDC low level alarm and fuse.
  3. Low Level Switch: Stainless steel bottom entering low level switch with 10 amp relay.
  4. Feed Pump: 1/3 HP gear pump; steady and even flow against pressure, with internal pressure relief bypass valve. Pump suction piping includes brass ball valve, brass Y-strainer, and flexible tubing. Pump discharge tubing includes brass check valve, piping and 1/4-inch NPT back tap pressure gauge.
  5. Pressure Switch: 1/4-inch NPT pressure switch. Cut-in 10-45 psi, cut-out 20-50 psi with 10-30 psi differential.

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- J. Glycol: Corrosion inhibited propylene fluid suitable for use with all common metals used in HVAC systems. Operating range -50°F to 325°F. Dow Chemical Company DOWFROST HD or approved equal.
- K. Water Treatment Chemicals: Specially formulated to prevent accumulation of scale and corrosion in closed-loop piping system and connected equipment; based on a water analysis of makeup water. Ferrous metal corrosion inhibitor with sodium nitrite and sodium hydroxide; non-ferrous metal corrosion inhibitor with tolytriazole; and biocides to prohibit biological growth within the closed system.

### PART 3 - EXECUTION

#### 3.1 PIPE APPLICATIONS

- A. Heating Water, Chilled Water, Heat Recovery Water and Process Cooling Water, 2-Inch NPS and Smaller: Type L drawn-temper copper tubing with soldered joints and wrought-copper fittings.
- B. Heating Water, Chilled Water, Heat Recovery and Process Cooling Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded joints and Schedule 40 wrought-steel butt-welding fittings; flanged joints where indicated, at equipment connections and where pipe removal for equipment access is required, with Class 150 wrought-steel flanges. Grooved Mechanical-Joint Piping System may be used at the Contractor's option, but shall not allowed in shafts or other none accessible areas.
- C. Condenser Water, 2-Inch NPS and Smaller: Type L drawn-temper copper tubing with soldered joints and wrought-copper fittings. Condenser Water 2-1/2-Inch NPS and Larger: Schedule 40 steel pipe with welded joints and Schedule 40 wrought-steel butt-welding fittings; flanged joints where indicated, at equipment connections and where pipe removal for equipment access is required, with Class 150 wrought-steel flanges. Grooved Mechanical-Joint Piping System may be used at the Contractor's option, but shall not allowed in shafts or other none accessible areas.
- D. Refrigerant Vent: Type L drawn-temper copper tubing with brazed joints and wrought-copper fittings.

#### 3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
  - 1. Shutoff Duty: Use ball or butterfly valves.
  - 2. Throttling Duty: Use globe, ball, and butterfly valves.
- B. Install shutoff-duty valves at each branch connection to supply mains, at supply connections to each piece of equipment, and elsewhere as indicated.
- C. Install throttling-duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- D. Install Circuit Balancing Valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing. Valve size shall be based on manufacturers recommended size for flow control, not on pipe size. Provide pipe transitions upstream and downstream of valve if pipe size is larger than valve connections. Install per manufacturer's recommended methods.
- E. Install hose end drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- F. Install check valves on each pump discharge and elsewhere as required to control flow direction.
- G. Install Safety Relief Valves on hot water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor drain without valves. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 01, for installation requirements.
- H. Install Pressure-Reducing Valves on hot water generators and elsewhere as required to regulate system pressure.
- I. Install Automatic Flow-Control Valves per the manufacturer's recommendations.
- J. Install Pressure Independent Flow Control Valves per the manufacturer's recommendations. Valve actuators shall be provided under Section 23 09 00 "Instrumentation and Control for HVAC," sized for actual system requirements.

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K. Install control valves per manufacturer's recommendations.

3.3 PIPING INSTALLATIONS

- A. Install piping according to Section 23 05 00 "Common Mechanical Materials and Methods."
- B. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage and cleaning/flushing activity.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using concentric reducers for up to and including 2 1/2-inch NPS and eccentric reducer fitting installed with level side up for 3-inch NPS and larger.
- F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- G. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated. Unions are not required at flanged connections.
- H. Install flanges on valves, apparatus, and equipment having 2-1/2-inch NPS and larger connections.
- I. Install Flexible Expansion Loops where indicated.
- J. Install Rubber Flexible Connectors at inlet and discharge connections to pumps (except fractional horsepower circulating pumps) and other vibration-producing equipment.
- K. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blow-down connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- L. Anchor piping to building structure where indicated. Anchors shall be designed by a structural engineer.
- M. Install dielectric fittings between dissimilar pipe and/or tubing materials.

3.4 HANGERS AND SUPPORTS

- A. General: Pipe hangers and supports are specified in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment." Pipe seismic bracing requirements are specified in Section 23 05 48 "Vibration and Seismic Control for Mechanical Piping and Equipment." Conform to requirements below for maximum spacing of supports.
- B. In addition to the requirements of Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" provide the following:
  - 1. Heating Water pipe 2-inch NPS and smaller with suspended individual horizontal runs 60 feet or longer: use Adjustable Roller Hangers (MSS Type 43); and spring hangers on rod supports within 20 feet of a vertical change in direction.
  - 2. Heating Water pipe 2 1/2-inch NPS and larger with suspended individual horizontal runs 20 feet or longer: use Adjustable Roller Hangers (MSS Type 43); with spring hangers on the support rod within 30 feet of a vertical change in direction of the pipe run.
  - 3. Pipe within 25 feet of pumps: use spring isolated support.
  - 4. Valves and Pipe-Mounted Equipment: Provide pipe supports within 12-inches of all pipe connections to valves or pipe-mounted equipment. Supports shall be on both sides of the valve or equipment, allowing removal of valve or equipment without additional temporary pipe support.
- C. Install hangers for steel piping and copper tubing with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size (Inches)	Steel Pipe Max. Span (Feet)	Copper Tube Max. Span (Feet)	Min. Rod Diameter (Inches)
Up to 3/4	6	5	3/8
1	7	6	3/8

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1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	3/8
2-1/2	11	9	1/2
3	12	10	1/2
4	14	12	5/8
6	17	N/A	3/4
8	19	N/A	7/8
10	20	N/A	7/8
12	23	N/A	7/8

D. Support vertical runs at each floor or at maximum spacing of 15'-0", whichever is less.

3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Section 23 05 00 "Common Mechanical Materials and Methods" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping.
- B. Mechanical Joints: Assemble joints according to fitting manufacturer's written instructions.
- C. Grooved Mechanical-Joint Piping System: Use as allowed by Pipe Application section. Install per manufacturer's written instructions.
  - 1. Use Flexible Couplings at three joint couplings nearest the suction and discharge side of each hydronic system pump, throughout Heating Water systems and where indicated.
  - 2. Use Rigid Couplings at all other locations.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in system, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents where high point vent is located over 14'-0" above the floor and where indicated. Pipe discharge to drain. Install with shut-off valve at inlet.
- C. Install air separator where indicated. Install blow-down piping with ball valve; extend to nearest drain.
- D. Install Chemical Feeders or Bypass Filter/Chemical Feeders in each hydronic system where indicated; in upright position with top of funnel not more than 48 inches above floor. Install ball valves on each side of feeder. Pipe drain, with ball valve, to nearest floor drain.
- E. Install Expansion Tanks as indicated. Line from pipe system to tank shall be connected to system pipe at 90-degrees from vertical. Vent and purge air from hydronic system, and charge tank with proper air charge. Tank shall be charged to indicated pressure prior to initial system fill.
- F. Install Portable Instrument Connections on inlet and outlet of all hydronic system pumps, filters, strainers, coils, heat exchangers, chillers, hot water boilers and where indicated. Mount in 1/2-inch NPT pipe collar welded to pipe.
- G. Install Y-Pattern strainers and basket strainers with ball valve on blow down connection. Above ceilings, terminate with hose end drain connection.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Piping size for supply and return shall be same size as equipment connections, unless indicated differently.
- B. Install control valves in accessible locations close to equipment.
- C. Install Circuit Balancing Valves in accessible locations close to equipment.
- D. Install Portable Instrument Connections at supply and return connections to each coil.

3.8 FIELD QUALITY CONTROL

- A. Testing Preparation: Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.

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2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  3. Isolate equipment that is not subjected to test pressure from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Flanged joints where blinds are inserted to isolate equipment need not be tested.
  4. Install safety relief valve set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of over-pressure during test.
- B. Testing: Test hydronic piping as follows:
1. Use ambient temperature water as testing medium, except where there is risk of damage due to freezing. Another liquid may be used if it is safe for workers and compatible with piping system components.
  2. Use vents installed at the high points of system to release trapped air while filling system. Use drains installed at low points for complete removal of liquid.
  3. Examine system to see that equipment and parts 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 hydrostatic test pressure that is not less than 1.5 times the maximum operating pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Check to verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, "Building Services Piping."
  5. After hydrostatic test pressure has been applied for at least 4 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. Prepare written report of testing and submit.
  7. Testing shall be witnessed by the Owner or Owner's designated representative. Minimum seven days notice is required.

### 3.9 CHEMICAL TREATMENT

- A. Perform an analysis to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling. Perform analysis of local water supply if necessary. Submit results.
- B. Fill system and perform initial chemical treatment.

### 3.10 START-UP PROCEDURES

- A. Perform these steps before operating the system:
  1. Open valves to fully open position. Close coil bypass valves (3-way valves only).
  2. Check pump for proper direction of rotation.
  3. Verify expansion tank air charge is properly set.
  4. Set automatic fill valves for required system pressure.
  5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) and bleed air completely from manual type.
  6. Set temperature controls so all coils are calling for full flow.
  7. Check expansion tanks to determine that they are not air bound and that system is completely full of water.

### 3.11 CLEANING

- A. Preparation:
  1. System shall be operational prior to cleaning.
  2. Provide all isolation and drain valves to allow complete system flushing.
  3. Provide temporary piping connections, temporary pumps, and temporary water meter as required to properly accomplish cleaning entire system. If a temporary

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pump is required, it shall be sized to provide a minimum of 1.5 fps fluid velocity at all points in the system. Provide strainer with temporary pump.

### B. Products:

1. Cleaning Solutions in the Following Concentrations: Garratt-Callahan Formula 248-L Cleaner and formula 60 Defoamer. Formula 248-L is a concentrated alkaline formula of phosphates, silicates, iron oxide sequestrants, dispersant polymers and a wetting agent. Formula 60 is a silicone defoamer.
  - a. Chilled Water System: Add 12 gallons of Formula 248-L per 1000 gallons of system water to be cleaned. Add 8 oz of defoamer per 1000 gallons of system water to be cleaned.
  - b. Condenser Water, Glycol Heating, Heat Recovery, and Heating Water Systems: : Add 12 gallons of Formula 248-L per 1000 gallons of system water to be cleaned. Add 8 oz of defoamer per 1000 gallons of system water to be cleaned.
  - c. Circulate systems with formula 248-L for at least 24 hours with temporary pump, then begin a running flush for 24 hrs. with clean water as rapidly as possible. Use all drains in flushing and be sure that the bleed rate out of the system does not exceed the make up rate into the system.
    - 1) After 24 hrs drain the system. Refill and circulate for 1 hr. then drain the system again. Refill the system and perform tests to show pH below 8.0 , TDS below 100 and no visible particulate matter is present. The use of neutralizing agents is prohibited.
    - 2) As soon as possible after flushing, and in no case later than 2 hours, and with clean water in the system, add Garratt-Callahan formula 12-L at 4 gallons per 1000 gallons of water and formula 315 biocide at 32 oz. per 1000 gallons water.

### C. Cleaning Sequence:

1. Initial Flush:
  - a. Completely fill the system with fresh water and circulate (1<sup>st</sup> filling) for 4-hours minimum.
  - b. Initial flushing shall be sufficient to remove all contaminants such as cuttings, filings, loose rust and scale, welding and soldering, residue and debris.
  - c. Drain the entire system and refill with fresh water (2<sup>nd</sup> filling).
2. Condenser Water System with Open Cooling Tower:
  - a. Add Garratt-Callahan Formula, or approved equal per manufacturers recommendation to passivate metal surfaces.
  - b. Circulate for duration recommended by chemical treatment manufacturer.
  - c. Drain and flush system.
  - d. Refill with fresh water and immediately start chemical treatment program
3. Cleaning:
  - a. Use concentrated chemical cleaner in piping system(s). Cleaner shall be a phosphate wetting agent combined with an alkaline surfactant with a sodium carbonate type alkalinity supplement introduced as necessary to produce 600 PPM of phenolphthalein alkalinity. Chemicals shall be non-toxic.
  - b. Circulate solution for the recommended time period that corresponds to the fluid temperature.
  - c. Test solution for proper concentration.
  - d. Partially close and reopen all manual valves several times.
  - e. Completely drain the entire system
  - f. Refill the system with fresh water (3<sup>rd</sup> filling). Then, with the circulation pump running:
    - 1) Open one or more drains as far downstream from the fill point as is possible. Be sure the makeup is sufficient to keep up with the drain so as to maintain full system.
    - 2) Partially close and reopen all manual valves several times.

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- 3) Blowdown all strainers, dead legs and low points in the system.
- 4) Continue to flush the system in this manner until the drain water is of the same clarity as the makeup water and testing reveals no further traces of cleaning solution (minimum 1 hour).
- g. Following the fresh water flush, drain the entire system.
  - 1) Clean all strainers.
  - 2) Remove all startup strainers.
- h. Fill system (water systems):
  - 1) Fill system with clean water.
  - 2) Immediately start chemical treatment program
- i. Fill system (Glycol systems):
  - 1) Fill system with required quantity of glycol (% by volume).
  - 2) Complete filling of system with clean water.
  - 3) Glycol solution must be added within 2 hours after final draining of the system.
  - 4) Upon completion of filling system with glycol solution, tag each system: "CAUTION THIS SYSTEM HAS BEEN 'CHARGED' WITH GLYCOL. DO NOT DILUTE SYSTEM WITH WATER OR DRAIN SYSTEM WITHOUT AUTHORIZATION."
4. Upon completion of cleaning and chemical treatment addition, tag each system so that tag is plainly visible as follows: **"THIS SYSTEM HAS BEEN CHEMICALLY CLEANED AND TREATED."**
5. Field Reports: Submit field report indicating analysis of system's water after cleaning and after chemical treatment.

### 3.12 ADJUSTING

- A. Balance system. See Section 23 05 94 "Testing, Adjusting, and Balancing Support for Owner."

### 3.13 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Preview data proposed to be included in the operation and maintenance manuals with the Owner.
- C. Schedule 4 hours training with Owner, through Architect, with at least 14 days' advance notice.
- D. Demonstrate operation of systems. Conduct walking tour of the project. Briefly identify location and describe function, operation, and maintenance of each system.

END OF SECTION

## SECTION 23 21 23 HYDRONIC PUMPS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 13 "Common Motor Requirements for Mechanical Equipment" for pump motor requirements.
  - 2. Section 23 05 63 "Variable Frequency Drives" for VFDs.
  - 3. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for inertia pads, isolation pads, spring supports, spring hangers, and seismic restraints.

#### 1.2 SUMMARY

- A. This Section includes the following categories of hydronic pumps and accessories for hydronic systems:
  - 1. Vertical close-coupled in-line pumps.
  - 2. Vertical split coupled in-line pumps.

#### 1.3 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include Setting Drawings with templates for installing foundation and anchor bolts and other anchorages.
- C. Maintenance Data: For pumps to include in maintenance manuals specified in Division 01.

#### 1.4 QUALITY ASSURANCE

- A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

#### 1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section "Cast-in-Place Concrete."

#### 1.7 WARRANTY

- A. The pumps shall be warranted by the manufacturer for a period of 18 months from date of shipment. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized on-site service.

#### 1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Mechanical Seals: One mechanical seal for each pump.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Vertical Close-Coupled In-Line Pumps:
    - a. Armstrong Pumps, Inc.
    - b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
    - c. PACO Pumps.
    - d. Patterson Pump Co.
    - e. Peerless Pump Co.
    - f. Taco; Fabricated Products Div.
  2. Vertical Split Coupled, In-Line Pumps:
    - a. Armstrong Pumps, Inc.
    - b. Taco; Fabricated Products Div.

## 2.2 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors: Include built-in, thermal-overload protection, and grease-lubricated ball bearings. Select each motor to be nonoverloading over full range of pump performance curve.
- C. Motors Indicated to Be Energy Efficient: Minimum efficiency as indicated according to IEEE 112, Test Method B. Include motors with higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B, if efficiency is not indicated.

## 2.3 VERTICAL CLOSE-COUPLED IN-LINE PUMPS

- A. Description: Vertical, in-line, centrifugal, close-coupled, single-stage, radially split case design. Include vertical-mounting, bronze-fitted design and mechanical seals rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
1. Casing: Cast iron, radially split with equal suction and discharge flange sizes, drain plug at low point of volute, and threaded gage tappings at inlet and outlet connections.
  2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
  3. Shaft: Ground and polished stainless-steel shaft with axially split spacer coupling.
  4. Seals: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.
  5. Motor: Directly mounted to pump casing and with lifting and supporting lugs in top of motor enclosure.

## 2.4 VERTICAL SPLIT COUPLED IN-LINE PUMPS

- A. Description: Centrifugal, split-coupled, single-stage, bronze-fitted, radially split volute; made for vertical mounting; and rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F, with mechanical seals. Pump construction allows removal and replacement of seals without removal of pump motor.
1. Casing: Cast iron; with ASME B16.1, Class 125 flanged pipe connections. Include threaded gage tappings at inlet and outlet connections and threaded drain plug at low point of volute.
  2. Casing: Cast iron; with ASME B16.1, Class 250 flanged pipe connections. Include threaded gage tappings at inlet and outlet connections and threaded drain plug at low point of volute.
  3. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced.
  4. Shaft: Stainless-steel shaft deflection at seal limited to 0.001-inches.
  5. Seals: Mechanical, outside balanced type with carbon rotating face, ceramic stationary seat and Viton secondary seal.
  6. Coupling: Axially split, spacer type rigid coupling which permits seal maintenance without disturbing pump or motor.

## SECTION 23 21 23 HYDRONIC PUMPS

7. Mounting Frame: Heavy cylindrical bracket with 360° register on each flange to provide a rigid union of pump and motor. Fabricate for mounting pump casing, coupling guard, and motor.
8. Motor: Open Dripproof; secured to mounting frame, with adjustable alignment.

### 2.5 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle or straight pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory- or field-fabricated support.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.
  1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PUMP INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.
- D. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers. Install seismic bracing as required in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
- E. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
  1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
  2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

### 3.3 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting them on foundations, after grout has been set and foundation bolts have been tightened, and after piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps. Provide reducers where required to adapt to line sizes indicated.
- D. Install check valve and throttling valve on discharge side of in-line circulators.
- E. Install nonslam check valve and shut-off valve on discharge side of pumps.
- F. Install suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge. Install at integral pressure-gage tappings where provided.

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I. Electrical power and control wiring and connections are specified in Division 26 Sections.

### 3.5 START-UP PROCEDURES

- A. Verify that pumps are installed and connected according to the Contract Documents.
- B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- C. Perform the following preventive maintenance operations and checks before starting:
  - 1. Lubricate bearings.
  - 2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
  - 3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
  - 4. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
  - 5. Check suction piping connections for tightness to avoid drawing air into pumps.
  - 6. Clean strainers.
  - 7. Verify that pump controls are correct for required application.
- D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
  - 1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
  - 2. Open cooling water-supply valves in cooling water supply to bearings, where applicable.
  - 3. Open circulating line valves if pumps should not be operated against dead shutoff.
  - 4. Start motors.
  - 5. Open discharge valves slowly.
  - 6. Check general mechanical operation of pumps and motors.
  - 7. Verify proper rotation of pump.
  - 8. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.
- E. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.
- F. Refer to Section 23 05 94 "Testing, Adjusting, and Balancing for Support for Owner" for detailed requirements for testing, adjusting, and balancing hydronic systems.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:
  - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
  - 2. Review data in maintenance manuals. Refer to Section 01 77 00 "Closeout Procedures."
  - 3. Review data in maintenance manuals. Refer to Section 01 78 23 "Operation and Maintenance Data."
  - 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

## SECTION 23 22 13 STEAM AND CONDENSATE HEATING PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods" for general piping materials and installation methods.
  - 2. Section 23 05 23 "General-Duty Valves for Mechanical Piping" for general-duty gate, globe, ball, and check valves applicable to this Section.
  - 3. Section 23 05 13 "Meters and Gages for Mechanical Piping" for steam and condensate flow meters, thermometers, and pressure gages.
  - 4. Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment" for pipe supports and seismic restraints.
  - 5. Section 23 05 53 "Identification for Mechanical Piping and Equipment" for labeling and identifying piping systems.
  - 6. Section 23 22 23 "Steam Condensate Pumps."
  - 7. Section 23 09 00 "Instrumentation and Control for HVAC" for temperature-control valves and sensors.
  - 8. Section 23 07 13 "Pipe Insulation for Mechanical Systems" for insulation of pipe.
  - 9. Section 23 07 16 "Equipment Insulation for Mechanical Equipment" for insulation of equipment.

#### 1.2 SUMMARY

- A. This Section includes steam, condensate, safety valve discharge, and specialties for steam systems up to 125 psig, inside the building.

#### 1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data including rated capacities where applicable, furnished options and accessories, and installation instructions for safety relief valves, pressure-reducing valves, and steam traps.
- C. Shop Drawings: Provide the following:
  - 1. Plan layout drawings of all piping systems covered under this section. Drawings shall be 1/4-inch = 1'-0" scale and indicate location of all equipment, pipe, fittings, valves, supports and accessories. Drawings shall include dimensions, weights, loading at each support point, required clearances for equipment service and location and size of each field connection.
  - 2. Details of pipe supports, anchors, expansion joints, flash tank assemblies and equipment connections.
- D. Maintenance data for steam and condensate specialties and special-duty valves to include in the operation and maintenance manual specified in Division 01.
- E. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

#### 1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with the following provisions:
  - 1. ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
  - 2. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 01.
  - 3. Welding Standards: Qualify welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

#### 1.5 COORDINATION

- A. Coordinate layout and installation of piping and flash tanks with steam and condensate equipment and with other installations.

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- B. Coordinate pipe sleeve installation for foundation wall penetrations.
- C. Coordinate installation of roof curbs, equipment and pipe supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete housekeeping pads. Cast anchor-bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.
- F. Coordinate installation of pipe sleeves for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping" for fire and smoke wall and floor assemblies.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Safety Valves:
    - a. Kunkle Inds. Inc.; Kunkle Valve Div.
    - b. Spirax Sarco, Inc.
    - c. Conbraco.
  - 2. Steam Pressure Regulating Valves:
    - a. Armstrong International, Inc.
    - b. Leslie Controls, Inc.
    - c. Spence Engineering Co., Inc.
    - d. Spirax Sarco, Inc.
  - 3. Steam Traps:
    - a. Armstrong International, Inc.
    - b. Spirax Sarco, Inc.
  - 4. Inverted Bucket Steam Trap Valve Station:
    - a. Armstrong International, Inc.
  - 5. Thermostatic Air Vents and Vacuum Breakers:
    - a. Armstrong International, Inc.
    - b. Spirax Sarco, Inc.

#### 2.2 PIPE MATERIALS

- A. General: Refer to Part 3 pipe application articles for identifying where the following materials are used.
- B. Steel Pipe, 2-Inch NPS and Smaller: ASTM A 106, Type S (seamless), Grade B, Schedules 40 and 80, plain ends, unless threaded allowed in Pipe Applications.
- C. Steel Pipe, 2-1/2- to 12-Inch NPS: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedules 40 and 80, plain ends.
  - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedules 40 and 80, carbon steel, seamless for 2-inch NPS and smaller and electric-resistance welded for 2-1/2-inch NPS and larger.

#### 2.3 FITTINGS

- A. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300.
- B. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- C. Wrought-Steel Fittings: ASTM A 234, Schedules 40 and 80.
- D. Forged Socket-Welding Fittings: ASME B16.11; Class 3000 (Schedule 80).
- E. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, Material Group 1.1, raised face type with butt-welding connections; include nuts and bolts.
- F. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure, 250 deg F maximum operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

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2.4 JOINING MATERIALS

- A. Welding Materials: Comply with Section II, Part C of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- B. Flange Gasket: Flexible spiral wound metal gasket, type suitable for 125 psig steam service. Flexitallic or Garlock manufacturers.

2.5 VALVES

- A. Gate, globe, check, ball, and butterfly valves are specified in Section 23 05 23 "General-Duty Valves for Mechanical Piping."
- B. Refer to Part 3 "Valve Applications" Article for specific uses and applications for each valve specified.

2.6 SAFETY VALVES

- A. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code. Furnish complete with cast-iron drip-pan elbow having threaded inlet and outlet with threads conforming to ASME B1.20.1.
- B. Bronze Safety Valves: Cast-bronze or forged copper body, Class 250, with threaded inlet and outlet; forged copper-alloy disc; fully enclosed, cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
- C. Cast-Iron Safety Valves: Cast-iron body, Class 250; forged copper-alloy disc and nozzle; fully enclosed, cadmium-plated steel spring with adjustable pressure range and positive shutoff; raised-face flanged inlet and threaded outlet connections; factory set and sealed.
- D. Stop-Check Valves: Class 250, malleable-iron body and bonnet, cylindrical disc, removable liner and machined seat, brass-alloy stem, outside screw and yoke, polytetrafluoroethylene (PTFE)-impregnated packing with 2-piece packing gland assembly, flanged end connections, and cast-iron handwheel.

2.7 STEAM PRESSURE-REGULATING VALVES

- A. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
- B. Valve Characteristics: Self-operated, external pilot type, single seated, metal diaphragm actuated – Spence Type ED or equal by Armstrong or Sarco, valves equipped with adjustable pressure range and positive shutoff; cast-iron body with threaded connections for 2-inch and smaller and flanged end connections over 2-1/2-inch, hardened stainless-steel trim, and replaceable head and seat. Provide main head stem guide fitted with flushing and pressure-arresting device. Provide dirt cover over pilot diaphragm.

2.8 STEAM TRAPS

- A. Thermostatic Traps: Cast bronze, angle pattern body with integral union tailpiece and screw-on cap; maximum operating pressure of 50 psig; balanced-pressure, stainless steel or Hastelloy wafer, or phosphor bronze bellows element and renewable, stainless steel seat.
- B. Float and Thermostatic Traps: Cast iron body and bolted cap with maximum allowable and maximum working pressures not less than steam supply pressure. Renewable, stainless steel float mechanism with renewable, hardened stainless steel or chrome steel valve and valve seat. The valve shall be attached to the valve lever in such a manner that it will be free to rotate. The valve and valve seat shall be lapped together and installed as a paired set. Orifice size shall be stamped on the valve seat to aid in identifying proper replacement parts. Balanced-pressure thermostatic air vent made with stainless steel or phosphor bronze bellows, and stainless steel seat.
  - 1. Accessories:
    - a. Integral vacuum breaker.
- C. Inverted Bucket Traps: Cast iron body and bolted cap with maximum allowable and maximum working pressures not less than steam supply pressure. The steam trap mechanism shall be a free-floating lever design with no fixed pivot points, and the valve shall be attached to the valve lever in such a manner that it will be free to rotate. The valve and valve seat shall be of stainless steel or heat-treated chrome steel, lapped together and installed as a paired set. Stainless-steel valve lever, valve retainer, guide plate assembly, and bucket. Steam trap mechanism shall be renewable, and the orifice

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size of the mechanism shall be stamped on the valve lever, valve seat, and guide plate to aid in identifying proper replacement parts.

1. Accessories:
  - a. Integral stainless-steel inlet strainer within trap body.
  - b. Internal stainless-steel, spring loaded check valve.
  - c. Bi-metal thermic vent.

### 2.9 THERMOSTATIC AIR VENTS

- A. Thermostatic Air Vents: Cast-iron or brass body, with balanced-pressure, stainless steel or phosphor bronze thermostatic bellows, and stainless-steel seats.

### 2.10 VACUUM BREAKERS

- A. Vacuum Breakers: 150-psig steam working pressure, 365 deg F maximum operating temperature, brass or stainless-steel body, stainless-steel retainer, spring, and ball, with plain or threaded outlet.

### 2.11 STRAINERS

- A. Y-Pattern Strainers: Minimum 250-psig steam working pressure; cast-iron body, Type 304 or 316, 0.045-inch stainless-steel perforated screen with 20 mesh stainless steel screen liner for 2-inch NPS and smaller, and manufacturer recommended perforations for 2-1/2-inch NPS and larger; tapped blowoff plug. Threaded connections for 2-inch NPS and smaller and flanged connections for 2-1/2-inch NPS and larger.
- B. Basket Strainers: Minimum 250-psig steam working pressure; cast-iron body, Type 304 or 316, 0.045-inch stainless-steel perforated screen; bolted cover; flanged connections.

### 2.12 BYPASS AND TEST ORIFICES

- A. Solid stock machined nipple type, nozzle type orifice in a flanged joint; Type 300 Series stainless steel.

### 2.13 PIPE ANCHORS

- A. Pipe anchors constructed from ASTM A36 structural steel shapes and plate. Anchors shall be designed by a licensed Structural Engineer for the forces and moments indicated on the drawings.

## PART 3 - EXECUTION

### 3.1 PIPE APPLICATIONS LESS THAN 15 PSIG

- A. Steam Piping, 2-Inch NPS and Smaller: Schedule 40 steel pipe with threaded joints and Class 150 malleable-iron fittings.
- B. Steam Piping, 2-1/2- to 12-Inch NPS: Schedule 40 steel pipe with welded joints, Schedule 40 wrought-steel welding fittings, and Class 150 wrought-steel flanges.
- C. Condensate Piping, 2-Inch NPS and Smaller: Schedule 80 steel pipe with threaded joints and Class 300 malleable-iron fittings.
- D. Condensate Piping, 2-1/2- to 12-Inch NPS: Schedule 80 steel pipe with welded joints, Schedule 80 wrought-steel welding fittings, and Class 150 wrought-steel flanges.

### 3.2 PIPE APPLICATIONS UP TO 125 PSIG

- A. Steam and Safety Valve Discharge Piping, 2-Inch NPS and Smaller: Schedule 40 steel pipe with threaded joints and Class 300 malleable-iron fittings.
- B. Steam and Safety Valve Discharge Piping, 2-1/2- to 12-Inch NPS: Schedule 40 steel pipe with welded joints, Schedule 40 wrought-steel butt-welding fittings, and Class 150 wrought-steel flanges.
- C. Condensate Piping, 2-Inch NPS and Smaller: Schedule 80 steel pipe with threaded joints and Class 300 malleable-iron fittings.
- D. Condensate Piping, 2-1/2- to 12-Inch NPS: Schedule 80 steel pipe with butt-welded joints, Schedule 80 wrought-steel butt-welding fittings, and Class 150 wrought-steel flanges.
- E. Blowdown Piping, 2-Inch NPS and Smaller: Schedule 80 steel pipe with socket-welded joints and Class 3000 socket-welding fittings.

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- F. Blowdown Piping, 2-1/2- to 12-Inch NPS: Schedule 80 steel pipe with butt-welded joints, Schedule 80 wrought-steel butt-welding fittings, and Class 150 wrought-steel flanges.

### 3.3 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
  - 1. Shutoff Duty: Gate valves.
  - 2. Throttling Duty: Globe valves.
- B. Install shutoff-duty valves at each branch connection to supply mains, at inlet connection to each steam trap, and elsewhere as indicated.
- C. Vacuum Breakers Less than 15 psig: Class 150 bronze swing check with composition seat.

### 3.4 STEAM-TRAP APPLICATIONS

- A. Thermostatic Traps: As indicated on Steam Trap Schedule.
- B. Float and Thermostatic Traps: As indicated on Steam Trap Schedule.
- C. Inverted Bucket Traps: As indicated on Steam Trap Schedule and riser drip legs.

### 3.5 PIPING INSTALLATIONS

- A. Install piping according to Section 23 05 00 "Common Mechanical Materials and Methods."
- B. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install steam supply piping at a uniform grade of 0.2 percent downward in direction of flow.
- D. Install condensate return piping at a uniform grade of 0.5 percent downward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- F. Install branch connections to steam mains using 45-degree fittings in main with takeoff out top of main. Use of 90-degree tee fittings is permissible where 45-degree fittings are impractical. Where length of branch takeoff is less than 10 feet, pitch branch line down toward mains at 0.4 percent slope.
- G. Install unions or flanges adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated.
- H. Install strainers on supply side of each control valve, steam pressure-regulating valve, solenoid valve, traps, and elsewhere as indicated. Install 3/4-inch NPS nipple and ball valve in blow-down connection of strainers 2-inch NPS and larger. Match size of strainer blowoff connection. Provide gate valve with close nipple and pipe cap at blowdown connection.
- I. Install pipe anchors where indicated and where required to ensure proper pipe expansion and contraction.
- J. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.
  - 1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet where pipe is pitched down in direction of steam flow and a maximum of 150 feet where pipe is pitched in opposite direction of steam flow.
  - 2. Drip leg is to be same size as steam line up to 4-inches. Above 4-inches, drip leg is to be half of steam line size, but not less than 4-inches. Inlet to steam trap shall be located at least 18 inches below steam line. Provide gate valve at bottom of drip leg to allow removal of dirt and scale.
  - 3. Equip drip legs, dirt pockets, and strainer blow-downs with gate valves to allow removal of dirt and scale.
  - 4. Install steam traps close to drip legs.

### 3.6 STEAM-TRAP INSTALLATION

- A. Install steam traps in locations that provide access for inspection and maintenance, and as close as possible to connected equipment. Trap Valve Station having integral isolation valves, strainer, and check valve is an acceptable alternate for inverted bucket traps.

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1. Unless otherwise indicated, install gate valve, strainer, and union upstream from trap; install union, check valve, and gate valve downstream from trap.
2. Install trap a minimum of 18-inches below the bottom of the coil or heat exchanger.

3.7 STEAM PRESSURE-REGULATING VALVE INSTALLATIONS

- A. Install pressure-regulating valves as required to regulate system pressure, in readily accessible location for maintenance and inspection.
- B. Provide bypass around regulating valve station, with globe valve equal in size to area of regulating valve seat ring.
- C. Install gate valves and unions around each regulating valve. Unions may be omitted for regulating valves with flanged connections.
- D. Install pressure sensing tube as per manufacturer's recommendations.
- E. Install pressure gages on low-pressure side of each regulating valve and ahead of shutoff valve, plus one downstream for shutoff valve.
  1. On 2-stage reducing stations, install drip trap and pressure gage upstream from second stage regulating valve.
- F. Install strainers upstream for each regulating valve.
- G. Install safety valves downstream from regulating valve station.

3.8 SAFETY VALVE INSTALLATIONS

- A. Install valves according to ASME B31.1. Pipe discharge to atmosphere outside building, without stop valves. Install drip-pan elbow fitting adjacent to safety valve; pipe drain connection to nearest floor drain. Comply with ASME Boiler and Pressure Vessel Code installation requirements.

3.9 TERMINAL EQUIPMENT CONNECTIONS

- A. Piping size for supply and return shall be same size as equipment connections.
- B. Install traps and control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. Where multiple, parallel control valves are installed, only one bypass is required.
- D. Install vacuum breaker downstream from control valve and bypass, and close to coil inlet connection.
- E. Install pressure gage at coil inlet connections.
- F. Install a drip leg at coil outlet with steam trap located at least 18-inches below coil outlet.

3.10 HANGERS AND SUPPORTS

- A. General: Hanger, support, and anchor devices are specified in Section 23 05 29 "Hangers and Supports for Mechanical Piping and Equipment." Conform to requirements below for maximum spacing of supports.
- B. Install the following pipe attachments:
  1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.
  2. Adjustable roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal runs 20 feet or longer, supported on a trapeze.
  4. Spring hangers to support vertical runs.
- C. Install hangers for steel piping with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size (Inches)	Steel Pipe Max. Span (Feet)	Min. Rod Diameter (Inches)
Up to 3/4	7	1/4
1	7	1/4
1-1/4	7	3/8
1-1/2	9	3/8
2	10	3/8

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Nom. Pipe Size (Inches)	Steel Pipe Max. Span (Feet)	Min. Rod Diameter (Inches)
2-1/2	11	1/2
3	12	1/2
4	14	5/8
6	17	3/4
8	19	7/8

3.11 PIPE JOINT CONSTRUCTION

- A. Refer to Section 23 05 00 "Common Mechanical Materials and Methods" for joint construction requirements for threaded, welded, and flanged joints.

3.12 FIELD QUALITY CONTROL

- A. Testing Preparation: Prepare steam and condensate piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Flush system with clean water. Clean strainers.
3. Isolate equipment that is not subjected to test pressure from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Flanged joints where blinds are inserted to isolate equipment need not be tested.
4. Install relief valve set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

- B. Testing: Test steam and condensate piping as follows:

1. Notify Contracting Officer not less than 10 working days prior to scheduled date for testing. Test to be witnessed by Owner's staff designated by Contracting Officer.
2. Use ambient temperature water as testing medium, except where there is risk of damage due to freezing. Another liquid may be used if it is safe for workers and compatible with piping system components.
3. Use traps installed at the high points of system to release trapped air while filling system. Use drip legs installed at low points for complete removal of liquid.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Check to verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

3.13 CLEANING

- A. Preparation:

1. System shall be operational prior to cleaning.
2. Make temporary piping connections, furnish temporary pumps, and temporary bypass filter as required to properly accomplish cleaning entire system.
3. Place all manual, pressure regulating and control valves serving the system in open position during cleaning so that circulation through the system is obtained during cleaning. Isolate and bypass steam pressure regulating station.
4. Verify that electric power is available and of the correct characteristics for any cleaning equipment.

- B. Cleaning Sequence:

1. Initial Flush (all systems):

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- a. Completely fill the system with fresh water and circulate (1<sup>st</sup> filling) for 4-hour minimum.
- b. Initial flushing shall be sufficient to remove all contaminants such as cuttings, filings, loose rust and scale, welding and soldering, residue and debris.
- c. Drain the entire system and refill with fresh water (2<sup>nd</sup> filling).
2. Cleaning Flush:
  - a. Use concentrated chemical cleaner in piping system(s). Cleaner shall be a phosphate wetting agent combined with an alkaline surfactant with a sodium carbonate type alkalinity supplement introduced as necessary to produce 600 PPM of phenolphthalein alkalinity. Chemicals shall be nontoxic.
  - b. Circulate the solution for the recommended time period corresponding to the fluid temperature.
    - 1) Partially close and reopen all manual valves several times.
  - c. Test solution for proper concentration and document results.
  - d. Completely drain the entire system.
  - e. Refill the system with fresh water (3<sup>rd</sup> filling). Then, with the circulation pump running:
    - 1) Open one or more drains as far downstream from the fill point as is possible. Be sure the makeup is sufficient to keep up with the drain so as to maintain full system.
    - 2) Partially close and reopen all manual valves several times.
    - 3) Blowdown all strainers, dead legs and low points in the system.
    - 4) Continue to flush the system in this manner until the drain water is of the same clarity as the makeup water and testing reveals no further traces of cleaning solution (minimum 1 hour). Document the results.
  - f. Following the fresh water flush, drain the entire system.
    - 1) Clean all strainers.
3. Upon completion of cleaning and chemical treatment addition, tag the system so that tag is plainly visible as follows: **“THIS SYSTEM HAS BEEN CHEMICALLY CLEANED AND TREATED.”**
4. Field Reports: Submit field reports, not more than 5 working days after completion of testing, indicating analysis of system's water after cleaning and after chemical treatment.

END OF SECTION

## SECTION 23 22 23 STEAM CONDENSATE PUMPS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 00 "Common Motor Requirements for Mechanical Equipment" for general motor requirements for condensate pumps.

#### 1.2 SUMMARY

- A. This Section includes condensate receiver/pump sets for low-pressure steam systems.

#### 1.3 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each type of product. Indicate pump's operating point on curves. Include receiver capacity and material.
- B. Shop Drawings: Show pump layout and connections. Include Setting Drawings with templates for installing foundation and anchor bolts and other anchorages.
  - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: Include in maintenance manuals specified in Division 01.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 01.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store steam condensate pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

#### 1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Floor-Mounted, Condensate Receiver/Pump Sets:
    - a. ITT Fluid Handling; Div. of ITT Fluid Technology Corp.
    - b. Skidmore Div.; Vent-Rite Valve Corp.
    - c. Weil Pump Company, Inc.
    - d. Shipco.

#### 2.2 CONDENSATE RECEIVER/PUMP SETS

- A. Description: Factory-fabricated, packaged, electric-drive pump units; with receiver, pumps, controls, and accessories suitable for operation with low-pressure steam condensate.
- B. Configuration: Floor-mounting, duplex unit with receiver and unit mounted control panel.

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1. Receiver: Floor-mounting, close-grained cast iron, with externally adjustable float switches and flanges for pump mounting. Provide connection for atmospheric pressure vent.
2. Pumps: Centrifugal; close coupled; vertical design; permanently aligned; bronze fitted, and with enclosed bronze case rings, mechanical seals suitable for 220 degrees F, and independent pump control circuit for each pump; and mounted on receiver flanges.
3. Float Switches: Set for lead/lag operation.
4. Factory Wiring: Between pumps, float switches, and control panel.
5. Control Panel: NEMA 250, Type 2 enclosure with hinged door and grounding lug, mounted on unit; factory wired for single external electrical connection; and with the following included within cabinet:
  - a. Motor controller for each pump.
  - b. Electrical alternator.
  - c. Numbered terminal strip.
  - d. Disconnect switch.
  - e. Fused transformer for each control circuit.
6. Options: Provide the following options:
  - a. Gauge glass level indicator.
  - b. Thermometer.
  - c. Discharge pressure gauges.
  - d. High level alarm with dry contacts for monitoring by the DDC system.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 CONDENSATE RECEIVER/PUMP SET INSTALLATION

- A. Install receiver/pump sets according to manufacturer's written instructions.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately, so piping is not supported by pumps.
- D. Install receiver/pump sets on 4-inch high concrete bases. Anchor to bases using inserts or anchor bolts.
- E. Install thermometers and pressure gages.

#### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Install shutoff valves on inlet of units.
- D. Install inlet strainer and valved bypass to drain at system return connection.
- E. Install union, check valve, and shutoff valve at pump discharge connections for each pump.
- F. Install pipe drain to nearest floor drain for overflow and drain piping connections.
- G. Install full-size vent piping, terminating outside in 180-degree elbow at point above highest steam system connection or as indicated.
- H. Install electrical connections for power, controls, and devices.
- I. Electrical power and control wiring and connections are specified in Division 26 Sections.
- J. Ground equipment.
  1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

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3.4 START-UP PROCEDURES

- A. Verify that condensate receiver/pump sets are installed and connected according to the Contract Documents.
- B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- C. Complete installation and startup checks according to manufacturer's written instructions.
- D. Clean strainers.
- E. Set condensate receiver/pump set controls.
- F. Set pump controls for automatic start, stop, and alarm operation.
- G. Perform the following preventive maintenance operations and checks before starting:
  - 1. Lubricate bearings.
  - 2. Set float switches to operate at proper levels.
  - 3. Set throttling valves on pump discharge for specified flow.
  - 4. Check motors for proper rotation.
  - 5. Test pump controls and demonstrate compliance with requirements.
  - 6. Replace damaged or malfunctioning pump controls and equipment.
  - 7. Verify that pump controls are correct for required application.
- H. Start condensate pumps according to manufacturer's written startup instructions.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain condensate receiver/pump sets as specified below:
  - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
  - 2. Review data in maintenance manuals. Refer to Division 01 Operation and Maintenance Manual requirements.
  - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION



## SECTION 23 23 00 REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 07 Section "Roof Accessories" for roof curbs, piping supports, and roof penetration boots.
  - 2. Division 07 Section "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
  - 3. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
  - 4. Division 23 Section "Hangers and Supports for Mechanical Piping and Equipment" for pipe supports and installation requirements.
  - 5. Division 23 Section "Identification for Mechanical Piping and Equipment" for labeling and identifying refrigerant piping.
  - 6. Division 23 Section "Meters and Gages for Mechanical Piping" for thermometers and pressure gages.
  - 7. Division 23 Section "Instrumentation and Control for HVAC" for thermostats, controllers, automatic-control valves, and sensors.

#### 1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.
  - 1. Refrigerant piping indicated is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals specified in Division 01.

#### 1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX; "Welding and Brazing Qualifications."
- B. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- C. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."
- D. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

#### 1.5 COORDINATION

- A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

## SECTION 23 23 00 REFRIGERANT PIPING

- D. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
- E. Coordinate pipe fitting pressure classes with products specified in related Sections.

### 1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Refrigeration Oil Test Kits: Two each, containing everything required to conduct one test.
  - 2. Refrigerant: Two containers each, with 20 lb of refrigerant.
  - 3. Filter-Dryer Cartridges: Three of each type.

## 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Refrigerants:
    - a. Allied Signal, Inc./Fluorine Products; Genetron Refrigerants.
    - b. DuPont Company; Fluorochemicals Div.
    - c. Elf Atochem North America, Inc.; Fluorocarbon Div.
    - d. ICI Americas Inc./ICI KLEA; Fluorochemicals Bus.
  - 2. Refrigerant Valves and Specialties:
    - a. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
    - b. Danfoss Electronics, Inc.
    - c. Emerson Electric Company; Alco Controls Div.
    - d. Henry Valve Company.
    - e. Sporlan Valve Company.

### 2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B 280, Type ACR.
- B. Annealed-Temper Copper Tube: ASTM B 280, Type ACR.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).
- F. Flexible Connectors: 500-psig (3450-kPa) minimum operating pressure; seamless tin-bronze core, high-tensile bronze-braid covering, and solder-joint end connections; dehydrated, pressure tested, minimum 7 inches long

### 2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53, Schedule 40, seamless black steel.
- B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.
- C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, butt-welded end connection, and raised face.
- D. Flanged Unions: 400-psig working pressure, 330 deg F maximum operating temperature; 2 brass tailpiece adapters for solder-end connections to copper tubing; forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3 with 4 plated-steel bolts, with silicon bronze nuts and fiber gasket; and having factory-applied, rust-resistant coating on flanges and bolts.
- E. Flexible connectors: 500-psig minimum operating pressure; stainless-steel core and high-tensile stainless-steel-braid covering; dehydrated, pressure tested, minimum 7 inches long.
  - 1. NPS 2 and Smaller: With thread-end connections.

## SECTION 23 23 00 REFRIGERANT PIPING

### 2. NPS 2-1/2 and Larger: With flanged-end connections.

#### 2.4 VALVES

- A. Diaphragm Packless Valves: 500-psig working pressure and 275 deg F working temperature; globe design with straight-through or angle pattern; forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, and with solder-end connections.
- B. Packed-Angle Valves: 500-psig working pressure and 275 deg F working temperature; forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat, molded stem packing, and with solder-end connections.
- C. Check Valves Smaller Than NPS 1: 400-psig operating pressure and 285 deg F operating temperature; cast-brass body, with removable piston, polytetrafluoroethylene seat, and stainless-steel spring; globe design. Valve shall be straight-through pattern, with solder-end connections.
- D. Check Valves, NPS 1 and Larger: 400-psig operating pressure and 285 deg F operating temperature; cast-bronze body, with cast-bronze or forged-brass bolted bonnet; floating piston with mechanically retained polytetrafluoroethylene seat disc. Valve shall be straight-through or angle pattern, with solder-end connections.
- E. Service Valves: 500-psig pressure rating; forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, and with solder-end connections.
- F. Solenoid Valves: Comply with ARI 760; 250 deg F temperature rating and 400-psig working pressure; forged brass, with polytetrafluoroethylene valve seat, 2-way, straight-through pattern, and solder-end connections; manual operator; fitted with suitable NEMA 250 enclosure of type required by location, with 1/2-inch conduit adapter and 24-V, normally closed holding coil.
- G. Pressure-Regulating Valves: Comply with ARI 770; pilot operated, forged brass or cast bronze, stainless-steel bottom spring, pressure-gage tappings, 24-V dc standard coil, and wrought-copper fittings for solder-end connections; suitable for refrigerant specified.
- H. Pressure-Regulating Valves: Comply with ARI 770; direct acting, brass; with pilot operator, stainless-steel diaphragm, standard coil, and solder-end connection; suitable for refrigerant specified.
- I. Pressure Relief Valves: Straight-through or angle pattern, brass body and disc, neoprene seat, and factory sealed and ASME labeled for standard pressure setting.
- J. Thermostatic Expansion Valves: Comply with ARI 750; brass body with stainless-steel parts; thermostatic-adjustable, modulating type; size and operating characteristics as recommended by manufacturer of evaporator, and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.
- K. Hot-Gas Bypass Valve: Pulsating-dampening design, stainless-steel bellows and polytetrafluoroethylene valve seat; adjustable; sized for capacity equal to last step of compressor unloading; with solder-end connections.

#### 2.5 REFRIGERANT PIPING SPECIALTIES

- A. Straight- or Angle-Type Strainers: 500-psig working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen of 80 to 100 mesh in liquid lines up to 1-1/8 inches, 60 mesh in larger liquid lines, and 40 mesh in suction lines; with screwed cleanout plug and solder-end connections.
- B. Moisture/Liquid Indicators: 500-psig maximum working pressure and 200 deg F operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.
- C. Replaceable-Core Filter-Dryers: 500-psig maximum working pressure; heavy gage protected with corrosion-resistant-painted steel shell, flanged ring and spring, ductile-iron cover plate with steel cap screws; wrought-copper fittings for solder-end connections; with replaceable-core kit, including gaskets and the following:
  - 1. Filter Cartridge: Pleated media with integral end rings, stainless-steel support, ARI 730 rated for capacity.
  - 2. Filter-Dryer Cartridge: Pleated media with solid-core sieve with activated alumina, ARI 730 rated for capacity.

## SECTION 23 23 00 REFRIGERANT PIPING

3. Wax Removal Cartridge: Molded, bonded core of activated charcoal and desiccant with integral gaskets.
  - D. Permanent Filter-Dryer: 350-psig maximum operating pressure and 225 deg F maximum operating temperature; steel shell and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.
  - E. Mufflers: 500-psig operating pressure, welded-steel construction with fusible plug; sized for refrigeration capacity.
- 2.6 RECEIVERS
- A. Receivers, 6-Inch Diameter and Smaller: ARI 495, UL listed, steel, brazed, 400-psig pressure rating, with tappings for inlet, outlet, and pressure relief valve.
  - B. Receivers Larger Than 6-Inch Diameter: ARI 495, welded steel, tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII; 400-psig pressure rating, with tappings for liquid inlet and outlet valves, pressure relief valve, and liquid-level indicator.
- 2.7 REFRIGERANTS
- A. ASHRAE 34, R-123: Dichlorotrifluoroethane.
  - B. ASHRAE 34, R-134a: Tetrafluoroethane.
  - C. ASHRAE 34, R-22: Monochlorodifluoromethane.
  - D. ASHRAE 34, R-500: Azeotrope.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Aboveground, within Building: Type ACR drawn-copper tubing.
- B. Belowground for NPS 2 and Smaller: Type L annealed-copper tubing.

### 3.2 VALVE APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor, for gage taps at hot-gas bypass regulators, on each side of strainers.
- B. Install check valves in compressor discharge lines and in condenser liquid lines on multiple condenser systems.
- C. Install packed-angle valve in liquid line between receiver shutoff valve and thermostatic expansion valve for system charging.
- D. Install diaphragm packless or packed-angle valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated.
- E. Install a full-sized, three-valve bypass around each dryer.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve.
  1. Install solenoid valves in horizontal lines with coil at top.
  2. Electrical wiring for solenoid valves is specified in Division 26 Sections. Coordinate electrical requirements and connections.
- G. Install thermostatic expansion valves as close as possible to evaporator.
  1. If refrigerant distributors are used, install them directly on expansion-valve outlet.
  2. Install valve so diaphragm case is warmer than bulb.
  3. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
  4. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install pressure-regulating and pressure relief valves as required by ASHRAE 15. Pipe pressure relief valve discharge to outside.

### 3.3 SPECIALTY APPLICATIONS

- A. Install liquid indicators in liquid line leaving condenser, in liquid line leaving receiver, and on leaving side of liquid solenoid valves.
- B. Install strainers immediately upstream from each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.
- C. Install strainers in main liquid line where multiple expansion valves with integral strainers are used.

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- D. Install strainers in suction line of steel pipe.
- E. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.
- F. Install pressure relief valves on ASME receivers; pipe discharge to outdoors.
- G. Install replaceable-core filter-dryers in vertical liquid line adjacent to receivers and before each solenoid valve.
- H. Install permanent filter-dryers in low-temperature systems, in systems using hermetic compressors, and before each solenoid valve.
- I. Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.
- J. Install receivers, sized to accommodate pump-down charge, on systems 5 tons and larger and on systems with long piping runs.
- K. Install flexible connectors at or near compressors.

### 3.4 PIPING INSTALLATION

- A. Install refrigerant piping according to ASHRAE 15.
- B. Basic piping installation requirements are specified in Division 23 Section "Common Mechanical Materials and Methods."
- C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- D. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- E. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- F. Belowground, install copper tubing in protective conduit. Vent conduit outdoors.
- G. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
- H. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install traps and double risers to entrain oil in vertical runs.
  - 3. Liquid lines may be installed level.
- I. Install bypass around moisture-liquid indicators in lines larger than NPS 2.
- J. Install unions to allow removal of solenoid valves, pressure-regulating valves, and expansion valves and at connections to compressors and evaporators.
- K. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.
- L. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for Mechanical Piping and Equipment."
- M. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
  - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  - 3. Pipe rollers for multiple horizontal runs 20 feet or longer, supported by a trapeze.
  - 4. Spring hangers to support vertical runs.
- N. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
  - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
- O. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

## SECTION 23 23 00 REFRIGERANT PIPING

1. NPS 1/2: Maximum span, 84 inches; minimum rod size, 1/4 inch.
  2. NPS 3/4: Maximum span, 84 inches; minimum rod size, 1/4 inch.
  3. NPS 1: Maximum span, 84 inches; minimum rod size, 1/4 inch.
  4. NPS 1-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
- P. Support vertical runs at each floor.

### 3.5 PIPE JOINT CONSTRUCTION

- A. Braze joints according to Division 23 Section "Common Mechanical Materials and Methods."
- B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent scale formation.

### 3.6 FIELD QUALITY CONTROL

- A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.
  1. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
  2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.
    - a. System shall maintain test pressure at the manifold gage throughout duration of test.
    - b. Test joints and fittings by brushing a small amount of soap and glycerine solution over joint.
    - c. Fill system with nitrogen to raise a test pressure of 150 psig or higher as required by authorities having jurisdiction.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

### 3.7 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of the conditioned air or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  1. Open shutoff valves in condenser water circuit.
  2. Check compressor oil level above center of sight glass.
  3. Open compressor suction and discharge valves.
  4. Open refrigerant valves, except bypass valves that are used for other purposes.
  5. Check compressor-motor alignment, and lubricate motors and bearings.

### 3.8 CLEANING

- A. Before installing copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.
- B. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.

### 3.9 SYSTEM CHARGING

- A. Charge system using the following procedures:
  1. Install core in filter-dryer after leak test but before evacuation.
  2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
  3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
  4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION

## SECTION 23 25 00 HVAC WATER TREATMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods for Mechanical."
  - 2. Section 23 05 23 "General-Duty Valves for Mechanical Piping."
  - 3. Section 23 21 13 "Hydronic Piping".

#### 1.2 SUMMARY

- A. This Section includes water-treatment systems for the following:
  - 1. Heating, hot water piping (closed-loop system).
  - 2. Chilled-water piping (closed-loop system).
  - 3. Condenser water piping (open system).

#### 1.3 CHEMICAL FEED SYSTEM DESCRIPTION

- A. Closed-Loop System: One bypass feeder on each system with isolating and drain valves downstream from circulating pumps, unless otherwise indicated.
  - 1. Introduce chemical treatment through bypass feeder when required or indicated by test.
  - 2. The system volumes for the following systems are estimated. The chemical treatment supplier shall determine actual volume and treatment required prior to installation:
    - a. Heating hot water system: 3,215 gallons.
    - b. Chilled water system: 3,486 gallons.
    - c. Glycol system: TBD gallons.
- B. Closed-Loop, Heating Steam and Condensate Piping: Chemical introduced to the piping system through a temporary bypass feeder and circulating pumps provided by contractor.
  - 1. Chemical feed pump introduces sequestering agent and base from solution tank into steam piping, with minimum of one pump per system. Use agitator as required.
  - 2. Pump oxygen scavenger feed from solution tank into steam piping. Use agitator as required.
  - 3. Feed carbon dioxide, neutralizing amine from solution tank directly into steam header, or filming amine into steam header. Use agitator as required.
  - 4. Activate chemical solution pump when temporary circulating pumps are running.
  - 5. Liquid-level switch, in each solution tank, deactivates chemical solution pump and signals alarm.
- C. Open-Loop Systems for Cooling Towers: Drip feeders to feed chemical.
  - 1. Conductivity controller samples sump water when activated by pump and operates solenoid bleed-off valve in line to drain.
- D. Open-Loop, Condenser Water Piping: Pump sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Use agitator as required.
  - 1. Intermittently feed biocide to condenser water to achieve a toxic level of the chemical to kill the organism present.
  - 2. Change biocides periodically to avoid chemical immunity.
  - 3. Activate chemical solution pump from water meter in makeup water line to cooling tower when condenser water pumps are running.
  - 4. Automatically feed chemical with electronic solid-state controllers.
  - 5. Deactivate solution pump and signal alarm by a liquid-level switch in each solution tank on low chemicals.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

SECTION 23 25 00 HVAC WATER TREATMENT

- B. Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
1. Closed System: Maintain system essentially free of scale, corrosion, and fouling to sustain the following water characteristics in the table below.
  2. Steam and Condensate Piping System: Maintain system essentially free of scale, corrosion, total suspended solids, and fouling to sustain the following water characteristics in the table below.
  3. Condenser Water, Medium-to-Large Cooling Tower System: Maintain system essentially free of scale and total suspended solids to sustain the following water characteristics in the table below.

WATER CHARACTERISTIC REQUIREMENTS:

PARAMETER (Note 6)	COOLING TOWER CONDENSER WATER AND HEAT EXCHANGER WATER	CHILLED WATER	HOT WATER HEATING HEAT PUMP LOOP WATER AND GLYCOL/ WATER	STEAM COND
pH	[7.8-9.0] (Note 1)	8.0-9.5	8.0-9.5	8.0-9.0
Molybdate	5-10 ppm	150-250 ppm (Note 2)	150-250 ppm (Note 2)	N.A.
Organic Growths	None (For cooling towers, see Paragraph 2.1 B.)	None	None	None
Polymer/ Amine	N.A.	N.A.	N.A.	(Note 5)
Hardness	[500] ppm (Note 4)	N.A.	N.A.	N.A.
Phosphate	N.A.	N.A.	N.A.	N.A.
Sulfite as Na-SO <sub>3</sub>	N.A.	N.A.	N.A.	N.A.
Total Alkalinity as CaCO <sub>3</sub>	[400] ppm (Note 4)	N.A.	N.A.	N.A.
Total Dissolved Solids	[550] ppm	N.A.	N.A.	N.A.
Nitrite as Na-NO <sub>2</sub>	N.A.	1500 ppm (Note 3)	1500 ppm (Note 3)	N.A.

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PARAMETER (Note 6)	COOLING TOWER CONDENSER WATER AND HEAT EXCHANGER WATER	CHILLED WATER	HOT WATER HEATING HEAT PUMP LOOP WATER AND GLYCOL/ WATER	STEAM COND
Cycles of Con- centration	[4] (Note 4)	N.A.	N.A.	N.A.

N.A. = Not Applicable.

Note 1: Only if pH control (acid feed) is provided.

Note 2: Molybdate concentration if molybdate-based inhibitor is used.

Note 3: Nitrite concentration if nitrite-based inhibitor is used.

Note 5: Provide FDA and OSHA approved amines. Amine level shall be below the FDA and OSHA limitations.

Note 6: All the above values of concentration and pH are for general guidance only. The water treatment company shall recommend any required changes based on the actual chemicals used.

1.5 SUBMITTALS

- A. Product Data: Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:
  - 1. Pumps.
  - 2. Chemical solution tanks.
  - 3. Agitators.
  - 4. Control equipment and devices.
  - 5. Test equipment.
  - 6. Chemicals.
  - 7. Chemical feeders.
  - 8. Sand Filters.
  - 9. Basin sweepers.
- B. Shop Drawings: Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.
  - 2. Piping diagrams, clearly identifying components required to be field installed, and which items provided by the contractor or provided by chemical treatment provider.
- C. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site prior to treatment.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Maintenance Data: For pumps, agitators, filters, system controls, and accessories to include in maintenance manuals specified in Division 01.
- F. Provide material safety data sheets for all chemicals used.

1.6 QUALITY ASSURANCE

- A. Contractor Responsibility: The Contractor shall be responsible for providing clean piping systems. The procedures specified in Section 23 21 13 "Hydronic Piping" shall be mini-

SECTION 23 25 00 HVAC WATER TREATMENT

imum cleaning requirements. If dirt still remains in the piping system after completion of the specified procedures, the Contractor shall then initiate additional cleaning steps and procedures to the extent required to clean the piping system to the satisfaction and approval of the Owner and Architect.

- B. Installer Qualifications: An experienced installer who is an authorized representative of the chemical treatment manufacturer for both installation and maintenance of chemical treatment equipment required for this Project.
- C. Treatment Specialist: Cleaning and chemical treatment of piping systems shall be performed under the constant supervision of a water treatment specialist approved by the Owner and Architect. Cleaning and chemical treatment of systems shall be by the same treatment specialist. The treatment specialist shall have at least 3 years of experience in the cleaning and chemical treatment of piping systems and shall have provided similar services as specified within this Section for at least 3 building projects that were of similar size to this project. The treatment specialist shall also represent an established company that has been in the business of selling chemicals and equipment for cleaning and chemical treatment of piping systems for at least 10 years.
  - 1. Treatment specialist shall be Garratt-Callahan Co., Lawrence Camarda, 206-919-1410, lcamarda@g-c.com
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 MAINTENANCE

- A. Scope of Service: Provide chemicals and service program for maintaining optimum conditions in the circulating water for inhibiting corrosion, scale, and organic growths in the chilled-water piping, heating hot-water piping, steam and condensate piping and condenser water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, including the following:
  - 1. Initial water analysis and recommendations.
  - 2. Startup assistance.
  - 3. Periodic field service and consultation.
  - 4. Customer report charts and log sheets.
  - 5. Laboratory technical assistance.
  - 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Chemicals: Furnish quantity equal to 5% percent of amount initially installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. HVAC Water-Treatment Equipment and Products:
    - a. Garratt Callahan Water Treatment.

2.2 SERVICE PROVIDERS

- A. Service Providers: Subject to compliance with requirements, chemical treatment service shall be provided by one of the following:
  - 1. Garratt Callahan Company

2.3 CHEMICAL FEEDING EQUIPMENT

- A. Drip Feeders: Plastic reservoir with capillary tubing probe, weight, charging syringe, and clip.
- B. Positive-Displacement Diaphragm Pump: Simplex, self-priming, rated for intended chemical with 25 percent safety factor for design pressure and temperature.

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1. Adjustable flow rate.
  2. Thermoplastic construction.
  3. Fully enclosed, continuous-duty, 120-V, 60-Hz, single-phase motor.
  4. Built-in relief valve.
- C. Chemical Solution Tanks: Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with graduated markings.
1. Molded fiberglass cover with recess for mounting pump, agitator, and liquid-level switch.
  2. Provide molded fiberglass containment tray for the tanks to sit in.
- D. Agitator: Direct drive, 1750 rpm, mounted on tank with angle adjustment.
1. Fully enclosed, continuous-duty, 120-V, 60-Hz, single-phase motor.
  2. Stainless-steel clamp and motor mount, with stainless-steel shaft and propeller.
- E. Liquid-Level Switch: Polypropylene housing, integrally mounted PVC air trap, receptacles for connection to metering pump, and low-level alarm.
- F. Packaged Conductivity Controller: Solid-state circuitry, 5 percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control-function light, output to control circuit, and recorder.
- G. Cold-Water Meter: Positive-displacement type with sealed, tamperproof magnetic drive; impulse contact register; single-pole, double-throw, dry-contact switch.
1. Rotating-disc type with bronze or cast-iron body rated for 125 psig.
  2. Magnetic-drive or mechanical-impulse contactor matched to signal receiver.
  3. At least six-digit totalizers.
  4. 120-V ac.
- H. Solenoid Valves: Forged-brass body, globe pattern, and general-purpose solenoid enclosure with 120-V, continuous-duty coil.
- I. Electronic Timers: 150-second and 5-minute ranges, with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
- J. Chemical Tubing: Schedule 40, PVC with solvent-cement joints; or polypropylene tubing with heat fusion joints.
- K. Plastic Ball Valves: Rigid PVC or CPVC body, integral union ends, and polytetrafluoroethylene seats and seals.
- L. Plastic-Body Strainer: Rigid PVC or CPVC with cleanable stainless-steel strainer element.
- M. Condenser Water-Treatment Control Panel: Incorporate solid-state integrated circuits and digital LED displays, in NEMA 250, Type 12 enclosure with gasketed and lockable door. (Provide output contacts for alarm to the Building Automation System.)
1. Control dissolved solids, based on conductivity, and include the following:
    - a. Digital readout display.
    - b. Temperature-compensated sensor probe adaptable to sample stream manifold.
    - c. High, low, and normal conductance indicator lights.
    - d. High or low conductance alarm light, trip points field adjustable; with silence switch.
    - e. Hand-off-auto switch for solenoid bleed-off valve.
    - f. Bleed-off light to indicate valve operation.
    - g. Internal adjustable hysteresis or dead band.
  2. Control inhibitor feeding, based on makeup volume, and include the following:
    - a. Solid-state reset counter (accumulator), with selections from 1 to 15.
    - b. Solid-state timer, adjustable from 15 to 300 seconds.
    - c. Test switch.
    - d. Hand-off-auto switch for chemical pump.
    - e. Illuminated legend to indicate feed when pump is activated.
    - f. Solid-state lockout timer, adjustable from 15 to 180 minutes, with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
    - g. Electromechanical-type, panel-mounted makeup totalizer to measure amount of makeup water.
  3. Control biocide with an adjustable time programmer and include the following:

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- a. 24-hour timer with 14-day skip feature to permit activation any hour of day.
- b. Precision, solid-state, bleed-off lockout timer (zero to nine hours) and clock-controlled biocide pump timer (zero to two and one-half hours). Prebleed and bleed lockout.
- c. Solid-state alternator to enable the use of two different formulations.
- d. 24-hour digital display of time of day.
- e. 14-day LED display of day of week.
- f. Fast and slow internal clock set controls.
- g. Battery backup so clock is not disturbed by power outages.
- h. Quartz timekeeping accuracy.
- i. Hand-off-auto switches for biocide pumps.
- j. Biocide A and Biocide B illuminated legends to indicate pump is running.

### 2.4 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer recommended equipment and chemicals, in a carrying case, for testing pH, total dissolved solids, dissolved oxygen, biocount, chloride, and total alkalinity and for calcium hardness field tests.
- B. Corrosion Test Coupon Assembly: Constructed of corrosion material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test coupon assembly.
  1. Two station rack for closed-loop systems.
  2. Four station rack for open condenser water systems.

### 2.5 CHEMICALS

- A. Furnish chemicals that are compatible with piping system components and connected equipment.
- B. Biocide: Chlorine release agents or microbicides.
- C. Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.
- D. Heating Steam and Condensate Piping Chemicals: Sequestering agent to reduce hardness and prevent feedline congestion and to provide alkalinity, oxygen scavenger, carbon-dioxide neutralizer, and filming amines.
- E. Open-Loop, Condenser Water Piping Chemicals: Sequestering agent to inhibit scaling, acid to reduce alkalinity and pH, corrosion inhibitor, and biocide.
- F. Open-Loop Piping Chemicals Serving Humidifiers, Air Washers, Evaporative Condensers, Small Cooling Towers, and Liquid Coolers: Sequestering agent to inhibit scaling, corrosion inhibitor, and biocide nonoxidizing.

### 2.6 COOLING TOWER CONDENSER WATER

- A. Provide automatic chemical feed equipment for each applicable system as described below:
- B. One pre-wired control panel for continuously monitoring and controlling total dissolved solids (TDS) (conductivity monitoring and blowdown control) and chemical treatment (corrosion and scale inhibitor and biocide) in the water system. Control panel shall be a NEMA Type 12 steel enclosure, primed and painted, housing the following pre-wired components:
  1. Internal wiring harnesses (color coded, clearly identified and brought to a master terminal board).
  2. Grounded ac receptacles for chemical treatment pump and utility use.
  3. Main power switch and indicating lamp (with legend plate).
  4. Line voltage safety switch interlock with door to shut off line voltage to controls when adjustment or maintenance is required.
  5. Hand-Off-Auto selector switches and indicating lamps for bleed-off control, chemical feed and acid feed (with legend plates).
  6. Chemical feed control mode and selector switch for control of conductivity or pH controller.
  7. 24-hour, 7-day program timer to control the feeding of a biocide on a weekly or semi-weekly basis.

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8. Conductivity controller with indicating meter.
9. Front panel fuses.
- C. The TDS shall be monitored and controlled by a voltage-regulated, linear conductivity controller, which shall operate the bleed-off solenoid valve(s). The conductivity controller shall be fully-transistorized with plug-in printed circuit boards. The controller shall be linear over its full measuring range of 100 to 6,000 microsiemens, and shall have a built-in 20-amp heavy-duty relay. Power and bleed-off status shall be displayed by indicating lights on the front panel.
- D. The inhibitor feed shall be controlled by the makeup water flow. Provide the necessary water meter and all other required controls.
- E. The chemical feed shall be automatically controlled on an adjustable time proportioning basis utilizing the pH control mode.
- F. One (1) sample stream flow assembly consisting of a conductivity probe mounted in a flo-tee, and a pH flow cell. Sample stream flow assembly shall be completely piped with necessary nipples, elbows and shut-off valves, and shall include a fail-safe sample stream flow switch to automatically shut down if there is a loss of system flow. Control systems shall automatically return to operation upon resumption of flow.
- G. One (1) bleed-off solenoid(s) and throttling valve(s), sized for bleed-off requirements of the system.
- H. One (1) biocide 7-day timer and counter.
- I. Two (2) chemical feed pumps, positive-displacement type, with ball-type check valves, 110 V/1 phase/60 Hz fractional hp motor drives and discharge pressure relief valves. All pumps shall be suitable material of construction for the chemicals to be injected into the system. Pumps shall be in a metal enclosure with access door and factory-installed piping and wiring. Feed and frequency rates shall be suitable for flowrates shown on the contract drawings and shall be adjustable while pumps are running. Provide polyvinyl chloride (PVC) discharge tubing. Provide an individual chemical feed pump of the type specified for feeding the following:
  1. Biocide.
  2. Scale and Corrosion Inhibitor.
- J. Corrosivity monitor with alarm and control with all-silicon semi-conductor solid-state circuitry with no polarity switching circuits or moving parts. Corrosivity printed circuit board shall be independently removable. Circuit shall continuously monitor the relative corrosion rate of a pair of polarized metal electrodes (such corrosion rate being proportional to the corrosive tendency of the cooling tower water). Circuit shall have immediate response to changes in corrosivity. Corrosivity monitor shall have the following performance characteristics:
  1. Control Accuracy: Plus or minus 1 percent of full scale.
  2. Sensitivity: 0.1 percent of full scale.
  3. Stability: 0.5 percent of full scale.
- K. Injection assembly with PVC diffuser tube and check valve for injecting acid into the system.
- L. Solenoid valve with flow switch and controls to stop flow in metering line when condenser pumps are off.
- M. Provide 55-gallon drums for the inhibitor and biocide.
- N. Cooling Tower Filtration System: Garratt-Callahan Filtration System with Sweeper Jet piping for Evaporative Cooling System. Provide G.C. Model PF4030 Filtration for evaporative cooling systems.
  1. Garratt-Callahan Model PF4030 Series Filtration System to remove suspended solids from condenser water system, including filter, filter pump, strainer, valves and controls; factory assembled, piped and wired; mounted to a steel grid. Complete with a single point electrical connection. Filter will be sized to filter entire volume of system at least once per hour.
  2. Filter will automatically backwash collected solids based on differential pressure across media or on a timer basis.
  3. Silica filter media, removing 95% of solids d10 micron or larger.
  4. Silica filter media, removing 95% of solids d10 micron or larger.
  5. Tank will be Carbon Steel, epoxy lined.

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6. Pump: All bronze centrifugal pump with TEFC motor strainer mounted and manual reset motor overload switch and pilot light.
7. Sweeper Piping shall be copper.
8. Sweeper Jets Garratt-Callahan Model 0750.

### 2.7 HOT WATER HEATING AND CHILLED WATER SYSTEMS

- A. Provide the following equipment for each system as described below:
- B. Provide a complete chemical feed system for all closed loops. Package will consist of double containment tanks, level gauge, metering pump, and hand turn-pump timer.
- C. Provide fiberglass or PVC containment tray for tanks to sit in.
- D. One (1) corrosion coupon rack with holders and coupons sufficient for one-years testing at 60-day intervals.
- E. One (1) sidestream filter

## PART 3 - EXECUTION

### 3.1 FINAL TREATMENT

- A. Closed Loop Systems: Garratt-Callahan Formula 12-L and 315.
- B. Open Loop Systems: Sequestering agent to inhibit scaling and corrosion. Garratt-Callahan formula 2930-L 2 Biocides. Non oxidizing and oxidizing biocides: Garratt Callahan formula 315 and formula 3338.

### 3.2 WATER ANALYSIS

- A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

### 3.3 INSTALLATION

- A. Install treatment equipment level and plumb.
- B. Add cleaning chemicals as recommended by manufacturer.
- C. Provide all piping, wiring, and accessories necessary to provide a complete and operational sand filtration system and sump sweep system. Install per manufacturer's installation instructions.

### 3.4 MODIFICATIONS TO EXISTING SYSTEMS:

- A. Provide chemical treatment for the new piping added to the existing heating water systems based on the volume of water in the new piping that was added. Use the existing equipment and method of adding chemicals. The treatment specialist shall recommend the proper treatment for the systems and initiate the various treatments, including the required chemicals. Chemicals used shall be the same as the chemicals currently being used in the existing systems. G.C. Formula 12-L and 315

### 3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.

### 3.6 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.
  1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
  2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
- B. Test chemical feed piping as follows:

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1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
5. Repair leaks and defects with new materials and retest piping until satisfactory results are obtained.
6. Prepare test reports, including required corrective action.

### 3.7 ADJUSTING

- A. Sample water at one-week intervals after system startup for a period of five weeks, and prepare certified test report for each required water performance characteristic. Where applicable, comply with ASTM D 3370 and the following standards:
  1. Silica: ASTM D 859.
  2. Steam System: ASTM D 1066.
  3. Acidity and Alkalinity: ASTM D 1067.
  4. Iron: ASTM D 1068.
  5. Water Hardness: ASTM D 1126.
- B. Occupancy Adjustments: Within 12 months of Substantial Completion, perform two separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Perform analyses at least 60 days apart. Submit written reports of water analysis.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
  1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
- B. Review manufacturer's safety data sheets for handling of chemicals.
- C. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Section 01 77 00 "Contract Closeout."
- D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Section 01 78 23 "Operation and Maintenance Data."
- E. Schedule at least four hours of training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION



## SECTION 23 31 13 METAL DUCTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 07 92 00 for fire-resistant sealants for use around duct penetrations and fire-damper installations in fire-rated floors, partitions, and walls.
  - 2. Section 08 31 13 for wall- and ceiling-mounted access doors for access to concealed ducts.
  - 3. Section 08 91 19 for intake and relief louvers and vents connected to ducts and installed in exterior walls.
  - 4. Section 23 07 19 "Duct Insulation for Mechanical Systems" for duct insulation.
  - 5. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for vibration isolation and seismic restraints of metal ducts.
  - 6. Section 23 31 19 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
  - 7. Section 23 33 00 "Air Duct Accessories" for volume dampers, fire dampers, combination fire/smoke dampers, duct silencers, duct-mounted access doors and panels, turning vanes, screened openings, flexible connectors, and flexible ducts.
  - 8. Section 23 36 00 "Air Terminal Units" for air terminals and additional installation requirements.
  - 9. Section 23 37 13 "Diffusers, Registers, and Grilles."
  - 10. Section 23 09 00 "Instrumentation and Control for HVAC" for automatic control dampers and operators.
  - 11. Section 23 05 94 "Testing, Adjusting, and Balancing for Support for Owner" for air balancing and final adjusting of manual-volume dampers.

#### 1.2 SUMMARY

- A. This Section includes fabrication and installation of rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air-conditioning systems in pressure classes from minus 2-inch to plus 10-inch wg.

#### 1.3 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select and size air-moving and -distribution equipment and other components of air system. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Duct Pressure Classifications:
  - 1. Rectangular Duct Static-Pressure Classifications: Construct ducts to the following:
    - a. Supply Ducts, unless indicated otherwise: 3-inch wg.
    - b. Supply Ducts: 10-inch wg for ducts between the supply fan and first combination fire/smoke damper in each branch downstream of the supply fan.
    - c. Supply Ducts: 4-inch wg ducts between the first combination fire/smoke damper in each branch downstream of the supply fan and air terminals.
    - d. Return Ducts: 2-inch wg, negative pressure.
    - e. Exhaust Ducts: 2-inch wg, negative pressure.
    - f. Outside Air Intake Ducts: 2-inch wg, negative pressure.
  - 2. Round Duct Static Pressure Classifications: Construct ducts to the following:
    - a. Supply Ducts, unless indicated otherwise: 4-inch wg.
    - b. Supply Ducts: 10-inch wg for ducts between the supply fan or air handling unit and the first combination fire/smoke damper in each branch downstream of the supply fan.

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- c. Supply Ducts: 4-inch wg for ducts between the first combination fire/smoke damper in each branch downstream of the supply fan and air terminals.
- d. Return Ducts: 2-inch wg, negative pressure.
- e. Exhaust Ducts: 2-inch wg, negative pressure.
- f. Outside Air Intake Ducts: 2-inch wg, negative pressure.
- 3. Flat Oval Static Pressure Classifications: Construct ducts to the following:
  - a. Supply Ducts, unless indicated otherwise: 4-inch wg.
  - b. Supply Ducts: 10-inch wg for ducts between the supply fan or air handling unit and the first combination fire/smoke damper in each branch downstream of the supply fan.
  - c. Supply Ducts: 4-inch wg for ducts between the first combination fire/smoke damper in each branch downstream of the supply fan and air terminals.
  - d. Return Ducts: 2-inch wg, negative pressure.
  - e. Exhaust Ducts: 2-inch wg, negative pressure.
  - f. Outside Air Intake Ducts: 2-inch wg, negative pressure.
- B. Pressure Classification:
  - 1. 3-inch wg and Greater: Seal Class A; all transverse joints, longitudinal seams and duct wall penetrations.
  - 2. Below 3-inch wg: Seal Class B; all transverse joints and longitudinal seams.

### 1.5 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Joint Sealants.
  - 2. Gaskets joint systems.
- C. Shop Drawings: In addition to requirements set forth in Section 23 05 00, shop drawings for the listed systems shall also include duct sizes, top and/or bottom elevations, pressure classifications, combination fire/smoke dampers, fire dampers and smoke dampers, building structural components, connections to equipment, seam and joint construction, location of duct accessories, including dampers, turning vanes and access doors, and required service clearances. Provide submittals of the following metal duct systems:
  - 1. Supply Air
  - 2. Return Air
  - 3. Exhaust Air
  - 4. Duct Fittings
- D. Coordination Drawings:
  - 1. Comply with requirements in Section 01 33 00 and Section 23 05 00 for providing coordination drawings for areas as indicated on the drawings. Approved duct-work shop drawings shall be used to generate coordination drawings.
- E. Reports and Certificates: Provide submittals of the following:
  - 1. Duct Leakage Test Report.
  - 2. Duct Cleanliness Tests.
  - 3. Welding certificates.

### 1.6 QUALITY ASSURANCE

- A. Fabricate ducts and fittings according to SMACNA "HVAC Duct Construction Standards--Metal and Flexible" unless otherwise indicated.
- B. Welding Standards: Qualify welding procedures and welding personnel to perform welding processes for this Project according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports; AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members; and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems" unless otherwise indicated.

## SECTION 23 31 13 METAL DUCTS

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Keep metal ducts and dust free during fabrication and storage at factory.
- B. Before shipment shrink-wrap all openings of ducts. During shipment, protect all metal ducts from weather.
- C. Store all metal ducts in dry location on-site on elevated dunnage. Protect metal ducts from moisture, dirt, and dust.
- D. Retain shrink-wrap protection of openings (where required to be protected) until immediately prior to connection of that opening to erected duct system.
- E. Remove dust from the inside of metal duct sections as they are erected. Cover all openings with 6-mil poly and duct tape at the end of each workday to prevent dust migration into ducts.
- F. Deliver and store stainless-steel sheets with mill-applied adhesive protective paper maintained through fabrication and installation.

## PART 2 - PRODUCTS

### 2.1 SHEET METAL MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. Carbon-Steel Sheets: ASTM A 1008/A 1008M, cold-rolled sheets; commercial quality; with oiled, exposed matte finish.
- C. Stainless Steel: ASTM A 480/A 480M, Type 304 or 316L, sheet form with polished finish for surfaces of ducts exposed to view; Type 304, sheet form with No. 1 finish for concealed ducts.
- D. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form with standard, one-side bright finish for ducts exposed to view and with mill finish for concealed ducts.
- E. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.2 SEALANT AND ADHESIVE MATERIALS

- A. Joint and Seam Sealants:
  - 1. Joint and Seam Sealant: Water-based vinyl or acrylic copolymer mastic formulated to withstand temperatures from minus 20 to plus 180 Degrees F, minimum of 65 percent solids, water resistant, VOC: maximum 75g/L (less water).
  - 2. Flanged Joint Gasket Material: Elastomer butyl.

### 2.3 HANGERS, SUPPORTS AND RESTRAINTS

- A. Comply with Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
- B. Building Attachments: Concrete inserts, stud-wedge or female wedge, mechanical-anchor bolts, or structural-steel fasteners appropriate for building materials. Powder actuated concrete fasteners are not allowed.
  - 1. If concrete inserts cannot be used, install mechanical-anchor (stud-wedge or female wedge type) bolts in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Concrete inserts and mechanical-anchor fasteners shall be made of steel. Stainless steel for outdoor applications.
- C. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.
  - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rod or galvanized rods with threads painted after installation.
  - 2. Straps and Rod Sizes: Comply with SMACNA "HVAC Duct Construction Standards--Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.
- D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- E. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

## SECTION 23 31 13 METAL DUCTS

1. Supports for Galvanized-Steel Ducts: Galvanized steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials, unless materials are electrolytically separated from ductwork.

### 2.4 RECTANGULAR DUCT AND FITTING FABRICATION

- A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACNA "HVAC Duct Construction Standards--Metal and Flexible," based on indicated static pressure class, unless indicated otherwise. Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
  2. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
  3. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    - a. Prefabricated transverse joints shall comply SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," for static-pressure class, leakage rating.
      - 1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        - a) Duct Mate Industries, Inc.
        - b) Ward Flange.
  4. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  5. Material Thickness: For SMACNA "HVAC Duct Construction Standard - Metal and Flexible," but not less than 26 gauge.
- B. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of unbraced panel area, unless ducts are lined.
- C. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
    - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- D. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
    - a. Rectangular Main to Rectangular Branch: 45-degree entry.
    - b. Rectangular Main to Round Branch: Conical or Bellmouth.

### 2.5 ROUND AND FLAT-OVAL DUCT FABRICATION

- A. General: Diameter as applied to flat-oval ducts in this Article is the diameter of the size of round duct that has a circumference equal to perimeter of a given size of flat-oval duct. Minimum 26-gauge duct wall thickness.
- B. Round Ducts: Fabricate supply ducts of galvanized steel according to SMACNA "HVAC Duct Construction Standards--Metal and Flexible," unless indicated otherwise.

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- C. Flat-Oval Ducts: Fabricate supply ducts with standard spiral lock seams or with butt-welded longitudinal seams according to SMACNA "HVAC Duct Construction Standards--Metal and Flexible," unless indicated otherwise.
- D. Double-Wall (Insulated) Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner liner. Dimensions indicated on internally insulated ducts are inside dimensions.
  - 1. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
  - 2. Outer Shell: Base outer-shell metal thickness on actual outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner shell and insulation, and in metal thickness specified for single-wall duct.
  - 3. Insulation: 1-inch-thick fibrous-glass insulation, unless otherwise indicated. Terminate insulation where internally insulated duct connects to single-wall duct or uninsulated components. Terminate insulation and reduce outer duct diameter to inner liner diameter.
  - 4. Solid Inner Liner (supply ducts): Fabricate round and flat-oval inner liners with solid sheet metal of thickness listed below:
  - 5. Perforated Inner Liner (exhaust or return ducts): Fabricate round and flat-oval inner liners with sheet metal having 3/32-inch-diameter perforations, with an overall open area of 23 percent. Use the following sheet metal thicknesses and seam construction:
    - a. Ducts 3 to 8 Inches in Diameter: 28-gauge with standard spiral seam construction.
    - b. Ducts 9 to 42 Inches in Diameter: 26-gauge with single-rib spiral seam construction.
    - c. Ducts 44 to 60 Inches in Diameter: 24 gauge with single-rib spiral seam construction.
    - d. Ducts 62 to 88 Inches in Diameter: 22-gauge with standard spiral seam construction.
  - 6. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.
- E. Elbow Configuration:
  - 1. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
    - a. Round Elbows, 8 Inches and Smaller: Fabricate stamped elbows for 45- and 90-degree elbows and pleated elbows for 30-, and 60-degree elbows. Stamped elbows shall be 20 gauge thick minimum with two-piece welded construction. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with mitered construction.
    - b. Round Elbows, 9 through 12 Inches: Fabricate segmented (mitered) or pleated elbows for 30, 45, 60, and 90 degrees. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with mitered construction.
    - c. Round Elbows, Larger than 12-Inches: Segmented (mitered) elbows for all bend angle configurations.
    - d. Round Elbows, Segmented (mitered) Two-Piece 90-Degree: Use only where specifically indicated. Fabricate with single turning vane.
    - e. Flat Oval Elbows: Segmented (mitered) type.
- F. Branch Configuration:
  - 1. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are not permitted.
    - a. 90-degree Tee Fittings:
      - 1) Main to Branch (branch greater than 2/3 the diameter of main or 12-inch diameter branch): Use 90 degree conical tee fitting. 90-degree conical taps or 90-degree lateral fittings can be used for all others.
      - 2) 45 degree lateral tee and 45-degree elbow in lieu of 90-degree tee fitting or tap on supply ductwork where space allows.
    - b. 45-degree Tee Fittings:

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- 1) Main to Branch (branch greater than 2/3 the diameter of main or 12-inch diameter branch): Use 45-degree lateral fitting. 45-degree lateral taps or 45-degree lateral can be used for all others.

2.6 ROUND AND FLAT-OVAL SUPPLY AND EXHAUST FITTING FABRICATION

- A. 90-Degree Tee Fittings and Taps: Fabricate to comply with SMACNA "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Round Elbow Construction: Fabricate in die-stamped, pleated, or mitered construction as indicated above. Fabricate bend radius of elbows to one and one-half times elbow diameter. Unless elbow construction type is indicated otherwise, fabricate elbows as follows:
  1. Mitered Elbow Pieces: Welded construction with 5-pieces for 90-degree elbow, 4-pieces for 60-degree elbow and 3-pieces for 45-degree elbow.
  2. Metal Thickness, Pressure Classes from Minus 2- to Plus 2-inch wg:
    - a. Ducts 3 to 26 Inches in Diameter: 24-gauge.
    - b. Ducts 27 to 36 Inches in Diameter: 22-gauge.
    - c. Ducts 37 to 50 Inches in Diameter: 20-gauge.
    - d. Ducts 52 to 60 Inches in Diameter: 18-gauge.
    - e. Ducts 62 to 84 Inches in Diameter: 16-gauge.
  3. Metal Thickness, Pressure Classes from Minus 2- to 10-inch wg:
    - a. Ducts 3 to 14 Inches in Diameter: 24-gauge.
    - b. Ducts 15 to 26 Inches in Diameter: 22-gauge.
    - c. Ducts 27 to 50 Inches in Diameter: 20-gauge.
    - d. Ducts 52 to 60 Inches in Diameter: 18-gauge.
    - e. Ducts 62 to 84 Inches in Diameter: 16-gauge.
- D. Flat-Oval Elbow Construction: Welded construction with same metal thickness as longitudinal seam flat-oval duct. Use 5-piece construction for hard bend 90-degree elbows, 4-piece construction for hard bend 45-degree elbow and 3-piece construction for easy bend 90-degree elbow.
- E. Double-Wall (Insulated) Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner liner. Dimensions indicated on internally insulated ducts are inside dimensions.
  1. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
  2. Outer Shell: Base outer-shell metal thickness on actual outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner shell and insulation. Use the same metal thicknesses for outer duct as for uninsulated fittings.
  3. Insulation: 1-inch-thick fibrous-glass insulation, unless otherwise indicated. Terminate insulation where internally insulated duct connects to single-wall duct or uninsulated components. Terminate insulation and reduce outer duct diameter to nominal single-wall size.
  4. Solid Inner Liner (supply duct): Fabricate round and flat-oval inner liners with solid sheet metal of thickness listed below:
  5. Perforated Inner Liner (exhaust or return duct): Fabricate round and flat-oval inner liners with sheet metal having 3/32-inch-diameter perforations, with an overall open area of 23 percent. Use the following sheet metal thicknesses:
    - a. Ducts 3 to 34 Inches in Diameter: 24-gauge.
    - b. Ducts 35 to 58 Inches in Diameter: 22-gauge.
    - c. Ducts 60 to 88 Inches in Diameter: 20-gauge.
  6. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.
- F. Elbow Configuration:
  1. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
    - a. Round Elbows, 8 Inches and Smaller: Fabricate stamped elbows for 45- and 90-degree elbows and pleated elbows for 30-, and 60-degree el-

## SECTION 23 31 13 METAL DUCTS

- bows. Stamped shall be 20 gauge thick minimum with two-piece welded construction. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with mitered construction.
- b. Round Elbows, 9 through 12 Inches: Fabricate segmented (mitered) or pleated elbows for 30, 45, 60, and 90 degrees. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with mitered construction.
  - c. Round Elbows, Larger than 12-Inches: Segmented (mitered) elbows for all bend angle configurations.
  - d. Round Elbows, Segmented (mitered) Two-Piece 90-Degree: Use only where specifically indicated. Fabricate with single turning vane.
  - e. Flat Oval Elbows: Segmented (mitered) type.
- G. Branch Configuration:
- 1. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are not permitted.
    - a. 90-degree Tee Fittings:
      - 1) Main to Branch (branch greater than 2/3 the diameter of main or 12-inch diameter branch): Use 90 degree conical tee fitting. 90-degree conical taps or 90-degree lateral fittings can be used for all others.
      - 2) 45 degree lateral tee and 45-degree elbow in lieu of 90-degree tee fitting or tap on supply ductwork where space allows.
    - b. 45-degree Tee Fittings:
      - 1) Main to Branch (branch greater than 2/3 the diameter of main or 12-inch diameter branch): Use 45-degree lateral fitting. 45-degree lateral taps or 45-degree lateral can be used for all others.

### 2.7 SPECIAL EXHAUST DUCT AND FITTING FABRICATION

- A. Fume Hood Exhaust Duct:
  - 1. Fabricate fume hood exhaust ducts with a minimum 18-gauge thick, stainless steel sheet. Continuously butt-weld longitudinal and transverse joints. Use appropriate filler rod for Type 316L stainless steel. Provide weld sample.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION, GENERAL

- A. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts, fittings, and accessories.
- B. Provide access panels upstream of turning vanes in exhaust and return ductwork for inspection and duct clearing.
- C. Construct and install each duct system for the specific duct pressure classification indicated.
- D. Install round and flat-oval ducts in lengths not less than 12 feet, unless interrupted by fittings.
- E. Install ducts with fewest possible joints.
- F. Install fabricated fittings for changes in directions, changes in size and shape, and connections.
- G. Install couplings tight to duct wall surface with a minimum of projections into duct.
- H. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.
- I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- J. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- K. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

## SECTION 23 31 13 METAL DUCTS

- L. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work. Allow for post-construction access to air terminals, volume dampers, and other components requiring maintenance and/or readjustment.
- M. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures, unless ductwork is intended to serve these spaces.
- N. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.
- O. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated combination fire/smoke damper or fire damper sleeve, and firestopping sealant. Fire, smoke and combination fire/smoke dampers are specified in Section 23 33 00 "Air Duct Accessories." Firestopping materials and installation methods are specified in Section 07 84 00 "Firestopping."

### 3.2 Fume Hood Exhaust Duct INSTALLATIONS

- A. Install fume hood exhaust ducts according to SMACNA "HVAC Duct Construction Standards--Metal and Flexible."

### 3.3 SEAM AND JOINT SEALING

- A. General: Seal duct seams and joints according to the duct seal class described in SMACNA "HVAC Duct Construction Standards--Metal and Flexible" corresponding to the pressure class given below.
- B. Pressure Classification:
  - 1. 3-inch wg and Greater: Seal Class A; all transverse joints, longitudinal seams and duct wall penetrations.
  - 2. Below 3-inch wg: Seal Class B; all transverse joints and longitudinal seams.
- C. Seal externally insulated ducts before insulation installation.

### 3.4 HANGING, RESTRAINING, AND SUPPORTING

- A. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards--Metal and Flexible."
- B. Install duct seismic restraints as indicated in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
- C. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- F. Install concrete inserts before placing concrete.
- G. Install mechanical-anchor fasteners after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

### 3.5 CONNECTIONS

- A. Unless indicated otherwise, connect metal ducts to rotating equipment with flexible connectors according to Section 23 33 00 "Air Duct Accessories."
- B. For branch, outlet and inlet, and terminal unit connections, comply with SMACNA "HVAC Duct Construction Standards--Metal and Flexible," unless indicated otherwise.

### 3.6 FIELD QUALITY CONTROL

- A. Leakage Test:
  - 1. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.
  - 2. Conduct tests, in presence of Architect, at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing. Test ducts in shafts prior to shaft enclosure.

## SECTION 23 31 13 METAL DUCTS

3. Maximum Allowable Leakage: Comply with requirements for Leakage Classification 3 for round and flat-oval ducts, Leakage Classification 12 for rectangular ducts in pressure classifications less than and equal to 2-inch wg (both positive and negative pressures), and Leakage Classification 6 for pressure classifications from 2- to 10-inch wg.
  4. Remake leaking joints and retest until leakage is less than maximum allowable.
  5. Leakage Test: Perform tests according to SMACNA "HVAC Air Duct Leakage Test Manual." Submit test report.
- B. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
  2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- C. Duct system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Leakage Test: Perform tests according to SMACNA "HVAC Air Duct Leakage Test Manual." Submit test report for the following:
1. Ductwork constructed with a duct static pressure classification greater than 3-inch w.g.
- 3.7 ADJUSTING
- A. Refer to Section 23 05 94 "Testing, Adjusting, and Balancing for Support for Owner" for detailed procedures.
- 3.8 DUCT CLEANING
- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
  2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
  2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  4. Coils and related components.
  5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  6. Supply-air ducts, dampers, actuators, and turning vanes.
  7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

## SECTION 23 31 13 METAL DUCTS

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
5. Provide drainage and cleanup for wash-down procedures.
6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

### 3.9 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as follows:
  - a. Welded seams and joints.
  2. Acid-Resistant (Fume-Handling) Ducts:
    - a. Type 316L, stainless-steel sheet.
    - b. Exposed to View: No. 4 finish.
    - c. Concealed: No. 2D finish.
    - d. Welded seams and joints.
- B. Intermediate Reinforcement:
  1. Galvanized-Steel Ducts: Galvanized steel.
  2. Stainless-Steel Ducts: Galvanized steel.
  3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

END OF SECTION

## SECTION 23 33 00 AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 08 31 13 "Access Doors" for wall- and ceiling-mounted access doors and panels.
  - 2. Section 08 91 19 "Louvers" for intake and relief louvers and vents connected to ducts and installed in exterior walls.
  - 3. Section 23 31 00 "Metal Ducts" for ductwork, duct liner and duct sealants.
  - 4. Section 23 36 00 "Air Terminal Units" for air terminals.
  - 5. Section 23 37 13 "Diffusers, Registers, and Grilles."
  - 6. Section 23 05 94 "Testing, Adjusting, and Balancing Support for Owner" for final positioning of manual-volume dampers.
  - 7. Section 28 31 00 "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Backdraft dampers.
  - 2. Manual-volume dampers.
  - 3. Fire dampers.
  - 4. Smoke dampers.
  - 5. Combination fire/smoke dampers.
  - 6. Turning vanes.
  - 7. Duct-mounted access doors.
  - 8. Flexible ducts.
  - 9. Flexible connectors.
  - 10. Screened openings.
  - 11. Louvered penthouses/roof ventilation hoods.
  - 12. Duct accessory hardware.

#### 1.3 SUBMITTALS

- A. Product Data: For the following:
  - 1. Backdraft dampers.
  - 2. Manual-volume dampers.
  - 3. Fire, smoke and combination fire/smoke dampers.
  - 4. Duct-mounted access doors and panels.
  - 5. Flexible connectors.
  - 6. Flexible ducts.
  - 7. Roof ventilation hoods.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:
  - 1. Special fittings and manual-volume-damper installations.
  - 2. Fire- and smoke-damper installations, including sleeves and duct-mounted access doors and panels.
- C. Product Certificates: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static-pressure loss, dimensions, and weights.

#### 1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA standards:
  - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
  - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

#### 1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

SECTION 23 33 00 AIR DUCT ACCESSORIES

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Backdraft Dampers:
    - a. Ruskin.
    - b. American Warming & Ventilating.
    - c. Greenheck.
  2. Fire Dampers:
    - a. Ruskin.
    - b. Air Balancing, Inc.
    - c. Greenheck.
    - d. National Controlled Air.
  3. Smoke Dampers:
    - a. Ruskin.
    - b. Air Balancing, Inc.
    - c. Greenheck.
    - d. National Controlled Air.
  4. Combination Fire/Smoke Dampers:
    - a. Ruskin.
    - b. Air Balance, Inc.
    - c. Greenheck.
    - d. National Controlled Air.
  5. Roof Ventilation Hoods:
    - a. Penn Ventilator.
    - b. Cook.
    - c. Greenheck.
    - d. Ruskin.
  6. Flexible Ducts:
    - a. Thermaflex.
    - b. Flexmaster.
    - c. Wiremold.

2.2 SHEET METAL MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- C. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish for ducts exposed to view and mill finish for concealed ducts.
- D. Extruded Aluminum: ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Description: Suitable for horizontal or vertical installations as indicated.
- B. Counterbalance Type: Extruded aluminum with counterbalanced blades; blades begin to open at minimum 0.01 inches w.g. and be fully open at minimum 0.05 inches w.g. Designed for maximum 3500 feet per minute spot velocity and up to 4-inches w.g. back pressure.
  1. Frame: Minimum 0.125 inches thick extruded aluminum, braced at corners.

## SECTION 23 33 00 AIR DUCT ACCESSORIES

2. Blades: Minimum 0.070 inches thick extruded aluminum. Blade seals extruded vinyl, mechanically attached.
  3. Bearings: Corrosion resistant, long life synthetic.
  4. Linkage: 1/2-inch diameter tie bar with stainless steel pivot pins; mounted on blades. Adjustable counterbalance.
- C. Top-of-Blade Hinged Type: Extruded aluminum heavy duty backdraft dampers; blades begin to open at minimum 0.12 inches w.g. and be fully open at minimum of 0.20 inches w.g. Designed for maximum 3500 feet per minute spot velocity.
1. Frame: Minimum 0.125 inches thick extruded aluminum, braced at corners.
  2. Blades: Minimum 0.70 inches thick extruded aluminum. Blade seals extruded vinyl, mechanical attached.
  3. Bearings: Corrosion resistant, long life, synthetic.
  4. Linkage: 1/2-inch diameter tie bar with stainless steel pivot pins; mounted on blades.

### 2.4 MANUAL-VOLUME DAMPERS

- A. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
1. Pressure Classifications of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- B. Steel Standard Volume Dampers: Multiple- or single-blade, opposed-blade design unless indicated otherwise, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 16 gauge thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
  2. Roll-Formed Steel Blades: 16 gauge thick, galvanized, sheet steel.
  3. Blade Axles: Galvanized steel.
  4. Tie Bars and Brackets: Galvanized steel.
- C. Jackshaft: 1-inch diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper of a multiple-damper assembly.
- D. Damper Regulators: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

### 2.5 FIRE DAMPERS

- A. General: Labeled to UL 555. "Standard for Fire Dampers" for use in dynamic systems. Damper shall close with air velocity of 2375 fpm and 4-inch w.g. static pressure with airflow horizontal, airflow up or airflow down.
- B. Fire Rating: 1-1/2 and 3 hours.
- C. Frame: SMACNA Type B with blades out of airstream; fabricated with roll-formed, minimum 20-gauge thick galvanized steel; with mitered and interlocking corners.
- D. Mounting Sleeve: Factory- or field-installed galvanized, sheet steel.
1. Minimum Thickness: 20-gauge or 0.138 inch thick as indicated, and length to suit application. Provide retaining angles.
  2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
- E. Mounting Orientation: Vertical or horizontal as indicated.
- F. Blades: Roll-formed, interlocking, minimum 24-gauge thick, galvanized, sheet steel. In place of interlocking blades, use full-length, minimum 24-gauge thick, galvanized steel blade connectors.
- G. Closure Spring: Include stainless-steel constant force closure spring.

SECTION 23 33 00 AIR DUCT ACCESSORIES

- H. Fusible Link: Replaceable, 165 deg F rated unless specifically indicated, 212 deg F or 285 deg F.

2.6 SMOKE DAMPERS

- A. General: Labeled to UL 555S. Dampers shall have the ability to operate against pressures up to 4-inches w.g. and velocities up to 2,000 fpm. Class I leakage rating. Controlled gradual closure between 10 and 15 seconds. Automatic remote reset after test, smoke detection, or power failure.
- B. Temperature Rating: 350 degrees F.
- C. Frame: Minimum 16-gauge thick, galvanized, sheet steel.
- D. Blades: Minimum 14-gauge thick, galvanized sheet steel. Airfoil type blades. Flexible stainless steel compression type joint seals. Silicone blade edge seals capable of withstanding 450 degrees F. Opposed blade action.
- E. Mounting Sleeve: Factory-installed, minimum 18-gauge thick, galvanized, sheet steel; length to suit wall or floor application.
- F. Blade Position Indicator Switch: Provide blade position two-position indicator switch for remote monitoring of blade position.
- G. Damper Motors: Provide for two-position action.
  - 1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 2. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
  - 3. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  - 4. Two-Position Motor: 115 V, single phase, 60 Hz.

2.7 COMBINATION FIRE/SMOKE DAMPERS

- A. General: Labeled to UL 555 "Standard for Fire Damper" for 1-1/2 or 3 hour fire damper. Labeled to UL 555S "Standard for Leakage Rated Dampers for use in Smoke Control Systems". Open and close under operating conditions up to 4-inches w.g. in closed position and 4000 fpm in open position. Class I leakage rating. Controlled gradual closure between 10 and 15 seconds. Automatic remote reset after test, smoke detection or power failure.
- B. Fire Rating: 1-1/2 and 3 hours.
- C. Fusible Link: Replaceable, 165 deg F rated unless specifically indicated 212 deg F or 285 deg F.
- D. Frame: Minimum 16-gauge thick, galvanized, sheet steel.
- E. Blades: Minimum 14-gauge single piece airfoil construction. Opposed blade action, unless indicated specifically parallel. Stainless steel bearings. Flexible stainless steel compression type joints seals. Silicone blade edge seals, capable of withstanding 450 deg F.
- F. Mounting Sleeve: Factory-installed, minimum 20-gauge thick, galvanized, sheet steel; length to suit wall or floor application.
- G. Blade Position Indicator Switch: Provide blade position two-position indicator switch for remote monitoring of blade position.
- H. Damper Motors: Provide for two-position action.
  - 1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 2. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
  - 3. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  - 4. Two-Position Motor: 115 V, single phase, 60 Hz.

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### 2.8 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide, curved blades set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into side strips suitable for mounting in ducts.
- C. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

### 2.9 ROOF VENTILATION HOODS

- A. General Description: Louvered penthouse, low silhouette hood, or low silhouette aluminum spun housing, curb base, and accessories. Rated for 20 psf wind/snow load.
- B. Housing: Heavy-gauge, removable, louvered or spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base.
- C. Accessories:
  - 1. Bird Screens: Removable 1/2-inch mesh, 16-gauge, aluminum or brass wire.
  - 2. Backdraft Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base, factory set to close when fan stops. Provide where indicated.
  - 3. Roof Curbs: Prefabricated, heavy-gauge, galvanized steel; mitered and welded corners; 2-inch thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch wood nailer. Size as required to suit roof opening and fan base.

### 2.10 DUCT-MOUNTED ACCESS DOORS

- A. General: Fabricate doors and panels airtight and suitable for duct pressure class. 14-inch by 14-inch, unless indicated otherwise.
- B. Frame: Unless indicated differently, minimum 24-gauge thick galvanized, sheet steel, with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel where indicated. Include piano hinge and cam latches. Multiple cam latches used on doors greater than 12-inches in height.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- E. Insulation: 1-inch-thick, fibrous-glass.

### 2.11 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1. Fabricate designed to meet UL 214, NFPA 90A, airtight and waterproof.
- B. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-inches wide attached to two strips of 3-inch-wide, minimum 24-gauge thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts.
- C. Extra-Wide Metal-Edged Connectors: Factory fabricated with a strip of fabric 5-3/4 inches wide attached to two strips of 3-inch-wide, minimum 24-gauge thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts.
- D. Transverse Flanged Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 4-3/8-inch-wide, 24-gauge thick, galvanized, sheet steel or 0.032-inch aluminum sheets formed for flanged type connection. Select metal compatible with connected ducts.
- E. Conventional, Indoor System Flexible Connector Fabric: Woven nylon/polyester blend with vinyl coating.
  - 1. Minimum Weight: 22 oz./sq. yd..
  - 2. Tensile Strength: 240 lbf/inch in the warp, and 220 lbf/inch in the filling.
- F. Conventional, Outdoor System Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber, weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.
  - 1. Minimum Weight: 24 oz./sq. yd..

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2. Tensile Strength: 500 lbf/inch in the warp, and 500 lbf/inch in the filling.

### 2.12 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1, UMC Standard 6-1, and NFPA Standards 90A and 90B.
- B. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-inch-thick, glass-fiber insulation around a continuous inner liner. Rated for maximum pressures of 6-inches w.g. positive and 1-inch w.g. negative.
  1. Reinforcement: Steel-wire helix encapsulated in inner liner.
  2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
  3. Inner Liner: Polyethylene film.
- C. Flexible Ducts, Uninsulated: Spiral-wound steel spring with reinforced flameproof vinyl sheathing. Rated for maximum pressures of 10-inches w.g. positive and 2-inches w.g. negative and maximum velocity of 4000 fpm.

### 2.13 SCREENED OPENINGS

- A. Screened Openings: 16-gauge steel angle frame enclosing 1/2-inch mesh, 14-gauge galvanized steel wire screen.

### 2.14 ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness.
- B. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.
- D. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.
- E. Concealed Damper Regulators: Gear operated linkage, minimum 3/8-inch diameter, steel rod, chrome plated ceiling cover, flush mount.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Volume Dampers:
  1. Install volume dampers at all diffuser and grille duct connections. Place as far upstream as layout and accessibility allow.
  2. Install manual volume dampers in lined duct; avoid damage to and erosion of duct liner.
- C. Concealed Damper Regulators: Install concealed damper regulators in locations where manual volume dampers are inaccessible above ceilings or behind walls.
- D. Damper Actuators: Actuators shall not be mounted in the air stream.
- E. Maximum length of flexible duct is six feet.
- F. Provide instrument test holes where indicated.
- G. Install combination fire/smoke, fire and smoke dampers according to manufacturer's UL-approved written instructions.
  1. Install fusible links in fire dampers.
- H. Install duct access panels for access to both sides of duct coils. Install duct access panels downstream from branch volume dampers, fire dampers, smoke dampers, combination fire/smoke dampers, turning vanes, and equipment.
  1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining accessories and terminal units.
  2. Install access panels on side of duct where adequate clearance is available.

SECTION 23 33 00 AIR DUCT ACCESSORIES

- I. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Section 23 05 94 "Testing, Adjusting, and Balancing for Support for Owner."

END OF SECTION



## SECTION 23 34 00 FANS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 07 for roof curbs and equipment supports not provided with units.
  - 2. Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration and seismic restraints.
  - 3. Section 23 05 13 "Common Motor Requirements for HVAC Equipment" for fan motor requirements.
  - 4. Section 23 05 63 "Variable Frequency Drives" for variable frequency, variable speed drives.
  - 5. Section 23 09 00 "Instrumentation and Control for HVAC" for control devices.
  - 6. Division 26 sections for power supply wiring, field installed disconnects, electrical devices, and motor controllers.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Utility Set Fans.
  - 2. Wall Exhaust Fans.
  - 3. Cabinet Fans.
  - 4. Square In-Line Fans.
  - 5. Tubular In-Line Centrifugal Fans.
  - 6. Mixed Flow Fans.
  - 7. Vaneaxial Fans.
  - 8. Centrifugal Fans.
- B. Products furnished, but not installed, under this Section include roof curbs for roof-mounted exhaust fans.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations.
- B. Operating Limits: Classify according to AMCA 99.
- C. Fan Schedule: The following information is described in an equipment schedule on the Drawings.
  - 1. Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
  - 2. Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

#### 1.4 SUBMITTALS

- A. General: See Section 15050 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Utility Set Fans.
  - 2. Wall Exhaust Fans.
  - 3. Cabinet Fans.
  - 4. Square In-Line Fans.
  - 5. Tubular In-Line Centrifugal Fans.
  - 6. Mixed Flow Fans.
  - 7. Vaneaxial Fans.
  - 8. Centrifugal Fans.
- C. Shop Drawings: None required.
- D. Reports and Certificates: Provide submittals of the following:
  - 1. Factory authorized service representative report.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL.

## SECTION 23 34 00 FANS

- B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled by UL.
    - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - C. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.
  - D. NEMA Compliance: Provide components required as part of fans that comply with applicable NEMA standards.
  - E. Testing Requirements: The following factory tests are required as indicated:
    - 1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA Seal.
    - 2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
- 1.6 PROJECT CONDITIONS
- A. Field Measurements: Verify dimensions by field measurements. Verify clearances.
  - B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.
- 1.7 COORDINATION AND SCHEDULING
- A. Coordinate the size and location of structural steel support members.
  - B. Coordinate the installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.
- 1.8 EXTRA MATERIALS
- A. Furnish one set of belts for each belt-driven fan that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with moisture proof protective crating and covering.
  - B. Lift and support units with the manufacturer's designated lifting or supporting points.
  - C. Fans shall not be exposed to moisture or dust during construction or storage.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Utility Set Fans:
    - a. ACME Engineering & Mfg. Corp.
    - b. Aerovent, Inc.
    - c. Cook (Loren) Co.
    - d. Greenheck Fan Corp.
    - e. Twin City.
  - 2. Wall Exhaust Fans:
    - a. ACME Engineering & Mfg. Corp.
    - b. Cook (Loren) Co.
    - c. Greenheck Fan Corp.
    - d. Penn Ventilation.
    - e. Twin City.
  - 3. Cabinet Fans:
    - a. ACME Engineering & Mfg. Corp.
    - b. Cook (Loren) Co.
    - c. Greenheck Fan Corp.

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- d. Penn Ventilation.
- 4. Square In-Line Fans:
  - a. ACME Engineering & Mfg. Corp.
  - b. Cook (Loren) Co.
  - c. Greenheck Fan Corp.
  - d. Penn Ventilation.
  - e. Twin City.
- 5. Tubular In-Line Centrifugal Fans:
  - a. ACME Engineering & Mfg. Corp.
  - b. Aerovent.
  - c. Barry Blower.
  - d. Cook (Loren) Co.
  - e. Greenheck Fan Corp.
  - f. Twin City.
- 6. Mixed Flow Fans:
  - a. Twin City.
  - b. Cook (Loren) Co.
  - c. Greenheck Fan Corp.
- 7. Vaneaxial Fans:
  - a. Barry Blower.
  - b. Chicago Blower Corp.
  - c. Joy Mfg. Corp.
  - d. Wood.
  - e. Greenheck Fan Corp.
  - f. Twin City.
- 8. Centrifugal Fans:
  - a. ACME Engineering & Mfg. Corp.
  - b. Aerovent.
  - c. Barry Blower.
  - d. Cook (Loren) Co.
  - e. Greenheck Fan Corp.
  - f. Trane Co. (The).
  - g. Twin City.

2.2 UTILITY SET FANS

- A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and accessories.
- B. Construction: Minimum 14-gauge steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
  - 1. Housings Discharge Arrangement: Adjustable to 8 standard positions.
- C. Fan Wheels: Single width, single inlet, welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
  - 1. Blade Materials: Steel.
  - 2. Blade Type: Die formed, backward inclined or forward curved, as scheduled.
- D. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
  - 1. Open drip proof.
- E. Fan Shaft: Turned, ground, and polished steel keyed to wheel hub.
- F. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
  - 1. Service Factor Based on Fan Motor: 1.5.
  - 2. Motor Pulleys: Adjustable pitch for use with motors through 5 horsepower (HP); fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
  - 3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  - 4. Belt Guards: Fabricate of steel for motors mounted on the outside of the fan cabinet.

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- H. Finish: Baked polyester powder coating, electrostatically applied.
  - I. Accessories: The following accessories are required as indicated:
    - 1. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades and felt edges in steel frame installed on fan discharge.
    - 2. Access Doors: Gasketed doors with latch-type handles.
    - 3. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
    - 4. Spark-Resistant Construction: AMCA 99 construction, as indicated.
    - 5. Inlet Screens: Removable wire mesh.
    - 6. Drain Connections: 3/4-inch threaded coupling drain connection installed at lowest point of housing.
    - 7. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
    - 8. Drain Connection: Threaded drain connection with plug.
- 2.3 WALL EXHAUST FANS
- A. Description: Belt-driven or direct-drive centrifugal fans as indicated, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, curb base, and accessories.
  - B. Construction: Minimum 16-gauge, spun-aluminum, two-piece cap including windband, wall flange; inlet cone, and integral conduit chase.
  - C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
  - D. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
    - 1. Open drip proof.
  - E. Belt-Driven Units: Motor mounted out of airstream on vibration isolator with the following features:
    - 1. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000.
    - 2. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
    - 3. Belts: Oil and heat resistant, nonstatic type.
  - F. Direct-Drive Units: Motor mounted in airstream on vibration isolators.
  - G. Bird Screen: 1/2-inch wire mesh, aluminum or brass wire.
  - H. Accessories: The following items are required as indicated:
    - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount as indicated on plans.
    - 2. Damper: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- 2.4 SQUARE IN-LINE FANS
- A. Description: Square in-line, belt-driven or direct-drive centrifugal fans as indicated, consisting of housing, wheel, fan shaft, bearings, drive assembly, motor, mounting brackets, and accessories.
  - B. Construction: Minimum 18-gauge steel with integral duct collars. Bolted access doors on three sides, sealed with closed cell neoprene gasketing.
  - C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
  - D. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
    - 1. Open drip proof.
  - E. Belt-Driven Units: Motor mounted out of airstream on vibration isolator with the following features:
    - 1. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000.
    - 2. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
    - 3. Belts: Oil and heat resistant, nonstatic type.
  - F. Direct-Drive Units: Motor mounted in airstream on vibration isolators.
  - G. Finish: Baked polyester powder coating, electrostatically applied.
  - H. Accessories: The following accessories are required as indicated:
    - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount as indicated on plans.

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2. Insulated Housing: Fan housing and motor cover lined with fiberglass duct liner.
3. Inlet/Discharge Guards: Minimum 16-gauge 1/2-inch by 1-inch screen, complete with mounting frame.

### 2.5 CABINET FANS

- A. Description: Duct mounted, belt-driven centrifugal cabinet fans as indicated, consisting of housing, wheel, fan shaft, bearings, drive assembly, motor, mounting brackets, and accessories.
- B. Construction: Minimum 18-gauge galvanized steel with integral duct collars, two removable access panels, and mounting brackets.
- C. Fan Wheel: Steel scroll fan, double-width, double-inlet (DWDI), forward curved centrifugal type mounted on internal vibration isolators.
- D. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
  1. Open drip proof.
- E. Bearings: Permanently lubricated, sealed ball type, minimum L50 life in excess of 200,000 hours.
- F. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
- G. Belts: Oil and heat resistant, nonstatic type.
- H. Finish: Baked polyester powder coating, electrostatically applied.
- I. Accessories: The following accessories are required as indicated:
  1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount as indicated on plans.
  2. Insulated Housing: Fan housing and motor cover lined with 1/2-inch fiberglass duct liner.
  3. Inlet/Discharge Guards: 1/2 by 1/2-inch galvanized welded wire on a galvanized frame.

### 2.6 VANEAXIAL FANS

- A. Description: Vaneaxial fans, belt-driven or direct-drive as indicated, consisting of fan wheel and housing, straightening vane section, factory-mounted motor, an inlet bell and outlet cone section, and accessories.
- B. Construction: Minimum 12-gauge steel with inlet bell and diffuser sections.
  1. Inlet Bell and Outlet Cone Connections: Outer mounting frame and companion flanges; inlet bell and outlet cone shall be bolted to the fan housing.
  2. Guide Vane Section: Integral guide vanes downstream from the fan wheel designed to straighten the airflow.
- C. Fan Hub and Blade-Bearing Assemblies: Cast aluminum, machined and fitted with threaded bearing wells to receive blade-bearing assemblies.
  1. Blades: Replaceable, cast aluminum; factory mounted and balanced to the hub assembly.
  2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the fan's speed range.
  3. Manually adjustable rotor blade.
- D. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
  1. Open drip proof.
- E. Shaft Bearings: Heavy duty regreasable ball or roller type, minimum L50 life in excess of 200,000 hours.
- F. Direct-Drive Units: Direct-driven motor located downstream of the rotor.
- G. Belt-Driven Units: Factory mounted, with final alignment and belt adjustment made after installation.
  1. Service Factor Based on Fan Motor: 1.4.
  2. Pulleys: Cast iron with split, tapered bushing, dynamically balanced at factory.
  3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
  4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  5. Belt Guards: Fabricate of steel for motors mounted on the outside of the fan cabinet.

## SECTION 23 34 00 FANS

6. Motor Mount: Adjustable base.
- H. Controllable Pitch Blades: Designed to automatically change pitch while fan is running. Pitch control actuator contained in machined aluminum rotor.
- I. Finish: Baked polyester powder coating, electrostatically applied.
- J. Accessories: The following accessories are required as indicated:
  1. Companion Flanges: Rolled-steel flanges.
  2. Inlet and Outlet Screens: Wire mesh screen on fans not connected to ductwork.
  3. Flow Measurement Port: Pressure measurement taps installed in the inlet of the fan to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are specified in other Division 23 Sections.

### 2.7 CENTRIFUGAL FANS

- A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- B. Construction: Minimum 12-gauge steel, bolted and welded construction, continuously welded seam around fan housing, spun-metal inlet bell, and doors or panels to allow access to internal parts and components. Use aluminum or stainless steel to fabricate fans downstream from humidifiers.
  1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  2. Fabrication Class: AMCA 99 Class I, Class II, or Class III.
  3. Horizontal Flanged Split Housing: Bolted construction.
  4. Plug Fans: Fabricate without fan scroll and volute housing, with steel cabinet.
- C. Fan Wheels:
  1. Backward Inclined: Steel or aluminum construction with curved inlet flange, back plate, backwardly inclined blades welded or riveted to flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws.
  2. Forward Curved: Black-enameled or galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; cast-steel hub swaged to back plate and fastened to shaft with set screws.
  3. Airfoil Wheel: Steel construction with smooth curved inlet flange; heavy back plate; hollow die-formed airfoil-shaped blades continuously welded at tip flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws.
- D. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
  1. Open drip proof.
- E. Shafts:
  1. Statically and dynamically balanced and selected for continuous operation at the maximum rated fan speed and motor horsepower (HP), with final alignment and belt adjustment made after installation.
  2. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
  3. Designed to operate at no more than 70 percent of the first critical speed at the top of the fan's speed range.
- F. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
  1. Service Factor Based on Fan Motor: 1.5.
  2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.
  3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
  4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

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5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
6. Motor Mount: Adjustable for belt tensioning.
- H. Finish: Baked polyester powder coating, electrostatically applied.
- I. Accessories:
  1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
  2. Companion Flanges: Galvanized steel, for duct connections.
  3. Fixed Inlet Vanes: Steel, with fixed cantilevered vanes welded to inlet bell.
  4. Variable Inlet Vanes: Steel, with blades supported at both ends with 2 permanently lubricated bearings. Variable mechanism terminating in single control lever with control shaft for double-width fans.
  5. Adjustable Inlet Vanes: Steel, with blades cantilevered with 2 permanently lubricated bearings. Variable mechanism out of air stream terminating in single control lever with control shaft for double-width fans.
  6. Discharge Dampers: Heavy-duty steel assembly with opposed blades constructed of 2 plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
  7. Inlet Screens: Galvanized steel welded grid screen, mounted inside shaft bearings.
  8. Scroll Drain Connection: 1-inch steel pipe coupling welded to low point of fan scroll.
  9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
  10. Spark-Resistant Construction: AMCA 99 construction, as indicated.
  11. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
  12. Weather Cover: Heavy-gage steel sheet with ventilation slots, bolted to housing.

### 2.8 TUBULAR IN-LINE CENTRIFUGAL FANS

- A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- B. Construction: Minimum 11-gauge marine alloy aluminum, bolted and welded construction with inlet and outlet flanges.
  1. Straightening vanes.
  2. Brackets suitable for horizontal or vertical mounting.
- C. Fan Wheel: Aluminum airfoil wheel welded to spun aluminum dome, bolted to aluminum hub assembly, hub keyed and locked to fan shaft.
- D. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
  1. Open drip proof.
- E. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
- F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
  1. Service Factor Based on Fan Motor: 1.5.
  2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.
  3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
  4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short

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circuiting vibration isolation. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

6. Motor Mount: Adjustable for belt tensioning.
- G. Accessories:
1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
  2. Companion Flanges: Galvanized steel, for duct connections.
  3. Fixed Inlet Vanes: Steel, with fixed cantilevered vanes welded to inlet bell.
  4. Inlet Screens: Galvanized steel welded grid screen, mounted inside shaft bearings.
  5. Scroll Drain Connection: 1-inch steel pipe coupling welded to low point of fan scroll.
  6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
  7. Spark-Resistant Construction: AMCA 99 construction, as indicated.
  8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
  9. Weather Cover: Heavy-gage steel sheet with ventilation slots, bolted to housing.
  10. Split pillow block bearings selected for a minimum of 400,000 hours average life at the maximum RPM of each pressure class.

### 2.9 MIXED-FLOW IN-LINE FANS

- A. Description: Belt driven, tubular mixed-flow in-line blower.
- B. Construction: Minimum 14-gauge marine alloy aluminum, bolted and welded construction with inlet and outlet collars.
  1. Straightening vanes.
  2. Brackets suitable for horizontal or vertical mounting.
- C. Fan Wheel: Steel, non-overloading, high efficiency mixed-flow type with contoured single thickness blades and inlet cone to provide maximum performance and efficiency.
- D. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
  1. Open drip proof.
- E. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
- F. Belt Drives: Factory-mounted, with final alignment and belt adjustment made after installation.
  1. Service Factor Based on Fan Motor: 1.5.
  2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.
  3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
  4. Belts: Oil resistant, nonsparking, and non static.
  5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements; 0.1046-inch thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
  6. Motor Mount: Adjustable for belt tensioning.
- G. Accessories:
  1. Access Door: Hinged configuration.
  2. Motor cover.
  3. Belt tunnel.
  4. Drain: Drain coupling attached to bottom of housing for threaded 3/4-inch connection.
  5. Mounting rail where motor center of gravity is offset.
  6. Inlet/Outlet safety guards.
  7. Extended Life Bearings: L10 life in excess of 200,000 hours.
  8. Shaft seal constructed of aluminum and nitrile rubber.
  9. Rub ring construction of aluminum.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the fans. Do not proceed with installation until unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

- A. Install fans according to manufacturer's written instructions.
- B. Support units using the external vibration-control devices as indicated. Vibration-control devices are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
  - 1. Support floor mounted fans on concrete housekeeping bases or roof supports using housed spring isolators. Secure units to anchor bolts installed in housekeeping base.
  - 2. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
    - a. Installation of roof curbs is specified in Division 07 Sections.
  - 3. Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.
  - 4. Ceiling Units: Suspend units from structure using steel wire or metal straps.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

## 3.3 HOUSEKEEPING BASES

- A. Coordinate size of housekeeping bases with actual unit sizes provided.

## 3.4 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Electrical: Conform to applicable requirements in Division 26 Sections.
- C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

## 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, and to report results in writing.

## 3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

## 3.7 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

## 3.8 START-UP PROCEDURES

- A. Final Checks before Startup: Perform the following operations and checks before startup:
  - 1. Verify that shipping, blocking, and bracing are removed.

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2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts, and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnects.
  3. Perform cleaning and adjusting specified in this Section.
  4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
  6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
  7. Disable automatic temperature-control operators.
- B. Starting procedures for fans are as follows:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
  2. Measure and record motor voltage and amperage.
- C. Shut unit down and reconnect automatic temperature-control operators.
- D. Refer to Section 23 05 94 "Testing, Adjusting, and Balancing Support for Owner" for procedures for air-handling-system testing, adjusting, and balancing.
- E. Replace fan and motor pulleys as required to achieve design conditions.

### 3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in the operation and maintenance manuals. Refer to Section 01 77 00 "Closeout Procedures."
- C. Schedule 8 hours training with Owner, through Architect, with at least 7 days' advance notice.
- D. Demonstrate operation of fans. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each power ventilator.

END OF SECTION

## SECTION 23 36 00 AIR TERMINAL UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 13 "Common Motor Requirements for HVAC Equipment" for air terminal motor requirements.
  - 2. Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration control devices and seismic restraints.
  - 3. Section 23 33 00 "Air Duct Accessories" for flexible connectors.
  - 4. Section 23 09 00 "Instrumentation and Control for HVAC" for control devices installed on air terminals.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Single-Duct Air Terminals.

#### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: In addition to requirements of Section 23 05 00, include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished. Provide submittals of the following:
  - 1. Single-Duct Air Terminals
- C. Shop Drawings: None required.
- D. Reports and Certificates: None required.

#### 1.4 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Section 01 25 13 "Product Substitution Procedures."
- B. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. NFPA Compliance: Install air terminals that meet NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- D. Comply with NFPA 70 for electrical components and installation.
- E. All terminals including those equipped with electric heating coils must be UL and/or ETL rated and approved as an assembly.
- F. Sound Power Levels: All sound data submitted must be ARI certified. Submit both radiated and discharge sound power levels for review. Conform to maximum allowable sound power levels shown in documents.
- G. Controls shall be factory installed. Refer to controls section of this specification. Cost associated with installation of control component associated with air terminals shall be by this section.
- H. Source Quality Control:
  - 1. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals."
  - 2. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

SECTION 23 36 00 AIR TERMINAL UNITS

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:
  - 1. Single-Duct Air Terminals:
    - a. Titus.

2.2 SINGLE-DUCT AIR TERMINALS

- A. Configuration: Volume-damper assembly inside unit casing. Locate control components inside protective metal shroud.
- B. Casings: Galvanized steel sheet metal , 22-gauge minimum thickness.
- C. Casing Lining: Non-fibrous closed-cell elastomeric or polyethylene foam insulation; minimum 3/8-inch thick; 1.5-lbcu. ft. density; comply with NFPA 90A, UL 181 and ASTM E84. Secure lining to prevent delamination, sagging, or settling.
- D. Air Inlets: Round stub connection.
- E. Air Outlets: Rectangular, S-slip and drive, duct mounting collar or flanged connection.
- F. Volume Damper: Construct of galvanized steel with sandwich gasket and self-lubricating bearings.
  - 1. Maximum Damper/Air Valve Leakage: 1 percent of nominal airflow at 3-inch wg inlet static pressure.
- G. Hot-Water Heating Coil: 1/2-inch copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
- H. Factory-mounted and -wired controls. Mount electrical components in control panel enclosure with removable cover. Control panel enclosure shall be NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit. Incorporate single-point electrical connection to power source.
  - 1. Factory-mount transformer for DDC system control voltage and DDC terminal unit controller. Provide all wiring and connections between DDC components mounted in terminal unit control enclosure and all other terminal mounted sensing, control and power devices.
  - 2. Wiring Terminations: All connection points for field wire shall be terminated on a terminal strip; terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box sized according to NFPA 70.
  - 3. Disconnect Switch: Factory-mounted, fused, disconnect switch.
- I. Inlet Air Flow Sensor: Multiport, averaging flow sensor. Accuracy  $\pm 5\%$  of full flow with 1-1/2 diameter of straight duct upstream.
- J. Single-Duct Air Terminal Boxes Noise Specification: All air terminal boxes shall have been tested in complete accordance with the latest revision of ARI Industry Standard 880-98 for Air Terminals in a laboratory that is ARI-certified to conduct the test. When operating at the design capacities scheduled below, the tested radiated and discharge sound power values shall not exceed the values scheduled in the following table. Air terminals used in a pressure-independent system shall be tested with their inlet velocity sensors installed. Data is listed by octave bands and is without corrections for room absorption or duct attenuation.

Maximum Sound Power Levels, Lw

dB re 1 picowatt

CFM	Inlet Pressure	Frequency	125	250	500	1K	2K	4K
		Band No.	2	3	4	5	6	7
2000	1.0"	Radiated	69	64	64	64	61	61
2000	1.0"	Discharge	71	66	64	64	61	61
1400	2.0"	Radiated	69	64	64	64	61	61
1400	2.0"	Discharge	71	68	65	64	61	61

## SECTION 23 36 00 AIR TERMINAL UNITS

Octave Band Center Frequency in Hz

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards; and maintain sufficient clearance for normal service and maintenance.
- B. Support terminal units using threaded rod supports with seismic restraints as specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. [Provide flexible connectors at inlet and outlet of terminal units. Provide a minimum of 3 duct diameters of straight duct after flexible connector at terminal unit inlet][Provide a minimum of 3 duct diameters of straight duct upstream of terminal unit].
- D. Do not operate units until construction is complete and site is clean. Verify clean filters are in place prior to balancing.
- E. Install adjacent piping to allow service and maintenance of air terminals.
- F. Hot-Water Piping: In addition to requirements in Section 23 21 13 "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with circuit balancing valve and union or flange.
- G. Electrical: Comply with applicable requirements in Division 26 Sections, ground equipment.

#### 3.2 FIELD QUALITY CONTROL

- A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

#### 3.3 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

#### 3.4 START-UP PROCEDURES

- A. Verify that installation of each air terminal is according to the Contract Documents.
- B. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.
- C. Check that controls and control enclosure are accessible.
- D. Verify that control connections are complete.
- E. Check that nameplate and identification tag are visible.
- F. Verify that controls respond to inputs as specified.

#### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
  - 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance. Provide 2 hours of training per air terminal type.
  - 2. Review data in the maintenance manuals. Refer to Section 01 78 23 "Operation and Maintenance Data."
  - 3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION



## SECTION 23 37 13 DIFFUSERS, REGISTERS, AND GRILLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 08 for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
  - 2. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers and grilles.
  - 3. Section 23 05 94 "Testing, Adjusting, and Balancing Support for Owner" for balancing diffusers and grilles.

#### 1.2 SUMMARY

- A. This Section includes ceiling-, floor-, sill- and wall-mounted diffusers and grilles.

#### 1.3 DEFINITIONS

- A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
- B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, sill, or floor.

#### 1.4 SUBMITTALS

- A. Product Data: For each model indicated, include the following:
  - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
  - 2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
  - 3. Schedule of diffusers and grilles indicating drawing designation, room location, quantity, model number, size, finish/color, and accessories furnished.
  - 4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

#### 1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Install diffusers and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Titus.
  - 2. Camfil Farr.

#### 2.2 MANUFACTURED UNITS

- A. Diffusers and grilles are scheduled on Drawings.

#### 2.3 SOURCE QUALITY CONTROL

- A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

#### 2.4 CEILING DIFFUSERS

- A. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- B. Ceiling Compatibility: Provide diffusers with border styles that are compatible with ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit

## SECTION 23 37 13 DIFFUSERS, REGISTERS, AND GRILLES

and adequate support. Refer to general construction drawings and specifications for types of ceiling systems, which will contain each type of ceiling air diffuser.

- C. Types: Provide ceiling diffusers of type, construction, capacity, and with accessories and finishes as indicated and scheduled.
  - 1. Ceiling Diffuser – Square Louver (TDC)
    - a. Material: Steel, 24 gauge or Aluminum, 0.040 in.
    - b. Diffuser Construction: Round neck; three concentric square cones, two inner cones removable. Cones each one piece die stamped construction. The two inner cones constructed as single piece and assembly include adjustable vanes to change airflow discharge from fully horizontal to fully vertical
    - c. Finish: Anodic acrylic paint, color to match adjacent ceiling grid or painted hard ceiling surface. Refer to architectural reflected ceiling plans and specifications.
    - d. Accessories:
      - 1) Equalizing Grid (EG).

### 2.5 LINEAR DIFFUSERS

- A. Performance: Provide linear air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- B. Ceiling Compatibility: Provide diffusers with border styles that are compatible with ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems, which will contain each type of air diffuser.
- C. Wall Compatibility: Provide diffusers with border styles that are compatible with wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction, which will contain each type of wall diffuser.
- D. Types: Provide linear diffusers of type, construction, capacity, and with accessories and finishes as indicated.
  - 1. Linear Diffuser – Slot
    - a. Materials: 0.063-inch extruded aluminum frame; aluminum end borders, end caps and support bars. Steel pattern controller.
    - b. Diffuser Construction: One piece lengths up to 6 feet long. Multiple units, placed end to end, shall be joined with alignment pins to for a continuous slot appearance. Pattern controller shall be aerodynamically curved shaped deflector capable of 180 degree pattern adjustment from the face of the diffuser and shall allow dampening if required. Maximum length of each pattern controller is 3 feet. Exposed frame shall be constructed with mitered corners.
    - c. Finish: Border, Finish: Anodic acrylic paint, color to match adjacent ceiling grid or painted hard ceiling surface. Refer to architectural reflected ceiling plans and specifications. Pattern controller, shall be black.
    - d. Accessories: Diffuser plenum; galvanized sheet metal construction, lengths and widths to match individual diffusers, no internal duct liner.
  - 2. Linear Diffuser – Architectural Type
    - a. General
      - 1) The systems shall be complete in every respect and shall include all required appurtenances. Furnish and install all plenums, hoods, blank-offs, and associated sheet metal components including all duct connections there to.
      - 2) The diffusers shall integrate into the ceiling system. Where curved linear slot diffusers are indicated, they shall be stretched curved to the exact radii required. Rolled or segmented linear slot diffusers will not be accepted.
      - 3) The linear diffusers shall have a single slot unless shown otherwise and shall be capable of being used for supply air, return air, exhaust air, or any combination thereof.

## SECTION 23 37 13 DIFFUSERS, REGISTERS, AND GRILLES

- 4) The linear diffusers shall be capable of supporting the ceiling system. Linear diffusers supported by screws in the flanges or from air plenums are unacceptable. For lay-in ceiling, provide hanger wire support clips that are integral with the linear diffusers allowing the diffusers to be supported from the building structure with ceiling wire. For hard ceilings, provide clips that are integral with the diffusers allowing the diffusers to be secured directly to the ceiling framing without the requirement for hanger supports. Provide spline clips to secure joints and ceiling tees to the diffusers.
- 5) Provide ends and corners as required. Ends shall be butt type, field installed, or mitered picture frame type factory installed, as indicated herein or shown on the drawings. Corners shall be mitered one piece unit.
  - b. Materials: Extruded aluminum frame and pattern controllers, minimum wall thickness 0.062 inches. Spring steel retainer clips.
  - c. Diffuser Construction: Modular linear slot diffuser with adjustable pattern controllers to direct air horizontally in either direction or vertical. Pattern controllers shall be maximum 24-inches long and held by spring loaded spacers. Air throw pattern shall be adjustable horizontal flow.
  - d. Finish: Flanges exposed to view shall be painted to match adjacent ceiling grid or painted hard ceiling surface. Refer to architectural reflected ceiling plans and specifications. Paint shall be anodic acrylic. All other surfaces and blank-off panels shall be painted flat black.
  - e. Accessories: Diffuser plenums, 24 gauge galvanized steel with 1/2-inch duct lining. Provide blank-offs for any openings in the plenum or diffuser body that is not meant to deliver supply air directly to the space it serves.
  - f. Return Air Slots: Same unit as adjacent supply air diffusers. Provide return hood/light shield constructed of 51% free area perforated metal painted flat black.

### 2.6 SUPPLY GRILLES

- A. Performance: Provide supply grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
- B. Wall Compatibility: Provide grilles with border styles that are compatible with wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction, which will contain each type of wall grille.
- C. Types: Provide supply grilles of type, construction, capacity, and with accessories and finishes as indicated.
  1. Supply Grille – Louvered
    - a. Materials: 20 gauge steel or 0.050 aluminum frame with heavy duty aluminum blades
    - b. Grille Construction: 1-1/4-inch wide border, corners assembled with full penetration resistance welds. Screw holes countersunk. Double deflection solid airfoil blades, front blades parallel to the long dimension, spaced on 3/4-inch centers. Blades shall extend through the side frame on each side. Blades shall be individually adjustable, held in place with tension wire, adjustable without loosening or rattling.
    - c. Finish: White, anodic acrylic paint.

### 2.7 EXHAUST/RETURN GRILLES

- A. Performance: Provide exhaust and return grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
- B. Ceiling Compatibility: Provide grilles with border styles that are compatible with ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit

## SECTION 23 37 13 DIFFUSERS, REGISTERS, AND GRILLES

- and adequate support. Refer to general construction drawings and specifications for types of ceiling systems, which will contain each type of grille.
- C. Wall Compatibility: Provide grilles with border styles that are compatible with wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction, which will contain each type of wall grille.
  - D. Accessories: Opposed blade damper, operable from the face of the diffuser (OBD) where noted on plans or schedule.
  - E. Types: Provide exhaust and return grilles of type, construction, capacity, and with accessories and finishes as indicated.
    - 1. Exhaust/Return Grille – Louvered
      - a. Materials: 22-gauge roll formed steel frame and blades or 0.040 minimum extruded aluminum frame and blades.
      - b. Grille Construction: 1-1/4-inch wide border, corners assembled with full penetration resistance welds. Screw holes countersunk. Blades at 35 degree deflection at 1/2-inch spacing or as scheduled. Blades fixed in place, parallel to the long dimension of the grille.
      - c. Finish: Anodic acrylic paint, color to match adjacent ceiling grid or painted hard ceiling surface. Refer to architectural reflected ceiling plans and specifications.
    - 2. Exhaust/Return Grille – Airfoil Louvered
      - a. Materials: 20-gauge roll formed steel frame and blades or 0.040 minimum extruded aluminum frame and blades.
      - b. Grille Construction: 1-1/4-inch wide border, corners assembled with full penetration resistance welds. Screw holes countersunk. Airfoil shape blades at 45-degree deflection at 1/2-inch spacing or as scheduled. Blades fixed in place, parallel to the long dimension of the grille.
      - c. Finish: Anodic acrylic paint, color to match adjacent ceiling grid or painted hard ceiling surface. Refer to architectural reflected ceiling plans and specifications.

### 2.8 SPECIALTY DIFFUSERS

- A. Performance: Provide diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
- B. Wall Compatibility: Provide diffusers with border styles that are compatible with wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction, which will contain each type of wall diffuser.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems, which will contain each type of ceiling diffuser.
- D. Types: Provide diffusers of type, construction, capacity, and with accessories and finishes as indicated.
  - 1. Laminar Flow Diffusers:
    - a. Materials: Manufacturer's standard hinged heavy gauge stainless steel perforated face and welded back box.
    - b. Hepa filter.
    - c. Diffuser Construction: Laminar flow capable of supply air vertically with minimum flow and noise as scheduled. Provide internal damper under stainless steel leaf spring.
    - d. Finishes: Coordinate exact color with Architect.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas where diffusers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of

## SECTION 23 37 13 DIFFUSERS, REGISTERS, AND GRILLES

equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install diffusers and grilles level and plumb, according to manufacturer's written instructions, project Coordination Drawings, original design, and referenced standards.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Duct-Mounted Supply and Exhaust/Return Grilles: Mount to duct branch with 16-gauge steel angle collar. Mounting screws to match grille frame. Screws shall not protrude more than 1/4-inch past angle collar.
- D. Install diffusers and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- E. Install in-line multiple linear diffusers with alignment pins for a straight continuous appearance.

### 3.3 ADJUSTING

- A. After installation, adjust diffusers and grilles to air patterns indicated, or as directed, before starting air balancing.

### 3.4 CLEANING

- A. After installation of diffusers and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers and grilles that have damaged finishes.

END OF SECTION



## SECTION 23 57 00 HEAT EXCHANGERS FOR HVAC

### 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. Section 23 05 00 "Common Mechanical Materials and Methods."
  - 2. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
  - 3. Section 23 05 53 "Identification for Mechanical Piping and Equipment."
  - 4. Section 23 07 16 "Equipment Insulation."
  - 5. Section 23 21 13 "Hydronic Piping."

#### 1.2 SUMMARY

- A. This Section includes the following heat exchangers:
  - 1. Shell-and-Tube Heat Exchangers
  - 2. Gasketed -Plate Heat Exchangers

#### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Heat Exchange. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- C. Shop Drawings: In addition to requirements set forth in Section 23 05 00, shop drawings for the listed systems shall also include:
  - 1. Support Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
- D. Reports and Certificates: Provide submittals of the following:
  - 1. Mechanical Seismic Qualification Certificates: For heat exchanger with support frames, accessories, and components from manufacturer as required in 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."

#### 1.4 QUALITY ASSURANCE

- A. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

### PART 2 - PRODUCTS

#### 2.1 SHELL-AND-TUBE HEAT EXCHANGERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. API Heat Transfer Inc.
  - 2. Armstrong Pumps, Inc.
  - 3. ITT Industries; Bell & Gossett.
- B. Configuration: U-tube with removable bundle.
- C. Shell Materials: Steel.
- D. Head:
  - 1. Materials: Cast iron
  - 2. Flanged and bolted to shell.
- E. Tube:
  - 1. Seamless copper tubes.
  - 2. Tube diameter is determined by manufacturer based on service.
- F. Tube-sheet Materials: Steel tube-sheets.
- G. Baffles: Steel.
- H. Piping Connections:
  - 1. Shell: Flanged inlet and threaded outlet fluid connections, threaded drain, and vent connections.
  - 2. Head: Flanged inlet and outlet fluid connections.

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- I. Support Saddles:
  - 1. Fabricated of material similar to shell.
  - 2. Foot mount with provision for anchoring to support.
  - 3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger saddles are anchored to building structure.

### 2.2 GASKETED PLATE HEAT EXCHANGERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Alfa Laval Thermal, Inc.
  - 2. API Heat Transfer Inc.
  - 3. Armstrong Pumps, Inc.
  - 4. ITT Industries; Bell & Gossett.
- B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.
- C. Frame:
  - 1. Capacity to accommodate 20 percent additional plates.
  - 2. Painted carbon steel with provisions for anchoring to support.
- D. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.
  - 1. Fabricate attachment of heat exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat exchanger carrying and guide bars are anchored to building structure.
- E. End-Plate Material: Painted carbon steel.
- F. Tie Rods and Nuts: Steel or stainless steel.
- G. Plate Material: 0.024 inch thick before stamping; Type 304 stainless steel.
- H. Gasket Material: EPDM.
- I. Piping Connections:
  - 1. Threaded port for NPS 2 and smaller. For larger sizes, furnish end-plate port with threaded studs suitable for flanged connection.
  - 2. End plate with welded carbon-steel nozzles. Threaded pipe connection for NPS 2 and smaller; carbon-steel flanged pipe connection for larger sizes.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 HEAT-EXCHANGER INSTALLATION

- A. Install shell-and-tube heat exchangers on saddle supports, anchored to concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Anchor plate and frame heat exchanger to concrete base.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.
- C. Install shutoff valves at heat-exchanger inlet and outlet connections.
- D. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.
- E. Install vacuum breaker at heat-exchanger steam inlet connection.

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F. Install hose end valve to drain shell.

3.4 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION



## SECTION 23 64 23 PACKAGED WATER CHILLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections:
  - 1. Division 28 Section "Refrigerant Detection and Alarm" for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Packaged, air-cooled, electric-motor-driven, scroll water chillers.

#### 1.3 DEFINITIONS

- A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
- D. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Scroll water chillers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 1.5 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
  - 1. Performance at ARI standard conditions and at conditions indicated.
  - 2. Performance at ARI standard unloading conditions.
  - 3. Minimum evaporator flow rate.
  - 4. Refrigerant capacity of water chiller.
  - 5. Oil capacity of water chiller.
  - 6. Fluid capacity of evaporator.
  - 7. Fluid capacity of condenser.
  - 8. Characteristics of safety relief valves.
  - 9. Minimum entering condenser-water temperature.
- B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
  - 1. Assembled unit dimensions.
  - 2. Weight and load distribution.
  - 3. Required clearances for maintenance and operation.
  - 4. Size and location of piping and wiring connections.
  - 5. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Structural supports.
  - 2. Piping roughing-in requirements.

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3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
  4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
  - D. Certificates: For certification required in "Quality Assurance" Article.
  - E. Seismic Qualification Certificates: For water chillers, accessories, and components from manufacturers.
    1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - F. Source quality-control test reports.
  - G. Startup service reports.
  - H. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
  - I. Warranty: Sample of special warranty.
- 1.6 QUALITY ASSURANCE
- A. ARI Certification: Certify chiller according to ARI 590 certification program.
  - B. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
  - C. ASHRAE Compliance:
    1. ASHRAE 15 for safety code for mechanical refrigeration.
    2. ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
    3. ASHRAE/IESNA 90.1 for energy efficiency.
  - D. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
  - E. Comply with NFPA 70.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.
  - B. Package water chiller for export shipping.
- 1.8 COORDINATION
- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
  - B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
  - C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- 1.9 WARRANTY
- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified period.
    1. Compressor Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PACKAGED AIR-COOLED WATER CHILLERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Multistack or a comparable product by one of the following:
  1. Carrier Corporation; a United Technologies company.
  2. McQuay International.
  3. Trane.
  4. York International Corporation.

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- B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
- C. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.
- D. Cabinet:
  - 1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
  - 2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
  - 3. Casing: Galvanized steel.
  - 4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
  - 5. Sound-reduction package consisting of the following:
    - a. Acoustic enclosure around compressors.
    - b. Reduced-speed fans with acoustic treatment.
    - c. Designed to reduce sound level without affecting performance.
  - 6. Security Package: Provide security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.
- E. Compressors:
  - 1. Description: Positive-displacement direct drive with hermetically sealed casing.
  - 2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
  - 3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
  - 4. Capacity Control: On-off compressor cycling.
  - 5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
  - 6. Vibration Isolation: Mount individual compressors on vibration isolators.
- F. Compressor Motors:
  - 1. Hermetically sealed and cooled by refrigerant suction gas.
  - 2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- G. Compressor Motor Controllers:
  - 1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
- H. Refrigeration:
  - 1. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
  - 2. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
  - 3. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
- I. Evaporator:
  - 1. Brazed-plate or shell-and-tube design, as indicated.
  - 2. Shell and Tube:
    - a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
    - b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
    - c. Shell Material: Carbon steel.

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- d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
- e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
- f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
- 3. Brazed Plate:
  - a. Direct-expansion, single-pass, brazed-plate design.
  - b. Type 316 stainless-steel construction.
  - c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
  - d. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
- 4. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.
- 5. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.
- J. Air-Cooled Condenser:
  - 1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig.
    - a. Construct coils of copper tubes mechanically bonded to aluminum fins.
    - b. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
  - 2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
  - 3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
  - 4. Fan Guards: Steel safety guards with corrosion-resistant coating.
- K. Electrical Power:
  - 1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
  - 2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
  - 3. Wiring shall be numbered and color-coded to match wiring diagram.
  - 4. Install factory wiring outside of an enclosure in a raceway.
  - 5. Field power interface shall be to wire lugs.
  - 6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
    - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
  - 7. Provide each motor with overcurrent protection.
  - 8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
  - 9. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
  - 10. Provide power factor correction capacitors to correct power factor to 0.90 at full load.
  - 11. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
    - a. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.
  - 12. Control Relays: Auxiliary and adjustable time-delay relays.
  - 13. Indicate the following for water chiller electrical power supply:
    - a. Current, phase to phase, for all three phases.
    - b. Voltage, phase to phase and phase to neutral for all three phases.
    - c. Three-phase real power (kilowatts).
    - d. Three-phase reactive power (kilovolt amperes reactive).

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- e. Power factor.
  - f. Running log of total power versus time (kilowatt hours).
  - g. Fault log, with time and date of each.
- L. Controls:
- 1. Stand-alone, microprocessor based.
  - 2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
  - 3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
    - a. Date and time.
    - b. Operating or alarm status.
    - c. Operating hours.
    - d. Outside-air temperature if required for chilled-water reset.
    - e. Temperature and pressure of operating set points.
    - f. Entering and leaving temperatures of chilled water.
    - g. Refrigerant pressures in evaporator and condenser.
    - h. Saturation temperature in evaporator and condenser.
    - i. No cooling load condition.
    - j. Elapsed time meter (compressor run status).
    - k. Pump status.
    - l. Antirecycling timer status.
    - m. Percent of maximum motor amperage.
    - n. Current-limit set point.
    - o. Number of compressor starts.
  - 4. Control Functions:
    - a. Manual or automatic startup and shutdown time schedule.
    - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
    - c. Current limit and demand limit.
    - d. External water chiller emergency stop.
    - e. Antirecycling timer.
    - f. Automatic lead-lag switching.
  - 5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
    - a. Low evaporator pressure or high condenser pressure.
    - b. Low chilled-water temperature.
    - c. Refrigerant high pressure.
    - d. High or low oil pressure.
    - e. High oil temperature.
    - f. Loss of chilled-water flow.
    - g. Control device failure.
  - 6. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor, control, and display water chiller status and alarms.
    - a. Hardwired Points:
      - 1) Monitoring: On/off status, common trouble alarm.
      - 2) Control: On/off operation, chilled-water discharge temperature set-point adjustment.
    - b. ASHRAE 135 (BACnet) communication interface with building management system shall enable building management system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building management system.
- M. Insulation:
- 1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
  - 2. Thickness: 3/4 inch.

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3. Factory-applied insulation over cold surfaces of water chiller components.
    - a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
  4. Apply protective coating to exposed surfaces of insulation.
- N. Accessories:
1. Factory-furnished, chilled-water flow switches for field installation.
  2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
  3. Factory-furnished spring isolators for field installation.

### 2.2 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory performance test water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
  1. Allow Owner Insert entity access to place where water chillers are being tested. Notify Architect 14 days in advance of testing.
- C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- D. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
  1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 WATER CHILLER INSTALLATION

- A. Install water chillers on support structure indicated.
- B. Equipment Mounting: Install water chiller using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
  1. Minimum Deflection: 1/4 inch.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- E. Install separate devices furnished by manufacturer and not factory installed.

### 3.3 CONNECTIONS

- A. Comply with requirements in Division 23 Section "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Division 23 Section "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to chiller to allow service and maintenance.
- D. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve. Make connections to water chiller with a union, flange, or mechanical coupling.
- E. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

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- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
  - 2. Verify that pumps are installed and functional.
  - 3. Verify that thermometers and gages are installed.
  - 4. Operate water chiller for run-in period.
  - 5. Check bearing lubrication and oil levels.
  - 6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
  - 7. Verify proper motor rotation.
  - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
  - 9. Verify and record performance of chilled-water flow and low-temperature interlocks.
  - 10. Verify and record performance of water chiller protection devices.
  - 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

END OF SECTION



## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for chiller vibration isolation requirements.
  - 2. Section 23 07 16 "Equipment Insulation for Mechanical Equipment" for chiller evaporator insulation requirements.
  - 3. Section 23 09 00 "Instrumentation and Control for HVAC" for temperature-control devices for chillers.
  - 4. Section 28 35 00 "Refrigerant Detection and Alarm" for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.

## 1.2 SUMMARY

- A. This Section includes packaged, water-cooled, electric-motor-driven, rotary-screw water chillers.

## 1.3 DEFINITIONS

- A. EER: Energy-efficiency ratio.
- B. IPLV: Integrated part-load value.

## 1.4 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Complete set of manufacturer's certified prints of water chiller assemblies, control panels, sections, and elevations, and unit isolation. Include the following:
  - 1. Assembled unit dimensions.
  - 2. Operating weight and load distribution.
  - 3. Required clearances for maintenance and operation.
  - 4. Size and location of piping and wiring connections.
  - 5. Vibration Isolation Calculations and Details: Signed and sealed by a qualified professional engineer.
    - a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
    - b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment.
  - 6. Wiring Diagrams: Power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring.
- C. Coordination Drawings: Floor plans drawn to scale and coordinated with the following:
  - 1. Structural supports.
  - 2. Piping roughing-in requirements.
  - 3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
  - 4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
- D. Certificates: For certification required in "Quality Assurance" Article.
- E. Manufacturer Seismic Qualification Certification: Submit certification that water chillers, accessories, and components will withstand seismic forces defined in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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- a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Source quality-control test reports.
- G. Startup service reports.
- H. Operation and Maintenance Data: For each water chiller to include in emergency, operation and maintenance manual.
- I. Warranties: Special warranties specified in this Section.

### 1.5 QUALITY ASSURANCE

- A. ARI Certification: Signed by manufacturer certifying compliance with requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
- C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NFPA 70.
- E. Comply with UL 1995.
- F. Green Seal Certification: Signed by manufacturer certifying compliance with Green Seal's GS-31.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Ship water chillers from the factory fully charged with refrigerant or nitrogen.

### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Carrier; a United Technologies Company.
  2. YORK International Corporation.

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### 2.2 PACKAGED WATER CHILLERS

- A. Description: Factory-assembled and -tested water chiller complete with compressor, evaporator, condenser, controls, interconnecting unit piping and wiring, indicated accessories, and mounting frame.
- B. Fabricate water chiller mounting frame and attachment to the pressure vessel with reinforcement strong enough to resist water chiller movement during a seismic event when the water chiller mounting frame is anchored to the building structure.

### 2.3 COMPRESSORS

- A. Description: Positive displacement, oil injected with direct-drive, semi-hermetic motor.
  - 1. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
  - 2. Rotors: Twin screw.
- B. Capacity Control: Hydraulically operated, modulating or stepped sliding valve to maintain chilled-water temperature set point without hunting within throttling range. Throttling range shall be from 100 to 10 percent of full load.
- C. Oil Lubrication System: Positive-displacement submersible pump with heater, oil filter, and sight glass.
- D. Refrigerant and Oil: HFC-134a.
- E. Refrigerant Compatibility: Seals, O-rings, motor windings, and internal water chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- F. Refrigerant Circuit: Two independent circuits. Each circuit shall include an electronic expansion valve, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter drier, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

### 2.4 HEAT EXCHANGERS

- A. Evaporator:
  - 1. Description: Shell-and-tube design, ASME labeled.
  - 2. Shell Material: Carbon steel.
  - 3. Tube Construction: Individually replaceable, expanded into tube sheets.
    - a. Material: Copper.
    - b. Internal Finish: Enhanced.
  - 4. Water Box: Standard, with design working pressure of 300 psig, and having grooved mechanical-joint coupling water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle.
- B. Condenser:
  - 1. Description: Shell-and-tube design, ASME labeled.
  - 2. Shell Material: Carbon steel.
  - 3. Tube Construction: Externally enhanced and individually replaceable, expanded into tube sheets.
    - a. Material: Copper.
    - b. Minimum Size: 3/4-inch OD; 0.028-inch wall thickness.
    - c. Internal Finish: Smooth.
  - 4. Water Box: Standard, with design working pressure of 300 psig, and having grooved mechanical-joint coupling water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle.

### 2.5 INSULATION

- A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type II, for sheet materials.
  - 1. Thickness: 3/4 inch.
  - 2. Adhesive: As recommended by insulation manufacturer.
  - 3. Factory apply insulation over entire surfaces of water chiller components.

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- a. Apply adhesive to 100 percent of insulation contact surface.
- b. Seal seams and joints.
- c. After adhesive has fully cured, apply two coats of protective coating to insulation.

### 2.6 ACCESSORIES

- A. Pressure Relief Valve: Single- or multiple-reseating-type, spring-loaded relief valve.

### 2.7 CONTROLS

- A. Control Panel: Stand-alone, microprocessor based. Battery backup system shall not be accepted.
- B. Enclosure: Unit-mounted, NEMA 250, Type 1 enclosure, hinged or lockable; factory wired with a single-point power connection and a separate control circuit.
- C. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad. Display the following conditions:
  1. Date and time.
  2. Operating or alarm status.
  3. Operating hours.
  4. Temperature and pressure of operating set points.
  5. Entering and leaving temperatures of chilled water.
  6. Entering and leaving temperatures of condenser water.
  7. Refrigerant pressures in evaporator and condenser.
  8. Saturation temperature in evaporator and condenser.
  9. Oil temperature and pressure.
  10. Percent of maximum motor amperage.
  11. Current-limit set point.
  12. Number of compressor starts.
  13. Compressor lockout.
  14. Loss of charge.
  15. Low fluid flow.
  16. Low oil pressure.
  17. Cooler freeze protection.
  18. High or low suction superheat.
  19. Thermistor malfunction.
- D. Control Functions:
  1. Manual or automatic startup and shutdown seven-day time schedule.
  2. Entering and leaving chilled-water temperature, control set points, and motor load limit. Chilled-water temperature shall be reset based on return-water temperature with setpoint accuracy to 0.1 degrees F.
  3. Current limit and demand limit.
  4. Condenser-water temperature.
  5. External water chiller emergency stop.
  6. ON/OFF control switch.
  7. Replaceable solid-state relay panels.
  8. Automatic circuit lead/lag.
  9. Limiting the chilled water temperature pull-down rate at start-up to adjustable range of 0.2 degrees F to 2 degrees F per minute to prevent excessive demand spikes at start-up.
  10. Demand limit control with 2-stage control (0 to 100% each) or through 4 to 20 mA input (0 to 100%).
  11. Chilled and condenser water pump start/stop control.
  12. Amperage readout per compressor with % MTA per compressor.
  13. The chiller controller shall include multiple connection ports for communicating with the local equipment network and the ability to access all chiller control functions from any point on the chiller.
  14. The control system shall allow software upgrade without the need for new hardware modules.

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- E. Manually Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
1. Low evaporator pressure; high condenser pressure.
  2. Low chilled-water temperature.
  3. Low oil differential pressure (each compressor circuit).
  4. High or low oil pressure.
  5. High oil temperature.
  6. High compressor-discharge temperature.
  7. Loss of chilled- or condenser-water flow.
  8. Electrical overload.
  9. Voltage imbalance.
  10. Ground current fault.
  11. Current imbalance.
  12. Sensor- or detection-circuit fault.
  13. Processor communication loss.
  14. Loss of refrigerant charge.
  15. Reverse rotation.
  16. Thermal overload.
- F. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control chilled-water set point and chiller-control displays and alarms.

### 2.8 MOTORS

- A. Comply with requirements in Section 23 05 13 "Common Motor Requirements for Mechanical Equipment."
1. Open-drive motors shall have flanged or flexible coupling suitable for direct connection to compressor.

### 2.9 MAGNETIC ENCLOSED CONTROLLERS

- A. Enclosure: Unit mounted, NEMA 250, Type 1, with hinged access door with lock and key or padlock and key.
- B. Control Circuit: 120 V; obtained from a field-installed control power transformer with a control power source of enough capacity to operate connected pilot and indicating and control devices.
- C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of water chiller control microprocessor.
- D. Star-Delta Controller: NEMA ICS 2, closed transition.
- E. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.
1. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  2. Light-emitting-diode indicators showing motor and control status, including the following conditions:
    - a. Controller on.
    - b. Overload trip.
    - c. Loss of phase.
    - d. Starter fault.
- F. Accessories: Devices shall be factory installed in controller enclosure, unless otherwise indicated.
1. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
    - a. Selectable, digital display of the following:
      - 1) Phase Currents, Each Phase: Plus or minus 1 percent.
      - 2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

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- 3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
  - 4) Three-Phase Real Power: Plus or minus 2 percent.
  - 5) Three-Phase Reactive Power: Plus or minus 2 percent.
  - 6) Power Factor: Plus or minus 2 percent.
  - 7) Frequency: Plus or minus 0.5 percent.
  - 8) Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
  - 9) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
- b. Mounting: Display and control unit flush or semirecessed in instrument compartment door.
2. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hard-wired connections.

### 2.10 SOURCE QUALITY CONTROL

- A. Factory test and rate water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle." Stamp with ARI label.
- B. Factory test heat exchangers hydrostatically at 1.50 times the design pressure.
- C. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- D. Factory test and inspect water boxes at 150 percent of working pressure.
- E. Rate sound power level according to ARI 575 procedure.
- F. Allow Owner access to places where water chillers are being source quality-control tested. Notify Architect 14 days in advance of testing.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Before water chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
  1. Final water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 WATER CHILLER INSTALLATION

- A. Install water chillers on concrete base. Concrete base is specified in Section 23 05 00 "Common Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 03.
- B. Concrete Bases: Anchor chiller mounting frame to concrete base.
  1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
  5. Cast-in-place concrete materials and placement requirements are specified in Division 03.

## SECTION 23 64 26 ROTARY-SCREW WATER CHILLERS – WATER COOLED

- C. Vibration Isolation: Mount water chiller on vibration isolation equipment base as specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Charge water chiller with refrigerant if not factory charged.
- F. Install separate devices furnished by manufacturer.

### 3.3 CONNECTIONS

- A. Chilled- and condenser-water piping installation requirements are specified in Section 23 21 13 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Connections: Connect inlet to evaporator with controller-bulb well, shutoff valve, thermometer, strainer, pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, flow switch, balancing valve, thermometer, pressure gage, and union or flange.
- D. Condenser Connections: Connect inlet to condenser with shutoff valve, thermometer, plugged tee, and pressure gage. Connect outlet to condenser with shutoff valve, thermometer, drain line and shutoff valve, strainer, and plugged tee.
- E. Refrigerant Pressure Relief Valve Connections: Extend vent piping to the outside without valves or restrictions.
- F. Connect wiring according to Section 26 05 21 "Low-Voltage Electrical Power Conductors and Cables."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
  - 2. Verify that pumps are installed and functional.
  - 3. Verify that thermometers and gages are installed.
  - 4. Operate water chiller for run-in period according to manufacturer's written instructions.
  - 5. Check bearing lubrication and oil levels.
  - 6. Verify that refrigerant pressure relief is vented outside.
  - 7. Verify proper motor rotation.
  - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
  - 9. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
  - 10. Verify and record performance of water chiller protection devices.
  - 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.
- E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

SECTION 23 64 26 ROTARY-SCREW WATER CHILLERS – WATER COOLED

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION

## SECTION 23 65 00 PACKAGED COOLING TOWERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections:
  - 1. Section 23 05 23 "General-Duty Valves for Mechanical Piping."
  - 2. Section 23 05 19 "Meters and Gages for Mechanical Piping."
  - 3. Section 23 05 13 "Common Motor Requirements for Mechanical Equipment."
  - 4. Section 23 25 00 "HVAC Water Treatment."
  - 5. Section 23 05 63 "Variable Frequency Drives."
  - 6. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
  - 7. Section 23 21 13 "Hydronic Piping."
  - 8. Section 23 09 00 "Instrumentation and Control for HVAC."

#### 1.2 SUMMARY

- A. This Section includes factory-fabricated, mechanical-draft cooling towers.

#### 1.3 SUBMITTALS

- A. Product Data: Include rated capacities, pressure drop, fan performance, rating curves with selected points indicated, startup instructions, furnished specialties, and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Product Certificates: Signed by manufacturers of cooling towers to include certified performance curves plotting leaving-water temperature against wet-bulb temperature.
- D. Maintenance Data: For each cooling tower to include in maintenance manuals specified in Division 01. Include part lists for tower fill, water distribution system, fans, bearings, fan drives, vibration isolators, controls, basin heaters, and accessories.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer's Certification: Certify cooling tower's thermal performance according to CTI Certification Standard STD-201.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

#### 1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.

#### 1.6 WARRANTY

- A. Warranty: Cooling Tower warranty shall be provided for one year from date of startup or 18 months from date of shipment, whichever is less. Warranty shall cover all parts and labor charges including shipping and handling costs for replacement and refrigerant loss.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cooling tower as a factory-assembled unit with protective crating and covering.
- B. Rig units for unloading and moving as recommended by equipment manufacturer.

## SECTION 23 65 00 PACKAGED COOLING TOWERS

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Induced-Draft, Cross-Flow Cooling Towers:
    - a. Marley Cooling Tower Co.

#### 2.2 INDUCED-DRAFT, CROSS-FLOW COOLING TOWERS

- A. Description: Induced-draft, cross-flow cooling tower that is factory fabricated and assembled. Air intake on two opposite sides.
- B. Fan: Cast aluminum, axial flow fan. Air shall discharge through a fan cylinder equipped with a removable fan guard.
  - 1. Drive: Belt drive with one-piece, multi-groove, solid back V-type belt with taper lock sheaves designed for 150% of the motor nameplate horsepower. The belt shall be constructed of neoprene reinforced polyester cord and be specifically designed for cooling tower service.
  - 2. Bearings: Fans(s) and shaft(s) shall be supported by heavy-duty, self-aligning, grease packed ball bearings with moisture proof seals and integral slinger collars, designed for a minimum L10 life of 40,000 hours.
  - 3. Vibration Cutout Switch: De-energize fan motor(s) if excessive vibration occurs.
    - a. Enclosure: NEMA 250, Type 4.
    - b. Vibration Detection: Sensor with a field-adjustable acceleration sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
    - c. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
    - d. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.
- C. Hot-Water Distribution System: Single water inlet connection. Metering device to evenly distribute water over the wet deck surface.
  - 1. Materials: Type 304 stainless steel.
  - 2. Lift Covers: Designed for 50 psf live load or 200 lb concentrated load.
  - 3. Hot-Water-Basin Control Valves: Manufacturers standard butterfly or globe valves arranged to balance flow to each distribution basin and shut flow off during servicing.
- D. Casing: Galvanized steel; comply with ASTM A 653/A 653M, G235 coating designation panels and frame.
  - 1. Fasteners: Stainless steel.
  - 2. Joints: Sealed watertight.
  - 3. Welded Connections: Continuous and watertight.
  - 4. Rigging Supports: For handling cooling towers at construction site.
- E. Cold Water Basin: The cold water basin shall be constructed of heavy gauge Type 304 stainless steel panels and structural members. Basin shall include a depressed center section with drain/clean-out connection. The basin area under the wet deck surface sections shall be sloped toward the depressed center section to facilitate cleaning.
  - 1. Provide basin sump sweep piping and nozzles for condenser water filtration system as indicated on drawings. Piping shall be schedule 80 PVC.
- F. Connections: Provide connection sizes as indicated.
  - 1. Make-Up Water: Side connection, threaded or flanged.
  - 2. Inlet: Top connection, flanged.
  - 3. Outlet: Side connection, flanged; removable strainer with openings smaller than nozzle orifices.
  - 4. Equalizer Line: Side connection, interconnecting flume between cells shall be equipped with a removable cover plate to permit the shutdown of one cell for maintenance purposes or to operate cells independently...
  - 5. Drain: Side connection, flanged or threaded.
  - 6. Overflow Drain: Side connection, flanged or threaded.

## SECTION 23 65 00 PACKAGED COOLING TOWERS

7. Condenser Water Filtration System: Side connection(s), threaded. Number of connections as indicated.
- G. Fill and Drift-Eliminator Material: PVC; resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E 84. Fill material fabricated, formed, and installed by manufacturer to ensure that water breaks up into droplets.
- H. Air Inlet Louvers: Air inlet louvers shall be separate from the wet deck surface and removable to provide easy access for inspection of the air/water interface at the louver surface. Louvers shall prevent water splash-out during fan cycling and be constructed of maintenance free, corrosion resistant, fiberglass reinforced polyester (FRP).
- I. Water-Level Control: Electric float switch and solenoid-operated, make-up water valve shipped loose for field installation. Provide low and high water level alarm switches to be monitored by the DDC system.

### 2.3 MOTORS

- A. Refer to Section 23 05 13 "Common Motor Requirements for Mechanical Equipment" for general requirements for factory-installed motors.
- B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- C. Enclosure Type: Totally enclosed, fan cooled, energy efficient.
- D. Motor Speed: Single speed, suitable for variable-speed drive.

### 2.4 BASIN HEATERS

- A. Heater Type: Electric immersion heaters with thermostat and low-water cutout switch, enclosed in weatherproof housing suitable for field wiring.

### 2.5 ACCESSORIES

- A. Handrails: Fabricate galvanized-steel pipe rails. Pipe-rail materials and fabrication are specified in Section 05 52 13 "Pipe and Tube Railings."
- B. Ladders and Safety Cages: Fabricate steel ladders and safety cages. Materials and fabrication are specified in Section 05 50 00.
- C. Access Door Platform: Platform shall be galvanized steel framework attached to the tower, surrounded by guardrail, kneerail, and toeboard, and with grated platform.
- D. Plenum Walkway: Provide factory installed, galvanized steel bar grating walkway extending from one endwall access door to the other end wall. Walkway supported by a galvanized steel framework, and the top of the grating shall be at or above the cold water basin overflow level.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine proposed route of moving cooling towers into place and verify that it is free of interferences.
- B. Examine elements and surfaces to support cooling tower.
- C. Verify piping and wiring roughing-in locations.
- D. Verify suitability of branch-circuit wiring.

### 3.2 INSTALLATION

- A. Install cooling towers according to manufacturer's written instructions.
- B. Install cooling towers level and plumb, and fasten to supporting structure with anchor bolts, vibration isolators and seismic restraints. Install multiple cooling towers at the same elevation.
- C. Maintain recommended clearances for service and maintenance.
- D. Install grade-mounted cooling towers on reinforced-concrete bases. Concrete, formwork, and reinforcement are specified in Section 03 30 00 "Cast-in-Place Concrete."
- E. Install cooling towers and their support structures to withstand the effects of seismic events according to authorities having jurisdiction.
- F. Electrical Wiring: Install electrical devices furnished by cooling tower manufacturer that are not factory mounted.

## SECTION 23 65 00 PACKAGED COOLING TOWERS

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping adjacent to cooling towers to allow service and maintenance.
  - 2. Install flexible pipe connections for towers mounted on vibration isolators.
  - 3. Pitch piping down to drain into sump, or provide hose and drain valves at any low points.
  - 4. Connect overflow drain and bleed lines to sanitary sewage system.
  - 5. Non-Potable Water Piping: Comply with applicable requirements of Section 22 11 16 "Water Distribution Piping." Connect to water-level control with shutoff valve and union or flange at each connection.
  - 6. Condenser-Water Piping: Comply with applicable requirements of Section 23 21 13 "Hydronic Piping." Connect to supply and return cooling-tower connections with shutoff valve, flow control valve, and union or flange on supply connection to the tower and shutoff valve and union or flange to return connection from the tower to the chiller.
- B. Electrical: Comply with applicable requirements in Division 26 sections, ground equipment.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

### 3.5 ADJUSTING

- A. Set and balance condenser-water flow to each tower inlet.
- B. Adjust water-level control for proper operating level.

### 3.6 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

### 3.7 START-UP PROCEDURES

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
  - 1. Clean entire unit and wash basins.
  - 2. Ensure accessories are properly installed.
  - 3. Check makeup water float.
  - 4. Check clearances for airflow and for tower servicing.
  - 5. Check for vibration isolation and structural support.
- B. Obtain wet-bulb, tower-size, and performance selection tables from manufacturer.
- C. Lubricate bearings on fans and shaft as recommended by manufacturer.
- D. Ensure fan wheels rotate in correct direction without vibration or binding.
- E. Adjust belts to proper alignment and tension.
- F. Start cooling-tower and condenser-water pumps. Follow manufacturers written starting procedures.
- G. Check water level in tower basin.
- H. Check operation of tower basin, makeup line, automatic freeze protect dump, and controlling device.
- I. Check operation of basin immersion heater and control thermostat.
- J. Ensure system chemical treatment is working, and measure chemical treatment levels. Check operation of tower basin automatic blow-down, and controlling device.
- K. Verify that tower discharge is not recirculating into air intakes.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

SECTION 23 65 00 PACKAGED COOLING TOWERS

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining cooling towers.
2. Review data in maintenance manuals. Refer to Section 01 78 23 Operation and Maintenance Data.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION



## SECTION 23 73 13 –MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNIT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods" for common materials and methods.
  - 2. Section 23 05 63 "Variable Frequency Drives" for VFD equipment.
  - 3. Section 23 05 13 "Common Motor Requirements for Mechanical Equipment" for details of motor requirements.
  - 4. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for inertia bases, isolation bases, vibration isolation and seismic restraints.
  - 5. Section 23 09 00 "Instrumentation and Controls for HVAC" for HVAC controls.
  - 6. Division 26 for field-installed disconnect switches, motor starters, field-mounted alternating-current starters and motor-control centers used for centralizing or grouping controls in building projects.

#### 1.2 SUMMARY

- A. This Section includes modular air-handling units with cabinet, fans, coils, filter frames and housings, dampers and miscellaneous accessories.

#### 1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each modular air-handling unit specified, including the following:
  - 1. Certified fan-performance curves with system operating conditions indicated.
  - 2. Certified fan-sound power ratings with system operating conditions indicated.
  - 3. Certified coil-performance ratings with system operating conditions indicated.
  - 4. Motor ratings and electrical characteristics plus motor and fan accessories.
  - 5. Material gages and finishes.
  - 6. Dampers, including housings, linkages, and operators.
  - 7. Performance ratings for silencers included with unit(s).
- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.
- E. Coordination Drawings, including floor plans and sections drawn to scale. Show mechanical-room layout and relationships between units and adjacent structural, mechanical, and electrical elements. Show support locations, type of support, and weight on each support.
- F. Field test reports indicating and interpreting test results relative to compliance with specified requirements.
- G. Maintenance data for modular air-handling units to include in the operation and maintenance manual specified in Division 01 Sections and Division 23 Section "Common Mechanical Materials and Methods."

#### 1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Modular air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- B. Underwriters Laboratory (UL) Compliance: All electrical components shall be UL listed and labeled.
- C. ARI Certification: Modular air-handling units and their components shall be factory tested according to the applicable portions of ARI 430, "Modular Air-Handling Units," and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute (ARI).

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- D. National Electrical Manufacturers Association (NEMA) Compliance: Construct electrical components to the applicable NEMA standards.
  - E. Comply with NFPA 70 for components and installation.
  - F. Listing and Labeling: Provide electrically operated components 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 "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
  - G. Coordination: Coordinate layout and installation of modular air-handling units with piping, ductwork, electrical equipment, structural components, and with other installations.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver air-handling unit as a factory-assembled module with protective crating and covering. Units shall be sealed with a protective water-tight membrane to prevent any and all entrainment of water within the unit(s). Unit interior shall be maintained clean and dry at all times through the completion of construction.
  - B. Lift and support units with manufacturer's designated lifting or supporting points.
  - C. Air-handling units shall be stored inside and kept dry prior to installation, and shall be kept dry and free of moisture after installation.
  - D. Install heaters and dehumidifiers as required to ensure compliance. Coordinate any electrical requirements with the electrical contractor.
- 1.6 SEQUENCING AND SCHEDULING
- A. Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into base.
  - B. Coordinate size and location of structural-steel support members.
- 1.7 EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed, are packaged and sealed with protective covering for storage, and are identified with labels describing contents.
  - B. Fan Belts: Furnish 1 set for each modular air-handling unit fan(s).

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. York.
  - 2. Trane.
  - 3. Modular Climate Changer.

### 2.2 MANUFACTURED UNITS

- A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, humidifiers, damper, plenums, filters, mixing dampers and controls.

### 2.3 CABINET ASSEMBLY

- A. General Description: Formed and reinforced galvanized steel panels, fabricated to allow removal for access to internal parts and components, with sealed joints between sections. Fabricate unit casing of 16-gauge channel posts and removable panels assembled with mechanical fasteners and a galvanize steel or painted galvanized steel. Assemble sections with high compression gasketing between each frame member and unit panel or door to prevent thermal bridging from interior to exterior of unit.
- B. Materials:
  - 1. Outside Casing: Galvanized steel, 16-gauge minimum.
  - 2. Inside Casing (General): Galvanized steel, 20-gauge as indicated.
  - 3. Floor Plate: Galvanized steel, 20-gauge, as indicated.
  - 4. Insulation:

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- a. Coated, glass-fiber insulation, complying with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," for insulation. Outer coating exposed to air stream shall contain EPA registered anti-microbial agent, so it will not support the growth of fungus or bacteria per UL 181. All insulation and accessories including adhesives and facing have a composite fire and smoke hazard rating tested by ASTM E84, NFPA 225, UL 181 and UL 723 not exceeding: Flame Spread 25, Smoke Developed 50.
  - b. Thickness: 2-inches unless otherwise indicated.
  - c. Density: 1-1/2-lb per cubic foot unless otherwise indicated.
  - d. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels.
- C. Unit Base:
1. Unit bases shall be constructed from structural steel channel iron around the entire perimeter of the unit and provided with intermediate structural channel and angle iron as required to support all internal components. All channel and angle joints shall be solid welded. Bolted or formed channel bases are not acceptable. Channel to be deep enough to allow for installation of condensate drain and trap.
- D. Fan Section:
1. Fan sections shall be of the same construction and finish as the unit. Provide access door of sufficient size for motor removal.
- E. Coil Sections:
1. Coil sections shall be of the same construction and finish as the unit. Access from both sides designed and constructed to facilitate removal and replacement of coil for maintenance.
  2. Cooling Coil Drain pans shall be 304 stainless double sloping pitch construction with solid welded seams for complete water captures and containment. Pans shall be insulated. Pans shall be constructed in accordance with ASHRAE Standard 62-2001, addendum t. Drain connection shall be a minimum 1-1/4-inch diameter MIPS thread extending out through the channel base the same side as the coil connections unless otherwise indicated on the drawings. Pans shall be provided for cooling coils, outside air intakes and under other components as required. Mastic coated drain pans are not acceptable. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.
- F. Unless otherwise noted, all sections shall be of the same construction, assembly and materials as listed above.
- G. Access Panels and Doors:
1. Access doors shall be double wall of the same construction and finish as the unit. Door panel shall be insulated with 2-inch insulation completely encapsulated between the door panels and frame sealed with a continuous bead of silicone caulking.
  2. Doors shall be provided with minimum (2) 6-inch stainless steel piano-type hinges. Stainless latch and full size handle assembly (4-5-inch minimum). Door latches on doors into fan sections shall be provided with a hasp or other mechanism to facilitate locking of the doors.
  3. Doors shall open against static pressure unless obstructed by internal components. Standard door size shall be 24-inches wide by 60-inches high unless restricted by height or section width. Doors on positive pressure sections shall have a secondary latch to relieve pressure and prevent injury upon access.
  4. Doors to fan sections shall be provided with thermal pane wire glass viewing windows as called out for on the unit drawings. Minimum window size to be 9-inch by 9-inch with 12-inch by 12-inch as standard if door size permits.
  5. All doors with access to moving parts shall have provision for padlocking and meet UL 1995 mechanical protection guidelines. The Safety "lockout" provision allows the Owner the opportunity to provide padlocks to lock doors in the closed position.
- H. Exterior Finish:

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1. Painted with two-component bond primer and manufacturers standard color industrial air-dried albrzyd enamel paint.

### 2.4 FANS

- A. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.
- B. Bearings shall be self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Grease fittings shall be attached to the fan base assembly near access door. If not supplied at the factory, contractor shall mount copper lube lines in the field.
- C. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be as required per Division 23 Section "Vibration and Seismic Controls for Mechanical Piping and Equipment."
- D. Bearings and Drives:
  1. Bearings: Basic load rating computed in accordance with AFBMA – ANSI Standards, L-50 life at 400,000 hours, heavy duty pillow block type, self-aligning, grease-lubricated ball bearings.
  2. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
  3. V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Fixed sheaves, matched belts, and drive rated based on motor horsepower. Minimum of 2 belts shall be provided on all fans with 10 HP motors and above. Drive service factor 1.1 (1/4HP – 7.5HP) times fan brake horsepower.

### 2.5 COOLING AND HEATING COILS

- A. Provide access to coils from connection side of unit for service and cleaning. Enclose coil headers and return bends bully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5-inches beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior and gasket sleeve between outer wall and liner where each pipe extends through the unit casing to minimize air leakage and condensation inside panel assembly. If not factory packaged, contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
- B. Certify air coil capacities, pressure drops, and selection procedures in accordance with ARI 410.
- C. Water Coils:
  1. Fins shall have a minimum thickness of 0.0095-inches of aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
  2. Coil tubes shall be 5/8-inch OD seamless copper, 0.035-inch nominal tube wall thickness, expanded into fins, brazed at joints. Soldered U-bends shall be provided to minimize the effects of erosion and premature failure having a minimum tube wall thickness of .025-inch. 1/2-inch tubes and hairpin construction are not acceptable.
  3. Water coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be carbon steel or copper with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point.

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4. Coil casings shall be a formed channel frame of galvanized steel.

### 2.6 DAMPERS

- A. General: Extruded aluminum automatic control dampers. Leakage rate, according to AMCA 500, "Test Methods for Louvers, Dampers and Shutters," shall not exceed 0.2 percent of air quantity at 2000-fpm face velocity through damper and 2-inch wg pressure differential.
  1. Damper operators are specified in Division 23 Section "Instrumentation and Controls for HVAC."
  2. Dampers shall be hollow core airfoil blades, fully gasketed and have continuous vinyl seals between damper blades. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided when return and outside air dampers sized for full airflow.
- B. Application: Provide indicated blade type.
  1. Mixing Dampers: Parallel-blade.
  2. Face and Bypass Dampers: Opposed-blade.

### 2.7 ELECTRICAL

- A. Motors
  1. General: Refer to Division 23 Section "Common Motor Requirements for Mechanical Equipment" for general requirements.
  2. Enclosure Type: Open drip proof.
  3. Motors: Provide ODP type with premium efficiency. Electrical characteristics shall be as shown in schedule. All motors capable of connection to a VFD.
  4. Starters, Electrical Devices, and Wiring: Requirements for electrical devices and connections are specified in Division 26 Sections.
  5. Motor Connections: Provide a single point connection for the entire unit.
- B. Starters, Electrical Devices, and Wiring: Provide electrical wiring devices and connections per Division 16 requirements.
- C. Provide factory mounted starters and disconnects.
- D. Lighting: Provide one 120V marine type light fixtures each accessible section of the unit. Switch on outside of unit near electrical connection point. Provide 120V connection point for unit at electrical connection point on unit from a separate power supply from main connection.
- E. Outlets: Provide 120V GFCI weatherproof convenience outlet in each fan section of outdoor units from a separate power supply from main connection.

### 2.8 FILTER SECTION

- A. Filter sections shall be of the same construction and finish as the unit. Side service filter sections shall include hinged access doors.
- B. Filters shall be arranged for side loading.
- C. Each filter bank to be provided with a Dwyer Series 2000 Magnehelic Air Filter Gauge with adjustable signal flag. Gauges to be flush mounted. Exterior unit gauges to be covered with a weatherproof enclosure to protect the gauge and prevent hazing of the glass.
- D. Air Filters: Refer to Division 23 Section "Particulate Air Filtrations."

### 2.9 MIXING BOX

- A. Mixing box section shall be provided with factory mounted low leak airfoil blade outside and return air dampers of galvanized steel in a galvanized frame. Dampers shall be hollow core airfoil blades, fully gasketed and have continuous vinyl seals between damper blades. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided when return and outside air dampers sized for full airflow. Return and outside air dampers of different sizes must be driven separately. For details on dampers, see the "Dampers" section of this specification.

### 2.10 ECONOMIZER

- A. Economizer section shall be provided with factory mounted low leak hollow core airfoil blade outside air and return air dampers, and exhaust damper where indicated. Return

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and outside air dampers of different sizes must be driven separately. For details on dampers, see the "Dampers" section of this specification.

### 2.11 ACCESS SECTION

- A. Access section shall provide access between components shall be as indicated in the Contract Document. Access doors of galvanized steel for flush mounting, with gasket, latch and full size (minimum of 4.5-inches) handle assembly. Heavy-duty floor thickness to be 14-gauge to accommodate walk-in weight of service technician.

### 2.12 BLENDER/AIR MIXER SECTION

- A. Blender / air mixer section to provide proper air mixing and distribution of the outside and return airstreams. Proper spacing provided in the direction of airflow as recommended by the blender manufacturer (Blender Products or Kees).

### 2.13 INLET AND DISCHARGE PLENUM SECTION

- A. Inlet and Discharge plenum sections shall be provided as indicated on the drawings. The plenum shall provide single or multiple openings, as indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions to receive equipment, for compliance with installation tolerances, access requirements, coil removal and other conditions affecting performance of modular air-handling units.
- B. Examine roughing-in of hydronic, condensate drainage piping, and electrical to verify actual locations of connections before installation.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install modular air-handling units level and plumb, according to manufacturer's written instructions.
  - 1. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and vibration isolation.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Coordinate size of housekeeping bases with actual unit sizes provided. Construct base 6 inches larger in both directions than overall dimensions of supported unit.

### 3.3 CONNECTIONS

- A. Pipe Connections: Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping adjacent to machine to allow service and maintenance of all parts of the equipment, as well as the piping installations.
  - 2. Connection piping to air-handling units with flexible connectors.
  - 3. Connect condensate drain pans using 1-1/4-inch NPS, Type L copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction. Verify depth of trap required to offset static pressure.
  - 4. Hot- and Chilled-Water Piping: Conform to applicable requirements of Division 23 Section "Hydronic Piping." Connect to supply and return coil tapings with shutoff, balancing valve and union or flange at each connection.
- B. Duct Connections: Duct installation and connection requirements are specified in other Division 23 Sections. Make duct connections to the unit with flexible connections.
- C. Electrical: Conform to applicable requirements of Division 26 Sections.
  - 1. Connect fan motors to wiring systems and to ground.
  - 2. Temperature control wiring and interlock wiring is specified in Division 23 Section "Instrumentation and Controls for HVAC."

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### 3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

### 3.5 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- C. Do not operate fan system without all filters in place. Units shall not be used for building ventilation, heating or cooling during construction without the written approval and authorization of the Owner and Architect.
- D. Wipe down all interior surfaces exposed to airflow with a 50% solution of isopropyl alcohol prior to unit start up.

### 3.6 START-UP PROCEDURES

- A. Manufacturer's Field Inspection: Engage a factory-authorized service representative to perform the following:
  - 1. Inspect field assembly of components and installation of modular air-handling units including piping, ductwork, and electrical connections.
  - 2. Prepare a written report on findings and recommended corrective actions.
- B. Final Checks before Startup: Perform the following before startup:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
  - 3. Perform cleaning and adjusting specified in this Section.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
  - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
  - 6. Set zone dampers to fully open position for each zone.
  - 7. Set face-and-bypass dampers to full face flow.
  - 8. Set outside-air and return-air mixing dampers to minimum outside-air setting.
  - 9. Comb coil fins for parallel orientation.
  - 10. Install clean filters.
  - 11. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.
- C. Starting procedures for modular air-handling units include the following:
  - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
    - a. Replace fan and motor pulleys as required to achieve design conditions.
  - 2. Measure and record motor electrical values for voltage and amperage.
  - 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- D. Refer to Division 23 Section "Testing, Adjusting, and Balancing for Mechanical" for air-handling system testing, adjusting, and balancing.

### 3.7 DEMONSTRATION

- A. Engage the services of a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
  - 1. Review data in the operation and maintenance manuals. Refer to Division 01 Section "Closeout Procedures."
  - 2. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION



## SECTION 23 73 23 CUSTOM AIR-HANDLING UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods" for common materials and methods.
  - 2. Section 23 05 13 "Common Motor Requirements for Mechanical Equipment" for fan motors.
  - 3. Section 23 05 63 "Variable Frequency Drives" for VFD equipment.
  - 4. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment" for vibration isolation equipment and seismic restraints.
  - 5. Section 23 09 00 "Instrumentation and Controls for HVAC" for HVAC controls.
  - 6. Division 26 for field-installed disconnect switches, motor starters, field-mounted alternating-current starters and motor-control centers used for centralizing or grouping controls in building projects.

#### 1.2 SUMMARY

- A. This Section includes custom air-handling units with cabinet, fans, coils, filter frames, dampers and miscellaneous accessories.

#### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data for each custom air-handling unit specified, including the following:
  - 1. Certified fan-performance curves with system operating conditions indicated.
  - 2. Certified fan-sound power ratings with system operating conditions indicated.
  - 3. Certified coil-performance ratings with system operating conditions indicated.
  - 4. Motor ratings and electrical characteristics plus motor and fan accessories.
  - 5. Material gages and finishes.
  - 6. Dampers, including housings, linkages, and operators.
  - 7. Filters
- C. Performance ratings for silencers included with unit(s).
- D. Shop Drawings: In addition to requirements set forth in Section 23 05 00, shop drawings for the listed systems shall also include:
  - 1. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.
- E. Reports and Certificates: Provide submittals of the following:
  - 1. Mechanical Seismic Qualification Certificates: For air handling units from manufacturer as required in 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment", Section 1.4C
    - a. This unit shall comply with Seismic User Group III.
  - 2. Other Certificates: ARI and ASHRAE. See "Quality Assurance" article.
  - 3. Field test and Start-up reports.

#### 1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Custom air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- B. ETL Compliance: The custom air-handling unit(s), including all components, shall be labeled by ETL.
- C. Underwriters Laboratory (UL) Compliance: All electrical components shall be UL listed and labeled.

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- D. ARI Certification: Custom air-handling units and their components shall be factory tested according to the applicable portions of ARI 430, "Custom Air-Handling Units," and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute (ARI).
- E. National Electrical Manufacturers Association (NEMA) Compliance: Construct electrical components to the applicable NEMA standards.
- F. Comply with NFPA 70 for components and installation.
- G. Listing and Labeling: Provide electrically operated components 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 "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- H. Coordination: Coordinate layout and installation of custom air-handling units with piping, ductwork, electrical equipment, structural components, and with other installations.
- I. Laboratory Acoustical Testing: Air handlers shall undergo laboratory acoustical testing of inlet, discharge and radiated noise to verify units meet the specified tolerances. Test laboratory shall be AMCA certified. Testing shall be conducted in accordance with AMCA Standard 300-96. Units shall not be shipped until test data is approved by the Owner or Owner's Representative.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver air-handling unit as a factory-assembled module with protective crating and covering. Units shall be sealed with a protective watertight membrane to prevent any and all entrainment of water within the unit(s). Unit interior shall be maintained clean and dry at all times through the completion of construction.
- B. Lift and support units with manufacturer's designated lifting or supporting points.
- C. Air-handling shall be stored inside and kept dry prior to installation, and shall be kept dry and free of moisture after installation. Install heaters and dehumidifiers as required to ensure compliance. Coordinate any electrical requirement with the electrical contractor.

### 1.6 SEQUENCING AND SCHEDULING

- A. Coordinate size and location of concrete housekeeping bases.
- B. Coordinate size and location of structural-steel support members.

### 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged and sealed with protective covering for storage, and are identified with labels describing contents.
- B. Fan Belts: Furnish 1 set for each custom air-handling unit fan(s).
- C. Gaskets: Furnish 1 for each sectional joint and one set of door gaskets for outer casing doors of each custom air-handling unit.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Haakon Industries.

### 2.2 MANUFACTURED UNITS

- A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers.
  - 1. Unit shall be completely assembled in the factory and de-mounted for shipping in the largest sections possible. Re-assembly in the field shall be per the manufacturer's recommendation.

### 2.3 CABINET ASSEMBLY

- A. General Description: Formed and reinforced galvanized steel panels, fabricated to allow removal for access to internal parts and components, with sealed joints between sec-

## SECTION 23 73 23 CUSTOM AIR-HANDLING UNITS

tions. The casing structure shall incorporate an exterior bolted standing seam construction, suitable for Class II design, with insulated thermal breaks as required. When fully assembled, no conduction path of continuous unbroken metal-to-metal contact from inner to outer surfaces exists.

### B. Materials:

1. Outside Casing: Galvanized steel, 16-gauge minimum.
2. Inside Casing (General): Galvanized steel, 0.0276-inch, 22-gauge as indicated.
3. Floor Plate: Aluminum checker plate, 0.071-inch as indicated.
4. Insulation:
  - a. Coated, glass-fiber insulation, complying with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," for insulation. Outer coating exposed to air stream shall contain EPA registered anti-microbial agent, so it will not support the growth of fungus or bacteria per UL 181. All insulation and accessories including adhesives and facing have a composite fire and smoke hazard rating tested by ASTM E84, NFPA 225, UL 181 and UL 723 not exceeding: Flame Spread 25, Smoke Developed 50.
  - b. Thickness: 4-inches unless otherwise indicated.
  - c. Density: 3-lb per cubic foot unless otherwise indicated.
  - d. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels.

### C. Unit Base:

1. Unit bases shall be constructed from ASTM A36 structural steel channel iron around the entire perimeter of the unit and provided with intermediate structural channel and angle iron as required to support all internal components. All channel and angle joints shall be solid welded. Bolted or formed channel bases are not acceptable.
2. The unit base shall be covered with indicated floor plate and a 22-gauge galvanized steel bottom plate on the underside of the base. Base shall be provided with removable lifting lugs minimum (4) per section, properly located to assure uniform loading.
3. Base void space shall be completely filled with insulation under the base floor plate and bottom plate.
4. Provide a perimeter collar around the entire unit to insure unit is water tight up to 1-1/2-inch above the floor of the unit.

### D. Fan Section:

1. Fan sections shall be of the same construction and finish as the unit. Inside side casing shall be perforated galvanized steel. Provide access door of sufficient size for motor removal.

### E. Coil Sections:

1. Coil sections shall be of the same construction and finish as the unit. Inside side casing panels shall be solid Type 304 stainless steel. Design and construct individual coil racks to facilitate removal and replacement of coil for maintenance.
2. Cooling Coil Drain pans shall construction from 16 gauge Type 304 stainless steel with double wall construction and solid welded seams for complete water capture and containment. Pans shall be insulated between the liner and the main pan. Pans shall be constructed in accordance with ASHRAE Standard 62-2001, addendum t. Drain connection shall be a minimum 1-1/4-inch diameter MIPS thread extending out through the channel base the same side as the coil connections unless otherwise indicated on the drawings. Pans shall be provided for cooling coils, outside air intakes and under other components as required. Mastic coated drain pans are not acceptable. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil and drains to main drain pan through copper piping downspouts.

### F. Filter Section:

1. Filter sections shall be of the same construction and finish as the unit. Inside side casing shall be galvanized panels. Side service filter sections shall include hinged access doors. Filter boxes shall be fabricated to flange to the air unit.

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2. Filters shall be arranged for face, side, or rear loading. Face or rear loading shall be used for walk-in unit. Side access housing shall only be used for units that do not have walk-in access.
    - a. Face or rear loading to be in gasketed Universal Holding Frames. Holding frames constructed of 16-gauge galvanized steel minimum. Equip with polyurethane foam sealing gaskets and filter centering dimples. Filter fasteners shall be capable of being installed without tools or additional nuts and bolts. Provide vertical stiffeners for filter assemblies over 3 frames high.
    - b. Side access housing constructed of 16-gauge galvanized steel. Access doors on both sides; weatherproof housing. Prefilters serviceable without disturbing final filters.
    - c. The filter rack assemblies shall be blanked off to the sides, roof, and floor and properly sealed to minimize filter bypass.
  3. Each filter bank to be provided with a Dwyer Series 2000 Magnehelic Air Filter Gauge with adjustable signal flag. Gauges to be flush mounted. Provide gauge range to match the type used in filter in filter bank from unloaded to loaded filter conditions. Exterior unit gauges to be covered with a weatherproof enclosure to protect the gauge and prevent hazing of the glass.
  4. Air Filters: Refer to Section 23 41 00 "Particulate Air Filtrations."
- G. Mixing and General Plenum Sections:
1. Mixing and general plenums shall be of the same construction and finish as the unit. Inside casing shall be perforated galvanized steel. Provide access door in mixing plenums.
- H. Access Panels and Doors:
1. Access doors shall be double wall constructed with 16-gauge galvanized interior panel and panel frames with continuously welded corners for rigidity. Door panel shall be insulated with 4-inch insulation completely encapsulated between the door panels and frame sealed with a continuous bead of silicone caulking.
  2. Doors shall be provided with minimum (2) dual acting chrome-plated latches through 48-inches high, (3) latches through 72-inches high. Latches shall be operable from both the interior and exterior of unit. Door latches on doors into fan sections shall be provided with a hasp or other mechanism to facilitate locking of the doors. Door hinge shall be heavy-duty stainless steel.
  3. Doors to be provided with double high performance closed cell replaceable neoprene bulb type gasket seals around the entire perimeter of the door/frame. One system will be placed on the door and one system will be placed on the frame.
  4. Doors shall open against static pressure unless obstructed by internal components. Standard door size shall be 24-inches wide by 60-inches high unless restricted by height or section width.
  5. Doors shall be provided with thermal pane wire glass viewing windows as called out for on the unit drawings. Minimum window size to be 9-inch by 9-inch with 12-inch by 12-inch as standard if door size permits.
  6. All doors with access to moving parts shall have provision for padlocking and meet UL 1995 mechanical protection guidelines. The Safety "lockout" provision allows the Owner the opportunity to provide padlocks to lock doors in the closed position.
- I. Exterior Finish:
1. Indoor Units: The exterior shall be painted with two-component bond primer and manufacturers standard color industrial air-dried alkyd enamel paint.
  2. Outdoor Units: All exterior surfaces shall be prime coated and painted at the factory. Provide a 5-year warranty against peeling and cracking of the factory applied finish. The finish color shall be as directed by the Architect.

### 2.4 FANS

- A. Fan Description: Direct Drive housed centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure, equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan wheel, shaft, bearings, and motor on structural-steel equipment base

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- which is mounted to unit structural floor with vibration isolation (see Section 23 05 48 for vibration isolation and seismic restraint requirements).
- B. Plug Fan Construction: Belt drive plug fans shall be single width single inlet Arrangement 3 or Arrangement 1 plenum fans as indicated on the schedule. Direct drive plug fans shall be single width single inlet Arrangement 4.
1. Fabricate without fan scroll and volute housing.
  2. Fabrication Class: AMCA 99 Class I, Class II, or Class III. As scheduled or required by duty point. Fans within 10% of class rpm limitation shall be provided as the next higher class.
  3. Use galvanized steel to fabricate fans downstream from humidifiers.
  4. Provide inlet guards.
- C. Housed Fan Construction: Minimum 12-gauge steel, bolted and welded construction, continuously welded seam around fan housing, spun-metal inlet bell, and doors or panels to allow access to internal parts and components. Use galvanized steel to fabricate fans downstream from humidifiers. The structure supporting the bearing shall be fabricated from structural steel and be detachable to allow for removal of the fan wheel and shaft as one piece. The fan discharge shall be isolated from the cabinet by means of a neoprene-coated flexible connection
1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  2. Fabrication Class: AMCA 99 Class I, Class II, or Class III. As scheduled or required by duty point. Fans within 10% of class rpm limitation shall be provided as the next higher class.
  3. Horizontal Flanged Split Housing: Bolted construction.
  4. Use galvanized steel to fabricate fans downstream from humidifiers.
- D. Fan Wheels:
1. Airfoil Wheel: Steel construction with smooth curved inlet flange; heavy back plate; hollow die-formed airfoil-shaped blades continuously welded at tip flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws.
- E. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at the maximum rated fan speed and motor horsepower (HP), with final alignment and belt adjustment made after installation.
  2. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
  3. Designed to operate at no more than 70 percent of the first critical speed at the top of the fan's speed range.
- F. Bearings: Heavy duty re-greasable ball type, pillow block cast iron housing, minimum L10 life in excess of 200,000 hours. Extend lube lines to single readily accessible point.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
1. Service Factor Based on Fan Motor: 1.5.
  2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.
  3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
  4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan housing or fan supports without short circuiting vibration isolation. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
  6. Motor Mount: Adjustable for belt tensioning.
- H. Finish: Baked polyester powder coating, electrostatically applied.
- I. Accessories:

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1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Provide motor lift rails mounted to the cabinet, above the motors.
3. Companion Flanges: Galvanized steel, for duct connections.

### 2.5 MOTORS

- A. General: Refer to Section 23 05 13 "Common Motor Requirements for Mechanical Equipment" for general requirements. Provide premium efficiency motors as specified. Motors shall be compatible for VFD drives.
- B. General: Refer to Section 23 05 63 "Variable Frequency Drives" for VFD equipment. Provide VFDs mounted to the exterior of the units. One VFD per motor. Provide ventilation of the VFD cabinet from the unit.
- C. Enclosure Type: Open drip proof.
- D. Starters, Electrical Devices, and Wiring: Requirements for electrical devices and connections are specified in Division 26 Sections.

### 2.6 COILS

- A. Coil Sections: Common or individual, insulated, stainless steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to assure full airflow through coils.
  1. Multizone Units: Provide air deflectors and air baffles to balance airflow across coils.
- B. Coil Construction: Rigidly supported across full face, pitched to allow drainage.
  1. Fins: Aluminum, mechanically bonded to tubes, 10 fins per inch or less, .008-inch thick.
  2. Tubes: Seamless copper, 5/8-inch diameter with 0.025-inch minimum thick walls.
  3. Coil Casing: 16-gauge stainless steel.
  4. Headers for Water Coils: Steel, cast iron, or seamless copper with drain valve and air vent, and threaded piping connections. Vents and drains shall be extended to panel exterior and capped.
- C. Water Coils: Drainable with threaded plugs, serpentine with return bends.
- D. Coil-Performance Tests: Factory-test cooling and heating coils, except sprayed surface coils for rating according to ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

### 2.7 DAMPERS

- A. General: Extruded aluminum automatic control dampers. Leakage rate, according to AMCA 500, "Test Methods for Louvers, Dampers and Shutters," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential. Ruskin CD50 or approved equal.
  1. Damper operators are specified in Section 23 09 00 "Instrumentation and Controls for HVAC."
- B. Application: Provide indicated blade type.
  1. Mixing Dampers: Parallel-blade.

### 2.8 ELECTRICAL

- A. Starters, Electrical Devices, and Wiring: Provide electrical wiring devices and connections per Division 26 requirements.
- B. Lighting: Provide one 120V marine type light fixtures each accessible section of the unit. Switch on outside of unit near electrical connection point. Provide 120V connection point for unit at electrical connection point on unit.
- C. Outlets: Provide 120V GFCI weatherproof convenience outlet in each fan section of outdoor units.
- D. Motor Connections: Provide a single point connection for each supply fan and return fan motors at electrical connection point (location indicated) on outside of unit, unless otherwise noted. Provide all conduit and wiring from connection point to motor.

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### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions to receive equipment, for compliance with installation tolerances, access requirements, coil removal and other conditions affecting performance of custom air-handling units.
- B. Examine roughing-in of hydronic piping, condensate drainage piping, and electrical to verify actual locations of connections before installation.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install custom air-handling units level and plumb, according to manufacturer's written instructions.
  - 1. Floor-Mounted Units: Support on concrete housekeeping bases using neoprene pads. Secure units to anchor bolts installed in concrete housekeeping base.
  - 2. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and vibration isolation.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Coordinate size of housekeeping bases with actual unit sizes provided. Construct base 6 inches larger in both directions than overall dimensions of supported unit.

#### 3.3 CONNECTIONS

- A. Pipe Connections: Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping adjacent to machine to allow service and maintenance of all parts of the equipment, as well as the piping installations.
  - 2. Connection piping to air-handling units with flexible connectors.
  - 3. Connect condensate drain pans using 1-1/4-inch NPS, Type L copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
  - 4. Hot- and Chilled-Water Piping: Conform to applicable requirements of Section 23 21 13 "Hydronic Piping." Connect to supply and return coil tapings with shutoff, balancing valve and union or flange at each connection.
- B. Duct Connections: Duct installation and connection requirements are specified in other Division 23 Sections. Make duct connections to the unit with flexible connections.
- C. Electrical: Conform to applicable requirements of Division 23 Sections.
  - 1. Connect fan motors to wiring systems and to ground.
  - 2. Temperature control wiring and interlock wiring is specified in Section 23 09 00 "Instrumentation and Controls for HVAC."

#### 3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

#### 3.5 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- C. Do not operate fan system without all filters in place. Units shall not be used for building ventilation, heating or cooling during construction without the written approval and authorization of the Owner and Architect.
- D. Wipe down all interior surfaces exposed to airflow with a 50% solution of isopropyl alcohol prior to unit start up.

#### 3.6 START-UP PROCEDURES

- A. Manufacturer's Field Inspection: Engage a factory-authorized service representative to perform the following:

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1. Inspect field assembly of components and installation of custom air-handling units including piping, ductwork, and electrical connections.
  2. Prepare a written report on findings and recommended corrective actions.
- B. Final Checks before Startup: Perform the following before startup:
1. Verify that shipping, blocking, and bracing are removed.
  2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
  3. Perform cleaning and adjusting specified in this Section.
  4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
  5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
  6. Set zone dampers to fully open position for each zone.
  7. Set outside-air and return-air mixing dampers to minimum outside-air setting.
  8. Comb coil fins for parallel orientation.
  9. Install clean filters.
  10. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.
- C. Starting procedures for custom air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
    - a. Replace fan and motor pulleys as required to achieve design conditions.
  2. Measure and record motor electrical values for voltage and amperage.
  3. Manually operate dampers from fully closed to fully open position and record fan performance.
- D. Refer to Section 23 05 94 "Testing, Adjusting, and Balancing for Mechanical" for air-handling system testing, adjusting, and balancing.

### 3.7 DEMONSTRATION

- A. Engage the services of a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
1. Review data in the operation and maintenance manuals. Refer to Section 01 77 00 "Closeout Procedures."
  2. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION

## SECTION 23 74 13 PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
- B. Related Sections include the following:
  - 1. Section 23 05 00 "Common Mechanical Materials and Methods" for common materials and methods.
  - 2. Section 23 05 13 "Common Motor Requirements for Mechanical Equipment" for fan motors.
  - 3. Section 23 05 63 "Variable Frequency Drives" for VFD equipment.
  - 4. Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration and seismic restraints.

#### 1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design RTU supports to comply with wind and seismic performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

#### 1.5 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for selecting vibration isolators wind and seismic restraints and for designing vibration isolation bases.
  - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

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3. Wind-and Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
- D. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Manufacturer Seismic Qualification Certification: Submit certification that RTUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Structural members to which RTUs will be attached.
  2. Roof openings
  3. Roof curbs and flashing.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
- I. Warranty: Special warranty specified in this Section.

### 1.6 QUALITY ASSURANCE

- A. ARI Compliance:
  1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
  2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
  1. Comply with ASHRAE 15 for refrigeration system safety.
  2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
  3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.
- C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- D. UL Compliance: Comply with UL 1995.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

### 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
  1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

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### 1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan Belts: One set for each belt-driven fan.
  - 2. Filters: One set of filters for each unit.

## 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
  - 1. Carrier Corporation.
  - 2. McQuay International.
  - 3. Trane; American Standard Companies, Inc.
  - 4. YORK International Corporation.

### 2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
  - 1. Exterior Casing Thickness: 0.052 inch thick.
- C. Inner Casing Fabrication Requirements:
  - 1. Inside Casing: Galvanized steel, 0.034 inch thick.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
  - 1. Materials: ASTM C 1071, Type I.
  - 2. Thickness: 1 inch.
  - 3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
  - 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.
  - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
  - 2. Drain Connections: Threaded nipple both sides of drain pan.
  - 3. Pan-Top Surface Coating: Corrosion-resistant compound.

### 2.3 FANS

- A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- C. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.
- D. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

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### 2.4 COILS

- A. Supply-Air Refrigerant Coil:
  - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
  - 2. Coil Split: Interlaced.
  - 3. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
  - 4. Condensate Drain Pan Stainless steel formed with pitch and drain connections complying with ASHRAE 62.
- B. Outdoor-Air Refrigerant Coil:
  - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
  - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
- C. Hot-Gas Reheat Refrigerant Coil:
  - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
  - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

### 2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
- B. Refrigeration Specialties:
  - 1. Refrigerant Charge: R-410A.
  - 2. Expansion valve with replaceable thermostatic element.
  - 3. Refrigerant filter/dryer.
  - 4. Manual-reset high-pressure safety switch.
  - 5. Automatic-reset low-pressure safety switch.
  - 6. Minimum off-time relay.
  - 7. Automatic-reset compressor motor thermal overload.
  - 8. Brass service valves installed in compressor suction and liquid lines.

### 2.6 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  - 1. Pleated: Minimum MERV 7.

### 2.7 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.
- B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously for full economizer control.
  - 1. Damper Motor: Modulating with adjustable minimum position.
  - 2. Relief-Air Damper: Gravity actuated with bird screen and hood.

### 2.8 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

### 2.9 CONTROLS

- A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."
- B. Basic Unit Controls:
  - 1. Control-voltage transformer.
  - 2. Wall-mounted thermostat or sensor with the following features:

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- a. Heat-cool-off switch.
  - b. Fan on-auto switch.
  - c. Fan-speed switch.
  - d. Automatic] changeover.
  - e. Adjustable deadband.
  - f. Exposed set point.
  - g. Exposed indication.
  - h. Degree F indication.
  - i. Unoccupied-period-override push button.
  - j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
3. Remote Wall-Mounted Annunciator Panel for Each Unit:
    - a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
    - b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
    - c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.
  4. Economizer Outdoor-Air Damper Operation:
    - a. Occupied Periods: Open to 25 percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. During economizer cycle operation, lock out cooling.
    - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
- C. Interface Requirements for HVAC Instrumentation and Control System:
1. Interface relay for scheduled operation.
  2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
  3. Provide BACnet compatible interface for central HVAC control workstation for the following:
    - a. Adjusting set points.
    - b. Monitoring supply fan start, stop, and operation.
    - c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature.
    - d. Monitoring occupied and unoccupied operations.

### 2.10 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer. Outlet shall be energized even if the unit main disconnect is open.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Coil guards of painted, galvanized-steel wire.
- D. Hail guards of galvanized steel, painted to match casing.
- E. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

### 2.11 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
  1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
    - a. Materials: ASTM C 1071, Type I or II.
    - b. Thickness: 1 inch.

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2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
  - a. Liner Adhesive: Comply with ASTM C 916, Type I.
  - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
  - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
  - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- C. Curb Height: 24 inches.
- D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete base, level and secure, according to [NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." ] [ARI Guideline B.] Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
- C. Install wind and seismic restraints according to manufacturer's written instructions.[ Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." ]

#### 3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  1. Install ducts to termination at top of roof curb.
  2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
  3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section " Air Duct Accessories."
  4. Install return-air duct continuously through roof structure.
  5. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified in Division 03.

## SECTION 23 74 13 PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- C. Tests and Inspections:
  - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

### 3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
  - 1. Inspect for visible damage to unit casing.
  - 2. Inspect for visible damage to furnace combustion chamber.
  - 3. Inspect for visible damage to compressor, coils, and fans.
  - 4. Inspect internal insulation.
  - 5. Verify that labels are clearly visible.
  - 6. Verify that clearances have been provided for servicing.
  - 7. Verify that controls are connected and operable.
  - 8. Verify that filters are installed.
  - 9. Clean condenser coil and inspect for construction debris.
  - 10. Clean furnace flue and inspect for construction debris.
  - 11. Connect and purge gas line.
  - 12. Remove packing from vibration isolators.
  - 13. Inspect operation of barometric relief dampers.
  - 14. Verify lubrication on fan and motor bearings.
  - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  - 16. Adjust fan belts to proper alignment and tension.
  - 17. Start unit according to manufacturer's written instructions.
    - a. Start refrigeration system.
    - b. Do not operate below recommended low-ambient temperature.
    - c. Complete startup sheets and attach copy with Contractor's startup report.
  - 18. Inspect and record performance of interlocks and protective devices; verify sequences.
  - 19. Operate unit for an initial period as recommended or required by manufacturer.
  - 20. Calibrate thermostats.
  - 21. Adjust and inspect high-temperature limits.
  - 22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
  - 23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:
    - a. Coil leaving-air, dry- and wet-bulb temperatures.
    - b. Coil entering-air, dry- and wet-bulb temperatures.
    - c. Outdoor-air, dry-bulb temperature.
    - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
  - 24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

SECTION 23 74 13 PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
  - a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outdoor-air intake volume.
26. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
  - a. High-temperature limit on gas-fired heat exchanger.
  - b. Low-temperature safety operation.
  - c. Filter high-pressure differential alarm.
  - d. Economizer to minimum outdoor-air changeover.
  - e. Relief-air fan operation.
  - f. Smoke and firestat alarms.
28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

## SECTION 23 81 26 SPLIT-SYSTEM AIR-CONDITIONERS

### 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. Section 23 05 00 "Common Mechanical Materials and Methods."
  - 2. Section 23 05 13 "Common Motor Requirements for Mechanical Equipment."
  - 3. Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."
  - 4. Section 23 05 53 "Identification for Mechanical Piping and Equipment."
  - 5. Section 23 09 00 "Instrumentation and Controls for HVAC."
  - 6. Section 23 23 00 "Refrigerant Piping."
  - 7. Section 23 21 13 "Hydronic Piping."

#### 1.2 SUMMARY

- A. This Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

#### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Evaporator sections
  - 2. Condensing units
  - 3. Refrigerate piping
- C. Shop Drawings: In addition to requirements set forth in Section 23 05 00, shop drawings for the listed systems shall also include: None required.
- D. Reports and Certificates: Provide submittals of the following:
  - 1. Start-up and reports. See "Field Quality Control" article.
- E. Sustainable Submittals:
  - 1. Credit EA 4: Manufacturers' product data for refrigerants, including printed statement that refrigerants are free of HCFCs.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- D. Units shall be designed to operate with HCFC-free refrigerants.

#### 1.5 COORDINATION

- A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Section 07 52 00.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## SECTION 23 81 26 SPLIT-SYSTEM AIR-CONDITIONERS

### 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set of filters for each unit.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Liebert.
  - 2. Mitsubishi Heavy Industries America, Inc.; Air-Conditioning & Refrigeration Division, Inc.
  - 3. Sanyo Fisher (U.S.A.) Corp.

### 2.2 EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Fan: Direct drive, centrifugal fan.
- D. Fan Motors: Comply with requirements in Section 23 05 13 "Common Motor Requirements for Mechanical Equipment."
  - 1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
- E. Filters: Disposable, Merv 7.

### 2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

- A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - 1. Compressor Type: Scroll.
  - 2. Refrigerant Charge: R-407C.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Fan: Aluminum-propeller type, directly connected to motor.
- E. Motor: Permanently lubricated, with integral thermal-overload protection.
- F. Low Ambient Kit: Permits operation down to 45 deg F.
- G. Mounting Base: Polyethylene.

### 2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Sections 23 09 00 "Instrumentation and Control for HVAC."
  - 1. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
  - 2. Unit monitoring interface for BMS. Communicates with I/O, status, alarm panels, and autodial out.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install units level and plumb.

## SECTION 23 81 26 SPLIT-SYSTEM AIR-CONDITIONERS

- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounting, compressor-condenser components on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Section 03 45 00. Coordinate anchor installation with concrete base.
- D. Install roof-mounting compressor-condenser components on equipment supports specified in 07 52 00. Anchor units to supports with removable, cadmium-plated fasteners.
- E. Install seismic restraints.
- F. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 33 00 "Air Duct Accessories."
- D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Section 01 77 00.

END OF SECTION



## SECTION 23 82 39 UNIT AND CABINET HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related sections include the following:
  - 1. Section 23 09 00 "Instrumentation and Control for HVAC" for DDC interface (where indicated) and installation of control devices furnished in this section.
  - 2. Section 23 05 13 "Common Motor Requirements for HVAC Equipment" for fan motor requirements.
  - 3. Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment" for spring hangers and seismic restraints.

#### 1.2 SUMMARY

- A. This Section includes hydronic unit heaters and cabinet heaters.

#### 1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
  - 1. Hydronic Unit Heaters.
  - 2. Cabinet Heaters.
- C. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.
- D. Reports and Certificates: Provide submittals of the following:
  - 1. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of unit heaters.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70 for components and installation.
- B. 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.

#### 1.5 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
  - 1. Special Warranty Period: Manufacturer's standard but not less than 5 years after date of installation.

#### 1.6 EXTRA MATERIALS

- A. Furnish the following extra materials, matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.
- B. Cabinet Heater Filters: Furnish one spare filter for each filter installed.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide unit heaters and cabinet heaters by one of the following:
  - 1. Hydronic Unit Heaters and Cabinet Heaters:
    - a. Trane.
    - b. Carrier.
    - c. Sterling.
    - d. Modine.

## SECTION 23 82 39 UNIT AND CABINET HEATERS

### 2.2 HYDRONIC AND STEAM UNIT HEATERS

- A. Casing: Steel or aluminum with removable access panels to remove, service, and maintain major components.
- B. Heating Water Coil: Fin-and-tube coil fabricated of copper, with copper or aluminum fins spaced no closer than 0.1 inch. Tube wall thickness minimum 0.031-inch. Rated for minimum working pressure of 200 psig and maximum entering water temperature of 325 deg F. Test for leaks to 375 psig under water.
- C. Fan and Motor: Direct-drive propeller fan and manufacturer's standard motor. Motors sized 1/2 HP and less include integral motor overload protection.
- D. Wiring Terminations: Match conductor materials and sizes indicated.
- E. Unit Configuration: Horizontal discharge with horizontal, adjustable louvers or vertical discharge with radial louver diffuser as indicated.
- F. Optional Accessories as scheduled: Include the following:
  - 1. Stratification thermostat for summer fan only operation.
  - 2. Disconnect switch.
  - 3. Horizontal Configuration: Louver fin diffuser.
  - 4. Vertical Configuration: Louver cone diffuser.

### 2.3 HYDRONIC CABINET HEATERS

- A. Arrangement: Provide following cabinet arrangement as indicated.
  - 1. HC: Horizontal style, concealed cabinet with back duct collar air inlet and front duct collar air outlet.
- B. Coil: Fin-and-tube coil fabricated of copper, with copper or aluminum fins spaced no closer than 0.1 inch. Test for leaks to 150 psig under water.
- C. Fan and Motor: Centrifugal blower, direct driven by a single-phase, 2-speed or 3-speed electric motor with inherent overload protection and resilient motor/fan mount.
- D. Wiring Terminations: Match conductor materials and sizes indicated.
- E. Filter: Manufacturer's standard throw away filter, 1 inch thick, on inlet of each fan.
- F. Unit Controls: Fan-speed switch and fan ON-AUTOMATIC switch. Provide capability for stop/start and temperature control by DDC system.
- G. Optional Accessories: Include the following:
  - 1. Integral power disconnect switch.
  - 2. Kickplate base for floor-mounted units.
- H. Cabinet finish manufacturer's standard enamel, color as selected by Architect where units are exposed, applied to factory-assembled units prior to shipping.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive unit heaters and cabinet heaters for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install unit heaters and cabinet heaters as indicated, according to manufacturer's written instructions and NFPA 90A.
- B. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is plumb and level. Install cable type seismic restraints.
  - 1. Spring hangers and seismic restraints are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install controls as specified in Section 23 09 00 "Instrumentation and Control for HVAC."

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  - 1. Unless indicated otherwise, install shut-off valve and union at each connection.
  - 2. Install piping adjacent to machine to allow service and maintenance.

## SECTION 23 82 39 UNIT AND CABINET HEATERS

- B. Connect heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.4 ADJUSTING AND CLEANING

- A. After completing system installation, inspect heaters and associated components. Repair scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.
- B. Replace filters in each cabinet heater at completion of construction.

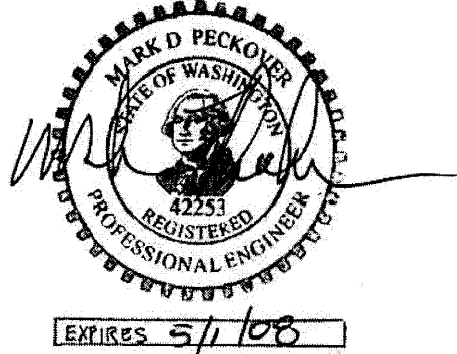
### 3.5 START-UP PROCEDURES

- A. Start-up Services: Provide start-up service, as specified below.
  - 1. Start units and operate controls and safeties.
  - 2. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
  - 3. Correct deficiencies identified by tests and observations and retest until specified requirements are met.

END OF SECTION



PROJECT:  
MultiCare  
Tacoma General Hospital  
Emergency Department and  
Cancer Center Expansion



**Electrical Engineer of Record:**  
Sparling  
111 SW Fifth Avenue, Suite 1575  
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\_\_\_\_\_  
Electrical Engineer of Record

04/03/08  
Date



Multicare Tacoma General Hospital ED/CC Expansion

DIVISION 26, 27 AND 28 ELECTRICAL SPECIFICATIONS  
100% CONSTRUCTION DOCUMENTS  
September 26, 2008

**ELECTRICAL SPECIFICATION INDEX**

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SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. Test and provide written certification on company letterhead that the entire electrical installation complies with contract documents, code and proper system operation. Perform acceptance tests in accordance with manufacturer's recommendations, NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-2003.
- B. The following testing shall be performed by an independent testing company:
  - 1. Service Grounding Test
  - 2. Ground Fault Protection Systems Test & Calibration
  - 3. Transformers Dry Type
  - 4. Automatic Transfer Switch Test & Calibration
  - 5. Switchboards
  - 6. Molded-Case Circuit Breakers
  - 7. Metering Test & Calibration
  - 8. Bus Duct
  - 9. Power System
  - 10. Primary Voltage Cables
  - 11. Primary Switchgear

1.3 EQUIPMENT AND DEVICE TESTS

- A. Perform all equipment and device testing after installation and prior to Substantial Completion or Owner Occupancy under the provision of Section 01 45 21, allowing enough time for corrective action of all deficiencies.
- B. Review manufacturer's installation instruction and confirm that equipment is installed in accordance with manufacturer's instructions.
- C. Prior to performing tests confirm that the equipment is clean and free of construction debris and dust.
- D. Phase Relationship Tests: Check connections to all new and existing equipment for proper phase relationship. During such check, disconnect all devices which could be damaged by the application of voltage or reversed phase sequence.
- E. Test the open/close or energize/deenergize operation of each switch, circuit breaker, contactor and other item of electrical control with the systems fully energized and operating. Each shall be tested three times. Test report shall include a list of equipment tested and the signed initials of the electricians performing the test on a device by device basis.

1.4 SUBMITTALS

- A. General
  - 1. Provide submittal information in accordance with Section 01 33 00, Section 26 05 00 - Common Work Results For Electrical, and requirements described in this Section.
- B. Test Report
  - 1. The testing firm shall maintain a written record of all tests and shall assemble and certify a final test report indicating all equipment tested and the results found for each. Any system, material, or workmanship which is found to have abnormal operation, shall be specifically identified.

## SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

- C. Quality Assurance
  - 1. The testing firm shall submit proof of company qualifications and personnel qualifications. Include resumes of recent experience (within the last three years) for the firm, engineers and technicians that will be assigned to the project. Include references with current phone numbers in the resume.
  - 2. Test Equipment: Provide a complete list of test equipment utilized in all of the testing. Include manufacturer, model number, current calibration date, next calibration date and age of equipment.
- D. Closeout
  - 1. Operational and Maintenance Manuals
    - a. All approved Submittal information
    - b. Full test report in the O&M Manual
    - c. Completed form for each item of equipment tested
  - 2. One electronic version of the test report on CD and in the latest version of Microsoft Word.
  - 3. Schedule of recommended testing frequency for all equipment tested under this Contract
  - 4. Testing company test stamps or stickers on all tested equipment. Indicate testing company name, testing date and expiration date.

### 1.5 RECEPTACLES

- A. Receptacle Polarity Test: Test every receptacle installed or reconnected under this Contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest. Submit statement of completed testing signed by the electrician that performed the test.
- B. Ground-Fault Receptacle Circuit Interrupter Tests: Test each receptacle or branch circuit breaker having ground-fault circuit protection to assure that the ground-fault circuit interrupter will not operate when subjected to a ground-fault current of less than 4 milliamperes and will operate when subjected to a ground-fault current exceeding 6 milliamperes. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. "TEST" button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shutoff power with 7/1000 of an ampere within 1/40th of a second and retest.
- C. Receptacle testing per NFPA 99.

### 1.6 WIRING - 600 VOLTS AND UNDER

- A. Scope: Test all circuits that are installed or reconnected under this contract.
- B. Test for continuity of each circuit.
- C. Test for grounds in each circuit which shall consist of the physical examination of the installation to ensure that all required ground jumpers, devices, and appurtenances do exist and are mechanically firm.
- D. Perform a 500 volt megohm meter test between the conductor and ground of every feeder and all circuits rated over 100 amperes. The insulation resistance shall not be less than 2 megohms for circuits under 115V, 6 megohms between conductor and ground on those circuits (115V-600V) with total single conductor length of 2,500 feet and over, nor less than 8 megohms for those circuits (115V-600V) with single conductor length of less than 2,500 feet. If conductor fails test replace wiring or correct defect and retest.
- E. Perform torque test for every conductor tested and terminated in an overcurrent device or bolted type connection; torque all connections per manufacturers' recommendations and tabulate the results on a tabular form.
- F. Provide branch circuit and ground system testing per NFPA 99.

## SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

### 1.7 WIRING - OVER 600 VOLTS

- A. Perform tests required by the Washington Administrative Code 296-46B-250.

### 1.8 SERVICE GROUNDING

- A. Perform service ground test prior to installation of the ground level slab.
- B. Perform fall-of-potential tests on main grounding electrode system provided by this Contract per IEEE Standard No. 81. Maximum resistance to ground shall be less than 10 ohms. If this resistance cannot be obtained with the ground system shown, notify the Architect immediately for further instruction.
- C. Confirm that the neutral is grounded only at the service equipment by removing the service neutral grounding conductor and meggering the neutral bus. System neutral insulation resistance shall be two (2) megohm or greater.

### 1.9 GROUND FAULT PROTECTION SYSTEMS

- A. Scope. Test all ground fault systems provided by this Contract.
- B. Prior to test:
  - 1. Inspect neutral main bonding connection to assure:
    - a. Zero sequence system is grounded upstream of sensor.
    - b. Ground connection is made ahead of neutral disconnect link.
    - c. Ground strap systems are grounded through sensing device.
    - d. Verify ground electrode conductor(s) for proper size and connection.
  - 2. Inspect control power transformer to insure adequate capacity for system.
  - 3. Monitor panels (if present) shall be manually operated for:
    - a. Trip test.
    - b. No trip test.
    - c. Non-automatic reset.
    - d. Proper operation and test sequence shall be recorded.
  - 4. Zero sequence systems shall be inspected for symmetrical alignment of core balance transformers about all current carrying conductors.
  - 5. Ground fault system integral to the circuit breaker will have its current sensors and neutral sensor inspected for proper polarity.
  - 6. Ground fault device circuit nameplate identification shall be verified by device operation.
  - 7. Pickup and time delay settings shall be set in accordance with Electrical Engineer of Record's instructions or as shown.
- C. Electrical Test
  - 1. The relay pickup current shall be determined by current injection at the sensor and the circuit interrupting device operated.
  - 2. The relay timing shall be tested by injecting one hundred fifty percent (150%) and three hundred percent (300%) of pickup current into sensor. Total trip time shall be electrically monitored.
  - 3. System operation shall be tested at fifty-seven percent (57%) rated voltage.
  - 4. Zone interlock systems shall be tested by simultaneous sensor current injection and monitoring zone blocking function.
- D. Test Parameters
  - 1. Relay pickup current shall be within ten percent (10%) of device dial of fixed setting.
  - 2. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves.

### 1.10 TRANSFORMERS DRY TYPE

- A. Test transformers dry type rated 150 kVA and over provided by this Contract.

## SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

- B. Visual and Mechanical Inspection. Test dry type transformers per the following procedures:
  - 1. Inspect for physical damage, proper installation, anchorage and grounding.
  - 2. Verify transformer is supplied and connected in accordance with Contract Documents.
- C. Electrical Tests. Perform insulation resistance tests winding-to-winding and winding-to-ground.

### 1.11 MOTOR CONTROLLERS

- A. Visual and Mechanical Inspection
  - 1. Inspect for physical damage and code violation.
  - 2. Inspect for anchorage and grounding.
  - 3. Compare overload ratings or settings with motor full load current, confirm correct application.
  - 4. Compare starter size with motor horsepower.
- B. Electrical Tests
  - 1. For each motor larger than 5 HP, measure overload time delay by primary current injection at three (3) times motor full load current.
  - 2. Perform operational tests on each starter.
  - 3. Confirm operational interface with Fire Alarm and Division 23 control signals.

### 1.12 MOLDED-CASE CIRCUIT BREAKERS

- A. Scope. Test all new circuit breakers 100 amps and over within new switchboards and panelboards. Bench test new circuit breakers 100 amps and over that are installed in existing switchboards and panelboards.
- B. Inspect each breaker, operate manually, and electrically. Test shunt trips and alarm devices manually and electrically.
- C. Adjust breaker trips to settings furnished by the coordination study and verify settings of the manufacturer's rating by passing controlled current through the trip devices. Record values and report deficiencies.
- D. Circuit Breaker Electrical Tests
  - 1. Contact resistance shall be measured.
  - 2. Time-current characteristic tests shall be performed by passing three hundred percent (300%) rated current through each pole separately. Trip time shall be determined.
  - 3. Instantaneous pickup current shall be determined by run-up or pulse method. Clearing times should be within four (4) cycles or less.
  - 4. Insulation resistance shall be determined pole to pole, across pole and pole to ground and across open contacts. Test voltage shall be 1000 volts D.C.
  - 5. Check trip unit reset operation.

### 1.13 SWITCHBOARDS

- A. Scope. Test all new switchboards.
- B. Inspect equipment and each breaker, fused switch and report installation or shipping damage, loose material, shipping blocks, contamination or unfavorable environmental conditions that must be corrected. Check equipment for operation of doors, security of mounting. Report deficiencies.
- C. Check the equipment ground and record the number and size of ground bus and straps. Report deficiencies.
- D. Inspect the bus assembly for deficiencies and torque test all bolted connections. Test insulation of each bus phase-to-phase and phase-to-ground and all control circuits to ground with a suitable megohmmeter. Record values and report deficiencies.
- E. Inspect for proper identification of protective devices.

SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

- F. Surge Arrestors. Test surge arresters per the following procedures:
  - 1. Visual and Mechanical Inspection
    - a. Inspect for physical damage, such as chipped or fractured porcelain.
    - b. Inspect ground and discharge counter connections for integrity.
  - 2. Electrical Tests
    - a. Perform ground continuity test to ground grid system.

1.14 AUTOMATIC TRANSFER SWITCHES

- A. Scope. Test Automatic Transfer Switches provided by this Contract.
- B. Visual and Mechanical Inspection
  - 1. Inspect for physical damage, anchorage and grounding.
  - 2. Perform manual transfer operation.
  - 3. Clean and lubricate transfer mechanism as required. Check alignment and operation in accordance with manufacturer's instructions.
  - 4. Verify proper operation of all interlocks.
  - 5. Perform bypass and isolation functions, if switches are so equipped.
- C. Electrical Tests. Monitor and verify correct operation and timing of the following applicable items:
  - 1. Normal voltage sensing relays.
  - 2. Emergency voltage sensing relays.
  - 3. Test switch.
  - 4. In-phase monitor.
  - 5. Engine start sequence.
  - 6. Time delay upon transfer.
  - 7. Alternate voltage sensing relay.
  - 8. Interlocks and limit switch function.
  - 9. Timing delay and re-transfer upon normal power restoration.
  - 10. Engine cool-down time delay and shutdown.
  - 11. Contact resistance shall be measured across main contacts.
- D. Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
- E. Set and calibrate in accordance with Specifications:
  - 1. Voltage sensing relay.
  - 2. Frequency sensing relay.
  - 3. Transfer time delay relay.
  - 4. Engine shutdown relay.
  - 5. Engine exercise time (if present).

1.15 METERING

- A. Scope: Test all new meters provided by this Contract.
- B. Instrument Transformers
  - 1. Verify correct taps and proper connection to meter, instrumentation or transducer.
  - 2. Test transformer polarity electrically
  - 3. Verify connection at secondary CT leads by driving a low current through the leads and checking for this amount at applicable devices
  - 4. Confirm transformer ratio by primary current injection
  - 5. Measure insulation resistance primary-to-ground, secondary-to-ground and primary-to-secondary.
  - 6. Overpotential test primary insulation
  - 7. Measure potential transformer ratio.
- C. Metering and Instrumentation
  - 1. Calibrate all meters at midscale

## SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

2. Calibrate watt-hour meter to one-half percent
3. Verify all instrument multipliers

### 1.16 BUS DUCT

- A. Scope: Test metal enclosed bus duct provided by this Contract per the following procedures:
- B. Visual and Mechanical Inspection
  1. Inspect bus for physical damage and proper connection. Clean interior and insulators where applicable.
  2. Inspect for proper bracing, suspension, alignment and enclosure grounding.
  3. Spot check 10% of bus joint bolts for proper torque. Selected bolts must be separated by 10% of the total length of the bus.
- C. Electrical Tests
  1. Measure insulation resistance of each bus phase-to-phase and phase-to-ground for one (1) minute.
  2. Inspect all accessible bus joints and cable connections by infrared scanner to detect loose or high-resistance connections and other circuit anomalies.

### 1.17 POWER SYSTEM TESTS

- A. Scope. Inspect and test entire electrical systems provided by this Contract to verify equipment and controls are correctly operating. Power system tests shall be performed 4 to 8 weeks after substantial completion, and at such time that the maximum possible load is connected (usually highest available occupancy at mid day.)
- B. Load Balance Tests: Check all panelboards for proper load balance between phase conductors and make adjustments as necessary to bring unbalanced phases to within 15% of average load. Check shall consist of clamp on ampere readings on each phase for a period of 15 minutes, of each panelboard. Include phase realignment of 1% of the project's 3 pole circuit breakers in Bid.
- C. Motor Tests: Check all motors and measure actual load current. Submit tabulation of motor currents for all motors 1 HP or more after the HVAC system has been balanced.
- D. Transformer Taps: Connect all transformers at "Normal" tap. Measure secondary voltages at all new and existing transformers. Forward a list to engineer including service switchboard voltmeter reading at the time of the test for evaluation. Reconnect taps as subsequently directed.

### 1.18 PRIMARY CABLE TESTS

- A. Scope. Perform a dc High Potential Test on new cables rated above 600 volts. When new cables are spliced into existing cables, perform the hi-pot test on the new cable prior to splicing. After test results are approved for new cable and splice is made, perform an insulation resistance test, continuity test and a dc hi-pot test on the length of cable including the splice; and test the existing cable to the nearest disconnection point.
- B. Visual and Mechanical Inspections
  1. Inspect exposed cable section for physical damage in equipment vaults and manholes.
  2. Verify cable is supplied and connected in accordance with single line diagram.
  3. Inspect for shield grounding, cable support, and termination.
  4. Visible cable bends shall be checked against ICEA or manufacturer's minimum allowable bending radius.
  5. Inspect for proper fireproofing in common cables areas.
  6. Inspect all splices and load break elbows for proper installation according to manufacturers' instructions.

SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

C. Electrical Tests

1. Perform D.C. Hypotential Test Using Step Voltage Method
  - a. Each conductor shall be individually tested with all other conductors grounded. All shields shall be grounded.
  - b. Terminations shall be properly corona suppressed by guard ring, field reduction sphere, or other suitable methods.
  - c. A D.C. hypotential shall be applied in at least eight (8) equal increments until maximum test voltage is reached. D.C. leakage current shall be recorded at each step after a constant stabilization time consistent with system charging current decay.
  - d. A graphic plot shall be made of leakage current (X axis) versus voltage (Y axis) at each increment.
  - e. The test conductor shall be raised to a maximum test voltage and held for a total of ten (10) minutes. Readings of leakage current (Y axis) versus time (X axis) shall be recorded and plotted on thirty (30) second intervals for the first two (2) minutes and each minute thereafter. Maximum test voltage to be held for a total of ten (10) minutes. Readings of leakage current (Y axis) versus time (X axis) will be recorded and plotted on thirty second intervals for the first two (2) minutes and every minute thereafter.
  - f. The applied conductor test potential shall be slowly reduced to zero (0) and grounds applied for a period adequate to drain all stored potential. Plot voltage delay versus time.
  - g. Maximum test voltage shall be in accordance with the value given below.
2. Perform a shield continuity test by ohm meter method. Ohmic value shall be recorded.

D. Test Values

1. D.C. hypotential test results:
  - a. Step voltage slope should be reasonably linear.
  - b. Absorption slope should be flat or negative. In no case should slope exhibit positive characteristic.
  - c. Maximum leakage current shall not exceed  $I_1$  corrected to 60F where  $I_1 = E / (K \text{ Log } D/d)$ 
    - K = insulation specific resistance Megohm per thousand feet at 60F.
    - D = diameter over insulation
    - d = diameter under insulation
    - E = maximum test voltage

E. Test Voltage Table

ACCEPTANCE TEST MAXIMUM D.C. VOLTAGE

<u>Cable Type</u>	<u>Standard</u>	
Rubber	ICEA S-19-81	Table 6-17
Varnish Cambric	ICEA S-65-375	Table 3-4*
Thermoplastic	ICEA S-61-402	Table 6-10
Cross Linked P.E.	ICEA S-66-524	Table 6-9
Ethylene Propylene (EPR)	ICEA S-68-516	Table 6-9

\* For D.C. test multiply values by 2.

## SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

### 1.19 PRIMARY SWITCHGEAR

Test primary switchgear provided by this contract per the following procedures:

- A. Visual and Mechanical Inspection
  - 1. Inspect for physical damage, proper installation, anchorage, and grounding. Clean interior, insulations, arc chutes and inter-phase barriers.
  - 2. Perform mechanical operator tests in accordance with manufacturer's instructions. Clean and lubricate contacts and mechanism.
  - 3. Check contact alignment, wipe and pressure.
  - 4. Check fuse linkage and element for proper holder and current rating. Record fuse data.
  - 5. Check key interlock for safe operation and proper key distribution.
  - 6. Verify arc interrupter operation.
- B. Electrical Tests
  - 1. Perform contact resistance test across each switch blade and fuse link.
  - 2. Perform insulation resistance test phase-to-phase and each phase-to-ground.
  - 3. Perform A.C. or D.C. overpotential test phase-to-phase and phase-to-ground.

## PART 2 PRODUCTS

### 2.1 TESTING COMPANY

- A. Owner will retain the services of an independent testing company that is qualified to test electrical equipment, and is an approved testing company by the Washington State Department of Labor and Industries. Approved companies: Advanced Electrical Testing, Inc. (AET), Cutler-Hammer Engineering Services and Systems Division (CH-ESS), Electrical Reliability Services, Apparatus Service and Engineering Technology, Inc. (ASET), Siemens Westinghouse Technical Services.
- B. Testing company shall perform tests and prepare test reports on the systems they test under Provisions of Section 01 45 21 and the requirements of this Section.
- C. Testing company shall be an independent company, separate from the Contractor, Sub Contractors, Suppliers and others involved with the Project.

### 2.2 TEST EQUIPMENT

- A. The testing agency shall provide all apparatus and material required for testing. The Contractor shall use installation tools and test equipment which are designed for the specific task and shall use this equipment per the manufacturer's instructions. All test equipment shall have current calibration certification by a third party calibration laboratory, and shall have a signed and dated calibration sticker affixed to the device. Calibration shall be traceable to the National Bureau of Standards and be less than 6 months since last calibration. Defective test equipment and installation tools shall not be used. Installation tools such as torque wrenches shall be calibration certified.

## PART 3 EXECUTION

### 3.1 PROJECT DOCUMENTS

- A. Contractor shall deliver applicable Project Documents to testing company two weeks prior to testing. As a minimum include:
  - Division 26 Specification
  - Electrical Floor Plans showing equipment to be tested.
  - Electrical One Line Diagrams
  - Submittals of Manufacturers Data and Shop Drawings including review letter from Electrical Engineer of Record of all systems to be tested.
  - Coordination Study

## SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

### 3.2 SCHEDULE

- A. Contractor shall perform all testing after installation and before energizing. All primary systems shall pass tests prior to placing in service. Notify Architect 10 working days prior to performance of any test.

### 3.3 TEST REPORTS

- A. The testing agency shall prepare test reports including description of Project, description of equipment tested, description of test, test results, conclusions and recommendations, retesting results and list of test equipment used and calibration date.
- B. One copy of each test report shall be delivered directly to the Electrical Engineer and Owner within 7 calendar days of the test.
- C. Insert a copy of each test report in the operation and maintenance manuals.

### 3.4 RETESTING

- A. Any fault in material or in any part of the installation revealed by tests performed under requirements of the Contract Documents shall be investigated, replaced or repaired by the Contractor and the same test repeated at Contractor's expense until no fault appears.

### 3.5 LABELS

- A. Upon completion of testing a label shall be attached to all serviced devices. These labels shall indicate date serviced and the testing company.

### 3.6 OBSERVATIONS BY ELECTRICAL ENGINEER OF RECORD

- A. Contractor shall remove and replace covers of electrical equipment, open manholes and remove/replace ceiling tiles to allow Electrical Engineer of Record to observe equipment and wiring provided. Furnish ladder and flashlight.

### 3.7 TROUBLESHOOTING

- A. If a system or device provided under this Contract does not operate per manufacturer's Specifications Contractor shall provide qualified men with tools and test equipment to trouble shoot and repair problem at Contractor's expense.

END OF SECTION



## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes general electrical requirements for all Division 26 Work and is supplemental and in addition to the requirements of Division 1.
- B. It is the intention of this Division, Specifications and the Contract Drawings to describe and provide for the furnishing, installing, testing and placing in satisfactory and fully operational condition all equipment, materials, devices and necessary appurtenances to provide a complete electrical system. Provide all materials, appliances and apparatus not specifically mentioned herein or shown on the Drawings, but which are necessary to make a complete, fully operational installation of all electrical systems shown on the Contract Drawings or described herein. Connect equipment and devices furnished and installed under other Divisions of this Specification (or the Owner) under Division 26.
- C. Workmanship shall be of the best quality and competent and experienced electricians shall be employed and shall be under the supervision of a competent and experienced foreman.
- D. The Drawings and Specifications are complimentary and what is called for (or shown) in either is required to be provided as if called for in both.
- E. See Division 1 for sequence of Work.

#### 1.3 WORK IN OTHER DIVISIONS

- A. See all other Specifications for other Work which includes but is not limited to:
  - 1. Communications
  - 2. Cutting and Patching
  - 3. Door Hardware
  - 4. Electronic Safety and Security
  - 5. Equipment Wiring
  - 6. Fire Protection
  - 7. Mechanical Control Wiring
  - 8. Mechanical Equipment
  - 9. Painting, Refinishing and Finishes
  - 10. Temporary Power

#### 1.4 CODES, PERMITS, INSPECTION FEES

- A. The following Codes and Standards are referenced in the Division 26 Specifications. Perform all Work and provide materials and equipment in accordance with the latest referenced Codes and Standards of the following organizations:
  - 1. American National Standards Institute (ANSI)
  - 2. National Electrical Manufacturer's Association (NEMA)
  - 3. National Fire Protection Association (NFPA)
  - 4. Underwriter's Laboratories (UL)
- B. Install the electrical systems based on the following:
  - 1. NFPA 70 National Electrical Code as adopted and amended by the Local Jurisdiction.
  - 2. IBC International Building Code, 2006 Edition as amended by the State of Washington.

## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

- C. The referenced Codes establish a minimum level of requirements. Where provision of the various Codes conflict with each other, the more stringent provision shall govern. If any conflict occurs between referenced Codes and this Specification, the Codes are to govern. Compliance with Code requirements shall not be construed as relieving the Contractor from complying with any requirements of the Drawings or Specifications which may be in excess of requirements of the governing Codes and Rules and not contrary to same.
- D. Obtain and pay for all licenses, permits and inspections required by laws, ordinances and rules governing Work specified herein. Arrange for inspection of Work by the Inspectors and give the Inspectors all necessary assistance in their Work of inspection.

### 1.5 COORDINATION

- A. Coordinate Work with that of the other Contractors and/or other trades doing Work on the project. Examine all Drawings and Specifications of other trades for construction details and coordination. Make every reasonable effort to provide timely notice of Work affecting other trades to prevent conflicts or interference as to space requirements, dimensions, openings, block-outs, sleeving or other matters which will cause delays or necessitate work-around methods. Refer to Section 01 31 13.
- B. Obtain Submittals and Shop Drawings of all equipment with electrical connections furnished under other Divisions of the Specification and by the Owner. Provide all wiring in accordance with specific equipment requirements. Immediately advise the Architect of any changes which may affect the Contract price.
- C. Special attention is called to the following items. Coordinate all conflicts prior to installation:
  - 1. Door swings such that switches will be located on the "strike" side of the door.
  - 2. Location of grilles, pipes, sprinkler heads, ducts and other mechanical equipment so that all electrical outlets, lighting fixtures and other electrical outlets and equipment are clear from and in proper relation to these items.
  - 3. Location of cabinets, counters, and doors so that electrical outlets, lighting fixtures and equipment are clear from and in proper relation to these items.
  - 4. Recessing and concealing electrical materials in CMU walls, concrete construction and precast construction.
  - 5. At each switchboard and panelboard location the Contractor shall monitor the Work of all trades to assure that the space and clearance requirements of Code are met.
- D. Furnish, install and place in satisfactory condition all raceways, boxes, conductors and connections and all other materials required for the electrical systems shown or noted in the Contract Documents to be complete, fully operational and fully tested upon completion of the Project. Raceways, boxes and ground connections are shown diagrammatically only and indicate the general character and approximate location. The layout does not necessarily show the total number of raceways or boxes for the circuits required, nor are the locations of indicated runs intended to show the actual routing of the raceways.
- E. The horsepower of motors and apparatus wattage's shown on the Drawings are estimated requirements of equipment furnished under other Divisions of this Contract. Provide overload elements to suit actual equipment nameplate current. Advise Architect of any equipment changes or substitutions affecting electrical systems.
- F. Consult the Architectural Drawings for the exact height and location of all electrical equipment not specified herein or shown on the Drawings. Make any minor changes (less than 6'-6" horizontal) in the location of the raceways, outlets, boxes, devices, wiring, etc., from those shown on the Drawings without extra charge, where coordination requires or if so directed by the Architect before rough-in.
- G. Provide inserts or sleeves for outlet boxes, conductors, cables and/or raceways as required. Coordinate the installation thereof with other trades.

## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

- H. The Contractor will not be paid for relocation of Work, cuttings, patching and finishing required for Work requiring reinstallation due to lack of coordination prior to installation.

### 1.6 WARRANTY

- A. Refer to Section 00 72 00.

### 1.7 CORRECTION OF WORK

- A. Within one year after the date of Substantial Completion of the Work, the Contractor shall correct any Work found to be not in conformance with the Contract Documents promptly after written notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive acceptance of the Work under this Contract and termination of the Contract. The Owner shall give such notice promptly after discovery of the condition.

### 1.8 ITEMIZED SCHEDULE OF COSTS

- A. Complete the Schedule of Values included at the end of this Section. This schedule shall be adhered to for the electrical Contractor to facilitate analysis and approval of the monthly progress billings. Provide a copy directly to Sparling.

### 1.9 SUBMITTALS AND SHOP DRAWINGS

- A. Submittals and Shop Drawings: Schedule so as not to delay construction schedule and no later than 60 days after award of Contract, submit common brochure(s) with index and divider tabs by Specification Section, containing all required catalog cuts. Allow two weeks for review for each Submittal and Resubmittal. Incomplete Submittals and Shop Drawings which do not comply with these requirements will be returned for correction, revision and Resubmittal. See General Conditions for format, quantity, etc. Refer to Section 01 33 00.
- B. Submit in a three ring binder with hardboard covers. Submittals shall show:
  1. Indicate listing by UL or other approved testing agency.
  2. Highlight with yellow or blue marker adequate information to demonstrate materials being submitted fully comply with Contract Documents.
  3. Review and check all material prior to submittal and stamp "Reviewed and Approved".
- C. Shop Drawings shall show:
  1. Ratings of items and systems.
  2. How the components of an item or system are assembled, interconnected, function together and how they will be installed on the project.
  3. System layout floor plans with complete device layout, point-to-point wiring connection between all components of the system, wire sizes and color coding.
  4. Coordinate with other Division Shop Drawings and Submittals. Identify interface points and indicate method of connection.
- D. The Contractor agrees:
  1. Submittals and Shop Drawings processed by the Architect are not change orders.
  2. The purpose of Submittals and Shop Drawings by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept.
  3. Submittals demonstrate equipment and material Contractor intends to furnish and install and indicate detailing fabrication and installation methods Contractor intends to use.
  4. To accept all responsibility for assuring that all materials furnished under this Division of the Specifications meet, in full, all requirements of the Contract Documents.
  5. To pay for Engineer's review cost of Submittal Review beyond one Resubmittal.

## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

- E. The Engineer's review is only for general conformance with the design concept of the Project and general compliance with the information given in the Contract Documents. Corrections or comments made during this review do not relieve Contractor from compliance with the requirements of the Drawings and Specifications. Contractor is responsible for: Dimensions which shall be confirmed and correlated at the job site; fabrication process and techniques of construction; coordination of his Work with that of all other trades; performing his Work in a safe and satisfactory manner.
- F. Submittals and Shop Drawings are required per the Submittals Schedule at the end of this Section.

### 1.10 PROJECT CLOSE-OUT

- A. Coordinate with close-out provisions in Section 01 77 00 - Closeout Procedures.
- B. Request For Final Punchlist
  1. To request a final electrical punch list, forward a letter to Sparling, Inc. stating: "The electrical Work on this Project is complete, all punch list items to date are complete, items a. - n. in the Punchlist Procure paragraph in Section 260500 - Common Work Results For Electrical are complete and the project is ready for final punch list observation."
  2. Project Punchlist Procedure: Perform the following procedures for project closeout of electrical portions of Work.
    - a. Perform testing, tests and documentation per Section 260126 - Maintenance Testing of Electrical Systems.
    - b. Provide engraved nameplates on electrical equipment.
    - c. Refinish electrical equipment finishes which are damaged.
    - d. Clean light fixtures per Section 260500 - Common Work Results For Electrical.
    - e. Color code junction boxes per Section 260533 - Raceways and Boxes For Electrical Systems.
    - f. Provide spare fuses and cabinet per Section 262813 - Fuses.
    - g. Insert word processed (typed) Panel Schedules in all new and existing panelboards with actual "as-built" circuit descriptions.
    - h. Number all circuit breakers.
    - i. Obtain final electrical permit inspection. Include copies in O & M manual.
    - j. Provide written warranty in O & M per the General Conditions of the Contract.
    - k. Furnish Record Drawings per this Section. Obtain signature on Job Completion Form.
    - l. Furnish O & M Manuals per this Section. Obtain signature on Job Completion Form.
    - m. Give instruction periods to Owner's personnel per this Section. Obtain signature on Job Completion Form.
    - n. To request final acceptance of project, fill out Job Completion Form in this Section and forward to Sparling. Note: If Inspectors have not signed form, a copy of signed-off permits will suffice.
    - o. Include with Job Completion Form, a copy of the final punch list with the word "DONE", and the date and Contractor's initials after each item on the list.

### 1.11 ELECTRICAL EQUIPMENT OPERATION AND MAINTENANCE (O&M) MANUALS

- A. Provide O&M manuals required in Section 01 78 23 plus one manual for Sparling for all equipment furnished under Division 26 - Electrical of the Specifications. Submit a preliminary copy, complete except for the bound cover, 60 days prior to completion of the project for checking and review. Deliver final bound corrected copies as noted in Section 01 78 23 plus a copy to Sparling 20 days prior to scheduled instruction periods. Obtain a receipt for the manuals and forward a copy of the receipt to the Engineer with the Job Completion Form.

## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

- B. The information included must be the exact equipment installed. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets.
- C. These O&M manuals shall contain all the information needed to operate and maintain all systems and equipment provided in the Project. Present and arrange information in a logical manner for efficient use by the Owner's operating personnel. The information provided shall include but not be limited to the following:
  - 1. Equipment manufacturer, make, model number, size, nameplate data, etc.
  - 2. Description of system configuration and operation including component identification and interrelations. A master control Schematic Drawings(s) may be required for this purpose.
  - 3. Dimensional and performance data for specific unit provided as appropriate.
  - 4. Manufacturer's recommended Operation Instructions.
  - 5. Manufacturer's recommended lubrication and servicing data including frequency.
  - 6. Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriate). Parts lists shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier not acceptable.
  - 7. Shop Drawings.
  - 8. Wiring Diagrams.
  - 9. Signal Equipment Submittals shall contain step-by-step circuit description information designed to acquaint maintenance personnel with equipment operation in each mode of operation.
  - 10. A complete list of local (nearest) manufacturer representative and distributor contacts for each type of equipment and manufacturer. Include name, company, address, phone, fax, e-mail address, and web site.
- D. Furnish complete wiring diagrams for each system for the specific system installed under the Contract. "Typical" line diagrams will not be acceptable unless revised to indicate the exact field installation.
- E. Group the information contained in the manuals in an orderly arrangement by Specification Index. Provide a typewritten index and divider sheets between categories with identifying tabs. Bind the completed manuals with hard board covers not exceeding 5" thick. (Provide two or more volumes if required.) Signal and communication systems shall be in separate volumes. Imprint the covers with the name of the Job, Owner, Architect, Electrical Engineer, Contractor and year of completion. Imprint the back edge with the name of the Job, Owner and year of completion. Hard board covers and literature contained may be held together with screw post binding.

### 1.12 INSTRUCTION PERIODS

- A. After date of Substantial Completion and 20 days after the O&M manuals have been delivered to the Owner and after all tests and final inspection of the Work by the Authority(s) Having Jurisdiction; demonstrate the electrical systems and instruct the Owner's designated operating and maintenance personnel in the operation and maintenance of the various electrical systems. The Contractor shall arrange scheduled instruction periods with the Owner. The Contractor's Representatives shall be superintendents or foremen knowledgeable in each system and suppliers representatives when so specified. When more than one training session is specified, the second session shall be 30 to 90 days after the first as agreed to by the Owner. Refer to Section 01 79 00.
- B. Include in each instruction session an overview of the system, presentation of information in maintenance manuals with appropriate references to Drawings. Conduct tours of the building areas with explanations of maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures and adjustment locations.

SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

- C. Include the following scheduled instruction periods:
- |  | 1 <sup>st</sup> Session |
|--|-------------------------|
| 1. Power Distribution System               | 4 hours                 |
| 2. Lighting Control & Dimming System       | 2 hours                 |
| 3. Automatic Transfer Switches             | 4 hours                 |
| 4. Static Uninterruptible Power Supply     | 4 hours                 |
| 5. Transient Voltage Suppression System(s) | 2 hours                 |
- D. Factory trained suppliers representatives shall provide instruction for lighting control/dimming, transfer switches, switchgear, static uninterruptible power supply and transient voltage suppression system(s).
- E. Provide one professionally produced digitally recorded or video tape of each training session in DVD format. Furnish two (2) copies to the Owner.

1.13 RECORD DRAWINGS

- A. Continually record the actual electrical system(s) installation on a set of prints kept readily available at the Project during construction. These prints shall be used for this purpose alone. Refer to Section 01 78 39.
1. Mark record prints with red erasable pencil. Mark the set to show the actual installation where the installation varies substantially from the work as originally shown.
  2. Accurately locate with exact dimensions all underground and underslab raceways and stub-outs.
  3. Note changes of directions and locations, by dimensions and elevations, as utilities are actually installed.
  4. Include addenda items and revisions made during construction.
  5. Erase conditions not constructed or "X-out" and annotate "not constructed" to clearly convey the actual "as constructed" condition.
  6. Organize Record Drawing sheets in manageable sets, bind and print suitable titles, dates and other identification on the cover of each set.
- B. Transmit the Record Drawing set to the Architect at the completion of the Work. Final payment to the Contractor will not be authorized until these prints have been submitted to and accepted by the Architect.
- C. Transfer the changes marked up on the record prints into AutoCAD 2002 (or higher) at the completion of the Work. Provide two (2) sets of prints, one set of fixed line reproducible Drawings and one set of AutoCAD Drawing files on CD Rom. Transmit Drawings, CAD files and the Record Drawing mark-ups to the Architect. Final payment to the Contractor will not be authorized until these Documents have been submitted to and accepted by the Architect.

1.14 FINAL ACCEPTANCE REQUEST

- A. Submit to the Architect, with a copy to the Electrical Engineer of Record, a Sparling Job Completion Form (form attached in this Section) properly filled out prior to the time Final Acceptance of the electrical Work is requested. Refer to Section 01 77 00.

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1.15 ABBREVIATIONS AND DEFINITIONS

A. When the following abbreviations and definitions are used in relation to the Work for Division 26 they shall have the following meanings:

<u>Item</u>	<u>Meaning</u>
AHJ	Authority Having Jurisdiction.
Boxes	Outlet, Junction or Pull Boxes.
Code	All applicable Codes currently enforced at Project location.
Compression	Compressed using a leverage powered (hydraulic or equivalent) crimping tool.
Connection	All materials and labor required for equipment to be fully operational.
Exterior Location	Outside of or penetrating the outer surfaces of the building weather protective membrane.
Fully Operational	Tested, approved, and operating to the satisfaction of the AHJ, manufacturer and Contract Documents.
Furnish	Deliver to the jobsite
Install	To enter permanently into the Project and make fully operational.
Kcml	Thousand circular mils (formerly MCM).
Mfr.	Manufacturer.
NEC	National Electrical Code, National Fire Protection Association, Publication #70.
Noted	Shown or specified in the Contract Documents.
Provide	Furnish and install.
Required	As required by Code, AHJ, Contract Documents, or manufacturer for the particular installation to be fully operational.
Shown	As indicated on the Drawings or details.
Wiring	Raceway, conductors and connections.

PART 2 PRODUCTS

2.1 GENERAL

- A. All materials and equipment installed shall have been tested and listed by Underwriters Laboratories or other approved testing organization and shall be so labeled unless otherwise permitted by the Authority Having Jurisdiction (Inspector).
- B. All materials to be new, free from defects and not less than quality herein specified. Materials shall be designated to insure satisfactory operation and operational life in the environmental conditions which will prevail where they are being installed.
- C. Each type of materials furnished shall be of the same make, be standard products of manufacturers regularly engaged in production of such materials and be the manufacturer's latest standard design.
- D. All materials, equipment and systems furnished that include provisions for storing, displaying, reporting, interfacing, inputting, or functioning using date specific information shall perform properly in all respects regardless of the century. Any interface to other new or existing materials, equipment or systems shall function properly and shall be century compliant, both in regards to information sent and received.

2.2 SUBSTITUTION OF MATERIALS

- A. No Substitute:  
Where a specified product is indicated "no Substitute", it is the intent of this Specification to require new materials to be compatible with the existing installation or as specifically requested by the Contracting Officer. To this end certain materials and systems no Substitution will be allowed. Refer to Section 01 33 00.

## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

- B. Prior to Bid Opening:  
Refer to Section 01 33 00. Acceptance of products other than those specified will be issued by addendum to the Bid Documents only after the following requirements are met and the proposed listed material is determined to meet or exceed the requirements:
1. Requests for listing to be original material, clearly indicating the product fully complies with Contract Documents and be neatly marked with yellow felt tip marker to clearly define and describe the product for which listing is requested.
  2. Include certified laboratory test report for lighting fixtures.
  3. Samples shall be submitted if requested.
  4. Requests shall be received 10 days prior to Bid Opening.
  5. Requests containing insufficient information to confirm compliance with Contract Documents will not be considered.
- C. After Award of Contract:  
Refer to Section 00 90 00 - Contractor Request for Design Deviation. Substitution of products will be considered after award of Contract only under the following conditions:
1. The Contractor shall have placed orders for specified materials promptly after Contract is awarded and the specified products can not be delivered to the Project to meet the Owner's construction schedule.
  2. The reason for the unavailability is beyond the Contractor's control, i.e., due to strikes, bankruptcy, discontinuance of manufacturer, acts of God.
  3. The specified product is no longer manufactured.
  4. There is compelling economic advantage to the Owner.
- D. In all cases, should a substituted material result in requiring electrical system or building modifications; the Contractor alone shall pay all costs to provide these modifications including all costs to the Electrical Engineer of Record and Architect for redesign, and updating of Record Drawings required to accommodate the required modifications.

### 2.3 NAMEPLATES

- A. Provide nameplates per Section 260553 - Identification for Electrical Systems.

## PART 3 EXECUTION

### 3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 01 60 00.
- B. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft. Handle all equipment carefully to prevent damage, breakage, denting, and scoring of finishes. Do not install damaged equipment.
- C. Store products subject to damage by the elements above ground, undercover in a weather tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instruction.

### 3.2 CUTTING BUILDING CONSTRUCTION

- A. Refer to Section 01 73 29.
- B. Obtain permission from the Architect and coordinate with other trades prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills or concrete saws except where space limitations prevent the use of such tools.
- C. All construction materials damaged or cut into during the installation of this Work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that particular building trade.

## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

### 3.3 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire rated floor and wall assemblies to maintain fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Section 07 84 13.

### 3.4 PAINTING

- A. Items furnished under this Division that are scratched or marred in shipment or installation shall be refinished with touchup paint selected to match installed equipment finish.

### 3.5 EQUIPMENT CONNECTION

- A. For equipment furnished under this or other Divisions of the Specifications, or by Owner, provide complete all electrical connections necessary to serve such equipment and provide required control connections to all equipment so that the equipment is fully operational upon completion of the Project. Provide disconnect switch as required by Code whenever an equipment connection is shown on the Drawings.
- B. Investigate existing equipment to be relocated and provide new connections as required.

### 3.6 HOUSEKEEPING PADS

- A. Provide steel reinforced concrete housekeeping pad under floor mounted and free standing electrical equipment as shown on Drawings. Size 4" greater (horizontal minimum) than base of equipment mounted thereon. Minimum height 4". Use 3000-psi (20.7-Mpa), 28 day compressive strength concrete and reinforcement as specified in Section 03 30 00 "Cast-in-Place Concrete". Chamfer edges and finish smooth with all blockouts square and plumb.
- B. When housekeeping pad is poured on previously poured concrete or is for engine or motor driven equipment, the pad shall be reinforced (4# rebar, 12" o.c., both ways) and the rebar shall be tied to the existing floor via #4 rebar epoxy grouted into the existing concrete spaced at 18" centers or other acceptable means. The existing slab shall be thoroughly cleaned and prepared for the pad just before the pour.

### 3.7 CLEAN UP

- A. Contractor shall continually remove debris, cuttings, crates, cartons, etc., created by his work. Such clean up shall be done daily and at sufficient frequency to eliminate hazard to the public, other workmen, the building or the Owner's employees. Before acceptance of the installation, Contractor shall carefully clean cabinets, panels, lighting fixtures, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied. Refer to Section 01 74 00.
  - 1. Wipe surfaces of electrical equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - 2. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent, high pressure sodium, metal halide, and mercury vapor fixtures to comply with requirements for new fixtures.

### 3.8 TESTING AND DEMONSTRATION

- A. Demonstrate that all electrical equipment operates as specified and in accordance with manufacturer's instructions. Perform tests in the presence of the Architect, Owner or Engineer. Provide all instruments, manufacturer's operating instructions and personnel required to conduct the tests. Repair or replace any electrical equipment that fails to operate as specified and or in accordance with manufacturer's requirements. Refer to Section 01 79 00.

SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

SPARLING ELECTRICAL JOB COMPLETION FORM

PROJECT NAME: MMC ED/CC EXPANSION  
 PROJECT LOCATION: \_\_\_\_\_  
 DATE: \_\_\_\_\_

A. Electrical Inspectors Final Acceptance (Copy of certificate attached.)

Name	Agency	Date
------	--------	------

B. Fire Marshal's Final Acceptance of Fire Alarm System (Copy of certificate attached.)

Name	Agency	Date
------	--------	------

C. The following systems have been demonstrated to Owner's representative.

- |  |              |      |
|--|--------------|------|
| 1. Power Distribution System Below 600V    | Owner's Rep. | Date |
| 2. Power Distribution System Over 600V     | Owner's Rep  | Date |
| 3. Lighting Control & Dimming System       | Owner's Rep  | Date |
| 4. Transfer Switches                       | Owner's Rep  | Date |
| 5. Transient Voltage Suppression System(s) | Owner's Rep  | Date |
| 6. Uninterruptible Power Supply System     | Owner's Rep  | Date |

D. Record Drawings  
 Attached Transmitted previously to \_\_\_\_\_  
 Date \_\_\_\_\_

E. O & M Manuals  
 Attached Transmitted previously to \_\_\_\_\_

F. Test Reports  
 Attached Transmitted previously to \_\_\_\_\_  
 Date \_\_\_\_\_

G. The Work is complete in accordance with Contract Documents and authorized changes except for

\_\_\_\_\_ and the Architect/Engineer's representative is requested to meet with  
 \_\_\_\_\_ at \_\_\_\_\_ on \_\_\_\_\_  
 Supervisor of Electrical Work Time Date  
 \_\_\_\_\_  
 Contractors Rep. Signature Date

## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

**Sparling Schedule of Values for MMC ED/CC Expansion**

<b>Description of Work</b>	<b>Amount</b>
Site Rough-in (ltg., pole bases, power & systems) - Labor and Materials	
Distribution Feeders Rough-in - Labor & Materials	
Distribution Feeders Conductors and Terminations - Labor & Materials	
Branch Circuit (lighting, receptacles, misc.) Rough-in - Material and Labor	
Branch Circuit Conductors and Terminations - Material and Labor	
Switchgear, Panelboards, Transformers, Starters, Disconnects - Material	
Switchgear, Panelboards, Transformers, Starters, Disconnects - Labor	
Transient Voltage Surge Suppression - Material	
Transient Voltage Surge Suppression - Labor	
Lighting - Material	
Lighting Exterior (installation & checkout) - Labor	
Lighting Interior (installation, trimout) - Labor	
Devices (switches, receptacles, equip. connections) - Labor & Materials	
Mechanical Power Connections (starter & disconnects) - Labor	
Secondary Unit Substations - Labor & Materials	
Dimming System - Labor & Materials	
Low Voltage Lighting Controls - Labor & Materials	
Uninterruptible Power Supply System - Labor & Materials	
Testing, Demonstration (AHJ approvals)	
Training	
Close Out (Record Drawings, O&M, etc.) - Materials & Labor	
<b>TOTAL DIVISION 26</b>	

## SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

## SPARLING SUBMITTAL LIST MMC ED/CC EXPANSION

SECTION	DESCRIPTION	SUBMIT RECEIVE DATE	STATUS
260126	MAINTENANCE TESTING OF ELECTRICAL SYSTEMS		
260513	MEDIUM VOLTAGE CABLES		
260519	COPPER CONDUCTORS AND CABLES		
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS		
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS		
260534	FLUSH FLOOR OUTLETS		
260536	CABLE TRAYS FOR ELECTRICAL SYSTEMS		
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS		
260573	OVERCURRENT PROTECTIVE DEVICE COORDINATION		
260923	LIGHTING CONTROL DEVICES		
261116	SECONDARY UNIT SUBSTATIONS		
261316	MEDIUM VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR		
262200	LOW VOLTAGE TRANSFORMERS		
262413	SWITCHBOARDS		
262416	PANELBOARDS		
262500	ENCLOSED BUS ASSEMBLIES		
262726	WIRING DEVICES		
262813	FUSES		
262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS		
263353	STATIC UNINTERRUPTIBLE POWER SUPPLY		
263624	TRANSFER SWITCHES WITH BYPASS / ISOLATION		
264313	TRANSIENT VOLTAGE SUPPRESSION FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS		
265100	INTERIOR LIGHTING		
265600	EXTERIOR LIGHTING		
280513	CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY		
283100	FIRE DETECTION AND ALARM		

END OF SECTION

## SECTION 26 05 10 EXISTING SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 RELATED WORK

- A. Same as in Section 26 05 00 - Common Work Results For Electrical.

#### 1.3 EXISTING SYSTEMS MAINTAINED

- A. Prior to bidding, existing systems and systems adjacent to the Work shall be investigated thoroughly. Any damage resulting from performance of Work under this Contract shall be repaired to assure continuing operation and integrity during and at completion of the Project at no increase in Contract Amount.
- B. Any existing wiring serving devices to remain in service and which is interrupted by Work performed under this Contract shall be rerouted to maintain circuit continuity. Contractor shall assume the risk of maintaining existing systems except relocation of wiring of #2 AWG and above shall be considered an additional cost if not shown to be relocated. If such wiring is found the Contractor shall notify Architect of wiring location, reason it must be removed and cost of relocation and receive the Owner's approval before proceeding with the Work.
- C. The building will continue operation during the Work and it is essential that no systems operation be interrupted unless scheduled with the Contracting Officer. Contractor shall assume responsibility for unscheduled interruptions and expedient repair.
- D. Provide new raceway support system for all existing raceways above existing or new accessible ceilings in the Project Area in accordance with Section 26 05 33 - Raceways and Boxes For Electrical Systems. (Note: The original construction consists of raceways being supported by the ceiling suspension system which is unacceptable to the Electrical Inspector.) Provide new earthquake support system for all existing fixtures in Project area in accordance with Section 26 51 00 - Interior Lighting.

#### 1.4 EXISTING SYSTEMS CONCEALED

- A. The Electrical Drawings show portions of the existing electrical systems which are to remain, be removed or be modified as a part of the Work of this Contract. Concealed features of the existing systems are derived from Record Drawings and the best judgment of the Electrical Engineer of Record of the configuration, but no guarantee is made as to their correctness.
- B. The Contractor shall inspect the existing installation prior to bidding and shall make his own judgment as to the work required to provide a complete installation within the intent of the Contract Documents.

#### 1.5 DEMOLITION WORK

- A. Not all Demolition Work required under this Contract is shown on the Drawings.
- B. The Demolition Drawings show portions of the existing systems which are derived from Record Drawings. The Contractor shall assume there is 20% more electrical systems than what is shown on the Demolition Drawings.
- C. The Contractor shall inspect the existing installation prior to bidding and shall make his own judgment as to the Work required to provide complete demolition within the intent of the Contract Documents.

## SECTION 26 05 10 EXISTING SYSTEMS

### 1.6 TEMPORARY ELECTRICAL EQUIPMENT

- A. Removing, temporary hanging by chains and reinstalling in ceilings of light fixtures, speakers, detectors, exit signs and other electrical equipment is not shown on the Drawings. The Contractor shall investigate the ceiling demolition Work and include this Work in the Bid. The sequence of Work shall be (1) Remove and store fixtures, detectors and speakers along with removal of ceiling, (2) Provide temporary support for wired fixtures and devices to be reinstalled in new ceiling at approximately the same location. Use chains for lighting fixture support, (3) Clean and reinstall in the new or replaced ceilings. Provide new lamps when so noted. Provide temporary relocation of exit signs to original location when exit is reactivated.

### 1.7 WORK OUTSIDE OF REMODEL AREAS

- A. Caution - this work is not shown on the Contract Documents. Provide new wiring systems in concealed ceiling spaces to switchboards, panelboards, communication and signaling and system control panels. Remove and relocate electrical equipment in the way of other trades Work installed under this Contract. Spaces above existing ceilings are highly congested. Route wiring around obstructions and provide pull boxes per Code.

### 1.8 PREMIUM TIME

- A. Premium time shall be included in the Base Bid for electrical system(s) outages and for other Work as required by the Schedule, as shown on the Drawings and as noted in other Divisions of the Specifications.

### 1.9 EXISTING STRUCTURAL CONDITIONS

- A. Verify existing floor slabs with Structural Engineer. Contractor shall penetrate floors by core drilling only. Extreme caution is required to avoid cutting post tensioned cables. X-ray of floor shall be performed prior to selecting location of cores and anchors for electrical equipment. Cores and anchors shall be kept 2" minimum away from the post tensioning cables. Refer to Section 01 35 15.

## PART 2 PRODUCTS

### 2.1 EXISTING MATERIALS

- A. All materials which are a part of the building shall remain the property of the Owner.

### 2.2 EXISTING MATERIALS TO BE REINSTALLED

- A. Existing materials and equipment (except interior, undamaged raceways) that are removed as a part of the Work or stored in surplus shall not be reinstalled as a part of the new systems unless specifically noted or authorized in writing by the Contracting Officer. Forward a copy of the authorization to the Architect. The requirements of the Contract Documents (i.e., condition, installation, testing, etc.) shall apply as if the materials were new, furnished by the Contractor.

### 2.3 EXISTING MATERIALS NOT TO BE REINSTALLED

- A. Materials not scheduled to be re-installed shall be made available for inspection by Contracting Officer and decision as to whether Owner will retain possession. Items selected for retention shall be turned over to the Owner. Retained items shall be delivered to a location on the premises as selected by Contracting Officer. Take reasonable care to avoid damage retained by Owner. If the Contractor fails to conform to this requirement, he shall purchase and turn over to the Owner replacement material of like kind and quantity.
- B. All material not selected for retention by the Owner and debris shall be property of the Contractor and be legally disposed of by the Contractor.

## SECTION 26 05 10 EXISTING SYSTEMS

### PART 3 EXECUTION

#### 3.1 EXISTING CONDITIONS

- A. Examine the structure, building, and conditions under which electrical Work is to be installed for conditions detrimental to proper and timely completion of electrical Work. Do not proceed with Work until deficiencies or detrimental conditions have been corrected. Report deficiencies or detrimental conditions of existing electrical Work to Architect which might be unsuitable to connect with or receive other Work. Failure to so report shall constitute acceptance of other Work as being fit and proper for the reception of electrical Work.

#### 3.2 DEMOLITION

- A. Switchboards, panelboards, signaling and communication systems, other electrical equipment free standing or surface mounted, raceway (exposed) and conductors; which are no longer in service presently or as a result of this Contract shall be removed. Unused flush-mounted devices, outlet and other boxes in finished areas shall be removed from wall and the remaining hole patched to match adjacent wall surfaces under the Provisions of Section 01 73 29. Unused raceways and sleeves shall be cut flush at ceiling, floor or wall and filled with grout. Unused raceways above accessible ceilings shall be removed.
- B. Contractor shall remove all floor, wall or ceiling-mounted electrical equipment in the "Demolition Area" indicated on the Drawing even if the equipment/or device is not shown in the Contract Documents. If Contractor is uncertain whether a particular device is to be removed, issue an RFI to Architect noting type and location of device. If so directed the Contractor shall maintain the existing device in service without any change in Contract Amount.

#### 3.3 POWER OUTAGES

- A. The facility will continue its normal operation during the construction Work; therefore it is required that the Contractor schedule electrical system(s) outages with the Contracting Officer. Electrical systems(s) outages to Owner-occupied areas shall not be permitted from 7:00 a.m. to 6:00 p.m. on any day of the week.
- B. Submit a written request for a power outage at least 7 days in advance identifying the areas, and systems to be affected, time and duration of the power outage. The Contractor shall receive written authorization from Contracting Officer to proceed with the outage and shall notify the Contracting Officer verbally at least one hour prior to the outage and also notify the Contracting Officer again when the outage is completed.
- C. **Unscheduled Outages:** In the event that the Contractor's Work causes or contributes to an electrical system(s) outage (or other system fault), the Contractor shall correct the problem immediately. Included (as examples) shall be any premium time required to stay on the Project Site until problem is corrected and air freight for parts not locally available. Owner maintains right to correct the problem under the provisions of Section 00 72 00, General Conditions.

#### 3.4 EXISTING SYSTEMS MAINTAINED

- A. **General**
  - 1. Reroute existing circuits that are interrupted as a result of this Contract that serve devices to remain in service.

## SECTION 26 05 10 EXISTING SYSTEMS

2. Power Circuits (Including removal or relocation of existing panelboards).
  - a. Prior to demolition Work trace out and identify each branch circuit and feeder circuit that serves loads in occupied areas.
  - b. Provide temporary wiring, schedule outage and reconnect loads to temporary wiring under Provisions of Section 01 50 00.
  - c. Provide new wiring in new location.
  - d. Schedule outage, disconnect temporary wiring, and connect loads to new wiring. Remove temporary wiring.
  - e. Outage for each circuit shall not be more than 20 minutes.
3. Signal and Communication Systems
  - a. Prior to demolition trace out and identify device and systems being served.
  - b. Provide temporary wiring to maintain operation of system throughout facility under Provisions of Section 01 50 00.
  - c. Schedule outage and connect to temporary wiring and test system.
  - d. Provide new wiring on new location.
  - e. Schedule outage, disconnect temporary wiring, and reconnect to new wiring. Remove temporary wiring.
  - f. Outage for each system shall not be more than 20 minutes.

### 3.5 ACCESS TO PERFORM WORK

- A. Carefully remove, store or temporarily hang and re-install in undamaged condition all electrical equipment, lighting fixtures and ceiling tiles where access to perform Work is required. Clean prior to re-installation. Provide new lamps when so noted.

### 3.6 NEW DEVICES IN REMODEL AREAS

- A. Provide flush mounting for devices in existing walls. Fish conduit in wall. Where existing boxes are indicated to be reused, extend box as necessary and provide new devices and plates.
- B. Contractor is cautioned that the existing building contains clay tile and concrete walls. New devices may require cutting and patching, and it shall be the responsibility of the Contractor to provide all cutting and patching under Provisions of Section 01 73 29 required for the installation of the Division 26 Work. Contractor shall investigate existing areas prior to Bid and shall include all costs of such Work in the Bid.
- C. This facility has wiring embedded in raceways in concrete slabs. Provide new concealed wiring to last outlet or pull box before homerun to panel.

END OF SECTION

## SECTION 26 05 13 MEDIUM VOLTAGE CABLES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution.
- B. Related sections.
  - 1. Section 26 01 26 - Maintenance and Testing of Electrical Systems
  - 2. Section 26 05 53 - Identification for Electrical Systems

#### 1.3 REFERENCES

Medium Voltage Distribution Systems shall be designed, manufactured and installed in conformance with the following Standards and Publications:

- A. American National Standards Institute (ANSI):
  - C2 National Electrical Safety Code
- B. National Electrical Manufacturers Association (NEMA):
  - WC8 Ethylene-Propylene-Rubber-Insulated Wire and Cable
- C. Institute of Electrical and Electronics Engineers (IEEE):
  - 386 Separable Insulated Connector Systems for Power Distribution Systems above 600 V
  - Std 48 Standard Test Procedures and Requirements for AC Cable Terminations 2.5 kV through 765 kV
- D. National Fire Protection Association (NFPA):
  - 70 National Electrical Code
- E. Underwriters Laboratories, Inc. (UL):
  - 1072 Medium-Voltage Power Cables

#### 1.4 DESCRIPTION

- A. Provide medium voltage distribution system including cable and terminations complete, fully operational and fully tested.

#### 1.5 SUBMITTALS

- A. General: Submit under Provisions of Section 01 33 00 and the requirements of Section 26 05 00 - Common Work Results For Electrical and requirements described in this Section.
- B. Product Data: Provide for each cable type, include splices, terminations for cables and cable accessories. Submittals shall include conductor construction, ratings, dimensions and standards conformance.
- C. Certification: Submit data indicating cable plant manufacturer's location, date of manufacture and factory testing certification.
- D. Cable Pulling Calculations: Submit cable pulling calculations for all cable pulls over 150-feet in length or with 180-degrees or more of bends. Typical calculations for maximum pulls are acceptable. Include jam ratio calculations.

#### 1.6 QUALITY ASSURANCE

- A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice and terminate medium voltage cable.

## SECTION 26 05 13 MEDIUM VOLTAGE CABLES

### PART 2 PRODUCTS

#### 2.1 MEDIUM VOLTAGE CONDUCTORS

- A. NEC Type MV, 15 kV Class, shielded, single conductor, copper. Insulation shall be ethylene propylene rubber, 133% insulation level. Construction shall be compact Class B stranded copper conductor, semi-conducting tape, insulation, shield, overall sunlight-resistant PVC jacket (a semi-conducting jacket with drain wires such as manufactured by General Cable is acceptable).
- B. All cable installed shall be the product of a single manufacturer and shall be of a single type and configuration. All cable lengths shall be supplied with factory installed waterproof seals on each end.
- C. Cable shall have U.L. label imprinted at regular intervals and be delivered to the job site on the original manufacturer's reels.
- D. Cable shall be constructed and rated for continuous or intermittent submersion in water and shall be suitable for installation in PVC ducts.
- E. Cable shield shall be capable of withstanding the fault current indicated on the drawings for one tenth of a second.
- F. Manufacturer: American Insulated Wire Corporation, BICC Brand-Rex Company, General Cable Corporation, Kerite Co. (The); Hubbell Incorporated, Okonite Company (The), Pirelli Cable & Systems, Rome Cable Corporation, Southwire Company.

#### 2.2 CONNECTORS AND TERMINATIONS

- A. Separable Connectors: Loadbreak, 15-kV, 95-kV BIL, rated for 200-amperes for use with cables 3/0 or smaller and rated for 600-amperes for use with cables larger than 3/0. Shall have steel reinforced hook-stick eye, grounding eye, test point and arc-quenching contact material. Provide wall-mounted connection bus with parking stand. Suitable for continuous or intermittent submersion in water.
- B. Terminations: Premolded stress cone type. Cone shall consist of a semi-conducting stress relief cone bonded to modular molded rubber insulating cone, and shall include a ground tab to ground the stress relief. The stress relief shall be maintained in tight contact with the cable shield under all conditions of cable load cycling.
- C. Manufacturer: Engineered Products Co., G&W Electric Co., MP Husky, Raychem Corp.; RTE Components; Cooper Power Systems, Inc., Scott Fetzer Co. (The); Adalet, Inc., Thomas & Betts Corporation, Elastimold, 3M Company; Electrical Products Division.

### PART 3 EXECUTION

#### 3.1 CABLE

- A. General: Comply with all manufacturers' recommendations regarding storage, handling, and installation of cable.
- B. Storage: Cable shall be stored indoors until the day of installation. Comply with manufacturer's recommendations regarding storage temperature.
- C. Handling: Comply with minimum bending radius recommendations. Prevent impact of objects against cable; prevent twisting of cable.
- D. Cutting: All cutting of cable shall be done in a clean, dry environment. Cut ends shall be sealed with a waterproof seal immediately after cutting, and the seal shall be maintained during and after pulling.

## SECTION 26 05 13 MEDIUM VOLTAGE CABLES

- E. Installation:
  - 1. All cable runs shall be continuous between terminations. Splices will be allowed only where cable installation requires and only in accessible locations.
  - 2. Comply with recommendations regarding minimum installation temperature, maximum pulling tension, and cable sidewall pressure. Use cable lubricant approved by cable manufacturer. Cable damaged by cable grips or pulling make-ups shall be cut off so as to provide clean, undamaged cable for termination. Continuously record pulling tension during installation.
- F. Support: Cables in handholes and manholes shall be supported from the walls at least 3" above the floor of the handhole. Support cables with reinforced nylon cradles. Anchor to wall with Type 316 stainless steel anchor bolts.
- G. Routing: All cables shall make at least one 360-degree sweep around the inside of each manhole prior to exiting. Fill the lowest ducts first, avoid covering duct entrances and allow space for future cable installation.

### 3.2 TERMINATIONS

- A. Comply with manufacturer's instructions regarding handling, storage, and installation. Terminations shall be selected to be compatible with the diameter and configuration of the cable actually used. Installation shall be done in a clean, dry environment. Apply silicone grease as recommended by the manufacturer.
- B. The cable shield shall be grounded at every termination. Provide 3/0 ground ring at each manhole. Shield ground wire shall be capable of withstanding same fault current as shield.

### 3.3 TAGS

- A. Provide identification tags per Section 26 05 53 - Electrical Identification on each conductor in every manhole or handhole and at each termination to identify the phase and neutral conductors.
- B. Tags shall be securely fastened and positioned, and all tags shall be visible from the outside of the handhole, transformer, etc. after cables re in place.

### 3.4 TESTING

- A. Provide under Provisions of Section 01 45 21 and per Section 26 01 26 - Electrical Testing.

END OF SECTION



## SECTION 26 05 19 COPPER CONDUCTORS AND CABLES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes
  - 1. Building wire and cable
  - 2. Remote control and signal circuits
  - 3. Splices, connectors, and terminations
- B. Substitutions: Substitute products will be considered only under the terms and conditions of Sections 00 90 00 - Clarifications and Changes: Contractor's Request for Design Deviation, 01 25 13 - Product Substitution Procedures, and 26 05 00 - Common Work Results For Electrical.

#### 1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM).
- B. National Electrical Manufacturers Association (NEMA).
- C. Underwriter's Laboratories, Inc. (UL).

#### 1.4 SUBMITTALS

- A. Make Submittals in accordance with Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results for Electrical. Submit product data for connectors and Manufacturer's recommended sheath cutting procedure including special tools.

### PART 2 PRODUCTS

#### 2.1 WIRE AND CABLE

- A. General
  - 1. Copper conductor, single insulated wire.
  - 2. AST B1-01 (2007) solid conductors; ASTM B8-04 for stranded conductors
  - 3. 600 volt insulation class, 90°C maximum operating temperature for dry and wet locations
- B. Thermoplastic Insulated Wires and Cables
  - 1. Type THHN/ THWN , UL 83 listed, comply with NEMA WC5.
- C. Rubber Insulated Wires and Cables
  - 1. Type XHHW-2, UL 44 listed, comply with NEMA WC3.
  - 2. Type USE-2, UL 44 listed, comply with NEMA WC3.

#### 2.2 REMOTE CONTROL AND SIGNAL CIRCUITS

- A. Class 1
  - 1. Copper conductor, single insulated wire
  - 2. Insulation type THHN/ THWN (90°C), 600 volt insulation class
  - 3. Type XHHW for ambient temperature less than 0°C
  - 4. UL 83 listed, ASTM B1-01 (2007) solid conductors; ASTM B8-08 for stranded conductors
- B. Class 2 and 3
  - 1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted
  - 2. 300 volt XLPE insulation rated 105°C
  - 3. UL listed for use in the space in which circuits will be installed

SECTION 26 05 19 COPPER CONDUCTORS AND CABLES

2.3 SPLICES, CONNECTORS & TERMINALS

- A. Splices
  - 1. Electrical Tape: 7 mil thick, PVC backing with flexibility and adhesion at 0°F.
  - 2. Pre-Stretched Tubing: EPR pre-stretched tubular rubber sleeve suitable for insulation of voltages up to 600 volts. 3M PST series or equivalent.
  - 3. Heat Shrink Tubing: Thermally stabilized cross-linked polyolefin with 3 to 1 expansion and internal adhesive sealant. Thomas & Betts Shrink-Kon, Raychem, or equivalent.
  - 4. Resin Filled Insulators: Plastic mold body with pourable insulating and sealing compound. 3M Scotchcast 82 or 90 series or equivalent.
- B. Connectors
  - 1. No. 10 AWG and Smaller: Pre-insulated "twist-on" type with integral spring and insulated housing per UL 486C. Manufacturers: Ideal, Thomas & Betts, or 3M.
  - 2. No 8 AWG and Larger: Bolt or compression set type per UL 486C. Provide two hole compression set connectors for ground bus applications. Manufacturers: Thomas & Betts, O.Z. Gedney.
- C. Terminals
  - 1. Stranded Conductors #10 and Smaller: Comply with UL 486A
  - 2. Heavy wall thickness copper, tin plated with nylon insulation
  - 3. Thomas & Betts Sta-Kon Terminals
  - 4. Cable ties - nylon locking type. Thomas & Betts Ty-Rap

2.4 TERMINATIONS

- A. Compression set, bolted, or screw type lug or direct to bolted or screw type terminal.

2.5 PLASTIC CABLE TIES

- A. Nylon or approved, locking type.

PART 3 EXECUTION

3.1 WIRE & CABLE

- A. Sizing
  - 1. Use stranded conductors for #8 AWG and larger. Conductors of #10 and #12 AWG may be solid or stranded at the Contractor's option.
  - 2. Minimum power and lighting branch circuit requirement of #12 AWG.
  - 3. Oversize neutral conductors for receptacle circuits using common neutrals, including those to power poles and powered furniture partitions for possible non-linear loads. See Drawings for sizing criteria.
- B. Color Coding
  - 1. Color code wire in accordance with the coding shown below:
 

	208Y/120V	480Y/277V
A Phase (Left bus in panel):	Black	Brown
B Phase (Center bus in panel)	Red	Orange
C Phase (Right bus in panel)	Blue	Yellow
Neutral	White	Gray
Equipment Ground	Green	Green
Isolated Ground	Grn/Yel*	Grn/Yel*
  - 2. If large conductors cannot be purchased with the correct insulation color, color code the conductors with wire and cable markers of the appropriate color. Completely encircle the conductor with color coding tape for a minimum length of 6 inches at all accessible locations.
  - 3. In the event that separate neutrals are specified with each phase conductor, provide a white neutral conductor with a tracer of the same color as the corresponding phase conductor.

## SECTION 26 05 19 COPPER CONDUCTORS AND CABLES

### C. Installation

1. Utilize type THHN/THWN wire for all power, lighting circuits except where the ambient temperature is below 0°C, use Type XHHW installation.
2. Install all wiring in a raceway system unless otherwise specified.
3. Install wire only after building interior has been protected from the weather.
4. Install wire only after mechanical Work likely to damage wire has been completed.
5. Completely and thoroughly swab exterior raceways before installing wire.
6. Pull all conductors into a common raceway simultaneously.
7. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
8. Neatly train and lace wiring inside boxes, equipment and panelboards.
9. Provide conductor vertical supporting device as required by NEC 300-19.
10. Conductors from one system shall not be intermixed in the same raceway as another system unless shown otherwise. Examples of circuits not to be intermixed are 480Y/277 with 208Y/120 volt circuits, emergency power, line voltage circuits with low voltage wiring, etc.

### 3.2 REMOTE CONTROL & SIGNAL CIRCUITS

#### A. Sizing - #16 AWG minimum.

#### B. Installation:

1. Install cables in cable tray and cable rings.
2. Provide protection for exposed cables where subject to damage.
3. Support cables above accessible ceilings; do not rest on ceiling tiles.
4. Use suitable cable fittings and connectors.

### 3.3 SPLICES, CONNECTORS & TERMINALS

#### A. Splices

1. Do not make splices without the approval of the Electrical Engineer of Record.
2. Splice wires and cables only in accessible locations such as within junction boxes.
3. Make splices to carry full capacity of conductors with no perceptible temperature rise.
4. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat shrinkable insulating tubing, or resin filled insulator.

#### B. Connectors

1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with the connectors being installed.
2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat shrinkable insulating tubing for splices and taps of #8 AWG copper conductors and larger.
3. Torque conductor connections to manufacturer's recommended values.
4. Use pre-insulated "twist-on" connectors with integral spring for splices and taps of #10 AWG copper conductors and smaller.

#### C. Terminals

1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
3. Train wires to eliminate fanning of stands, crimp with proper tool and die.
4. Torque screw termination per manufacturer's recommended values.
5. Cable ties: neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

END OF SECTION



## SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION

- A. Grounding systems shall be provided for service neutral power ground and for equipment grounds and bonding as required by Code.

### PART 2 PRODUCTS

#### 2.1 GROUNDING CONDUCTORS AND CONNECTORS

- A. Copper only, sized per code. Bare or green insulated in sizes #10 AWG or larger. Green insulated for size #12 AWG.

#### 2.2 GROUND RODS

- A. 3/4" x 10'-0" copper clad steel.

### PART 3 EXECUTION

#### 3.1 GROUNDING, GENERAL

- A. Provide all grounding for electrical systems and equipment as required by Codes and as specified herein.
- B. Branch Circuit Grounding: All branch circuits in patient areas shall include an insulated green ground wire connected between the branch circuit panelboard ground bus and the wiring device (or equipment) ground terminal that the branch circuit serves. One ground wire in each branch circuit raceway, looped between ground terminals, is required. For the purposes of this code requirement, the entire Project area up to a height of eight feet above the floor shall be considered to be a patient occupied area. Green tape identification (in lieu of green insulation) on ground wires is not acceptable.

#### 3.2 GROUND RODS

- A. Provide as shown and/or required. Connect the grounding conductor to each rod.

#### 3.3 SIZE OF GROUND WIRE

- A. As required by National Electric Code. Where ground wire is exposed to physical damage protect with rigid non-ferrous conduit as permitted by applicable Code.

#### 3.4 GROUND CONNECTION OF PIPING

- A. Metal internal piping shall be grounded, as a part of this Contract.

#### 3.5 CONNECTION TO THE POWER GROUND BUS

- A. Furnish and install connections in accordance with the Codes; including but not limited to:
  1. Raceway system
  2. Switchboard
  3. Service neutral
  4. "Separately derived system" (transformer or emergency power supply)
  5. Electrically operated equipment and devices.
- B. No device or equipment shall be connected for electrical service which has a neutral conductor connected to a grounding conductor or to the frame within the device or equipment.

#### 3.6 METHOD OF CONNECTIONS

- A. Make all ground connections and ground cable splices by thermal welding or copper compression set type connectors U.L. listed for grounding purposes. Grounding lugs, where provided as standard manufacturer's items on equipment furnished, may be used.

## SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### 3.7 EXPANSION FITTINGS

- A. In conduit runs requiring an expansion fitting, a bonding jumper shall be installed around the fitting to maintain continuous ground continuity.

### 3.8 TESTING

- A. Conform to Section 01 45 21 and Section 26 01 26 - Maintenance Testing of Electrical Systems

### 3.9 GROUND CABLE CROSSING EXPANSION JOINTS

- A. Ground cables crossing expansion joints or similar separations in structures or paved areas shall be protected from damage by means of suitable approved devices or methods of installation which will provide the necessary slack in the cable across the joint to permit movement. Stranded or other approved flexible copper run or jumper shall be used across such separations.

### 3.10 GROUNDING FOR PANELBOARD FEEDERS

- A. Provide a grounding bushing with ground conductor sized in accordance with NEC table 250.122 to the grounding bus in the panelboard and switchboards.

### 3.11 PANELBOARD BONDING

- A. Provide a bonding conductor not smaller than #10 AWG between the ground bus in the normal and emergency panels and/ or two or more emergency panelboards fed from separate transfer switches, serving the same individual patient vicinity in accordance with NEC 517.14.

END OF SECTION

## SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Seismic restraints for electrical equipment and systems.

#### 1.3 REFERENCES

- A. ASTM A325: American Society for Testing and Materials - Standard Specification for Structural Bolts.
- B. ASTM A603: American Society for Testing and Materials - Standard Specification for Zinc-Coated Steel Structural Wire Rope.
- C. IBC: International Building Code 2006 as amended by the State of Washington.
- D. ICC: International Code Council.
- E. MFMA-3: Metal Framing Manufacturers Association's Metal Framing Standards Publication.
- F. MSS SP-58: Manufacturers Standardization Society of the Valve and Fittings Industry - Standard for Pipe Hangers and Supports - Materials, Design, and Manufacture.
- G. NECA 1: National Electrical Contractors Association Standard Practices for Good Workmanship in Electrical Contracting.
- H. OSHPD: Office of Statewide Health Planning and Development.

#### 1.4 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.
- D. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.

#### 1.5 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00, Section 26 05 00 - Common Work Results For Electrical and requirements described in this Section.
- B. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.
  - 1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
  - 2. Annotate to indicate application of each product submitted and compliance with requirements.

## SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- C. Shop Drawings: Submit Shop Drawings indicating routing of single raceways, trapeze systems and cable trays requiring bracing. Indicate on the shop drawing the type and location of bracing to be used. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a registered structural engineer in the State of Washington. Include the following:
1. Fabricated Supports: Representations of field-fabricated supports not detailed on Drawings.
  2. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:
    - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile, compressive, and shear loads.
    - b. Details: Detail fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Submit details and calculations for the following items:
      - 1) Raceway Supports
      - 2) Busways
      - 3) Cable Trays
      - 4) Secondary Unit Substations
      - 5) Bypass/ Isolation Transfer Switches
      - 6) Switchboards
      - 7) Dry Type Transformers
    - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- D. Coordination Drawings: Submit under the Provisions of Section 01 33 13. Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- E. Welding certificates.
- F. Qualification Data: For Professional Engineer and testing agency..
- G. Field quality-control test reports.

### 1.6 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3 of this Section.

### 1.7 PROJECT CONDITIONS

- A. Site Class as Defined in the IBC: Refer to Structural Drawings, General Notes. Coordinate with Architect.
- B.  $S_s$ , Mapped Maximum Considered Earthquake Spectral Response at Short Periods: Refer to Structural Drawings, General Notes. Coordinate with Architect.
- C.  $S_1$ , Mapped Maximum Considered Earthquake Spectral Response at 1-Second Period: Refer to Structural Drawings, General Notes. Coordinate with Architect.
- D. Assigned Seismic Use Group or Building Category as Defined in the IBC: Refer to Structural Drawings, General Notes. Coordinate with Architect.

SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1.8 PROJECT CONDITIONS

- A. Project Seismic Zone as Defined in the IBC: Refer to Structural Drawings, General Notes.
- B. Project Seismic Zone Factor as Defined in the IBC: Refer to Structural Drawings, General Notes.
- C. The below listed systems shall have a component importance factor as described below:

<b>Ip = 1.0</b>	<b>Ip = 1.5</b>
Normal power feeders, busways and branch circuit raceways	Essential system feeders, busways and branch circuit raceways
Normal power distribution equipment	Essential system distribution equipment
Systems equipment and raceways not specifically listed as being braced with a component importance factor of 1.5.	
	Emergency power control system equipment and raceways
	Fire Alarm system equipment and raceways
	Nurse Call system equipment and raceways
	Voice Paging system equipment and raceways
	Cable tray
	Telecommunications Racks
	Battery Inverters

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of two times the applied force.
- B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.
  - 1. Manufacturers:
    - a. Cooper B-Line; a division of Cooper Industries.
    - b. ERICO International Corporation.
    - c. Allied Support Systems; Power-Strut Unit.

SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- d. GS Metals Corp.
  - e. Michigan Hanger Co., Inc.; O-Strut Div.
  - f. National Pipe Hanger Corp.
  - g. Thomas & Betts Corporation.
  - h. Unistrut; Tyco International, Ltd.
  - i. Wesanco, Inc.
2. Finishes:
    - a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
    - b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-3.
    - c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-3.
  3. Channel Dimensions: Selected for structural loading and applicable seismic forces.
- C. For existing slabs - Refer to Section 01 35 15.
- D. Raceway and Cable Supports: As described in NECA 1.
- E. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers:
      - 1) Hilti, Inc.
      - 2) ITW Construction Products.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co. Inc.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Manufacturers:
      - 1) Cooper B-Line; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc
      - 3) Hilti, Inc.
      - 4) ITW Construction Products.
      - 5) MKT Fastening, LLC.
      - 6) Powers Fasteners.
  3. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
  4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  5. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
  6. Toggle Bolts: All-steel springhead type.
  7. Hanger Rods: Threaded steel.

## SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### 2.2 SEISMIC-RESTRAINT COMPONENTS

- A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. Structural Safety Factor: Strength in tension, compression, shear, and pullout force of components used shall be at least two times the maximum seismic forces to which they will be subjected.
- B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.
  - 1. Manufacture: International Seismic Application Technology (ISAT) (877) 999-4728.
- C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.
  - 1. Manufacturers:
    - a. Amber/Booth Company, Inc.
    - b. International Seismic Application Technology (ISAT)
    - c. Loos & Co., Inc.
    - d. Mason Industries, Inc.
  - 2. Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.
  - 3. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.
  - 4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
  - 5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

### 2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 01 50 00 "Metal Fabrications" for steel shapes and plates.

## PART 3 EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
  - 2. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

## SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

3. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1 inch (25 mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION

- A. Comply with NECA 1 for installation requirements, except as specified in Article 3.2 of this Section.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.
- D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by Code:
  1. To Wood: Fasten with lag screws or through bolts.
  2. To New Concrete: Bolt to concrete inserts or use expansion anchor fasteners.
  3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  4. To Existing Concrete: Expansion anchor fasteners.
  5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  7. To Light Steel: Sheet metal screws.
  8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 00 50 00 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS

- A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Restraint Cables: Provide slack within maximums recommended by manufacturer.

## SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports under Provisions of Section 01 45 21.
- B. Testing: Test pullout resistance of seismic anchorage devices.
  1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Contracting Officer and Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Record test results in tabular form and submit to Architect.

END OF SECTION



## SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections
  - 1. Section 26 05 29 - Hangers and Supports for Electrical Systems
  - 2. Section 26 05 34 - Flush Floor Outlets

#### 1.2 SUMMARY

- A. Section includes raceways, fittings, boxes, enclosures and cabinets for electrical wiring.
- B. Substitutions: Substitute products will be considered only under the terms and conditions of Sections 00 90 00 Clarifications and Changes: Contractor's request for design deviation, 01 25 13 Product Substitution Procedures, and 26 05 00 - Common Work Results For Electrical.

#### 1.3 REFERENCES

- A. American National Standards Institute (ANSI)
- B. National Electrical Manufacturers Association (NEMA)
- C. Underwriters Laboratories, Inc. (UL)
- D. National Fire Protection Association (NFPA)

#### 1.4 SUBMITTALS

- A. Submit in accordance with the Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results For Electrical. Submit product data only for surface raceways and fittings, wireways, enclosures and cabinets.

#### 1.5 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

### PART 2 PRODUCTS

#### 2.1 RIGID METAL CONDUIT (RMC)

- A. Rigid Steel Conduit: ANSI C80.1, UL 6.
- B. Fittings: NEMA FB1, UL 514B, galvanized malleable iron or non-corrosive alloy threaded fittings. Erickson and watertight split couplings are permitted. Set screw and running thread fittings are not permitted.
- C. Conduit Bodies and Fittings Manufacturers: American Electric; Construction Materials Group, Crouse-Hinds; Div. of Cooper Industries, Emerson Electric Co.; Appleton Electric Co., Hubbell, Inc.; Killark Electric Manufacturing Co., Lamson & Sessions; Carlon Electrical Products, O-Z/Gedney; Unit of General Signal, Scott Fetzer Co.; Adalet-PLM, Spring City Electrical Manufacturing Co., Link Seal, Thomas & Betts.

#### 2.2 ELECTRIC METALLIC TUBING (EMT)

- A. Hot dip galvanized, electrogalvanized or sherardized, steel tubing, ANSI C80.3, UL 797.
- B. Fittings: NEMA FB1 UL 514B, steel or malleable iron, compression or set screw. Indentor, drive-on, die cast or pressure cast fittings not permitted.
- C. Conduit Bodies and Fittings Manufacturers: American Electric; Bridgeport, Construction Materials Group, Crouse-Hinds; Div. of Cooper Industries, Emerson Electric Co.; Appleton Electric Co., Hubbell, Inc.; Killark Electric Manufacturing Co., Lamson & Sessions; Carlon Electrical Products, O-Z/Gedney; Unit of General Signal, Scott Fetzer Co.; Adalet-PLM, Spring City Electrical Manufacturing Co., Link Seal, Thomas & Betts.

## SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### 2.3 FLEXIBLE METAL CONDUIT (FMC)

- A. UL 1, galvanized, or zinc coated flexible steel or aluminum for dry locations. Flexible metallic tubing not permitted. Fittings: malleable iron or steel.
- B. Liquidtight Flexible Metal Conduit. UL 360, PVC weatherproof cover over flexible steel conduit. Fittings: galvanized or zinc coated.

### 2.4 SURFACE RACEWAY

- A. Surface Metal Raceway: Galvanized steel with snap on covers. Manufacturer's standard ivory or buff painted finish. UL 5.
- B. Types, sizes, and channels as indicated on drawings and required for each application with fittings that match and mate with raceways.
- C. Manufacturers: Subject to compliance with the requirements, manufacturers offering products that may be incorporated into the Work include:
  - 1. Surface Metal Raceways: Airey-Thompson Co., Inc.; A-T Power Systems, American Electric; Construction Materials Group, Butler Manufacturing Co.; Walker Division, Wiremold Co. (The); Electrical Sales Division, Mono Systems, Hubbell Wiring Systems Inc.

### 2.5 RIGID NON-METALLIC CONDUIT (RNC)

- A. Schedule 40 and 80: UL 651.
- B. Type EB and B: UL 651, NEMA TC6.
- C. Fittings: NEMA TC3.

### 2.6 LIQUIDTIGHT FLEXIBLE NON-METALLIC CONDUIT (LFNC)

- A. UL 1660

### 2.7 EXPANSION FITTINGS

- A. Malleable iron, hot dip galvanized allowing 4"(100mm) (+/- 2" (50mm)) conduit movement. OZ/Gedney AX Series or equivalent by manufacturer listed in 2.1.D.

### 2.8 RACEWAY PENETRATION SEALS

- A. Thruwall and Floor Seals: New construction - OZ/Gedney FSK Series. Existing construction - OZ/Gedney CSM Series or equivalent by manufacturer lists in 2.1.D.

### 2.9 RACEWAY SEALING FITTINGS

- A. For one through four conductors: OZ/Gedney CSB Series.
- B. For greater than four conductors: OZ/Gedney EYA Series with sealing compound.
- C. Low temperature or hazardous locations: OZ/Gedney EYA Series with sealing compound.

### 2.10 VERTICAL CABLE SUPPORTS

- A. Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables. Body shall be malleable iron.
  - 1. OZ/Gedney Type S or equivalent by manufacturer listed in 2.1.D.

### 2.11 METAL WIREWAYS

- A. Material: Sheet metal, size and shape as indicated. Manufacturer's standard finish. UL 870.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Manufacturer: Subject to compliance with the requirements, manufacturers offering products that may be incorporated into the Work include: Hoffman Engineering Co., Keystone/Rees, Inc., Square D Co., Circle AW, B-Line.

## SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

D. Wireway Covers: Screw-cover type.

### 2.12 ENCLOSURES AND CABINETS

- A. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

### 2.13 OUTLET JUNCTION AND PULL BOXES

- A. Interior Wiring:
1. Outlet and Pull Boxes. Pressed steel, zinc coated with plaster ring where applicable. NEMA OS1, UL 514A.
  2. Large Junction and Pull Boxes. Fabricated sheet steel, zinc coated or baked enamel finish, with return flange and screw retained cover.
  3. Concrete and Masonry. Specifically designed boxes for casting in concrete or mounting in masonry walls for that purpose.
  4. Mounting. Provide boxes with fan side box support Caddy J1A series or Caddy quick mount H series.
- B. Exterior Wiring:
1. Above Grade:
    - a. Outlet and junction boxes: Cast or malleable iron or cast of corrosion resistant alloy, complete with conduit hubs, compatible with raceway to which it is connected. NEMA FB1.
    - b. Pull boxes: Fabricated steel and hot dipped galvanized complete with malleable iron hubs.
    - c. All boxes labeled for damp (NEMA 3R) or wet (NEMA 4) locations as applicable.
  2. Below Grade:
    - a. Where exposed to earth: Constructed of precast concrete with size, configuration, cover, grates and reinforcing as required by the particular installation. Manufacturer: Utility Vault or Renton Concrete Products.
    - b. Where exposed to earth: Constructed of fiberglass or plastic with size, configuration, and cover as required by the particular installation.

### 2.14 SOUND ISOLATION PADS

- A. Polybutene putty sheet caulking with inert fillers. Lowry's outlet box pads (available from Harry A. Lowry & Associates, 11176 Penrose St., Sun Valley, CA 91352, phone (818) 768-4661).

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

## SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### 3.2 WIRING METHODS

- A. Interior: Use the following wiring methods:
1. Exposed: Electric Metallic Tubing.
  2. Exposed Subject to Damage (i.e. from vehicles, carts and moving pallets including stubups in concrete): Rigid Steel or Intermediate Metal Conduit.
  3. Concealed: Electric Metallic Tubing.
  4. Connection to Vibrating Equipment (including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): Flexible Metal Conduit, (except in wet or damp locations, use Liquidtight Flexible Metal Conduit) with 90° loop, maximum 6 feet long.
- B. Exterior: Use the following wiring methods:
1. Exposed: Rigid Steel Conduit or Intermediate Metal Conduit.
  2. Concealed: Rigid Steel Conduit, Intermediate Metal Conduit, or Rigid Nonmetallic Conduit.
  3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): Liquidtight Flexible Metal Conduit.
  4. Boxes and Enclosures: NEMA 250, NEMA type 3R or type 4.
- C. Raceways Underground
1. Rigid Nonmetallic Conduit, schedule 40 except use extra heavy-duty schedule 80 for road crossings where not encased in concrete.
  2. Arrange and slope raceways entering building to drain away from building.
  3. Provide marker tape over underground raceways. Marker tape to read "Caution - Electric Line Buried Below". Install 1'-0" (300mm) below grade.
  4. Install underground raceways a minimum of 24" (600mm) below final grade (36" (910mm) on public property) unless otherwise noted or required.
  5. Provide backfill around underground raceways. Use 3/4" (20mm) minus material 6" (150mm) above and below rigid steel conduit and intermediate metal conduit. Use clean sand 6" (150mm) above and below PVC raceways. Backfill above 6" (150mm) free of debris or rocks greater than 1" (25mm) in diameter. Space raceways 7-1/2" (190mm) minimum between centers and 3" (80mm) minimum between raceways.
  6. Anchor raceways encased in concrete to prevent floating during pour.
- D. Hazardous Locations: Use the following wiring methods:
1. Rigid Steel or Intermediate Metal Conduit.
  2. Boxes and Enclosures: Cast Metal Boxes, NEMA FB1.

### 3.3 INSTALLATION

- A. Provide raceways concealed in construction unless noted otherwise or unless specifically authorized by the Architect.
- B. Install raceways level and square and at proper elevations. Provide not less than 6'-6" (200cm) headroom. Where raceways are installed in exit pathways provide not less than 7'-0" headroom. Do not block access to junction boxes, valves, mechanical equipment or prevent removal of ceiling panels, etc.
- C. Complete raceway installation before starting conductor installation.
- D. Use raceway fittings compatible with raceways and suitable for use and location.
- E. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members and follow the surface contours.
1. Run parallel or banked raceways together, on common supports where practical.
  2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

## SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

- F. Join raceways with fittings designed and approved for the purpose and make joints tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
  - G. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box. Provide bushings on all raceways 1-1/2" (40mm) and larger.
  - H. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
  - I. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
  - J. Size raceways not sized on the Drawings per manufacturer's Shop Drawings, applicable Standards or other Sections of this Specification.
  - K. Maintain 12" (300mm) minimum clearance to high temperature (greater than 90°C) surfaces.
  - L. When construction involves masonry work, assemble and install raceways at the same time as the wall is erected. Avoid surface cut masonry units whenever such units are to remain unplastered or uncovered in completed construction.
- 3.4 RIGID METAL CONDUIT
- A. All connections watertight.
- 3.5 SURFACE METAL RACEWAY
- A. Verify exact mounting and locations with Architect prior to rough-in. Install parallel to a building surface (i.e., wall, ceiling, floor) and fasten to surface as recommended by manufacturer. Mount so raceway is in the least obvious location. Provide all required boxes, extensions, fittings, elbows and devices for a complete installation. Ream all cuts smooth and provide bushings in ends of 1/2" (15mm) and 3/4" (20mm) runs at all boxes and devices.
- 3.6 RIGID NONMETALLIC CONDUIT
- A. May be used where permitted by Code and as specified in 3.2 above. Exception: Use rigid steel for elbows, penetrations through floors and walls and stub ups. Raceway size may need to be increased to include Code required ground wire. Field bends limited to less than 44 degrees, formed with manufacturer's recommended heater.
- 3.7 RACEWAY PENETRATION SEALS
- A. Exterior wall surfaces above grade: Provide watertight seal around all raceways. For concrete construction above ground level, cast raceway in wall or core drill wall and hard pack with a mixture of equal parts of sand and cement. For other types of construction use method acceptable to Architect.
  - B. Exterior surfaces below grade: Provide watertight seal around all raceways. Cast raceway into wall (or floor) or use manufactured seal assembly.
  - C. Roofs: Provide flashed and hot mopped weatherproof seal, or a pitch pan filled and sealed to be weatherproof where raceway penetrates roof membrane. Provide a weatherhead on all raceway stubups penetrating roof.
  - D. Fire rated construction: Seal penetrations to maintain fire rating of construction penetrated as specified in Division 7 Firestopping.

## SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### 3.8 RACEWAYS SEALING FITTINGS

- A. Provide watertight seal in the interior of all raceways which pass through building roof, ground floor slab or through outside walls of the building above or below grade. Seal on the end inside the building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in a flush steel box with a blank coverplate to match finish of adjacent plates or surfaces.  
Exception: Sealing fittings are not required on raceways through the floor slab when the raceway does not extend beyond the building footprint.
- B. Provide sealing fittings or duct seal in j-box for all raceways entering freezers and refrigeration units.

### 3.9 HANGERS FOR RACEWAYS

- A. Raceways 1" and larger: Provide lay-in pipe hangers on 1/4" (6mm) or larger all threaded rods attached to metal ceiling inserts or to structural members at not greater than 10'-0" (3m) on center and within 12" (300mm) of each change in direction.
- B. When more than two raceways will use the same routing, group together on a channel trapeze support system supported by 3/8" (9.5mm) (minimum) threaded rods attached to metal ceiling inserts or structural members. Size supports for multiple raceways for 25% future capacity.
- C. Suspended ceiling systems: Do not attach raceways to ceiling suspension system hangers. Raceways 3/4" (20mm) and smaller serving equipment located within ceiling cavity or mounted on or supported by the ceiling grid system may be supported by dedicated #12 ga. galvanized, soft annealed mild steel wire hangers. Two raceways maximum per hanger. Attach raceways with clips manufactured for the purpose.

### 3.10 EXPANSION FITTINGS

- A. Provide expansion fittings for raceways crossing expansion joints, building separation walls, and seismic joints. Provide bonding jumper.

### 3.11 VERTICAL CABLE SUPPORTS

- A. Provide cable support for vertical cable runs as required by NFPA 70.

### 3.12 STUB-UP CONNECTIONS

- A. Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches (150 mm) above the floor. For future equipment connections install threaded plugs flush with floor.

### 3.13 OUTLET AND JUNCTION BOXES

- A. Firmly anchor boxes directly or with concealed bracing to building studs or joists. Boxes must be so attached that they will not "rock" or "shift" when devices are operated.
- B. Flush Mounting: Install front edge (box or plaster ring) even with the finished surface of the wall or ceiling, except for those mounted above accessible ceilings or where drawings indicate surface mounting is permitted.
- C. Do not mount flush boxes back-to-back. Provide 6" (150mm) minimum horizontal separation between closest edges of the boxes. Option: Use sound isolation pads or other sound proofing method acceptable to Architect.
- D. When boxes are installed in fire resistive walls and partitions provide 24" (600mm) horizontal separation between boxes on opposite sides of a wall in accordance with IBC 712.3.2. In addition, limit penetrations to 16 square inches (103 square centimeters) per penetration and not to exceed a total of 100 square inches per 100 square feet (9.3 square meters) of wall area. Option: Apply fire stop putty pads acceptable to the fire marshal.

## SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### 3.14 ELECTRICAL OUTLETS

- A. General: Coordinate the Work of this Section with the Work of other Sections and trades. Study all Drawings that form a part of this Contract and confer with the various trades involved to eliminate conflicts between the Work of this Section and the Work of other trades. Check and verify outlet locations indicated on Architectural Drawings, door swings, installation details and layouts of suspended ceilings and locations of all plumbing, heating and ventilating equipment.
- B. Centered on Built-In Work: In the case of doors, cabinets, recesses or similar features, or where outlets are centered between two such features, such as between a door jamb and a cabinet, make these outlet locations exact. Relocate any outlets which are located off center.
- C. Vertical and Horizontal Relationships: Align outlets exactly on center lines horizontally or vertically where more than one outlet is shown or specified to be at the same elevation or one above the other. Relocate as directed all such outlets (including lighting, receptacle, power, signal and thermostat outlets) which are not so installed, at no additional cost to Owner.
- D. Device Outlet Height: Measure from the finished floor to the center line, unless otherwise noted.

Switches	4 feet, set vertically
Receptacles	18 inches, set vertically or as indicated
Telephone	18 inches, set vertically or as indicated
Other	As noted or as directed by Architect
- E. Ceiling Location: Locate outlet either at the corner joint or in the center of a panel for acoustical material, whichever is closer to the normal spacing. Locate all outlets in the same room in same panel position.

### 3.15 LIGHTING FIXTURES

- A. In ceilings of Acoustical Material: Locate in accordance with approved ceiling layout plans and so that fixtures replace full size ceiling tiles wherever possible.

### 3.16 ELECTRICAL WORK IN COUNTERBACKS, MILLWORK AND CASEWORK

- A. Provide templates, where required, to other trades for drilling and cutting to insure accurate location of electrical fixtures (outlets and devices) as verified with the Architect.
- B. Provide all wiring, devices, plates and connections required by said fixtures.

### 3.17 CONNECTION TO EQUIPMENT

- A. Provide outlet boxes of sizes and at locations necessary to serve equipment furnished under this or other Divisions and provide final connections to all equipment.
- B. Outlet box required if equipment has pigtail wires for external connection, does not have space to accommodate circuit wiring or requires a wire with insulation rating different from circuit wiring used.
- C. Study equipment details to assure proper coordination.

### 3.18 BLANK COVERS

- A. Provide blank covers or plates to match coverplates specified in section 16140 over all boxes that do not contain devices or are not covered by equipment.

### 3.19 DEVICE BOXES CONTAINING EMERGENCY AND NORMAL DEVICES

- A. Permitted only with steel barrier manufactured especially for the purpose of dividing the box into two completely separate compartments.

### 3.20 DEVICE BOXES CONTAINING MULTIPLE DEVICES AND WIRING RATED OVER 150 VOLTS TO GROUND AND OVER 300 VOLTS BETWEEN CONDUCTORS

- A. Permitted only with steel barrier manufactured especially for the purpose of dividing the box into separate compartments for each device having exposed live parts.

## SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### 3.21 JUNCTION OR PULL BOXES

- A. Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit the number of bends within Code requirements.
- B. Permanently accessible.
- C. Do not intermix conductors from one system in same junction box or pull box as another system unless shown or specifically authorized otherwise.
- D. In suspended ceiling spaces: Support from structure independently from ceiling suspension system.
- E. The Drawings do not necessarily show every pull or junction box required. Add all required boxes.

### 3.22 ELECTRIC WATER COOLERS

- A. Conceal the electrical outlet behind the unit housing when provided for by manufacturer.

### 3.23 BOXES IN EARTH

- A. Provide for all wire splices and as required to pull conductors. Set boxes (handholes) smaller than 3' x 3' (910mm x 910mm) in place on a 3" (80mm) sand or pea gravel bed. Set larger boxes with a 6" (150mm) bed.
- B. Set boxes so that coverplates match the slope of, and are flush with the final surface grade.

### 3.24 COLOR CODING

- A. Color Code all junction boxes installed in accessible ceiling spaces and exposed in unfinished areas using spray paint on the box and entire cover in the following manner:

480 Power	Brown	Telephone	Black
277V Lighting	Yellow	Nurse Call	Lt. Blue
120/208V	Unpainted	Public Address	Silver
Emergency Power	Orange	Television	Gold
Clock & Program	Green	Intrusion Alarm	Gray
Fire Alarm	Red	Intercom	White
- B. Use black felt tip marker following painting to indicate the circuit numbers in 1" (25mm) high letters contained within.

END OF SECTION

## SECTION 26 05 34 FLUSH FLOOR OUTLETS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes flush floor outlets and covers for power, telephone, communications, and special purpose outlets.

#### 1.3 SUBMITTALS

- A. Submit in accordance with the Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results For Electrical. Submit product data for each component utilized in the Project.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following manufacturers: Hubbell, Thomas & Betts, Walker or Lew. Hubbell catalog numbers used for illustration. Provide same manufacturer for all products.
- B. Part numbers listed do not constitute a complete assembly. Contractor is responsible to supply additional accessories as required for a complete working system.

#### 2.2 RECTANGULAR RECESSED BOX ASSEMBLY - SINGLE OR MULTIPLE SERVICE

- A. Above Grade: Formed steel, concrete tight, shallow construction.
  - 1. Single gang, Hubbell B-2429; except deep construction, B-2427 for 1-1/4" homeruns.
  - 2. Two gang cast iron (formed steel not available), Hubbell B-4214; except deep construction, B-4233 for 1-1/4" homeruns.
  - 3. Three gang cast iron (formed steel not available), Hubbell B-4314; except deep construction, B-4333 for 1-1/4" homeruns.
- B. On Grade: Cast iron, threaded hubs, shallow construction.
  - 1. Single gang, Hubbell B-2414; except deep construction, B-2436 for 1-1/4" home runs.
  - 2. Two gang, Hubbell B-4214; except deep construction; B-4233 for 1-1/4" homeruns.
  - 3. Three gang, Hubbell B-4314; except deep construction, B-4333 for 1-1/4" homeruns.
- C. COVERS
  - 1. Power-duplex receptacle: Forged brass, duplex flap. Hubbell S-3825 per gang.
  - 2. Telephone and communications outlet:
    - a. Single: Forged brass, Hubbell S-2425 cover with 2-1/8" and 3/4" threaded openings.
    - b. Duplex: Forged brass duplex flap, Hubbell S-3825.
  - 3. Special Purpose Outlet: Forged brass, S-2425 cover with 2-1/8" and 3/4" threaded openings. Provide accessories to suit device configuration.
- D. Carpet Flanges
  - 1. Single gang:
    - a. Polycarbonate, Hubbell S-3083
    - b. Aluminum, Hubbell SA-3083
    - c. Brass, Hubbell SB-3083

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2. Two Gang
  - a. Polycarbonate, Hubbell S-3084
  - b. Aluminum, Hubbell SA-3084
  - c. Brass, Hubbell SB-3084
3. Three Gang:
  - a. Polycarbonate, Hubbell S-3085
  - b. Aluminum, Hubbell SA-3085
  - c. Brass, Hubbell SB-3085

### 2.3 COMBINATION FLUSH FLOOR BOX

- A. Multi-Service flush outlet box suitable for poured concrete construction with adjustment after pour. Capacity for power, telephone and special systems, as shown on Drawings. Duplex receptacle per Section 262726 - Wiring Devices, provide communication device activation for telephone, data and special systems wiring.
  1. Flush coverplate with wire access door or opening. Color as selected by Architect.
  2. Recessed coverplate suitable for carpet installation with wire access door or opening. Color as selected by Architect.
- B. Multi-Service flush box suitable for up to (2) duplex devices.
  1. Hubbell, 3SFBS (stamped steel, or 3SFBC (cast iron).
    - a. Cover - gray, Hubbell 3SFBCGY
  2. Thomas & Betts, 664 (stamped steel), or 664-CI (cast iron).
    - a. Cover - gray, Thomas & Betts 664-CST-GRY
- C. Multi-Service flush box suitable for up to (4) duplex devices.
  1. Hubbell, LCFBS (stamped steel), or LCFBC (cast iron)
    - a. Cover - gray, Hubbell LCFBCGY (for carpeted floors only)
  2. Thomas & Betts, 665SC (stamped steel)
    - a. Cover - gray, Thomas & Betts 665-CST-GRY (for carpeted floors only)
  3. Walker RFB4-SS (stamped steel) or RFB4-CI-1 (cast iron)
    - a. Cover - Buffed finish, die-cast aluminum, Walker RAKMII (for carpeted floors only)

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Coordinate with Architect for exact location of all floor outlets prior to rough-in.
- B. Install cast iron floor boxes on grade above moisture barrier. (Do not penetrate moisture barrier). Install stamped steel (concrete tight) floor boxes for above grade installations.
- C. Adjust top surface to level and flush with finished floor.

### 3.2 RECEPTACLES

- A. Conform with Section 262726 - Wiring Devices.

### 3.3 CARPET FLANGES

- A. Install carpet flanges after installation of final floor covering.

END OF SECTION

## SECTION 26 05 36 CABLE TRAYS FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes cable trays and accessories.
- B. Substitutions: Substitute products will be considered only under the terms and conditions of Sections 00 90 00 Clarifications and Changes: Contractor's Request For Design Deviation, 01 25 13 Product Substitution Procedures, and Section 26 05 00 - Common Work Results for Electrical.

#### 1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
- B. National Electrical Manufacturers Association (NEMA)
- C. Underwriter's Laboratories, Inc. (UL)

#### 1.4 SUBMITTALS

- A. Submit in accordance with the Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results for Electrical. Submit product data for each size and type of cable tray including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies and fittings.
- B. Shop Drawings: Detail fabrication and installation of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
- C. Coordination Drawings: Include floor plans and sections drawn to scale. Fully dimension all cable tray components and lengths of runs. Determine exact layout and relationships between components adjacent structural and mechanical elements. Provide 1/8" scale (minimum) floor plans showing all cable tray components including transitions, expansion joints, supports, firestopping and sound wall penetrations. Show clearances between mechanical ducts and piping. AutoCAD backgrounds will be available upon request.

#### 1.5 COORDINATION

- A. Coordinate layout and installation of cable tray with other construction elements to ensure adequate headroom, working clearance and access. Revise locations and elevations from those indicated as required to suit field conditions and as approved by Engineer.
- B. Examine drawings and existing conditions above ceilings and include bends and offsets in Bid price to avoid ducts, pipes, conduits, etc. Installation in existing ceilings is very difficult. Include extra labor time involved in bid price.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. GS Metals Corp.
  - 2. Cooper B-Line
  - 3. Cablofil, Inc.

#### 2.2 MATERIALS AND FINISHES

- A. Cable Trays, Fittings, and Accessories: Steel, mill galvanized before fabrication, complying with ASTM A 653, G90 (ASTM A 653M, Z275) coating.

## SECTION 26 05 36 CABLE TRAYS FOR ELECTRICAL SYSTEMS

### 2.3

#### WIRE BASKET TYPE

- A. Cable tray shall be "wire basket" type and constructed of welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Cable tray shall be complete with all materials and incidental and miscellaneous hardware required for a complete cable tray system, including but not limited to support hangers, connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Cable tray shall have no sharp edges.
- B. Cable tray width: 24" as shown on drawings. 18" width may be used at contractor's discretion, provided that, during coordination drawing effort, the 24" width is in conflict with other utilities above the ceiling.
- C. Cable tray depth: 4 inch usable loading depth. Provide 6" depth cable tray if 18" width cable tray is used.
- D. Mesh: 2 x 4 inch mesh pattern with intersecting wires welded together.
- E. Fittings: Fittings shall be field fabricated through use of manufacturer's hardware and in accordance with manufacturer's instructions.
- F. Vertical Transitions (Elevation Changes): Vertical transitions shall be field fabricated through use of manufacturer's hardware and in accordance with manufacturer's instructions.
- G. Bends: Bends shall be field fabricated through use of Manufacturer's hardware and in accordance with Manufacturer's instructions.
- H. Supports: Supports shall be trapeze style or wall brackets (center support hangers are not acceptable) and provided in quantities as recommended by cable tray manufacturer according to maximum load.
- I. Support Hangers: Support hangers for trapeze style hangers shall be 1/4-inch or 3/8-inch diameter rods.
- J. Splicing assemblies: Shall be bolted type using serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 Stainless Steel.
- K. Load rating: NEMA 8C in accordance with NEMA VE 1.
- L. Barrier strips: Provide cable tray sections with a single barrier for separation of telecommunications cabling from other low-voltage cables (such as CATV, security, etc.). Barriers shall be of same materials and finish as cable tray.
- M. Grounding/bonding: Cable tray shall be complete with Manufacturer's hardware for grounding/bonding.
- N. Seismic bracing: Provide to meet local codes.
- O. Cable tray and all fittings and supports shall be manufactured by the same Manufacturer.

### 2.4 SUPPORTS

- A. Load Rating: As required to support cable tray load rating specified above.

### 2.5 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install cable tray level and plumb according to manufacturers written instructions, coordination drawings, original design, and referenced standards.
- B. Route cable tray as follows:
  - 1. Maintain a minimum clearance of 12 inches between top of cable tray and other elements such as ceiling structure, ducts, equipment, and other raceways. Where this is not possible, for very short distances (3 feet or less), a minimum clearance of 3 inches is acceptable. For longer distances, Contractor shall obtain the approval of the Engineer prior to installation.

## SECTION 26 05 36 CABLE TRAYS FOR ELECTRICAL SYSTEMS

2. Maintain a clearance of 6 inches between bottom of cable tray and ceiling grid or other equipment or raceway.
3. Maintain a clearance of 4 feet from motors or transformers.
4. Maintain a clearance of 1 foot from conduit or cables used for electrical power distribution.
5. Maintain a clearance of 18 inches from fluorescent lighting.

C. Pathways shall cross perpendicular to fluorescent lighting and electrical power

### 3.2 COORDINATION

A. Coordinate installation of the cable tray with mechanical ductwork, piping, structural members, fireproofing and sprinkler system piping so that tray remains accessible (minimum 1 foot clear above tray bottom) after installation. Coordinate exact routing with all trades to avoid interference.

### 3.3 PENETRATIONS OF BUILDING FIRE SEPARATIONS

A. Where cable tray is penetrating building fire separations, seal penetration according to Division 7 Firestopping. Seal penetration only after telephone cables and all other system distribution cables have been installed.

B. Sleeves for Future Cables: Install capped sleeves for future cables through firestopping-sealed cable tray penetrations of fire and smoke barriers.

### 3.4 CONNECTIONS

A. Tighten electrical connectors and joints according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.5 GROUNDING

A. Ground cable trays as required for conductor enclosures in accordance with NFPA 70. Provide #6AWG bare copper ground wire the full length of the cable tray system.

### 3.6 CLEANING

A. On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damage finishes, including chips, scratches, and abrasions.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

END OF SECTION



## SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Engraved Plastic Laminate Nameplates
  - 2. Wire and Cable Markers
  - 3. Primary Cable Tags
  - 4. Posted Drawings and Operating Procedures
  - 5. Safety Signs
- B. Related Sections:
  - 1. Section 26 05 13 – Medium Voltage Cables
  - 2. Section 26 24 13 – Switchboards
  - 3. Section 26 24 16 – Panelboards
- C. Substitutions: Substitute products will be considered only under the terms and conditions of Sections 00 90 00 Clarifications and Changes: Contractor's Request For Design Deviation, 01 25 13 Product Substitution Procedures, and Section 16 05 00 - Common Work Results for Electrical.

#### 1.3 REFERENCES

- A. American National Standards Institute (ANSI):
  - 1. ANSI A13.1 Operational and Warning signs.
- B. Occupational Safety and Health Administration (OSHA). 29 CFR - Labor Chapter XVII Part 1910-145 "Occupational and Safety Health Standards" 1992.

#### 1.4 SUBMITTALS

- A. Submit in accordance with the Provisions of Section 01 33 00 and Section 160500 - Common Work Results for Electrical.
- B. Submit a complete nameplate Schedule to indicate nameplate size, lettering size and color.

### PART 2 PRODUCTS

#### 2.1 ENGRAVED PLASTIC LAMINATE NAMEPLATES

- A. Materials: Three-layer laminated plastic with minimum nameplate dimensions of:
  - 1. 1 3/4" high by 5" wide. Lettering height for panel or equipment identifier @ 1/4". Remaining lines @ 1/8" high with 1/8" spacing between lines.
  - 2. Normal System: White letters on black background.
  - 3. Emergency System: White letters on red background.
  - 4. Comply with ANSI 13.1.
- B. Switchboard Nameplates:
  - 1. Provide engraved plastic nameplate for each new switchboard with the following information:
    - Line 1: Switchboard Name
    - Line 2: Source from which fed (i.e. "Fed From:")
    - Line 3: Voltage, phase and wire
    - Line 4: Branch from which served (Normal, Emergency, Legally Required Standby, Optional Standby).

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2. Provide engraved plastic nameplates for each branch device in each switchboard with the following information:

Line 1: Load Served (i.e. panel names, motor control center, etc.)

Line 2: Area of building served (i.e. penthouse, lab, etc.)

Line 3: Type of load served (i.e. lighting, receptacles, equipment, etc.)

C. Panelboard Nameplates

1. Provide engraved plastic nameplate for each new panelboard with the following information:

Line 1: Panelboard Name

Line 2: Source from which panel is fed

Line 3: Transfer switch from which panel is fed (if applicable)

Line 4: Voltage, phase and wire

D. Transfer Switches

1. Provide phenolic nameplate for each new automatic and manual transfer switch with the following information:

Line 1: Transfer switch name (i.e. ATS...)

Line 2: Branch of Emergency system (Emergency, Legally Required Standby, Optional Standby)

Line 3: Normal source feed

Line 4: Emergency source feed

Line 5: Load served

E. Disconnects, Starters, Combination Starters and Other Devices

1. Provide phenolic nameplate for each device with the following information:

Line 1: Load served

Line 2: Panelboard and circuit number from which device is fed

Line 3: Fuse size or breaker size as applicable

F. Main Service Project Nameplate

1. At Main Service Distribution Switchboard, provide engraved nameplate on switchgear front with the following information:

Project Name: (3/8" lettering, all other 1/4")

Architect

Electrical Consultant (Sparling, Inc.)

Electrical Contractor

Year of Manufacturer

## SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

2. At Main Service Distribution Switchboard, provide engraved nameplate on switchgear front with the following information, per NEC 230 -2(e) Identification.

"All other services, feeders, and branch circuits supplying the building or structure and the area served by each."

3. Emergency System: White letters on red background.
4. Comply with ANSI A13.1.

### 2.2 WIRE AND CABLE MARKERS

- A. Comply with ANSI A13.1, Table 3 for minimum lettering size.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather-and chemical-resistant coating.
- C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
- D. Tape Markers: Vinyl or vinyl-cloth, self adhesive, wraparound type with preprinted numbers and letters.
- E. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- F. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.
- G. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch (0.05 mm) thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.

### 2.3 PRIMARY CABLE TAGS

- A. Provide embossed copper tag with dimensions of 1 1/2" wide x 5" long x 0.05" thick. Use 1/2" high embossed letters. Apply white paint into embossed characters. Include phase information into identifier. Permanently fasten to cable with plastic tie wraps.

### 2.4 POSTED DRAWINGS AND OPERATING INSTRUCTIONS

- A. Print electrical riser diagrams on 20 lb. bond paper. (Blue print paper is not acceptable). Reduce Drawings to approximately 1/2 size using photocopier reduction process. Contact Electrical Engineer of Record to obtain updated original plans for printing.
- B. Mounting Frames: Extruded aluminum, 4 point screw mount with 1/8" clear plexiglass cover.
- C. Operating Instructions: Printed in all capital letters of 12 pt. size minimum.

### 2.5 SAFETY SIGNS

- A. Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
  1. Engraved legend with black letters on white face.
  2. Punched or drilled for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.

SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1mm) galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 ENGRAVED PLASTIC LAMINATE NAMEPLATES

- A. Provide nameplates for the following:
  - 1. Equipment identification labels including, but not limited to: switchboards, panelboards, disconnect switches, motor starters, transformers, fixed equipment and transfer switches.
  - 2. Special equipment outlet labels. (1/4" letters).
- B. Degrease and clean surfaces to receive nameplates.
- C. Install nameplate and label parallel to equipment lines.
- D. Secure nameplate to equipment front using screws or rivets. Adhesive is unacceptable.
- E. Secure nameplate to inside surface of door on panel board that is recessed in finished locations.

3.2 WIRE AND CABLE IDENTIFICATION

- A. Provide wire markers for control wiring as indicated on schematic and interconnection diagrams or equipment Manufacturer's Shop Drawings for control wiring.
- B. Provide identification labels with the following information in accordance with NEC 210.4(d).

Conductors of power systems in this building are identified as follows:

	280Y/120V	480Y/277V
A Phase (left bus in panel):	Black	Brown
B Phase (center bus in panel):	Red	Orange
C Phase (right bus in panel):	Blue	Yellow
Neutral:	White	Gray
Equipment Ground:	Green	Green
Isolated Ground:	Grn/Yel*	Grn/Yel*

\*Green with yellow tracer

- 1. 2.0 Mil, White Polyester, Permanent Adhesive Material. Peel-off self sticking type.
- 2. Lettering: Black #10 font Arial on white opaque background.
- 3. In electrical rooms and closets, mechanical rooms, and other similar areas, post decal on front of panel, MCC, and /or switchboard.
- 4. In finished areas, where panel may be painted at a later time, post decal behind circuit breaker doors or behind dead front door where decal can be easily seen when circuits are being added.

## SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

### 3.3 PRIMARY CABLE TAGS

- A. Install primary cable tags at all points of accessibility such as manholes, padmounted switches and interior switchgear. Firmly attach all tags to each cable phase using plastic tie wraps. Position tags so that they are clearly legible to the observer.

### 3.4 RACEWAY AND JUNCTION BOX COLOR CODING (IDENTIFICATION)

- A. Identify accessible conduits routed vertically or through ceiling spaces containing medium-voltage cable (voltages greater than 600V) by painting conduits with Orange Safety (FSC-1224) paint. Stencil the legend "DANGER HIGH VOLTAGE" in Gloss Black (FSC-17038) paint minimum 2" high letters at intervals not exceeding 50 feet at visible locations.
- B. Conduit Identification:
  - 1. In accessible ceiling spaces and exposed in unfinished areas, using an indelible marking pen, label all conduits 1" larger with panel and circuit numbers of conductors routed through the conduit. Label conduit at all wall penetrations and connections to all panels, junction boxes, and equipment served.
  - 2. Identify floor/wall area directly above or adjacent to medium voltage conduits within 12" of the floor or wall.

### 3.5 WARNING SIGNS

- A. General: Provide warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with ANSI A13.1 standard color and design.
- B. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either pre-printed or hand printed to convey the message; example: "DO NOT OPEN THIS SWITCH WHEN BREAKER IS CLOSED."

### 3.6 POSTED DRAWINGS AND OPERATING INSTRUCTIONS

- A. Mount Drawings and Operating Procedures on the wall immediately adjacent to the main piece of equipment for which the instructions apply. If sufficient wall space is available, mount directly to one of the sheet metal panels of the equipment.

### 3.7 ARC FLASH HAZARD LABELS

- A. Provide labels indicating results of arc flash study.

END OF SECTION



## SECTION 26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections:
  - 1. Section 260553 - Identification for Electrical Systems.

#### 1.2 SUMMARY

- A. This Section includes computer-based, fault-current, arc flash and overcurrent protective device coordination studies, and the setting of these devices.

#### 1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates:
  - 1. For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
  - 2. For arc flash calculations computer software programs certifying compliance with IEEE 1584-2002.
- C. Qualification Data: For coordination-study specialist and organization.
  - 1. Submit qualifications of the organization proposed for performing the study. Include description of the equipment and computer based computation methods or programs used, names and experience history of the personnel who will perform the study.
- D. Other Action Submittals:
  - 1. Coordination-study input data, including completed computer program input data sheets.
  - 2. Coordination-study report.
  - 3. Equipment evaluation report.
  - 4. Setting report.
  - 5. Arc flash report.
  - 6. Provide study and reports prior to manufacture of the electrical distribution equipment.
  - 7. Indicate in the study that the submitted equipment complies with the study recommendations.
  - 8. The study shall be stamped and signed by an engineer registered in the State of Washington.
  - 9. The equipment submittals will not be approved until the coordination study is approved and the equipment submittals indicate compliance with the approved study recommendations.
  - 10. The equipment submittals will not be approved until the coordination study is completed and the study has been approved by the Authority Having Jurisdiction.

#### 1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices. The study shall be performed by a registered electrical engineer licensed in the State of Oregon, with a minimum of five years recent experience in performing protective device coordination studies, arc flash calculations, and electrical system analysis.

## SECTION 26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION

- C. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise testing specified in Part 3.
- D. Comply with IEEE 399 for general study procedures.
- E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- F. Comply with IEEE 1584-2002 for arc flash calculations

### PART 2 PRODUCTS

#### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:
  - 1. CYME International, Inc.
  - 2. EDSA Micro Corporation.
  - 3. Electrical Systems Analysis, Inc.
  - 4. SKM Systems Analysis, Inc.

#### 2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399 and IEEE 1584-2002.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.
  - 1. Required Optional Features:
    - a. Arc flash and arcing faults.
    - b. Positive sequence faults
    - c. Zero sequence faults.
- D. Arc flash calculations: Software program shall be capable of calculating Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
- B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.
- C. Provide the study based on the actual electrical equipment supplied for the Project.

#### 3.2 FAULT-CURRENT STUDY

- A. Source Impedance: Utility company's fault-current contribution as indicated.

## SECTION 26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION

- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
  - 1. Model the entire electrical distribution system from the utility company point of connection to circuit breakers in 208 Volt distribution panels at the secondary side of distribution transformers. Include mechanical HVAC equipment, motor driven equipment feeder circuits, and elevator feeder circuits.
  - 2. The model shall include all components of the distribution system which would be exposed to fault current levels of 10,000 Amperes symmetrical on a calculated basis.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
  - 1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
  - 2. Low-Voltage Fuses: IEEE C37.46.
  - 3. Circuit Breakers: IEEE C37.13.
- E. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.
- F. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

### 3.3 COORDINATION STUDY

- A. Gather and tabulate the following input data to support coordination study:
  - 1. Product Data for overcurrent protective devices specified in other Division 16 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  - 2. Impedance of utility service entrance.
  - 3. Electrical distribution system diagram showing the following:
    - a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
    - b. Circuit-breaker and fuse-current ratings and types.
    - c. Relays and associated power and current transformer ratings and ratios.
    - d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    - e. Generator kilovolt amperes, size, voltage, and source impedance.
    - f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
    - g. Busway ampacity and impedance.
    - h. Motor horsepower and code letter designation according to NEMA MG 1.
  - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
    - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    - b. Magnetic inrush current overload capabilities of transformers.
    - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

SECTION 26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION

- d. Ratings, types, and settings of utility company's overcurrent protective devices.
  - e. Special overcurrent protective device settings or types stipulated by utility company.
  - f. Time-current-characteristic curves of devices indicated to be coordinated.
  - g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
  - h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
  - i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
- B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.
- C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.
- D. Comply with IEEE 242 recommendations for fault currents and time intervals.
- E. Transformer Primary Overcurrent Protective Devices:
- 1. Device shall not operate in response to the following:
    - a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  - 2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.
- F. Motors served by voltages more than 600V shall be protected according to IEEE 620.
- G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.
- H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
- 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
    - a. Device tag.
    - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
    - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
    - d. Fuse-current rating and type.
    - e. Ground-fault relay-pickup and time-delay settings.
  - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:
    - a. Device tag.
    - b. Voltage and current ratio for curves.
    - c. Three-phase and single-phase damage points for each transformer.
    - d. No damage, melting, and clearing curves for fuses.
    - e. Cable damage curves.
    - f. Transformer inrush points.
    - g. Maximum fault-current cutoff point.

## SECTION 26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION

3. Completed data sheets for setting of overcurrent protective devices.

### 3.4 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set overcurrent protective devices within equipment.
- B. Testing: Owner will engage a qualified testing agency to perform device setting.
- C. Testing: Engage a qualified testing agency to perform the following device setting and to prepare test reports.
- D. Testing: Perform the following device setting and prepare reports:
  1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
    - a. Verify that overcurrent protective devices meet parameters used in studies.
    - b. Adjust devices to values listed in study results.
  2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

### 3.5 ARC FLASH STUDY

- A. Study shall model worst-case arc flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst case bolted fault conditions.
- B. Provide study results in tabular form, and include:
  1. Device or bus name
  2. Bolted fault and arcing fault currents levels
  3. Arc Flash Incident Energy Level (AFIE) at 18 inches expressed in cal/cm<sup>2</sup>
  4. Voltage shock hazard.
  5. Flash protection boundary distances including
    - a. Limited shock approach boundary
    - b. Restricted shock approach boundary
    - c. Prohibited shock approach boundary
  6. Personal-protective equipment class (PPE).
- C. Provide recommendations for reducing AFIE levels and enhancing worker safety.

END OF SECTION



## Fixture Type A1

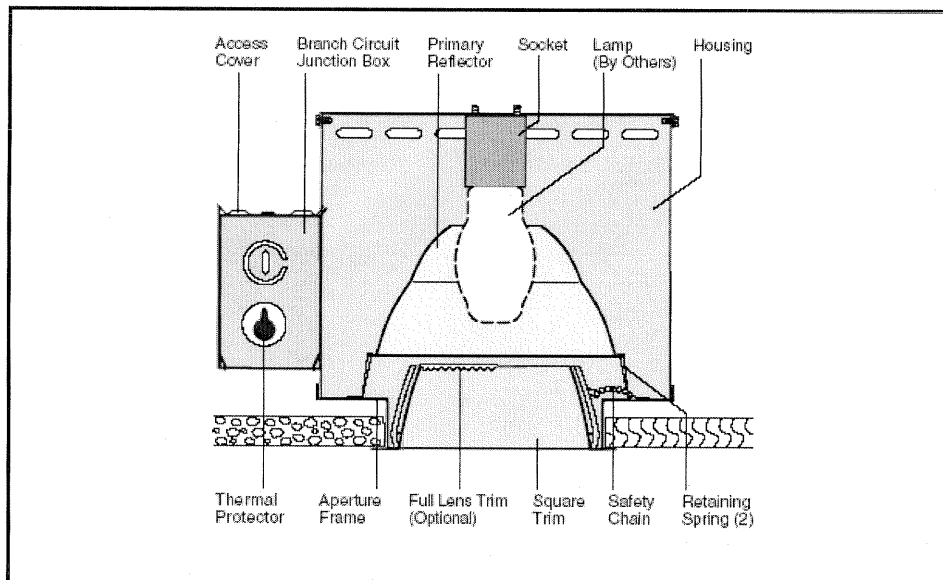
**DESCRIPTION:** Recessed lensed incandescent A lamp downlight, nominal 4" square aperture. Clear semi-specular Alzak parabolic cone, self-flanged overlap trim. Recess depth 7 3/4".

**MANUFACTURERS:** Kurt Versen - H8415 Series; Pathway 4SQVIA Series; Kirlin IRS Series; Kramer KL Series or approved

**LAMP:** 150A19/IF

**WATTS:** 150

**COMMENTS:**



Fixture drawing is an illustration of one acceptable manufacturer

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**Fixture Type A2**

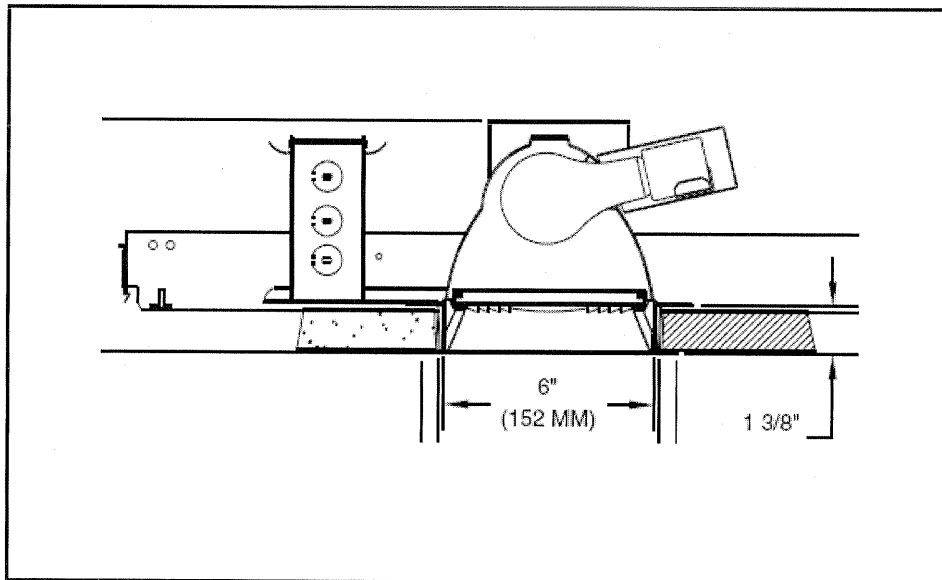
**DESCRIPTION:** Recessed incandescent A lamp downlight, nominal 6" aperture. Clear semi-specular Alzak parabolic splay, self-flanged overlap trim, regressed tempered fresnel glass lens. Minimum recess depth 9". Maximum recess depth 9 11/16".

**MANUFACTURERS:** Prescolite INC 600 Series; Omega Revelation Series; Gotham LG6 Series or approved

**LAMP:** 150A21/IF

**WATTS:** 150

**COMMENTS:**



Fixture drawing is an illustration of one acceptable manufacturer

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Fixture Type A3

**DESCRIPTION:** This fixture designation is not used.

**MANUFACTURERS:** N/A

**LAMP:** N/A

**WATTS:** N/A

**COMMENTS:**

Not used

**CANDELA**  
*Architectural Lighting Consultants*

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Seattle, WA 98101  
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Fax: 206 / 667-0512

## Fixture Type CC1

**DESCRIPTION:**

Custom fabricated cold cathode lamps in 3500K white color 120 ma., 25mm. Fabricate in size and shape as shown on architectural drawing. Submit working sample (min. 4' long) for review and final color selection. Field measure to determine lamp holder location. Refer to section 265100 for additional requirements.

If contractor submits manufacturers other than those listed, a list of five (5) previous jobs using 25 mm lamps operating at 120ma. must be submitted with bid. List shall include project name, contact name and telephone number.

**MANUFACTURERS:**

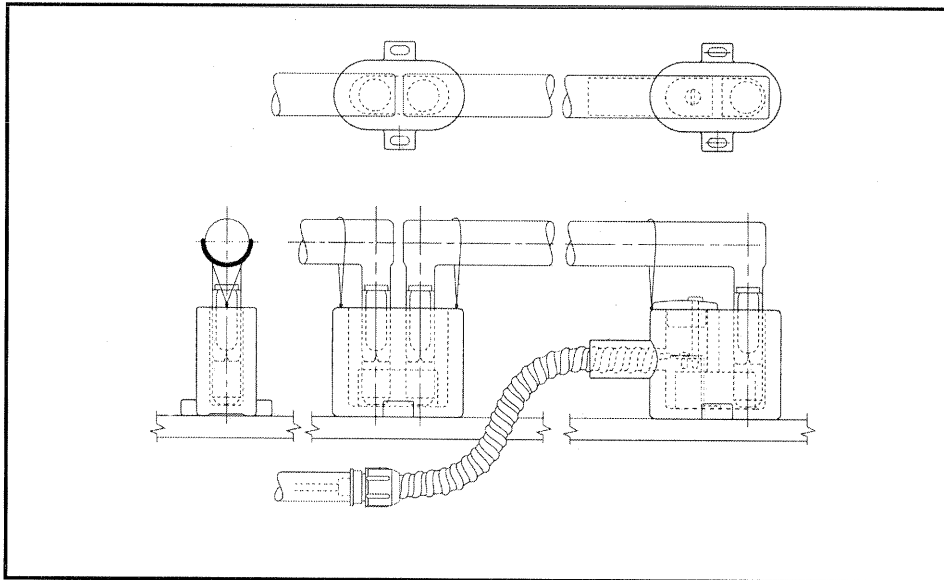
Architectural Cathode Lighting; National Cathode; Neotek; Cathode Lighting Systems

**LAMP:**

Tri-Phosphor 3500K white

**WATTS:**

Refer to section 265100

**COMMENTS:**

Fixture drawing is an illustration of a generic cold cathode detail

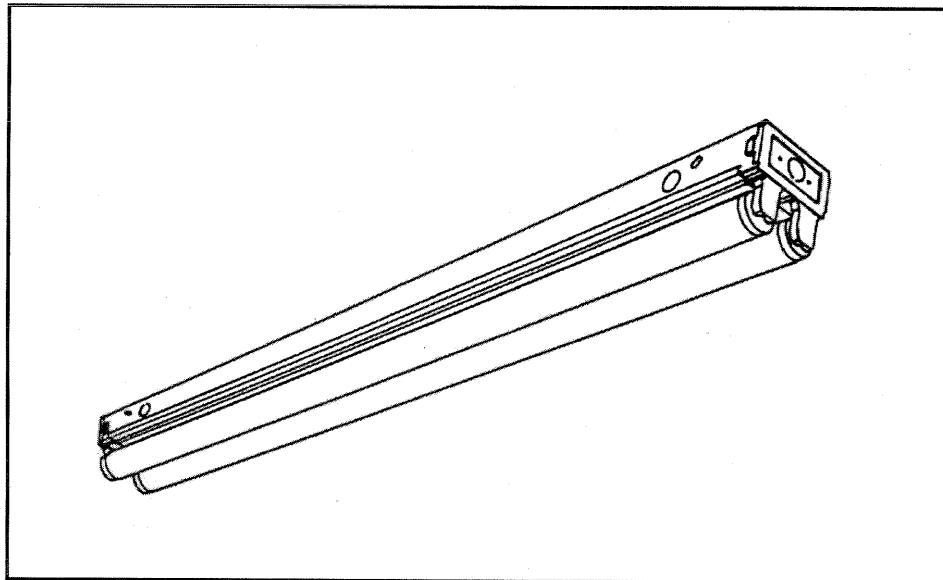
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**Fixture Type F1, F1A**

- DESCRIPTION:** Surface mounted two lamp fluorescent strip fixture nominal 48". Die formed steel, high reflectance baked white enamel finish. Electronic ballast. Provide wireguard. Provide with emergency battery pack for fixtures indicated on emergency drawings. Battery shall provide 30% of rated lumen output for 90 minutes.
- MANUFACTURERS:** Columbia CS Series; Lithonia C Series; Metalux SS Series; Day-Brite T Series; Lightolier SW Series; H.E. Williams 76 Series
- LAMP:** Two F32T8
- WATTS:** 62
- COMMENTS:** Fixture type F1A is similar to F1 but is chain hung.



Fixture drawing is an illustration of one acceptable manufacturer

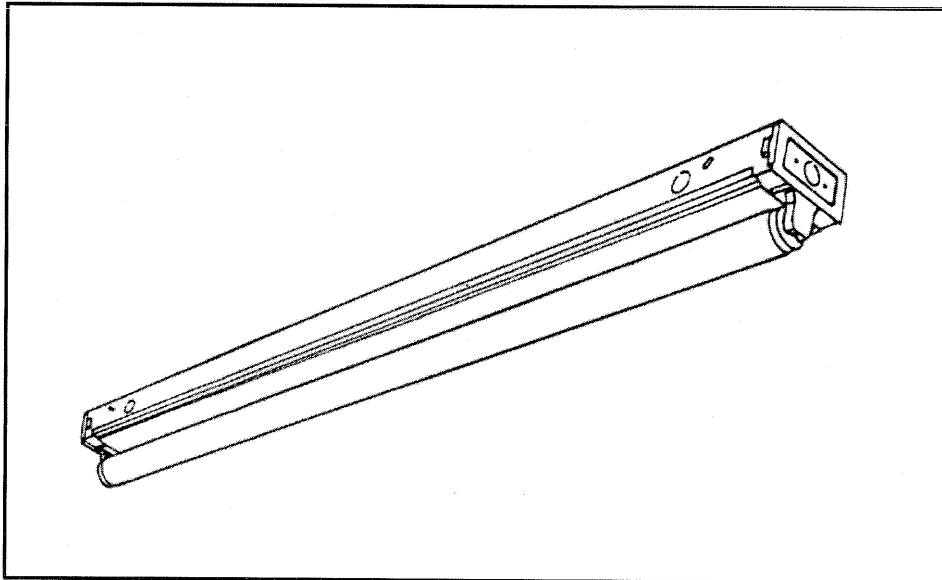
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**Fixture Type F2, F2A**

- DESCRIPTION:** Surface mounted one lamp fluorescent strip fixture nominal 48". Die formed steel, high reflectance baked white enamel finish. Electronic ballast.
- MANUFACTURERS:** Columbia CS Series; Lithonia C Series; Metalux SS Series; Day-Brite T Series; Lightolier SW Series; H.E. Williams 76 Series
- LAMP:** One F32T8
- WATTS:** 32
- COMMENTS:** F2A similar to F2 except fixture is 3' long with one F25T8 lamp at 28 watts.



Fixture drawing is an illustration of one acceptable manufacturer

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**Fixture Type F3, F3A, F3B, F3C**

**DESCRIPTION:**

Wall mounted semi-indirect fluorescent fixture, nominally 8" wide x 1.3" high x 8' long. One-piece 20 guage steel housing with 14 guage steel end caps. Low iridescent, semi specular aluminum reflector. Acrylic diffuser with linear diffusing pattern. Electronic ballast. Manufacturer's standard polyester powder coat finish as selected by the Architect. Provide clear dust cover over top of fixture.

**MANUFACTURERS:**

Focal Point Metro FMEW Series; Ledalite Sync 7408 Series or approved.

**LAMP:**

Two F54T5HO

**WATTS:**

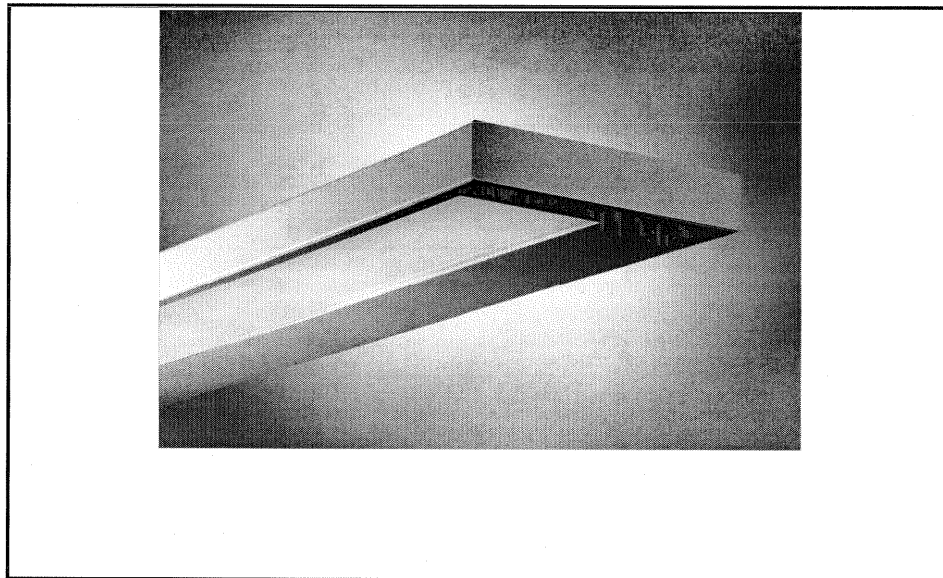
120

**COMMENTS:**

F3A similar to F3 except fixture is 4' long with one F54T5HO lamp at 62 watts.

F3B is similar to F3 except provide with 100% to 10% electronic dimming ballast.

F3C is similar to F3A except provide with 100% to 10% electronic dimming ballast.



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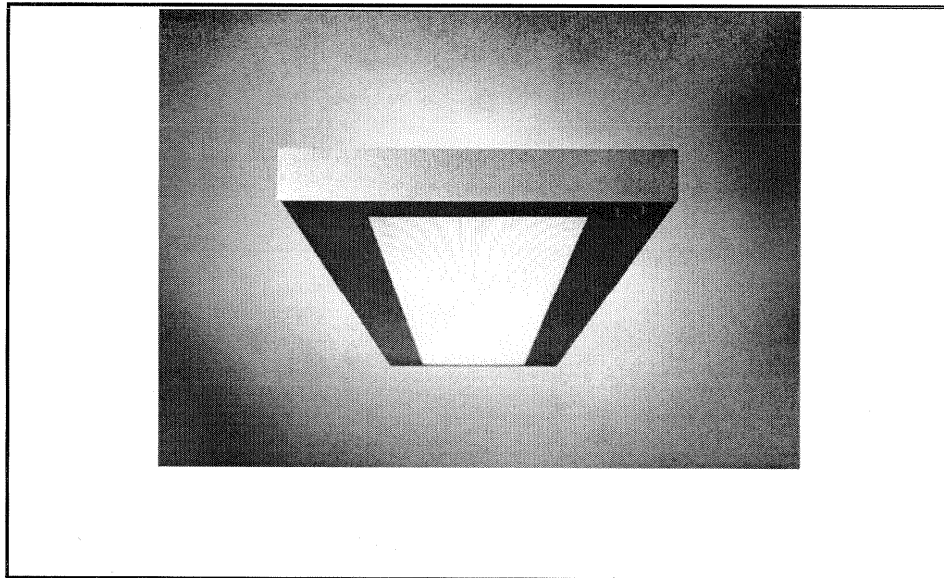
**Fixture Type F4, F4A**

**DESCRIPTION:** Pendant mounted semi-indirect fluorescent fixture, nominally 9" wide x 1" high x lengths as shown on drawings. One-piece 20 gauge steel housing with 14 gauge steel end caps. Low iridescent, semi specular aluminum reflector. Acrylic diffuser with linear diffusing pattern. Aircraft cable suspension with straight white cord. Electronic ballast. Manufacturer's standard polyester powder coat finish as selected by the Architect. Provide clear dust cover over top of fixture.

**MANUFACTURERS:** Focal Point Metro FMES Series Ledalite Sync 7406 Series or approved.

**LAMP:** Two F54T5HO  
**WATTS:** 120

**COMMENTS:** F4A is similar to F4 except provide with 100% to 10% electronic dimming ballast.



Fixture drawing is an illustration of one acceptable manufacturer

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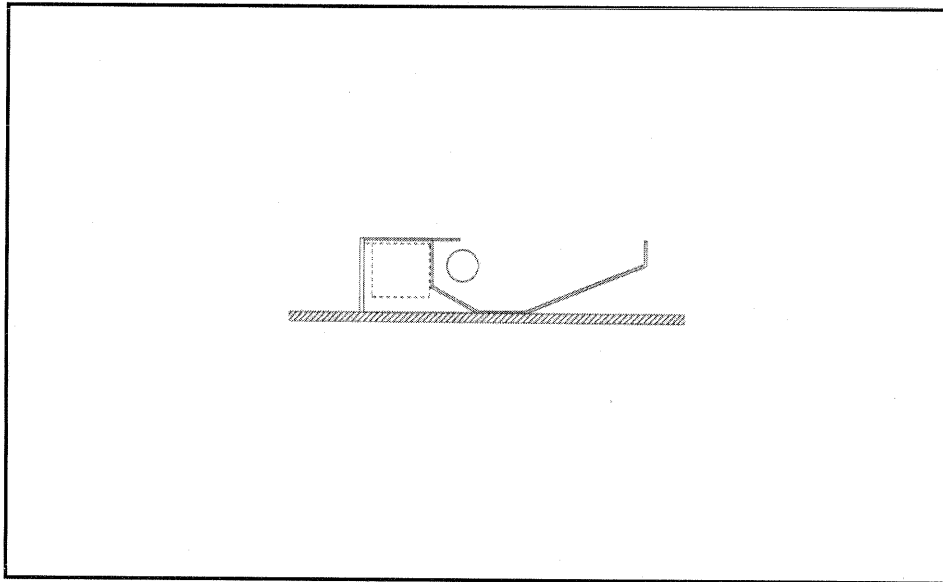
**Fixture Type F5, F5A**

**DESCRIPTION:** Surface mounted 1 lamp T5 HO uplight, nominal 6" wide x 1-1/2" high x 4' long. Housing of die-formed 24 gauge metal, painted white. Optical system of highly specular aluminum and high reflectance 24 gauge white painted metal for asymmetric distribution without striations or hotspots. Electronic ballast. Provide with acrylic lens dust cover.

**MANUFACTURERS:** Ledalite In-Cove 2808 Series; Lam SHPDA-T5 Series; Peerless HOT-5 Cove Series; Corelite CSSN1T5 Series

**LAMP:** One F54T5HO/4'  
**WATTS:** 62/4'

**COMMENTS:** Fixture Type F5A is similar to F5 except provide with one F39T5HO/3' at 42 watts. Aim as directed by Architect.



Fixture drawing is an illustration of one acceptable manufacturer

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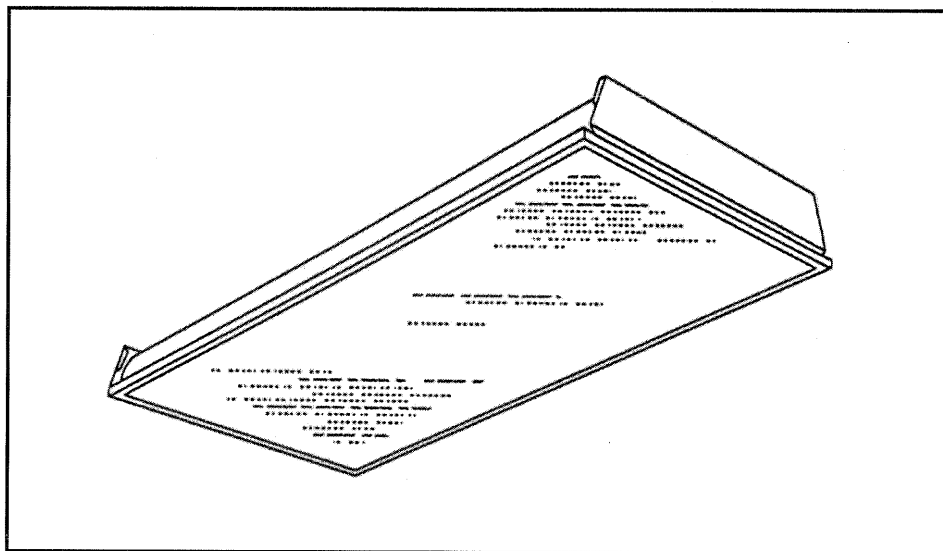
**Fixture Type F6**

**DESCRIPTION:** Recessed lensed troffer nominal 24" x 48" x 5", flush steel door with mitered corners, enclosed positive cam action latches and .125" virgin acrylic prismatic lens. Electronic ballast.

**MANUFACTURERS:** Columbia 4PS2 Series; Lithonia 2SP8 Series; Metalux 2GC Series; Daybrite 2TG Series; Lightolier SPS2 Series; H.E. Williams 50-S Series

**LAMP:** Two F32T8  
**WATTS:** 62

**COMMENTS:**



Fixture drawing is an illustration of one acceptable manufacturer

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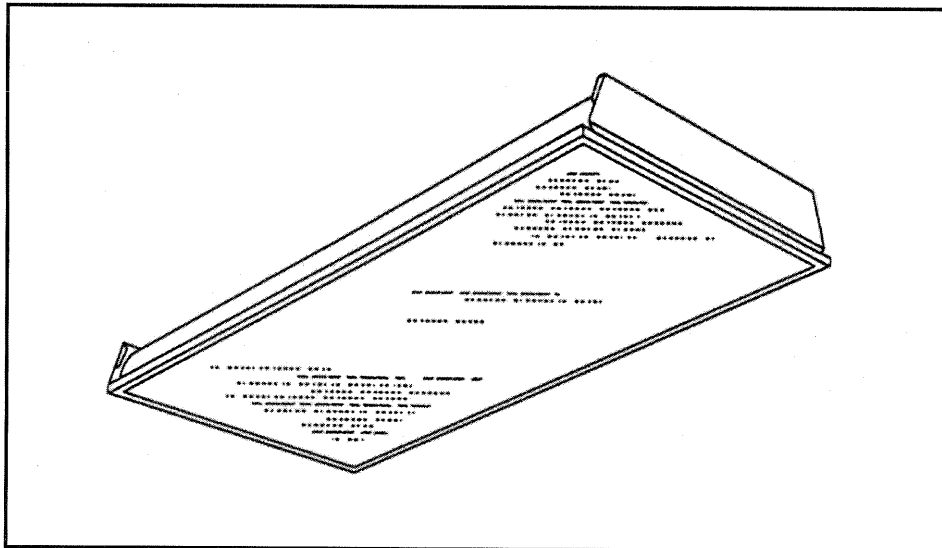
**Fixture Type F6A**

**DESCRIPTION:** Recessed lensed troffer nominal 24" x 48" x 5", flush steel door with mitered corners, enclosed positive cam action latches and .125" virgin acrylic prismatic lens. Electronic ballast.

**MANUFACTURERS:** Columbia 4PS Series; Lithonia 2SP8 Series; Metalux 2GC Series; Daybrite 2TG Series; Lightolier SPS2 Series; H.E. Williams 50-S Series

**LAMP:** Three F32T8  
**WATTS:** 93

**COMMENTS:**



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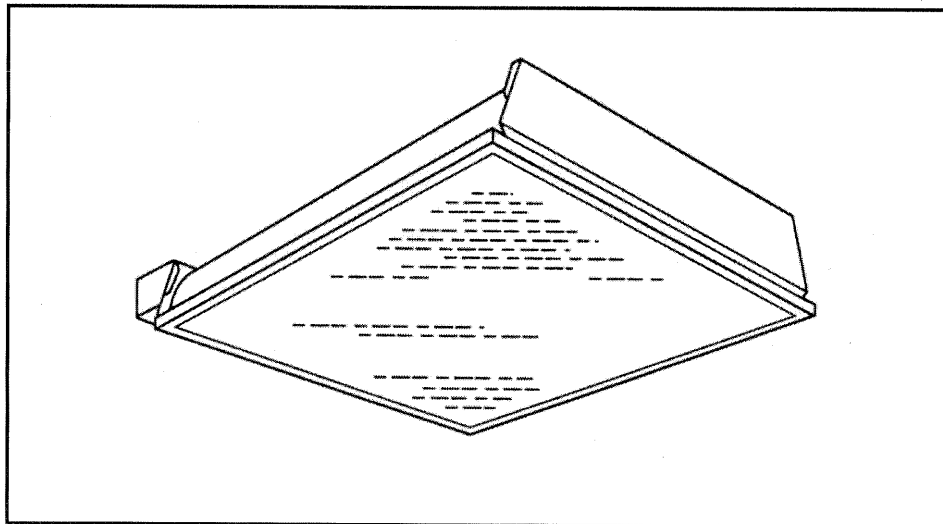
**Fixture Type F7**

**DESCRIPTION:** Recessed lensed troffer nominal 24" x 24" x 5", flush steel door with mitered corners, enclosed positive cam action latches and .125" virgin acrylic prismatic lens. Electronic ballast.

**MANUFACTURERS:** Columbia 4PS2 Series; Lithonia 2SP8 Series; Metalux 2GC Series; Daybrite 2TG Series; Lightolier SPS2 Series; H.E. Williams 50-S Series

**LAMP:** Two FT40W  
**WATTS:** 80

**COMMENTS:**



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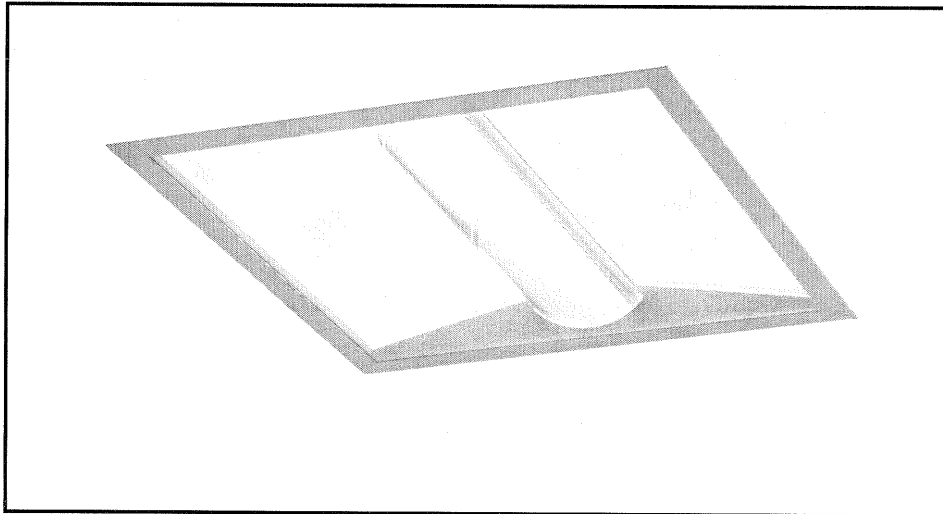
**Fixture Type F8**

**DESCRIPTION:** Recessed direct-indirect fluorescent lighting fixture, nominal 12-7/16" x 12-1/2" x 6". One piece die-formed 22 gauge cold rolled steel housing. Two flat non-glaze acrylic panels reflectors and extruded acrylic lens with a protected Meso Optics film layer. Optical frame allows for tool free access for relamping. Electronic ballast. Housing and frame are post-painted in white powder coat finish.

**MANUFACTURERS:** Ledalite Pure FX Micro Series; Focal Point Aerion Series or approved.

**LAMP:** Two FT18W  
**WATTS:** 35

**COMMENTS:**



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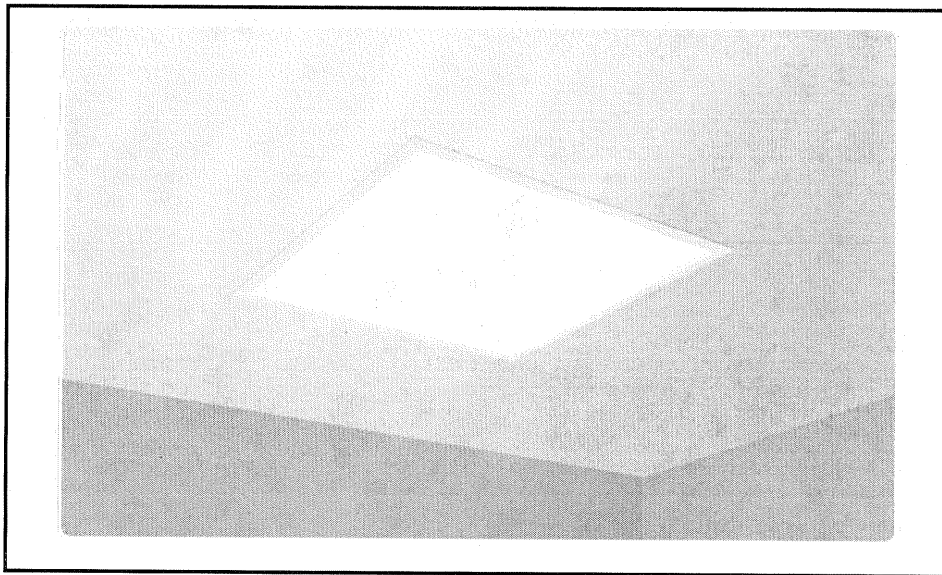
**Fixture Type F9,F9A**

**DESCRIPTION:** Recessed direct-indirect fluorescent lighting fixture, nominal 24" x 24" x 5". One piece die-formed 22 gauge cold rolled steel housing. Two flat non-glaze acrylic panels reflectors and extruded acrylic lens with a protected Meso Optics film layer. Optical frame allows for tool free access for relamping. Electronic ballast. Housing and frame are post-painted in white powder coat finish. Provide with emergency battery pack for fixtures indicated on emergency drawings. Battery shall provide 30% of rated lumen output for 90 minutes.

**MANUFACTURERS:** Ledalite Pure FX Series; Focal Point Aerion Series or approved.

**LAMP:** Two FT40W  
**WATTS:** 80

**COMMENTS:** Fixture Type F9A is similar to F9 except with 100% to 10% electronic dimming ballast.



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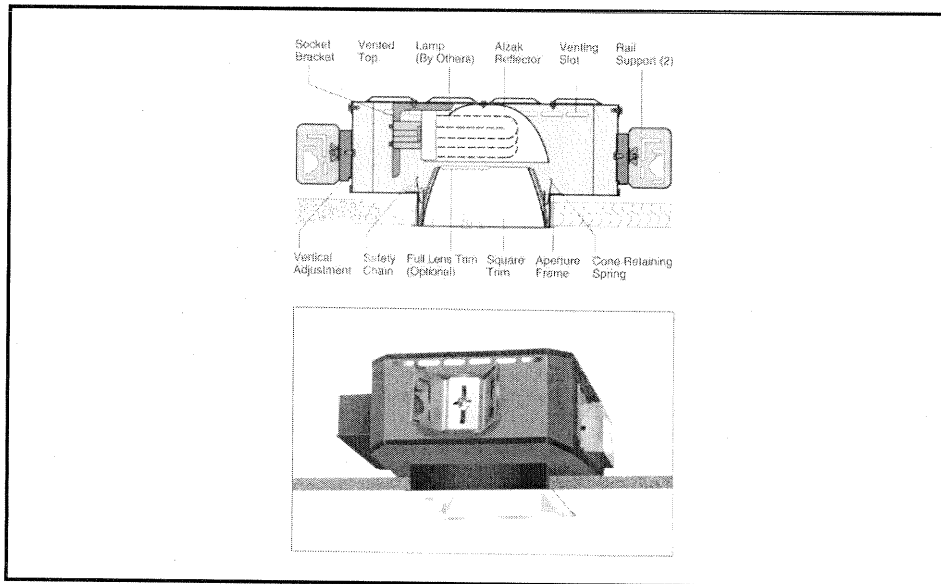
**Fixture Type F10**

**DESCRIPTION:** Recessed lensed compact fluorescent downlight with horizontal lamp, nominal 6" square aperture. Clear Alzak cone, self flanged overlap trim, low-iridescent finish with spread lens on top of reflector. Electronic ballast. Recess depth 6.5". UL listed for wet locations. Connect to GFCI circuit per local code.

**MANUFACTURERS:** Kurt Versen H8443 Series, Pathway 6SQHF Series; Iris P408 Series; Gotham SQF or approved.

**LAMP:** One CFTR32W  
**WATTS:** 33

**COMMENTS:**



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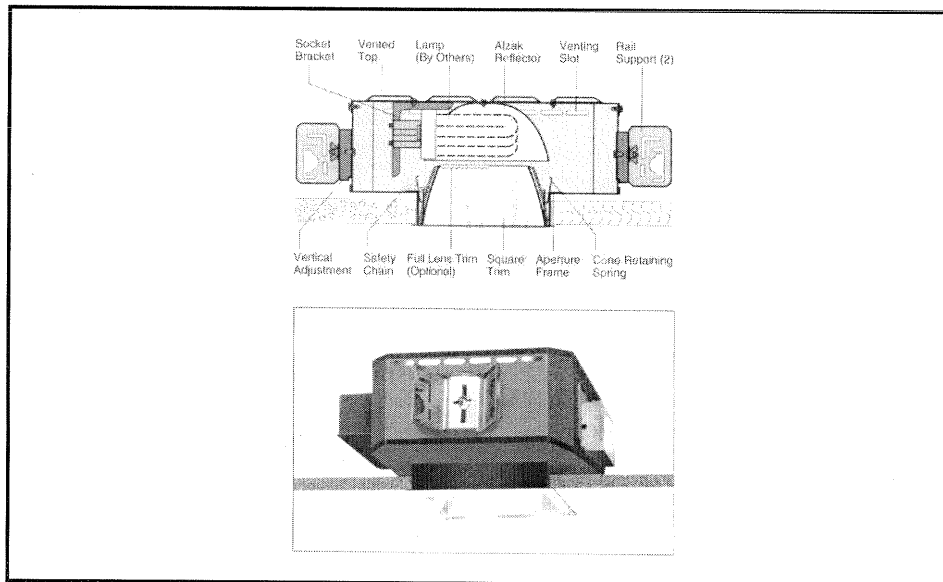
**Fixture Type F11**

**DESCRIPTION:** Recessed lensed compact fluorescent downlight with horizontal lamp, nominal 6" square aperture. Clear Alzak cone, self flanged overlap trim, low-iridescent finish with spread lens on top of reflector. Electronic ballast. Recess depth 6.5".

**MANUFACTURERS:** Kurt Versen H8643 Series, Pathway 6SQHF Series; Iris P408 Series; Gotham SQF or approved.

**LAMP:** One CFTR32W  
**WATTS:** 33

**COMMENTS:**



Fixture drawing is an illustration of one acceptable manufacturer

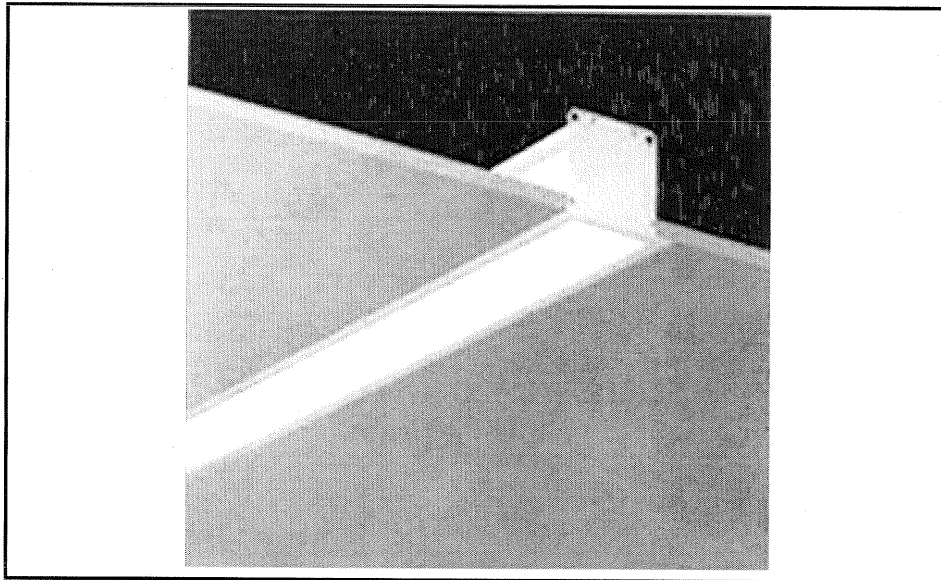
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**Fixture Type F12, F12A**

- DESCRIPTION:** Recessed linear fluorescent downlight, nominal 4" wide x 4" high x lengths shown on electrical drawings. Extruded aluminum housing. Reflector of 24 gauge steel with baked white enamel finish. Flush flat opal white diffuser. Electronic ballast. Trim finish as selected by Architect.
- MANUFACTURERS:** Linear Lighting RC45 Series; Litecontrol LGD44 Series; Neoray 23DR Series; Axis BBRF Series or approved.
- LAMP:** One F32T8/4'
- WATTS:** 32
- COMMENTS:** F12A is similar except, provide with 100%-10% electronic dimming ballast.



Fixture drawing is an illustration of one acceptable manufacturer

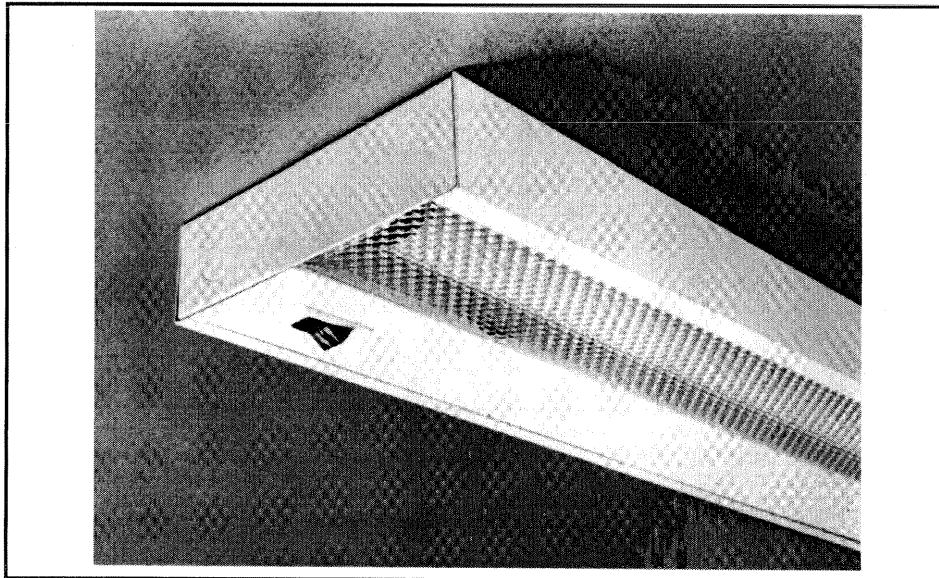
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**Fixture Type F13, F13A**

- DESCRIPTION:** Undercabinet tasklight nominal 48" with solid front, not to exceed 1-9/16" high, shall have a 45 degree batwing acrylic prismatic lens. Steel housing with baked white enamel finish. Hardwired and switched at wall. Electronic ballast.
- MANUFACTURERS:** Alkco SF332 Series; Failsafe MAS Series; Lithonia N2S Series; H.E. Williams 2SF-KSH25 Series; Daybrite 8UC Series; Vista MGT Series
- LAMP:** One F32T8
- WATTS:** 32
- COMMENTS:** F13A is similar to F13 expect 3' long with F25T8 lamp at 28 watts.



Fixture drawing is an illustration of one acceptable manufacturer

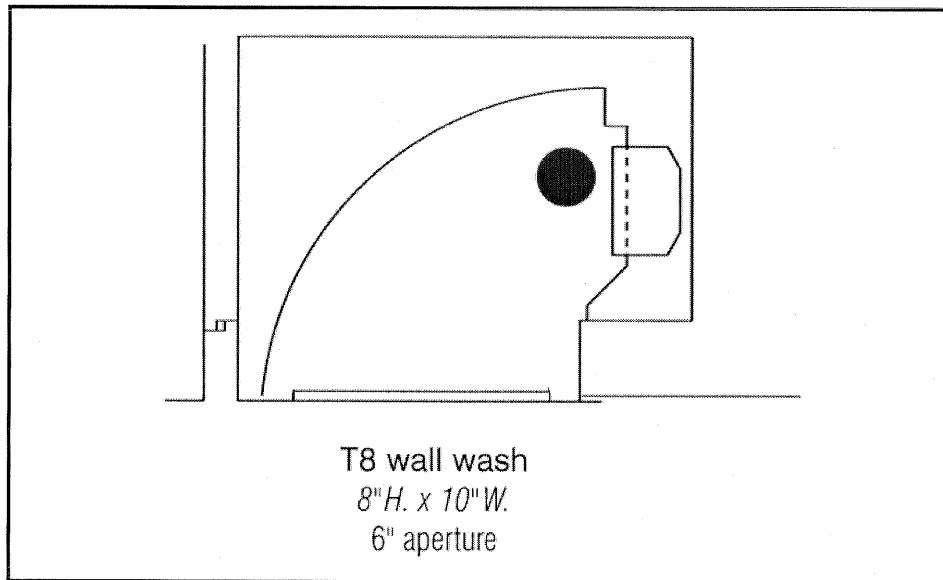
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**Fixture Type F14**

- DESCRIPTION:** Recessed fluorescent perimeter wallwash. Nominal 10" x 8" x 4' housing and 6" continuous opal acrylic lens. Mitered at corners. Housing in standard 3' and 4' lengths, parabolic upper reflectors. Verify exact quantities and lengths as shown on architectural drawings. Finish ceiling at ends of runs. Do not use filler plates or telescoping lamp holders.
- MANUFACTURERS:** Linear Lighting WW2 Series; Alera Lighting AL1T8 Series; Mark MP Series or approved.
- LAMP:** One F32T8, and/or F25T8
- WATTS:** 32/4', 28/3'
- COMMENTS:**



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**Fixture Type F15**

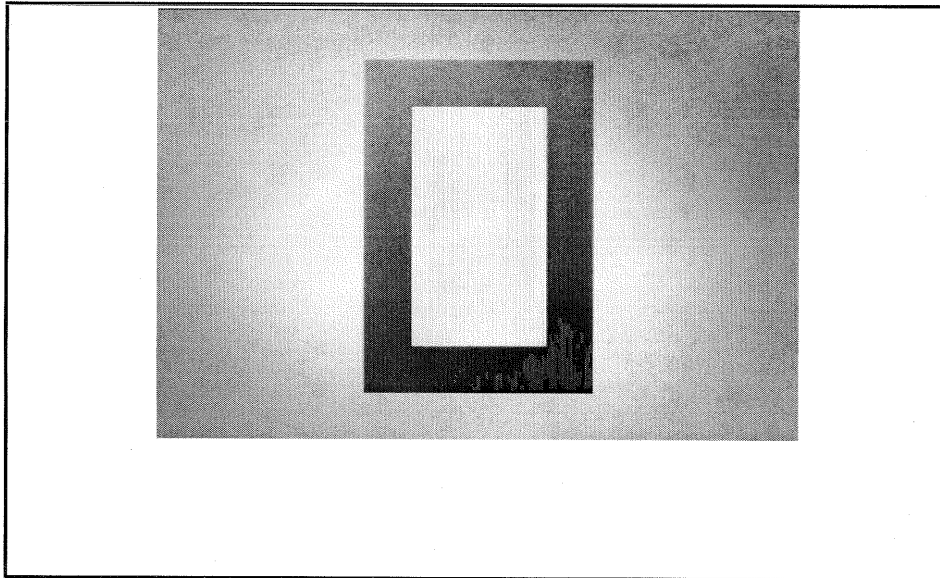
**DESCRIPTION:** Surface wall mounted fixture nominal 9" wide x 13" high x 2.88" projection from wall. Three piece ballast channel and frame fabricated from 20 guage, die formed cold rolled steel. Low iridescent, specular aluminum reflector with acrylic. Manufacturer's standard finish as selected by Architect. Electronic ballast.

**MANUFACTURERS:** Focal Point Metro FMEC Series or approved.

**LAMP:** One F18BX

**WATTS:** 19

**COMMENTS:**



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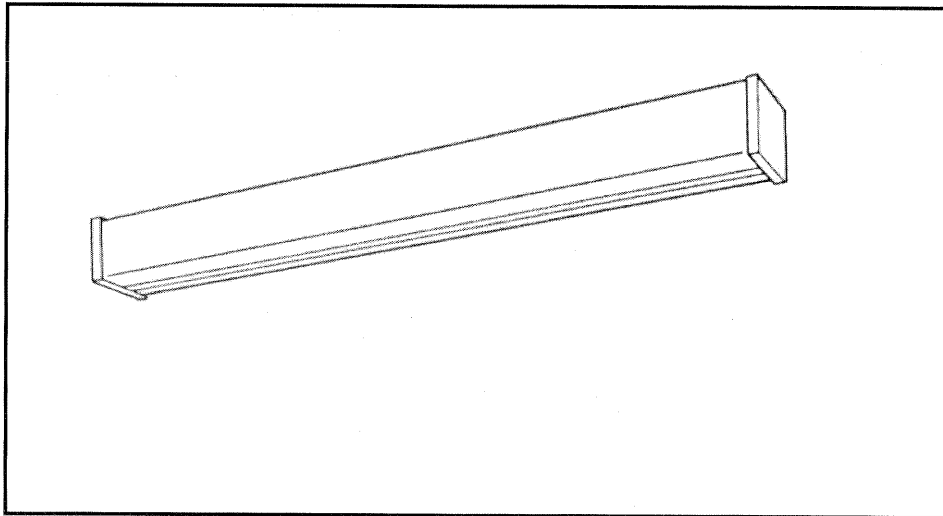
**Fixture Type F16**

**DESCRIPTION:** Surface wall-mounted fluorescent wraparound with translucent white acrylic diffuser, nominal 5" wide x 4 1/2" deep x 4' long. All metal parts die-formed steel. End plate welded to channel, channel cover secured with quarter-turn fasteners. Manufacturer's standard white paint finish. Electronic ballast.

**MANUFACTURERS:** Lithonia WC Series; Columbia W4-2 Series; Metalux BC Series; Daybrite WB232 Series; H.E. Williams 20-4-232 Series

**LAMP:** Two F32T8  
**WATTS:** 62

**COMMENTS:**



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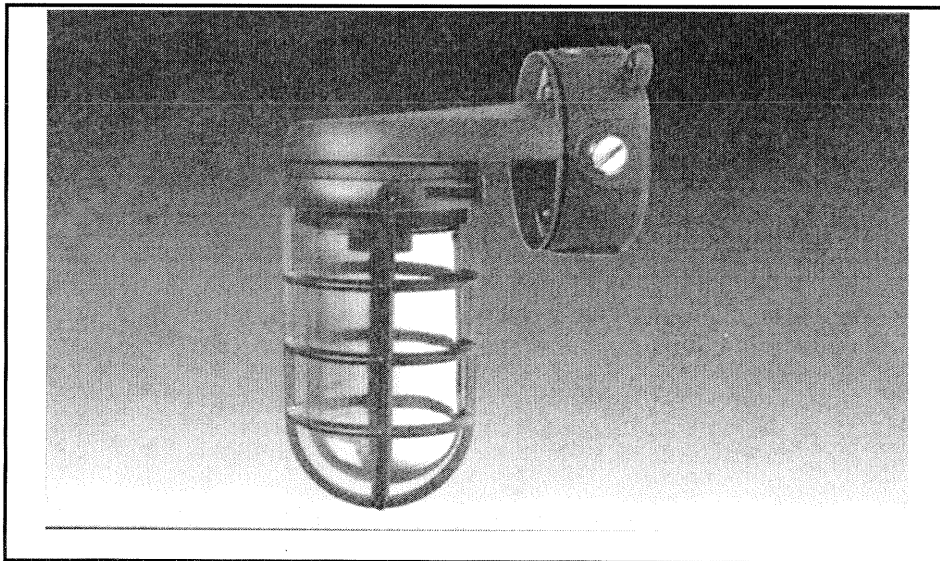
**Fixture Type F17**

**DESCRIPTION:** Surface mounted compact fluorescent "jelly jar", nominal 5" diameter x 10 3/8" high. Electrical enclosure and globe guard of die cast aluminum, in finish as selected by Architect. Ribbed prismatic glass globe. Electronic ballast shall operate all manufacturers' 26 or 32 watt lamps.

**MANUFACTURERS:** Lightolier Exceline Series; Abolite PET Series; DAC 1010 Series; Pauluhn F729A (Wall); Lumark PLVS Series or approved.

**LAMP:** One CFTR32W  
**WATTS:** 33

**COMMENTS:**



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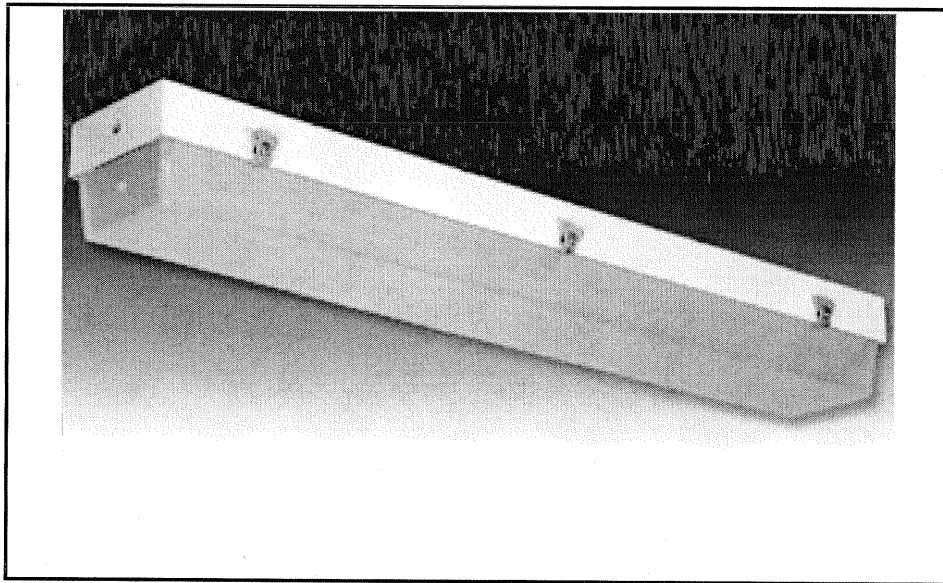
**Fixture Type F18**

**DESCRIPTION:** Wall mounted vapor tight fluorescent fixture, nominally 8" wide x 5-7/8" tall x 50-1/4" long. 20 guage zinc coated steel housing. Internal zinc coated steel reflector painted with reflectance of 88%. High impact .125 extruded prismatic acrylic lens with extruded EPDM gasketing to seal lens to housing. White polyester enamel finish. Electronic ballast. UL listed for wet locations and hazardous locations, Classes I & II, Groups A thru G.

**MANUFACTURERS:** Paramount Industries HL4 Series, SLS Linda SLS-LIN-2X32W-T8-UNIV; Metalux VT3; or approved.

**LAMP:** Two F32T8  
**WATTS:** 62

**COMMENTS:**



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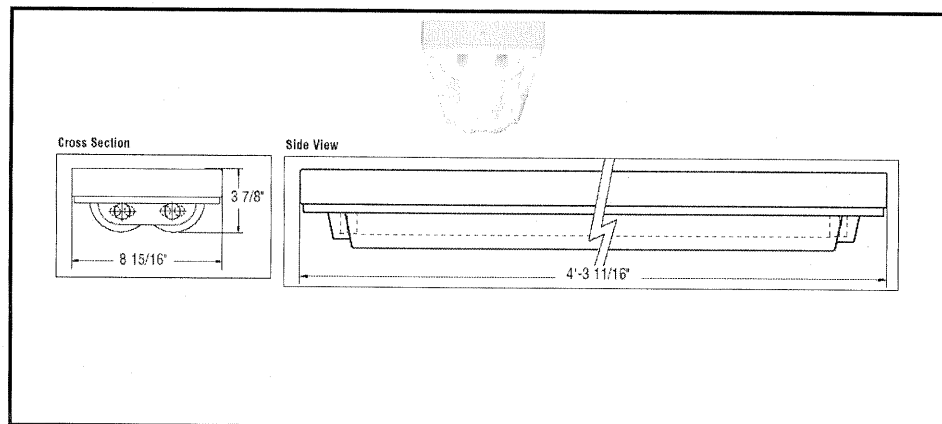
## Fixture Type F19

**DESCRIPTION:** Surface mounted lensed fluorescent fixture nominal 9" wide x 3 7/8" high x 51" long. Cold rolled steel housing. Impact resistant polycarbonate low glare prismatic diffuser with internal prisms. Fully enclosed and gasketed. Integral electronic ballast. UL listed for damp locations. Provide with emergency battery pack for fixtures indicated on emergency drawings. Battery shall provide 30% of rated lumen output for 90 minutes.

**MANUFACTURERS:** Zumtobel FZ800 Series; SLS Linda SS-LIN-2X32W-T8-UNIV Series or approved.

**LAMP:** Two F32T8  
**WATTS:** 62

**COMMENTS:**



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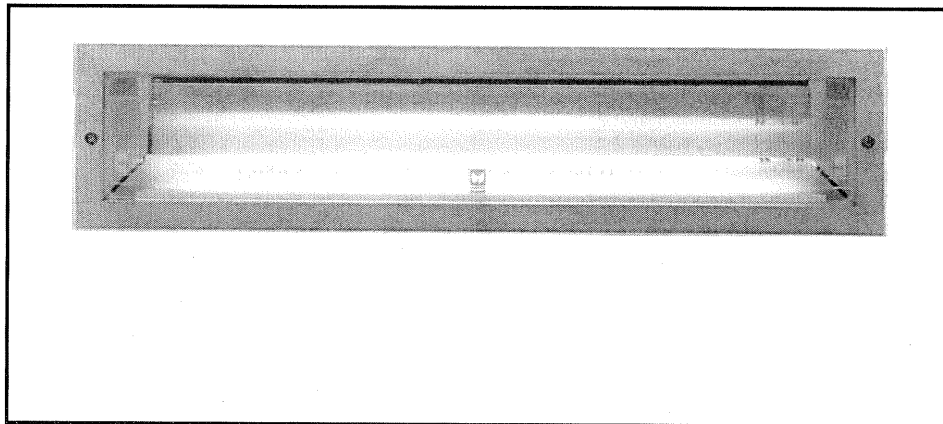
**Fixture Type F20**

**DESCRIPTION:** In-grade fluorescent asymmetrical uplight nominal 26.40 long x 5.91" wide and 5.12" deep. Fiberglass filled techno-polymer housing and anodized aluminum reflector. Stainless steel lens frame and flush asymmetrical glass lens with silicon rubber gasket. Suitable for wet locations. Electronic ballast.

**MANUFACTURERS:** Design Plan Cricket CRA Series; Bega 8234P Series

**LAMP:** One F14T5  
**WATTS:** 19

**COMMENTS:** Bega to use the CFT40 lamp at 44 watts. Exterior mounted.



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**Fixture Type F21**

**DESCRIPTION:**

Recessed lensed fluorescent vandal resistant fixture nominally 24" x 24" x 5". 18 gauge CRS steel housing and door frame with .156" prismatic polycarbonate lens. Flanged housing with positive dust and vapor seal, door frame closure by stainless steel security screws. Hole free design to prevent air exchange between fixture and plenum. Suitable for class 100 clean room environment. UL wet label. Electronic ballast.

**MANUFACTURERS:**

Failsafe 2VRGC Series, Kenall RGD Series or approved.

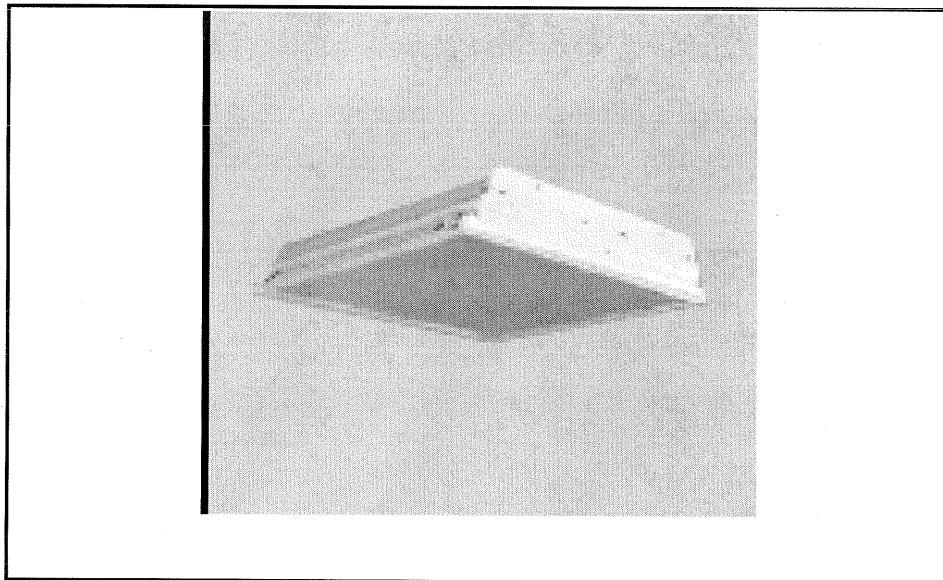
**LAMP:**

Two FT40W

**WATTS:**

88

**COMMENTS:**



Fixture drawing is an illustration of one acceptable manufacturer

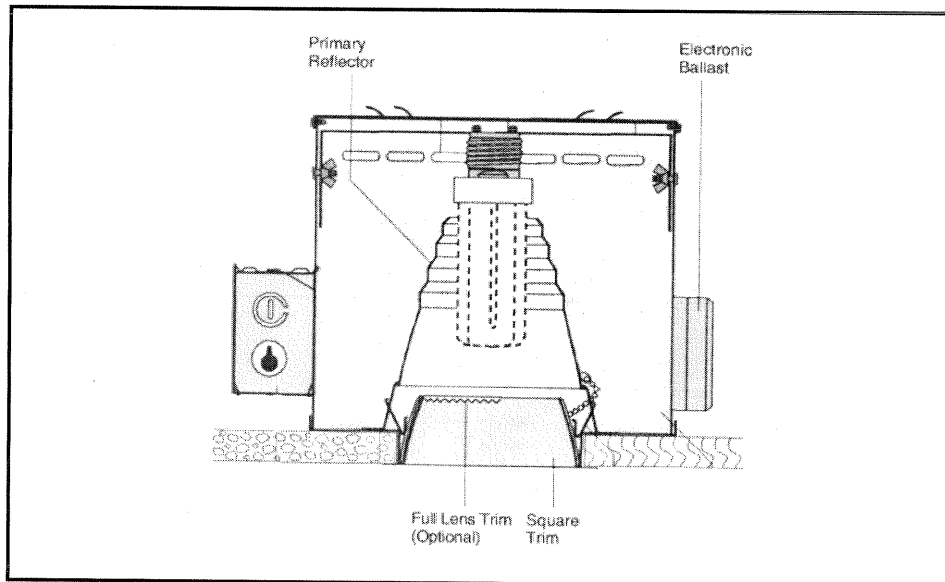
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**Fixture Type F22, F22A**

- DESCRIPTION:** Recessed lensed compact fluorescent downlight with vertical lamp, nominal 6" square aperture. Clear Alzak cone, self flanged overlap trim, low-iridescent finish with spread lens on top of reflector. Electronic ballast. Recess depth 11.25".
- MANUFACTURERS:** Kurt Versen H8632 Series; Prescolite CFT 632EB Series; Kirilin FRS Series; Kramer KL6 Series or approved.
- LAMP:** One CFTR32W (Amalgam Lamp)
- WATTS:** 33
- COMMENTS:** F22A is similar, except with 100%-10% dimming ballast.



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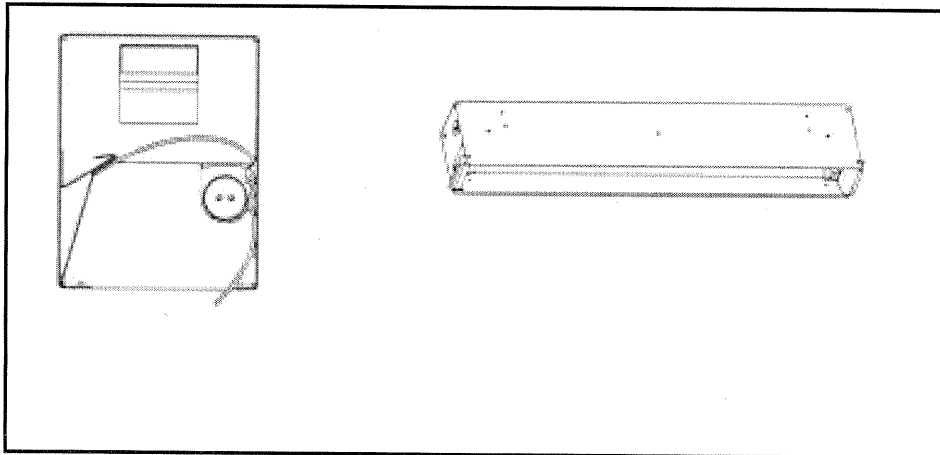
**Fixture Type F23**

**DESCRIPTION:** Recessed linear fluorescent wallwash fixture, nominal 3" wide x 3 7/8" high, with maximum 2-1/8" wide aperture, in lengths as shown on drawings. Housing constructed of painted steel with five-stage iron-phosphate pretreatment for rust resistance. Reflector of extruded aluminum, two component, specular asymmetric vacuum metalized reflector system. Perforated black metal diffusers. Electronic ballast.

**MANUFACTURERS:** Peerless Lightline LWAR9 Series; Pinnacle EW Series

**LAMP:** One F28T5  
**WATTS:** 32

**COMMENTS:** Contractor to verify T-bar or drywall installation.



Fixture drawing is an illustration of one acceptable manufacturer.

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**Fixture Type F24**

**DESCRIPTION:** Custom luminous fluorescent ceiling consisting of custom perimeter, custom cut grid, elevators, image tiles and complete lighting system. Provide with 100% to 10% electronic dimming ballast. Owner to select and approve final images for each room. Size as shown on drawings.

**MANUFACTURERS:** Sky Factory Luminous Sky Ceiling Series; Kenall Cleanscene Series or approved.

**LAMP:** One F28T5/2'  
**WATTS:** 32/2'

**COMMENTS:** Provide factory standard image as directed by architect.



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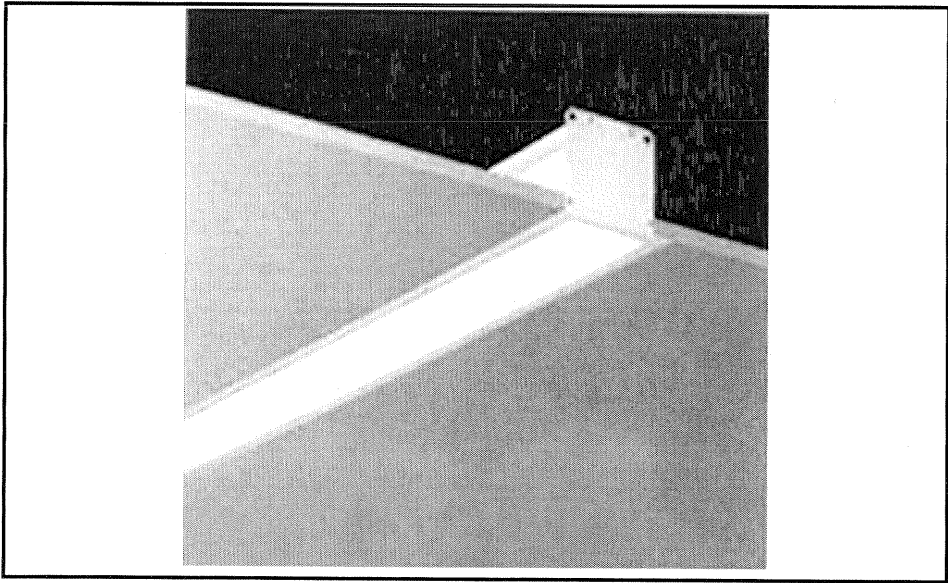
**Fixture Type F25**

**DESCRIPTION:** Recessed linear fluorescent downlight, nominal 4" wide x 4" high x lengths shown on electrical drawings. Extruded aluminum housing. Reflector of 24 gauge steel with baked white enamel finish. Flush flat opal white diffuser. Electronic 0°F cold start ballast. Trim finish as selected by Architect. U.L. listed for damp locations.

**MANUFACTURERS:** Selux M100 Series; Litecontrol LGD44 Series; Neoray 23DR Series; Mark MP Series or approved.

**LAMP:** One F32T8/4'  
**WATTS:** 32

**COMMENTS:**



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Fixture Type F26

**DESCRIPTION:** This fixture designation is not used.

**MANUFACTURERS:** N/A

**LAMP:** N/A

**WATTS:** N/A

**COMMENTS:**

Not used

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## Fixture Type F27

**DESCRIPTION:**

Surface mounted compact fluorescent wall pack, nominal 16-1/4" wide x 7" high x 9" projection from wall. Die-cast aluminum housing, flat aperture, perpendicular to wall with gasket seals. Hinged door frame of single piece die-cast aluminum. Specular Alzak reflectors. Medium throw distribution. Standard powder coat finish with color as selected by Architect. 0° F. cold start electronic ballast. UL listed for wet locations.

**MANUFACTURERS:**

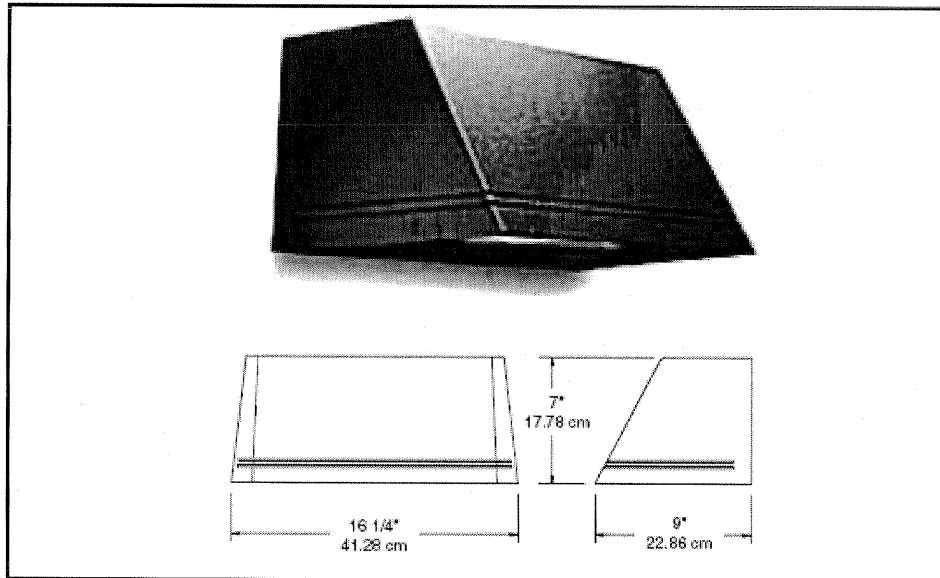
Gardco 101 Square Wedge; Lumark PLIP Series; Lithonia WST Series or approved.

**LAMP:**

One CFTR32W

**WATTS:**

33

**COMMENTS:**

Fixture drawing is an illustration of the acceptable manufacturer

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**Fixture Type F28**

**DESCRIPTION:**

Detention grade undercabinet tasklight nominal 48" with solid front, not to exceed 1-9/16" high, shall have a 45 degree batwing acrylic prismatic lens. Steel housing with baked white enamel finish. Hardwired and switched at wall. Electronic ballast.

**MANUFACTURERS:**

Alcco SF332 Series; Failsafe MAS Series; Lithonia N2S Series; H.E. Williams 2SF-KSH25 Series; Daybrite 8UC Series; Vista MGT Series

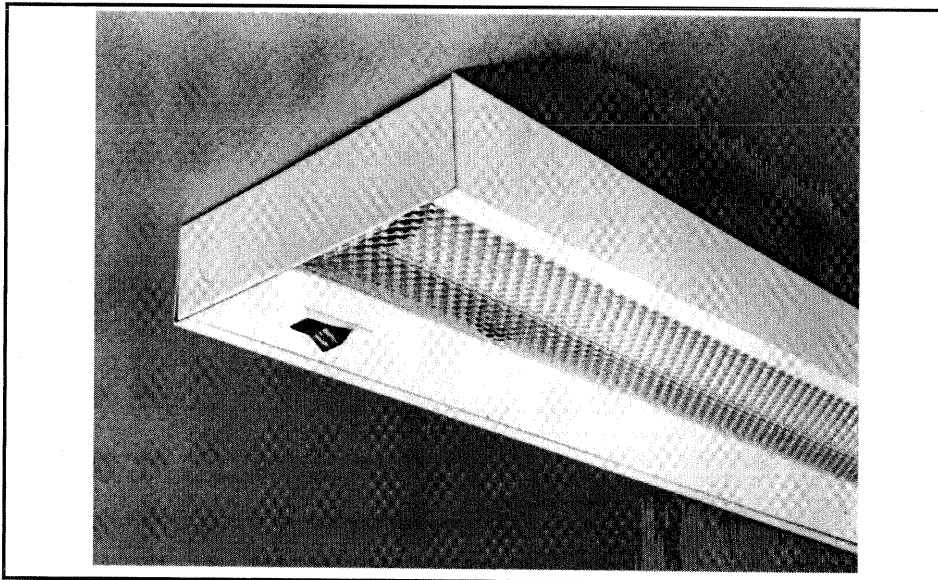
**LAMP:**

One F32T8

**WATTS:**

32

**COMMENTS:**



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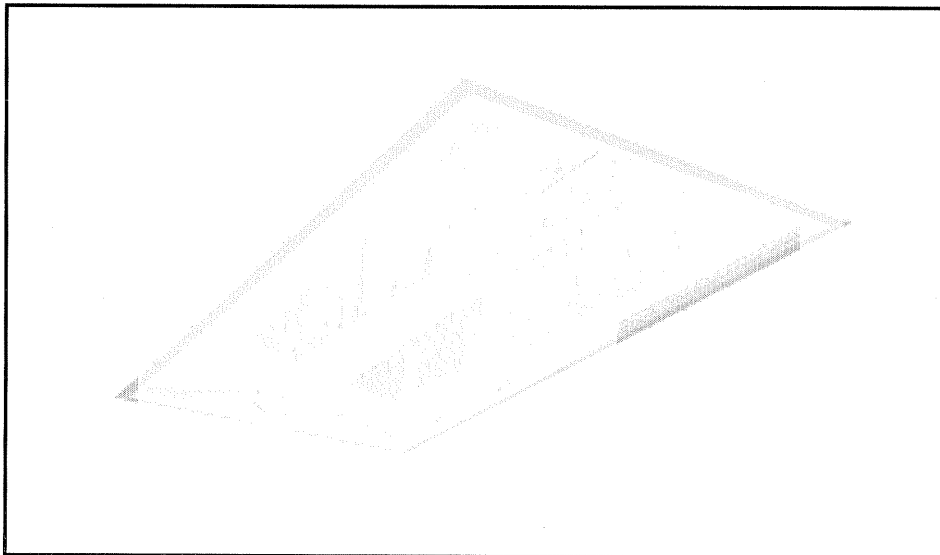
**Fixture Type F29**

**DESCRIPTION:** Recessed direct-indirect fluorescent lighting fixture, nominal 24" x 48" x 5". One piece die-formed 22 gauge cold rolled steel housing. Two flat non-glaze acrylic panels reflectors and extruded acrylic lens with a protected Meso Optics film layer. Optical frame allows for tool free access for relamping. Electronic ballast. Housing and frame are post-painted in white powder coat finish.

**MANUFACTURERS:** Ledalite Pure FX Series; Focal Point Aerion Series or approved.

**LAMP:** Two F54T5HO  
**WATTS:** 120

**COMMENTS:**



Fixture drawing is an illustration of one acceptable manufacturer

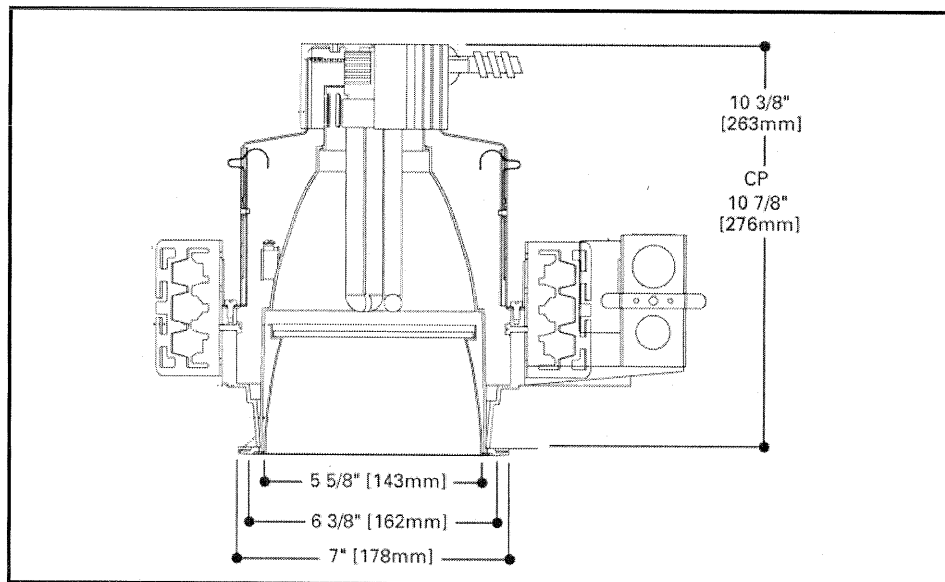
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## Fixture Type F30

- DESCRIPTION:** Recessed compact fluorescent downlight with vertical lamp, nominal 6" aperture. Clear semi-specular Alzak parabolic cone, self-flanged overlap trim, low-iridescent finish, and regressed clear acrylic lens. Electronic ballast.
- MANUFACTURERS:** Portfolio C6042 6081/81 Series; Prescolite CFT632EB Series; Gotham AFV32TRT Series or approved.
- LAMP:** One CFTR32W  
**WATTS:** 33
- COMMENTS:**



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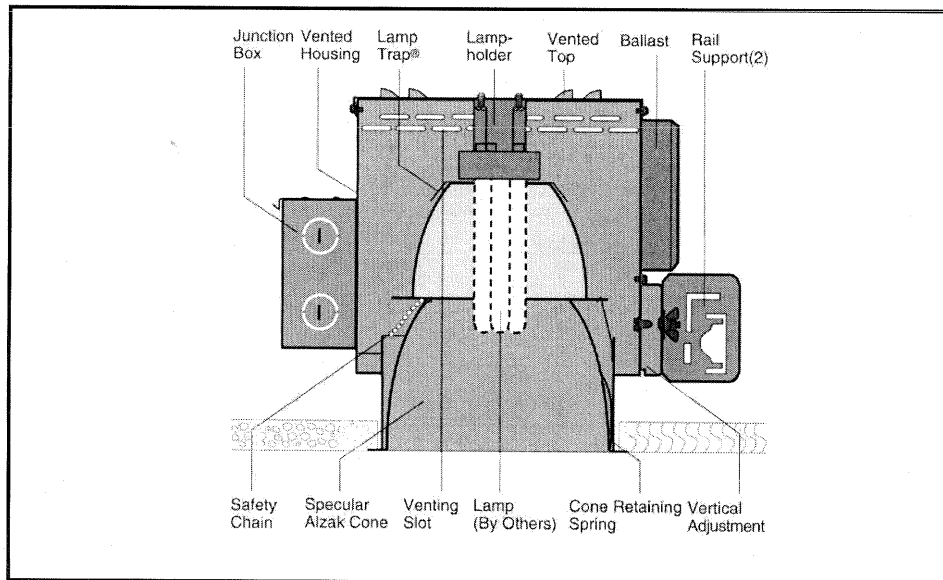
Fixture Type F30A

**DESCRIPTION:** Recessed compact fluorescent downlight with vertical lamp, nominal 6" aperture. Clear semi-specular Alzak parabolic cone, self-flanged overlap trim, low-iridescent finish. Electronic ballast. Ballast shall operate all manufacturer's 26 or 32 watt lamps. Minimum recess depth 9 3/4". Maximum recess depth 10 7/8".

**MANUFACTURERS:** Lithonia Gotham AFV 32TRT 6 Series; Halo C6042-6001 Series; Prescolite CFT632EB Series; Kurt Versen P926 Series; Lightolier 8021/6132 Series; Omega Spex S632 Series

**LAMP:** One CFTR32W (Amalgam Lamp)  
**WATTS:** 33

**COMMENTS:**



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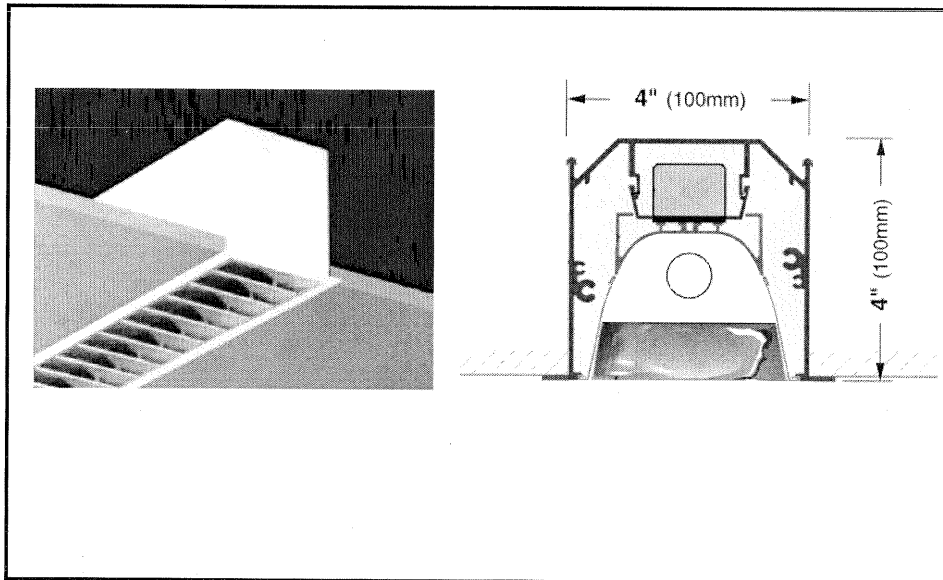
## Fixture Type F31

**DESCRIPTION:** Recessed linear fluorescent downlight, nominal 4" wide x 4" high x 8' long. Reflector of 24 gauge steel with baked white enamel finish. Single lamp cross section. Provide clear lens overlay fixed to top of louvers. Semi-specular natural aluminum parabolic louver. Configured with minimum 50° direct lamp cut-off. Electronic ballast with 0°F starting temperature. Trim finish as selected by Architect. U.L. listed for damp locations.

**MANUFACTURERS:** Selux M100 Series; Linear Lighting RC45 Series, Gammalux GB44D Series, Alight Accolade Series; Neoray 23DR Series; Axis BBR Series or approved.

**LAMP:** Two F54T5HO  
**WATTS:** 118

**COMMENTS:**



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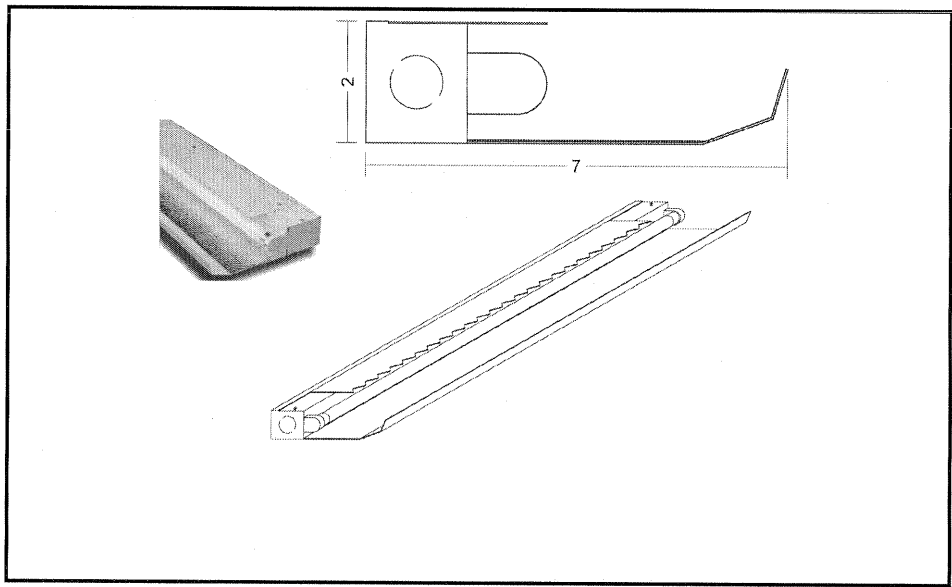
**Fixture Type F32, F32A, F32B, F32C**

**DESCRIPTION:** Surface mounted linear fluorescent uplight, nominal 7" wide x 2" tall x 4' long. Formed aluminum housing, highly reflective white and specular hammertone aluminum asymmetric reflector. Saw tooth reflector prevents socket shadows. Integral electronic ballast. Provide with acrylic lens dust cover.

**MANUFACTURERS:** Birchwood Lighting- Ashley Series; Corelite- Cove Duo Series; Mark Lighting- CVG Series; LAM Lighting HPD Series

**LAMP:** One F32T8/4'  
**WATTS:** 32/ 4'

**COMMENTS:** F32A is similar to F32 except 3' long with one F25T8 at 28 watts.  
 F32B is similar to F32 except with 100% - 10% electronic dimming ballast.  
 F32C is similar to F32A except with 100% - 10% electronic dimming ballast.  
 Aim as directed by Architect.



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**Fixture Type F33**

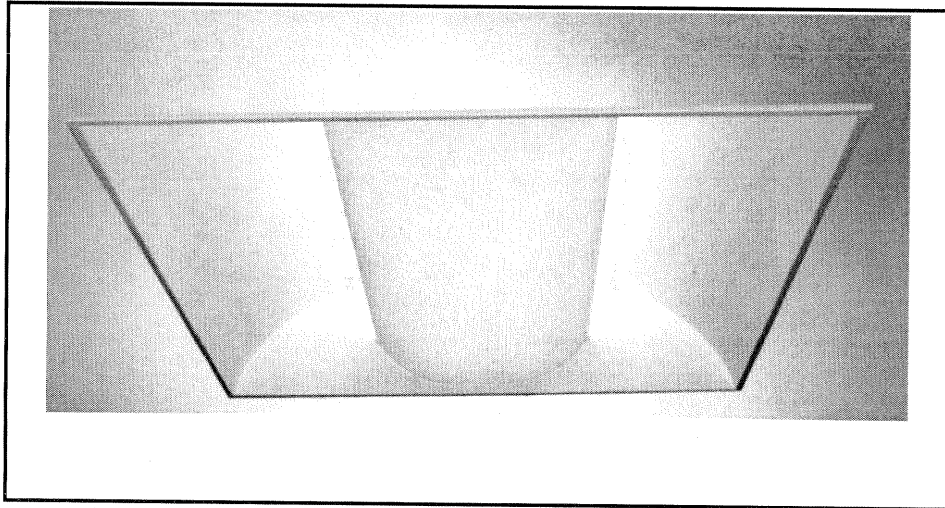
**DESCRIPTION:** Recessed direct-indirect fluorescent lighting fixture, nominal 24" x 24" x 6". One piece die-formed 20 gauge cold rolled steel housing. Two curved reflectors with high-reflectance matte white paint finish. Detachable perforated lamp shield formed of 22 gauge cold rolled steel with white acrylic lens insert. Lamp shield swings down for relamping. Two integral electronic 2-lamp ballasts, wired master/slave to adjacent fixture.

**MANUFACTURERS:** Focal Point Luna Series; Lithonia Avante Series; Mark Aurora Series; Alera Lumio Series; Day-Brite Arioso Series

**LAMP:** Two FT40W

**WATTS:** 74

**COMMENTS:**



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**Fixture Type F34**

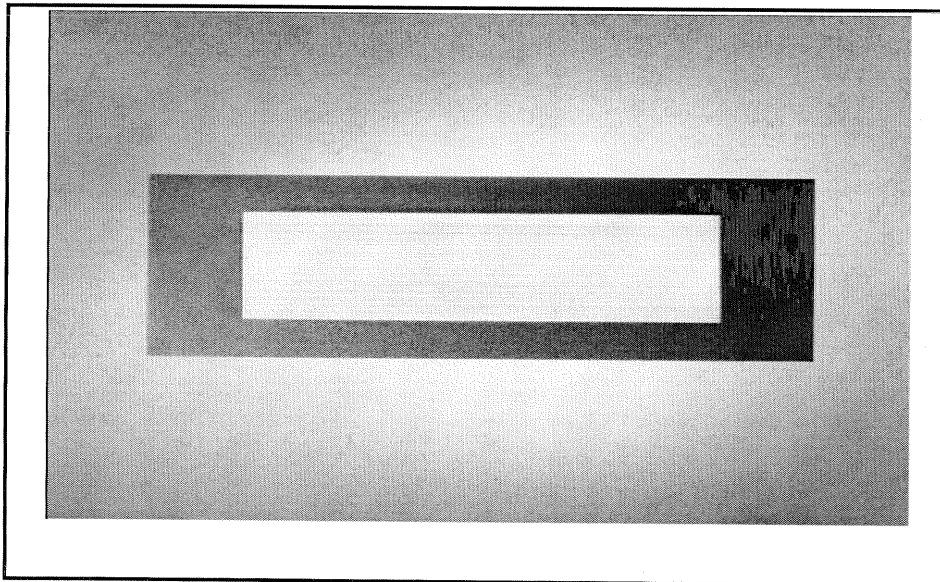
**DESCRIPTION:** Surface wall mounted fixture nominal 9" wide x 36" high x 2.60" projection from wall. Three piece ballast channel and frame fabricated from 20 guage, die formed cold rolled steel. Low iridescent, specular aluminum reflector with acrylic. Manufacturer's standard finish as selected by Architect. Electronic ballast.

**MANUFACTURERS:** Focal Point Metro FMEC3 Series or approved.

**LAMP:** One F39T5HO

**WATTS:** 42

**COMMENTS:**



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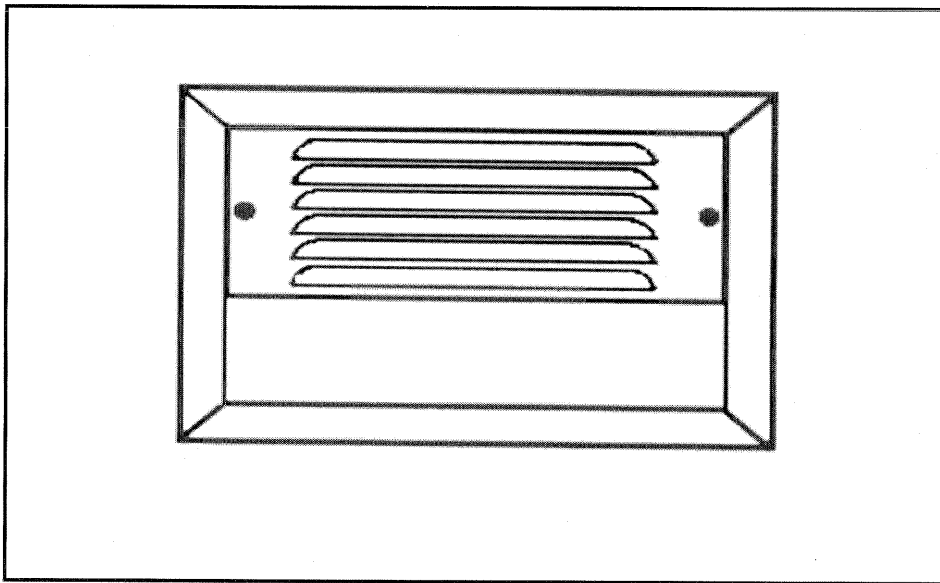
**Fixture Type L1**

**DESCRIPTION:** Wall recessed night light fixture, nominal 9.25" w x 6.25" h x 3.5" deep. Die cast aluminum housing and faceplate. Manufacturer's standard finish as selected by Architect. Electronic ballast.

**MANUFACTURERS:** Alcco SO4-WH series; Zumtobel 'Ledos Kava' white series; Vista VSP-LED series; Kirlin RN Series

**LAMP:** White LED  
**WATTS:** 2

**COMMENTS:**



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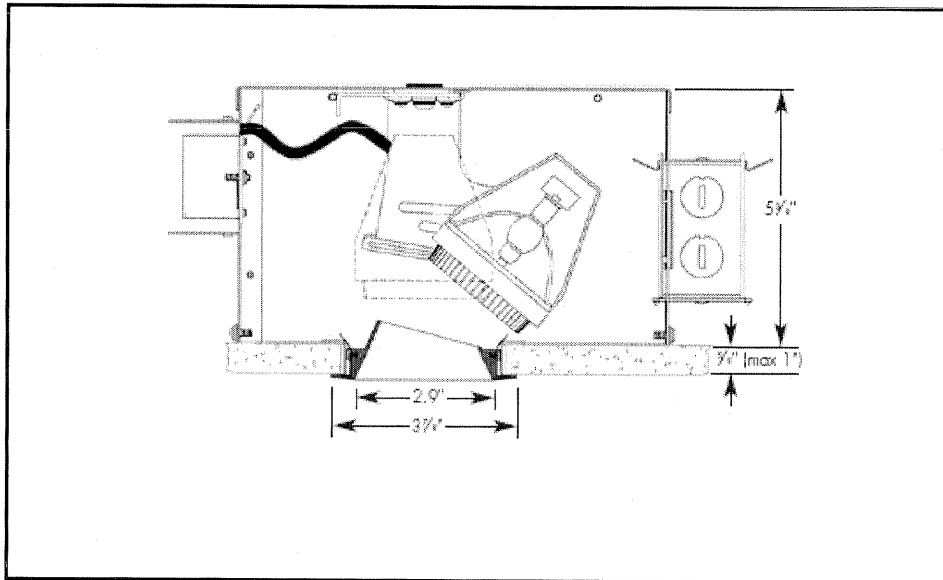
**Fixture Type M1**

**DESCRIPTION:** Recessed metal halide accent light for metal halide lamp, nominal 2.9" square aperture. Clear Alzak cone, self-flanged overlap trim. Vertical tilt of minimum 40°, horizontal rotation minimum 360°, and adjustment locking device. Provide with clear lens. Minimum recess depth 5-3/8". Provide electronic ballast.

**MANUFACTURERS:** Amerilux Evoke 2.9A Series; RSA Lighting ACT Series; or approved.

**LAMP:** One CMHMR16/40° (G.E.)  
**WATTS:** 24

**COMMENTS:**



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## Fixture Type M2

**DESCRIPTION:**

Recessed lensed metal halide wallwash fixture, nominal 3" square aperture and 9-1/2" depth. Optical assembly consists of clear semi-specular Alzak reflector with self-flanged overlap square trim and internal (kicker) reflector. 55° glass spread lens. Lamp and reflector assembly to be rotatable through 360° in 90° increments. Lens removable for lamp replacement. Ballast accessible through fixture aperture. Integral electronic ballast.

**MANUFACTURERS:**

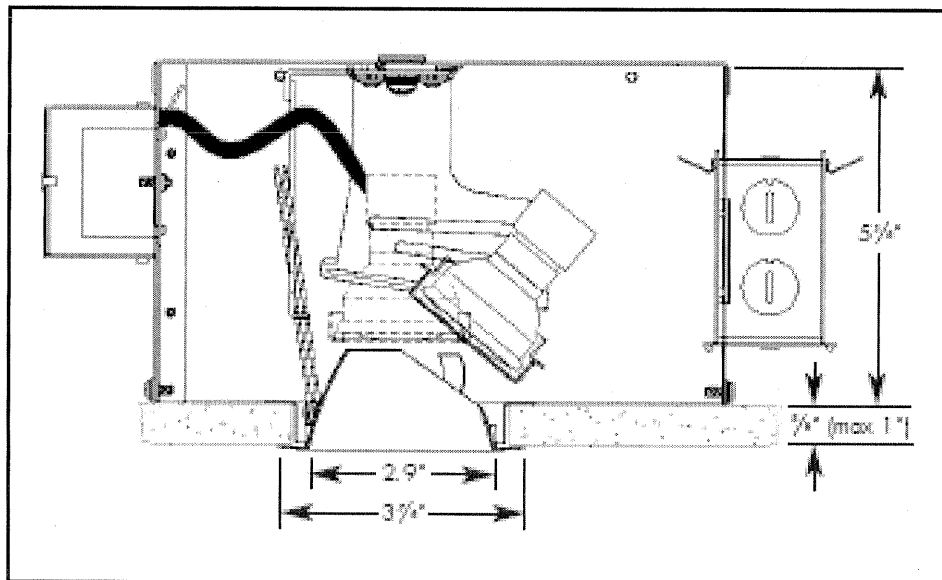
Amerlux Evoke 2.9 RA Series; RSA Lighting ACT Series or approved.

**LAMP:**

One CMHMR16/40° (G.E.)

**WATTS:**

24

**COMMENTS:**

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**Fixture Type M3,M3A**

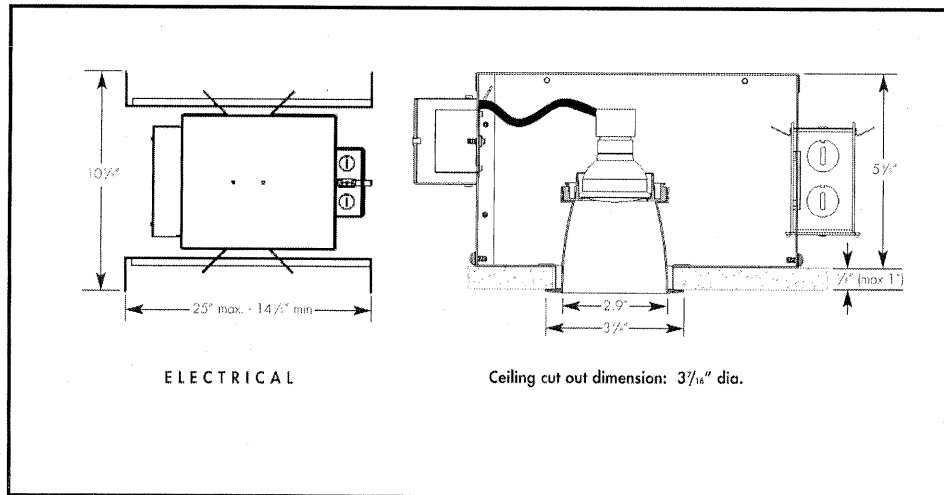
**DESCRIPTION:** Recessed lensed metal halide downlight fixture, nominal 3-7/8" dia. aperture and 5-3/8" depth. Optical assembly consists of die-cast aluminum seamless self-flanged square trim. Beam softening lens removable for lamp replacement. Ballast accessible through fixture aperture. Integral electronic ballast.

**MANUFACTURERS:** Amerlux Evoke 2.9 Series; RSA Lighting ACM Series or approved.

**LAMP:** One CMHMR16/40° (G.E.)

**WATTS:** 24

**COMMENTS:** Fixture type M3A is similar to M3 except provide fixture with damp label.



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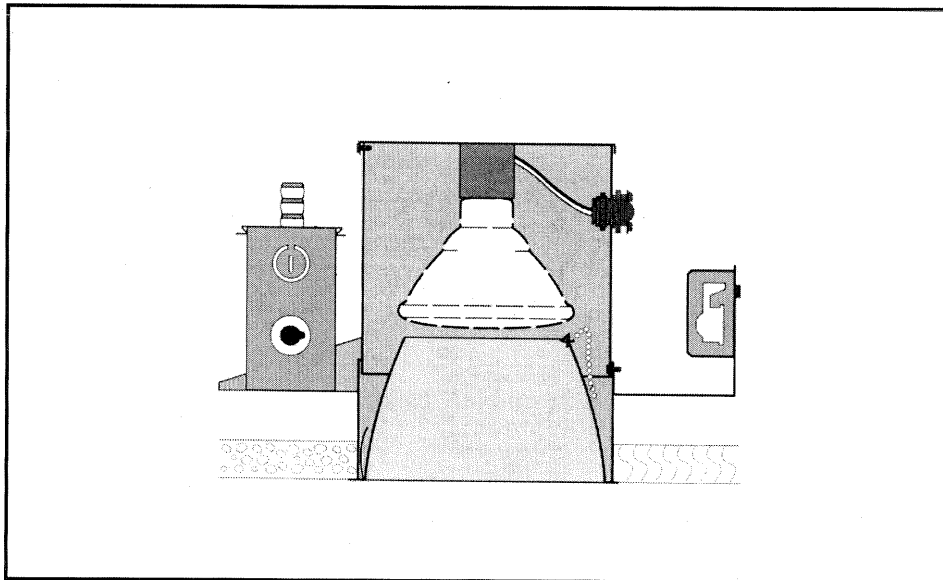
## Fixture Type M4

**DESCRIPTION:** Recessed metal halide downlight, nominal 6" aperture. Clear semi-specular Alzak parabolic reflector cone with self flanged trim. Fixture shall have a 40° shielding angle. Minimum 10 ½" depth, maximum 12" depth. Integral electronic ballast. U.L. listed for damp locations.

**MANUFACTURERS:** Edison Price Arclite 30/6 Series; Kurt Versen R7302 Series; Lightolier DL6P35HA-DL6PCLP Series; Lithonia RH6 Series; Omega Revelation OM6 Series; Prescolite 79M2 Series; Portfolio MA6 Series or approved.

**LAMP:** One CDM35/PAR30/FL (Philips MasterColor)  
**WATTS:** 44

**COMMENTS:**



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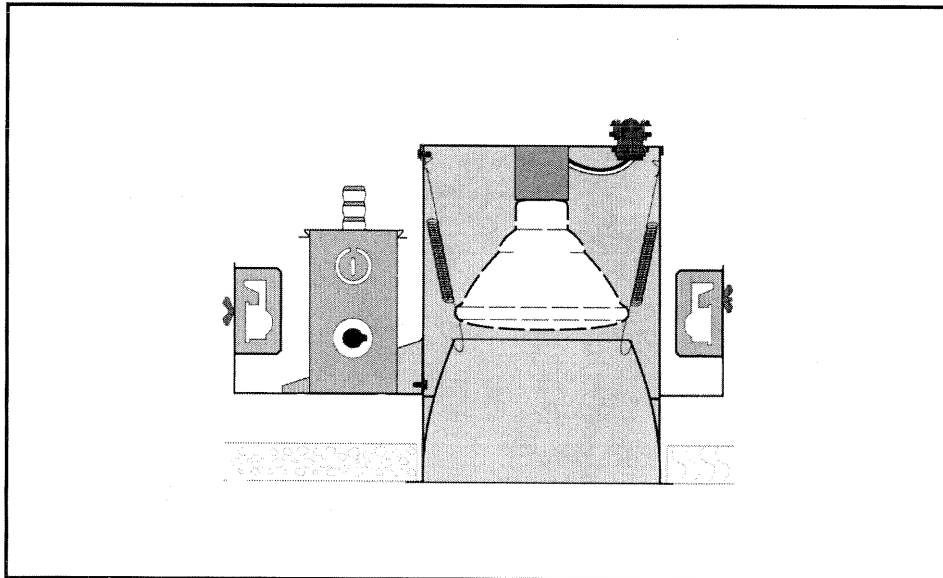
**Fixture Type M5**

**DESCRIPTION:** Recessed metal halide downlight, nominal 7" aperture. Clear semi-specular Alzak parabolic cone, self-flanged overlap trim. Minimum recess depth 10 1/4", maximum recess depth 13-3/8". Ingetral electronic ballast.

**MANUFACTURERS:** Kurt Versen R7303 Series; Edison Price Arclite 38/7 Series; Lithonia Gotham RH7 Series; Infinity MHR71 Series; Omega Revelation OM6 Series; Prescolite 79M2 Series; Portfolio MA6 Series or approved

**LAMP:** One CDM70/PAR38/FL (Philips MasterColor)  
**WATTS:** 78

**COMMENTS:**



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## Fixture Type M6

**DESCRIPTION:**

Wall mounted asymmetric metal halide uplight, nominal 9-7/8" high x 7-3/8" long x 11-13/16" wide. Extruded specular anodized aluminum reflector with solid aluminum endcaps and stainless steel hardware. Impact resistant clear glass lens. Provide with visor. Finish as selected by Architect. Integral electronic ballast. UL listed for wet locations.

**MANUFACTURERS:**

Elliptipar Style 452 Series, Winona Windirect Series or approved.

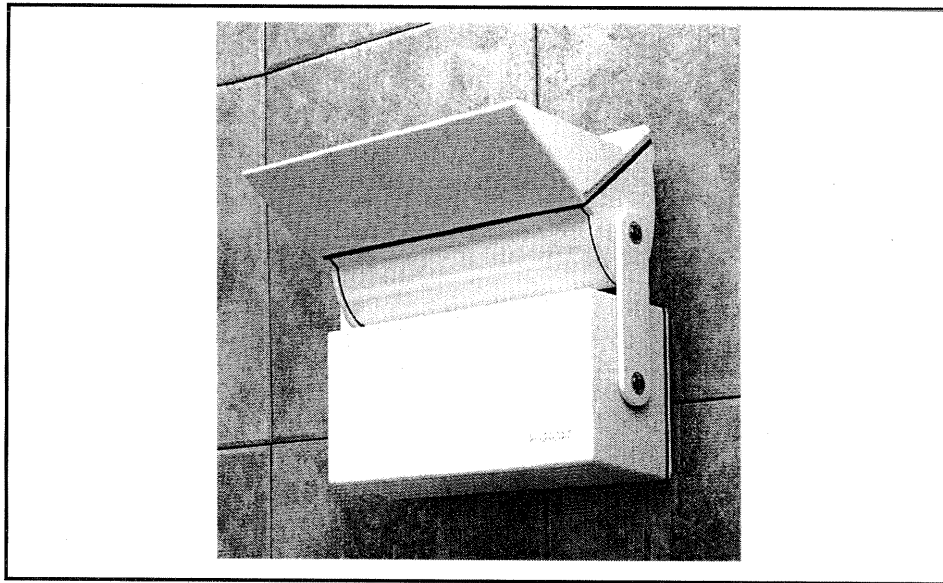
**LAMP:**

One CMH150/T6 (Philips MasterColor)

**WATTS:**

210

**COMMENTS:**



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**Fixture Type M7**

**DESCRIPTION:** Pendant mounted metal halide area light, nominal 18" diameter x 14 7/8" tall. Die-cast aluminum housing. One-piece injection molded non-yellowing Lexan SLX refractor. Integral electronic ballast. Bird Shroud. Canopy cover and hang-straight. Field cut stem to meet housing height indicated on drawings. Provide with internal glare shield. Tamper resistant latches. U.L. listed for wet locations. Standard white finish.

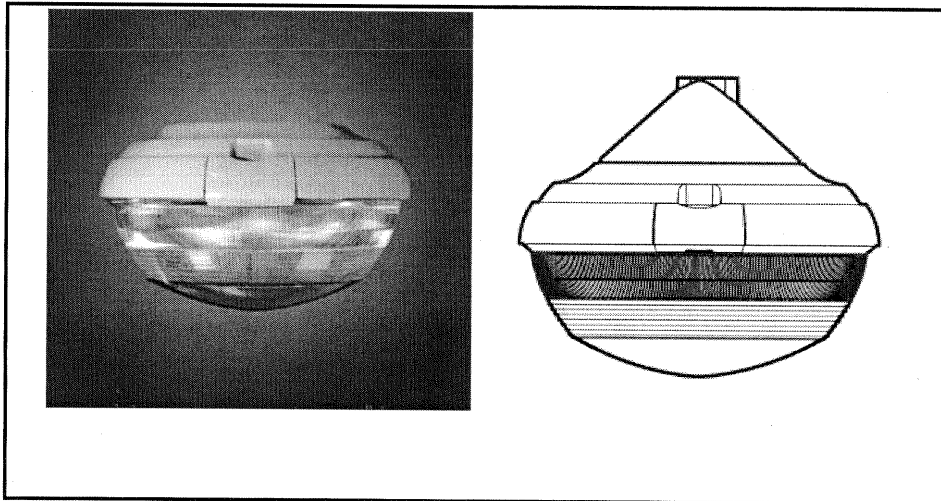
**MANUFACTURERS:** Kim PGL6 Series; no substitutions

**LAMP:** MHC100/U/M/3K/Alto (Philips MasterColor)

M5A only: TL5C 22 (standby lamp)

**WATTS:** 110

**COMMENTS:**



Fixture drawing is an illustration of both louvered and non-louvered quadrants

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## Fixture Type M8,M8A

**DESCRIPTION:**

Surface mount metal halide flood light. Die-cast copper aluminum cylindrical housing with integral cooling fins over entire length, nominal 9" wide x 14" long. Die-cast copper aluminum lens frame with 3/8" thick clear tempered glass lens seated to frame with one-piece silicone gasket. Internal specular Alzak wide flood reflector. Die-cast heavy duty aluminum swivel with integral locking teeth providing 5 degree adjustment intervals and 2" tenon welded to cast aluminum plate for surface mounting. Provide four-way barn doors. Integral electronic ballast. Powder coat finish in manufacturer's standard color as selected by Architect. U.L. listed for wet location.

**MANUFACTURERS:**

Kim AFL 10 Series; Invue VFS Series; Hydrel 7000 Series or approved.

**LAMP:**

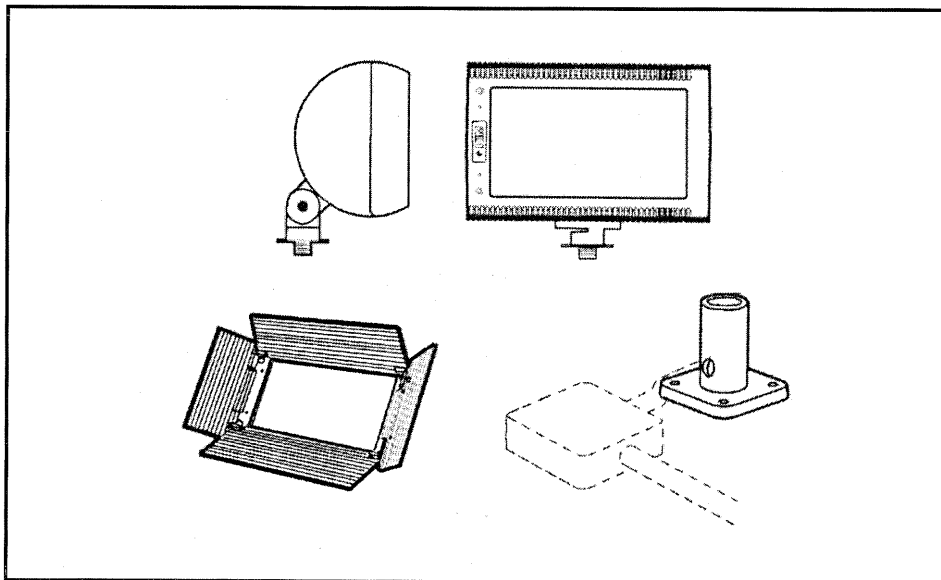
One MHC70 (Philips MasterColor)

**WATTS:**

90

**COMMENTS:**

Fixture type M8A is similar to type M8 except provide with medium flood reflector.



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**Fixture Type M9**

**DESCRIPTION:**

Surface ground mounted bullet uplight nominal 2.25" diameter x 4-1/2" long. Copper-free aluminum cylindrical housing, cap, stem and base. Tempered glass lens sealed with high temperature adhesive. Stainless steel hardware. 358 degree rotation and 90 degree vertical tilt. Provide integral universal clear lens, honeycomb baffle and 45 degree cap. Integral electronic ballast. UL listed for wet locations. Manufacturer's standard color as selected by Architect. Provide fixture with 8" anchor base and 18" power pipe option.

**MANUFACTURERS:**

B-K Lighting ES-16 Series; Lumiere 703 Series or approved.

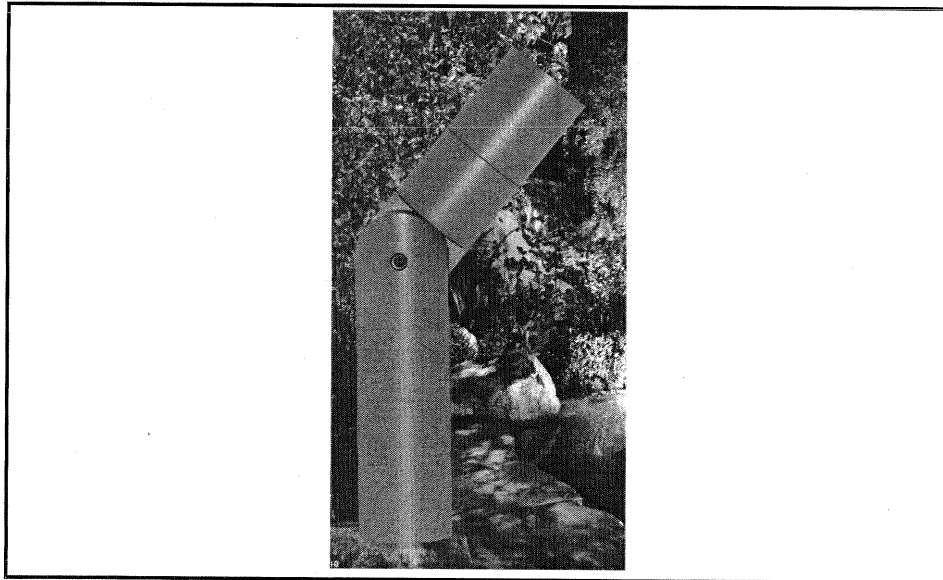
**LAMP:**

One CMHMR16/40° (G.E.)

**WATTS:**

24

**COMMENTS:**



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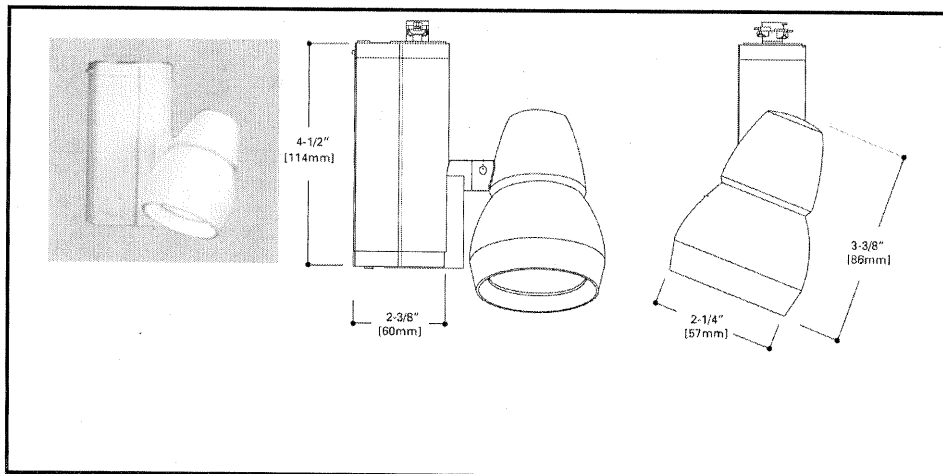
**Fixture Type M10**

**DESCRIPTION:** Track mounted metal halide wall grazer, nominal 2 1/4" dia. x 3 3/8". Die cast aluminum lamp housing. Quick lock track adapter. Locking aiming. Linear 5°x 50° spread lens for wall grazing. Integral power switch. Integral electronic ballast located in stem. Standard white finish.

**MANUFACTURERS:** Halo-Stasis Series; Lightolier Mini-HID Series;

**LAMP:** CMH20MR16/830/SP 12° (G.E.)  
**WATTS:** 24

**COMMENTS:** Type M10 track head shall be compatible with Type T1 track.



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## Fixture Type M11

**DESCRIPTION:**

Pole mounted single-head metal halide cut-off luminaire, nominal 22-1/2" x 16" x 8", with specular Alzak reflector. Fixture housing of one piece die cast aluminum with integral cooling fins over optical chamber and electrical compartment. Optical and electrical compartments separated by solid barrier wall. Type III light distribution. Door frame of one piece die cast aluminum with clear 3/16" thick tempered glass lens and one-piece silicone gasket. Stainless steel or electro-zinc plated steel hardware. Tamper resistant latch. Segmented specular Alzak reflector, field rotatable in 90 degree increments. 12' high, round, tapered, aluminum pole. Provide internal house side shield. Architect to select finish from manufacturer's standard product line. Integral electronic ballast.

**MANUFACTURERS:**

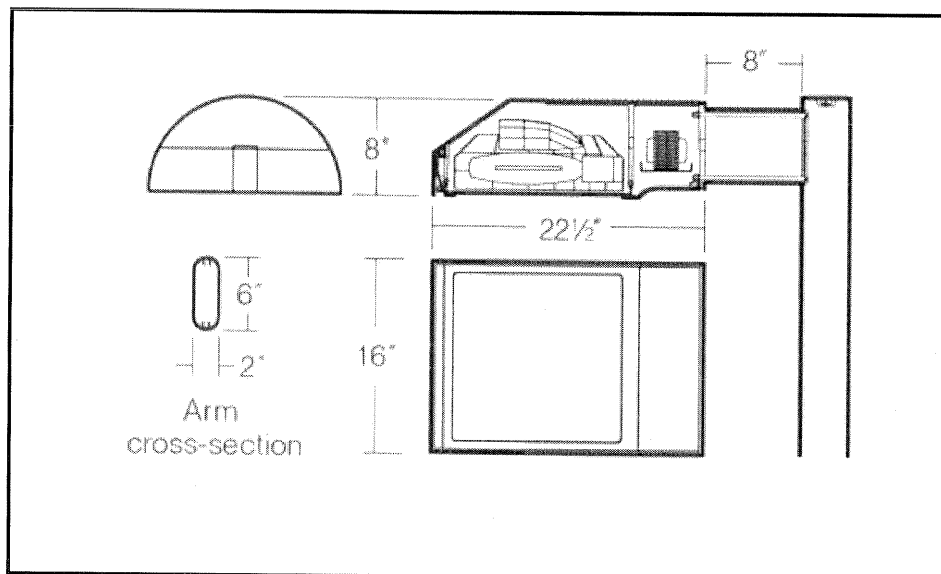
Kim AR Series; Cooper Invue VXM Series; Lithonia Aeris AS2 Series; Gardco Gullwing Series

**LAMP:**

One MH250/U

**WATTS:**

295

**COMMENTS:**

Fixture drawing is an illustration of one acceptable manufacturer

# SPARKLING

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111 SW Fifth Avenue • Suite 1575  
Portland, Oregon 97204  
Phone: 503/273-0060  
Fax: 503/273-0061

**Fixture Type M12**

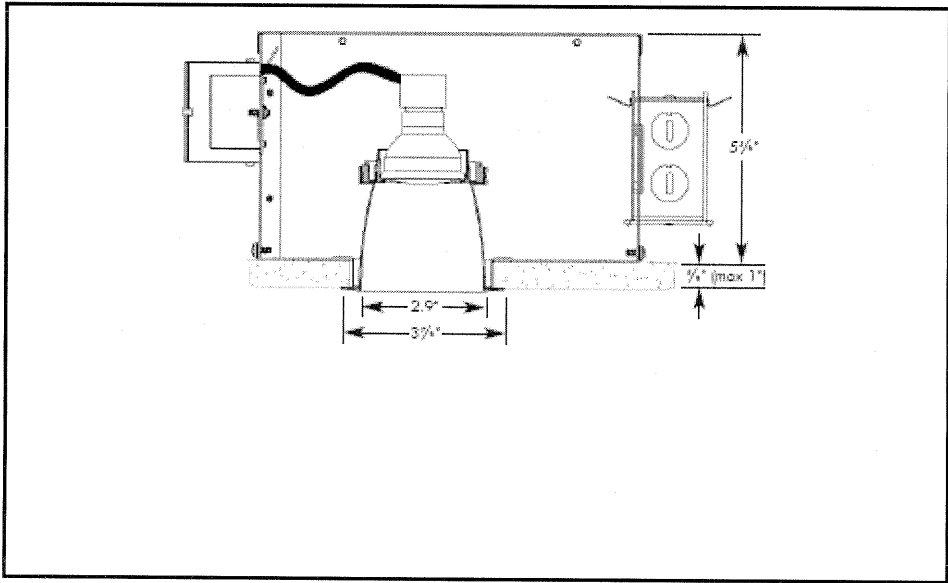
**DESCRIPTION:** Recessed metal halide MR16 downlight, nominal 4" aperture. Clear semi-specular Alzak parabolic cone, self-flanged overlap trim. Minimum recess depth 5-3/8". Maximum recess depth 8 1/2". Integral electronic ballast.

**MANUFACTURERS:** Amerlux Evoke 2.9 RD Series; RSA Lighting ACM Series or approved.

**LAMP:** One CMHMR16/40° (G.E.)

**WATTS:** 24

**COMMENTS:**



Fixture drawing is an illustration of one acceptable manufacturer

**CANDELA**  
*Architectural Lighting Consultants*

720 Olive Way \* Suite 1400  
Seattle, WA 98101  
Phone: 206 / 667-0511  
Fax: 206 / 667-0512

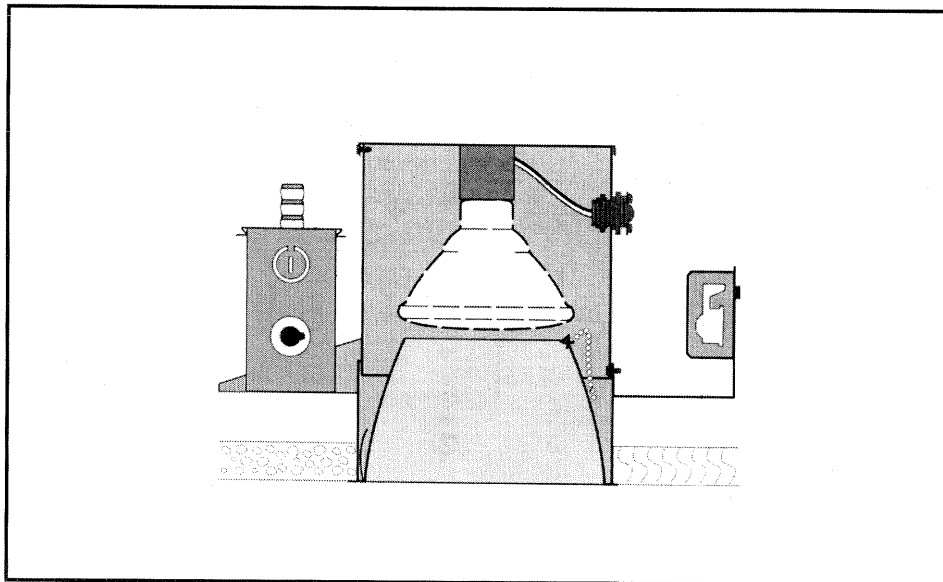
Fixture Type M13

**DESCRIPTION:** Recessed metal halide downlight, nominal 6" aperture. Clear semi-specular Alzak parabolic reflector cone with self flanged trim. Fixture shall have a 40° shielding angle. Minimum 10 ½" depth, maximum 12" depth. Provide electronic ballast.

**MANUFACTURERS:** Edison Price Arclite 30/6 Series; Kurt Versen R7302 Series; Lightolier DL6P35HA-DL6PCLP Series; Lithonia RH6 Series; Omega Revelation OM6 Series; Prescolite 79M2 Series; Portfolio MA6 Series or approved.

**LAMP:** One CDM35/PAR30/FL (Philips MasterColor)  
**WATTS:** 44

**COMMENTS:**



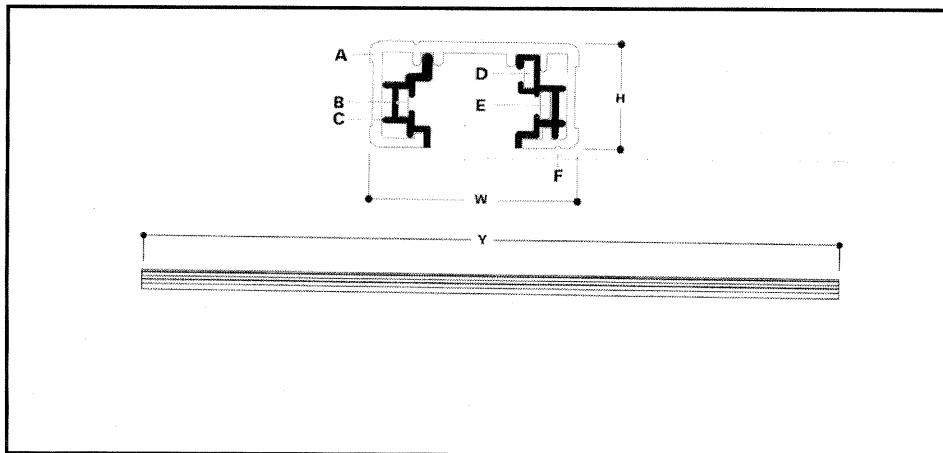
Fixture drawing is an illustration of one acceptable manufacturer

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*Architectural Lighting Consultants*

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Seattle, WA 98101  
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Fax: 206 / 667-0512

## Fixture Type T1

- DESCRIPTION:** Surface mounted single circuit lighting track. Extruded aluminum housing, with polarized solid copper buss in extruded polyvinyl insulator. 20 amp capacity at 120 volts. Electrical Contractor to confirm mounting requirements and order all necessary parts and accessories for complete installation. Standard white finish.
- MANUFACTURERS:** Halo Power-Trac Series; Lightolier Basic Track Series
- LAMP:** N.A.
- WATTS:** Circuit per code requirements
- COMMENTS:** Type T1 shall be compatible with M10 track heads.



**CANDELA**  
*Architectural Lighting Consultants*

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Seattle, WA 98101  
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**Fixture Type X1**

**DESCRIPTION:**

Single face green LED exit sign. Diecast aluminum housing, universal arrows and universal mount. Cast aluminum faceplate with stencil face, manufacturer's standard finish as selected by architect. Assembly shall be held in place within the diecast fixture frame using reinforced plastic or metallic clips. Rated lamp life shall be 20 years minimum. Shall meet UL Standard 924.

**MANUFACTURERS:**

SureLites CX Series; Lithonia Signature Series; Dual-Lite Sempra Series; Emergi-lite Prestige Series; Chloride CXL Series; Isolite LPDC Series

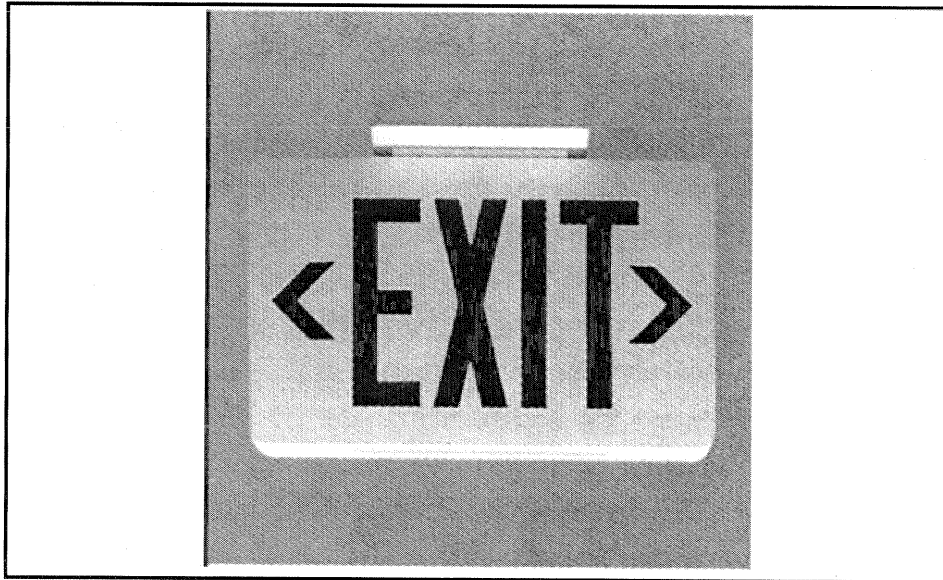
**LAMP:**

LED - Green - Supplied with fixture

**WATTS:**

3 maximum

**COMMENTS:**



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**Fixture Type X2**

**DESCRIPTION:** Dual face green LED exit sign. Diecast aluminum housing, universal arrows and universal mount. Cast aluminum faceplate with stencil face, manufacturer's standard finish as selected by architect. Assembly shall be held in place within the diecast fixture frame using reinforced plastic or metallic clips. Rated lamp life shall be 20 years minimum. Shall meet UL Standard 924.

**MANUFACTURERS:** SureLites CX Series; Lithonia Signature Series; Dual-Lite Sempra Series; Emergi-lite Prestige Series; Chloride CXL Series; Isolite LPDC Series

**LAMP:** LED - Green - Supplied with fixture  
**WATTS:** 3 maximum

**COMMENTS:**



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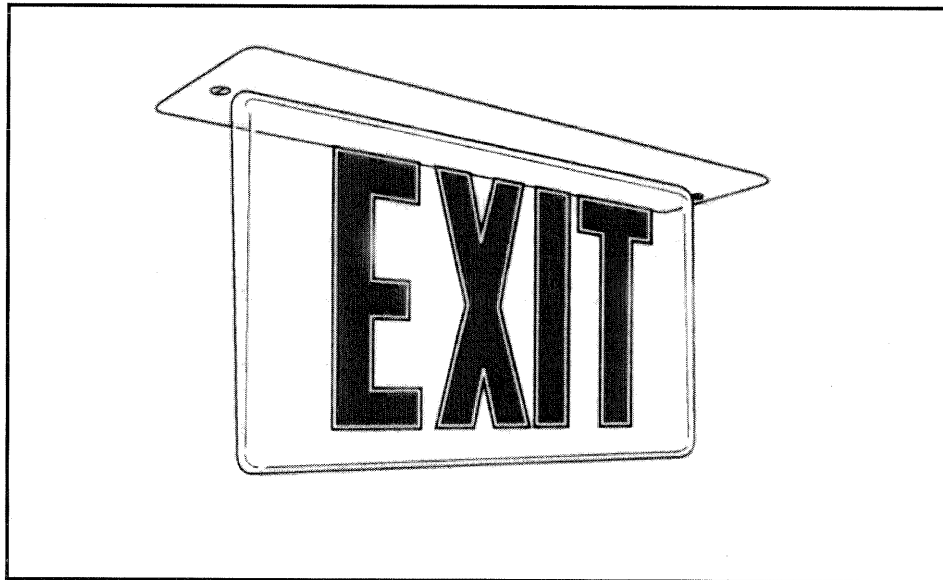
**Fixture Type X3**

**DESCRIPTION:** Single face edge-lit, green LED exit sign. Diecast or extruded aluminum housing with universal arrows. Polished clear acrylic panel with evenly illuminated letters provided by green LED lamps. Diecast fixture frame assembly using reinforced plastic or metallic clips. Rated lamp life shall be 20 years minimum. Shall meet U.L. Standard 924.

**MANUFACTURERS:** Lithonia Precise LRP Series; McPhilben 45V Line Series; Emergi-Lite Prestige X40 Series; Exide Lightguard LED Extra Bright Series; Sure-Lites ELX Series; Dual Lite LE Series; Isolite Elite Series

**LAMP:** LED - Green - Supplied with fixture  
**WATTS:** 3 maximum

**COMMENTS:**



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**Fixture Type X4**

**DESCRIPTION:**

Double face edge-lit, green LED exit sign. Diecast or extruded aluminum housing with universal arrows. Polished clear acrylic panel with evenly illuminated letters provided by green LED lamps. Diecast fixture frame assembly using reinforced plastic or metallic clips. Rated lamp life shall be 20 years minimum. Shall meet U.L. Standard 924.

**MANUFACTURERS:**

Lithonia Precise LRP Series; McPhilben 45V Line Series; Emergi-Lite Prestige X40 Series; Exide Lightguard LED Extra Bright Series; Sure-Lites ELX Series; Dual Lite LE Series; Isolite Elite Series

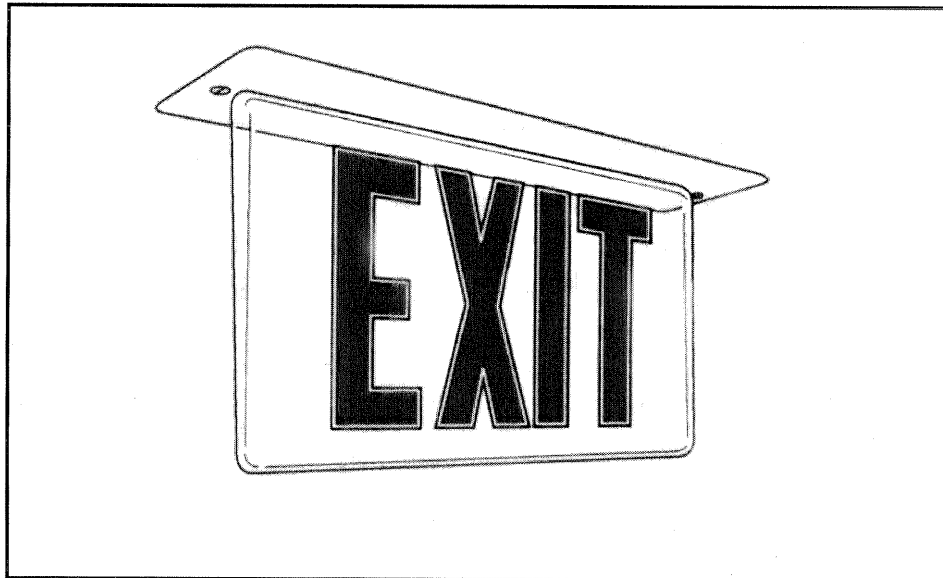
**LAMP:**

LED - Green - Supplied with fixture

**WATTS:**

3 maximum

**COMMENTS:**



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## SECTION 26 09 23 LIGHTING CONTROL DEVICES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following lighting control devices:
  - 1. Indoor occupancy sensors
  - 2. Outdoor photocell switches
  - 3. Time switches
  - 4. Multipole contactors
- B. This Section includes the following daylighting control devices:
  - 1. Multi-level switching of electronic fluorescent ballasts with photo sensor, occupancy sensor and wall box switches.
- C. Related Sections include the following:
  - 1. Section 26 05 19 Copper Conductors and Cables
  - 2. Section 26 27 26 Wiring Devices for light switches and wall-box dimmers
  - 3. Section 26 51 00 Interior Lighting and 26 06 50.16 Lighting Fixture Schedule for light fixture ballasts.

#### 1.3 DEFINITIONS

- A. LED: Light-Emitting Diode.
- B. PIR: Passive Infrared.
- C. PDT: Passive Dual Technology.

#### 1.4 SUBMITTALS

- A. Submit under Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results For Electrical.
- B. Product Data: Provide clearly marked and legible data sheets for each item of equipment being installed on the Project. This shall include each major replaceable component that is part of a larger assembly. Data sheets should clearly indicate:
  - 1. Equipment manufacturer, make, model number, size, nameplate data, etc.
  - 2. Dimensional and performance data for specific unit provided as appropriate
  - 3. Required environmental operating parameters
  - 4. UL, FM and ETL listing and category
  - 5. Manufacturer contact information including address, telephone number, facsimile number, email address, web site address and contact person or persons.
  - 6. Local Manufacturer's Representative contact information including address, telephone number, facsimile number, email address, web site address and contact person or persons.
- C. Shop Drawings: Show installation details for occupancy and light-level sensors.
  - 1. Lighting plan showing location, orientation, and coverage area of each sensor. This plan shall take into consideration the size and use of each space as well as the specific capabilities of submitted Manufacturer's equipment to provide proper coverage to the areas of control.
  - 2. Interconnection diagrams showing field-installed wiring.
- D. Label List: Submit list of proposed text for all labels prior to manufacturing for review and approval by Owner's Representative.
- E. Warranty: Submit a copy of product warranty that complies with Contract Document requirements. Where these requirements exceed Manufacturer's standard warranty include cost of extended warranty in Contract price.

## SECTION 26 09 23 LIGHTING CONTROL DEVICES

- F. Maintenance Requirements: Submit maintenance requirements manual or guidelines. This document should detail the requirements necessary to comply with the warranty. This is required for the submittal process and is in addition to the O&M requirements.
- G. Samples: Provide sample devices and finishes plus other samples when requested, as part of the Submittal process

### 1.5 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate with System Manufacturer to provide equipment which will most effectively control lighting within designated spaces. Contractor and Equipment Manufacturer are responsible for providing equipment which takes into consideration the size and occupant use of the space, and any other limiting factors in the field to properly control these areas.

### 1.6 QUALITY ASSURANCE

- A. Qualifications
  - 1. Manufacturer shall have been in the business of manufacturing and providing service for lighting control equipment for similar capabilities and size, under the same name and ownership, for a minimum of three years preceding Bid date of the project.
  - 2. All components and assemblies shall be factory pre-tested prior to installation.
  - 3. Factory trained technicians shall be on site for start-up, commissioning and training.
  - 4. Factory trained technicians shall be available for telephone support twenty four (24) hours a day, seven (7) days a week.
- B. Regulatory Requirements
  - 1. Underwriters Laboratories: Provide U.L. listed lighting control equipment.
  - 2. Code of Federal Regulations: 47 CFR - FCC All assemblies are to be in compliance with FCC emissions standards specified in Part 15 for Class A application.

### 1.7 WARRANTY

- A. Manufacturer's Warranty: The Manufacturer shall provide a written warranty agreeing to provide parts to replace any portion of the lighting control system equipment that fails due to material or workmanship for a period of twelve months from warranty commencement.
- B. Warranty Commencement: Warranty shall begin at the point of substantial completion of the system installation, which is defined as the date when commissioning and Owner training has been completed and the Owner obtains beneficial use of the system.
- C. Warranty Replacement Parts: The Manufacturer shall be able to ship replacement parts within 24 hours for any component that that fails due to material or workmanship during the warranty period.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, provide products from one of the following Manufacturers:
  - 1. Douglas
  - 2. Hubbell
  - 3. Intermatic, Inc.
  - 4. Leviton/PCI
  - 5. Lighting Control & Design (LC&D)
  - 6. Lithonia Lighting

## SECTION 26 09 23 LIGHTING CONTROL DEVICES

7. Lutron
8. Paragon Electric Co.
9. Pass & Seymour/ Legrand
10. Square D
11. TORK
12. Watt Stopper (The)

### 2.2 INDOOR OCCUPANCY SENSORS

#### A. General Operation

1. The Occupancy Sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the loads automatically. Sensors shall turn on the load within 2 feet of entrance and shall not initiate "on" outside of entrance.
2. Sensing technologies shall be completely passive in nature, in that the occupancy sensor system shall not emit or interfere with any other electronic device, or human characteristic. Acceptable known technologies are Passive Infrared (PIR), or Micro phonic.
3. Upon detection of human activity by the detector, a Time Delay shall be initiated to maintain the light on for a field adjustable pre-set period.
4. Mounting
  - a. Sensor: Suitable for mounting in any position on a standard outlet box.
  - b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
  - c. Time Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Automatic Photo Sensor: Adjustable from 2 to 200 footcandles to turn lighting off when selected light level is present.
6. Line Voltage Sensors
  - a. Sensor shall be a self-contained dual voltage device capable of directly switching loads upon detection of human activity.
  - b. Sensor must be rated for 800 watts at 120 VAC, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/6 hp motors or rated for 1000 watts at 277 VAC, suitable for fluorescent light fixtures with magnetic or electronic ballasts, or 1/3 hp motors minimum. Sensor shall be capable of parallel wiring for 3-way switching applications.
  - c. Sensor Time Delay shall be factory set for typical applications, and field adjustable from 30 seconds to 20 minutes. Sensor must provide a green LED motion indicator.
7. Low Voltage Sensor
  - a. Sensors must be designed to work in conjunction with remote power packs, relays, or other control systems. Sensors must operate with a Class 2, low voltage wiring strategy. Sensors must be capable of being parallel wired for multi-sensor applications.
  - b. Sensors must accept 12 to 24 volts AC or DC. Sensor must provide a transistor output, returning the voltage input rectified to DC, to control remote power packs, relays, or other control systems. Sensor must have optional single pole, double throw signal relay capable of being wired open on occupancy, or closed on occupancy. Sensor must also provide optional photo sensor output for daylight override. Sensor shall not consume more than 14 milliamps of current.

## SECTION 26 09 23 LIGHTING CONTROL DEVICES

- c. Sensor Time Delay shall be factory set for typical applications, and field adjustable from 30 seconds to 20 minutes. Photo sensor override shall be factory set in the off mode, but be field adjustable. All adjustments shall be concealed once installed. Sensor must provide a green LED motion indicator.
    8. System components shall be selected to provide full coverage of the intended area in the manner intended. This design should use any variety of sensors to accomplish this task, and shall be designed based on field conditions present at the time of installation.
  - B. Switch-Box Occupancy Sensors
    1. General
      - a. Photo sensor override shall be factory set in the off mode, but be field adjustable. All adjustments shall be concealed once installed.
      - b. Sensor must not protrude out from the cover plate more than 0.37 inches, and recess into the switch box more than 1 inch. Sensor must surface mount to single gang switch box, and accept accessory plates for multi-gang installations. Sensor must provide a vertical sliding Off/Auto override switch, (2 switches if 2-pole device).
      - c. Optional 2-Pole units must be available. Additional photo sensor override of either pole shall also be available. Power switching shall be performed with a mechanical relay in parallel with an AC Semiconductor to allow relay contacts to switch under a no load condition.
      - d. Where conditions exceed maximum allowable distances, areas, or other field conditions require additional control in the space, such control will be designed and installed as needed.
    2. Passive Infrared (PIR) Technology
      - a. PIR sensing, incorporating a combination of heat and movement sensing to detect occupancy in the area of coverage.
    3. Passive Dual Technology (PDT)
      - a. Sensing must incorporate PIR with Micro phonics, which utilizes a passive microphone with automatic gain control (AGC) to sense both occupants moving and sounds. The PIR must be used to initiate an ON condition; once ON the PIR or Micro phonics shall keep the load on. After the time delay expires and the load goes off, the Micro phonics shall remain active up to 10 seconds as a back-up grace period.
      - b. PDT sensors shall be provided unless specific site conditions prohibit the use of any devices utilizing Micro phonics which could interfere with equipment in the space.
    4. Small Area Wall Switch Sensors
      - a. Small Area Wall Switch Sensors must be provided for small spaces where the occupant's work area is within 20 feet of sensor and the space is no larger than 300 square feet.
      - b. PIR sensing, incorporating a nominal one half inch focal length Fresnel lens, designed to view at least 9 inches above and 9 inches below the horizontal plane when measured 10 feet from the sensor. The PIR beam pattern must be at least 170 degrees with 20 separate beams evenly spaced.

## SECTION 26 09 23 LIGHTING CONTROL DEVICES

5. Large Area Wall Switch Sensors
    - a. Large Areas Wall Switch Sensors must be provided for large spaces where the occupants work area is up to 40 feet from the sensor and the space is no larger than 900 square feet.
    - b. PIR sensing must incorporate a nominal one inch focal length Fresnel lens design to minimize beam spacing, providing no more than a 20 inch gap when measured at a 40 foot distance. The PIR beam pattern must be at least 170 degrees with 30 separate beams evenly spaced.
- C. Ceiling Occupancy Sensors
1. General
    - a. Sensor shall be circular ceiling mounted device, mounted to either a single gang enclosure, or surface mounted to a round surface raceway pancake box. Sensor shall be capable of either surface or recessed mounting.
    - b. Photo sensor override shall be factory set in the off mode, but be field adjustable. All adjustments shall be concealed once installed.
    - c. 2-Pole units shall be provided. Additional photo sensor override of either pole shall also be available. Power switching shall be performed with a mechanical relay in parallel with an AC Semiconductor to allow relay contacts to switch under a no load condition.
    - d. Where conditions exceed maximum allowable distances, areas, or other field conditions require additional control in the space, such control will be designed and installed as needed.
  2. Passive Infrared (PIR) Technology
    - a. PIR sensing, incorporating a combination of heat and movement sensing to detect occupancy in the area of coverage.
    - b. PIR sensing must utilize a high density Fresnel domed lens, providing a circular view pattern of at least 360 degrees by 56 degrees.
  3. Passive Dual Technology (PDT)
    - a. Sensing must incorporate PIR with Micro phonics, which utilizes a passive microphone with automatic gain control (AGC) to sense both occupants moving and sounds. The PIR must be used to initiate an on condition; once on the PIR or Micro phonics shall keep the load on. After the time delay expires and the load goes off, the Micro phonics shall remain active up to 10 seconds as a back-up grace period.
    - b. PDT sensors shall be provided unless specific site conditions prohibit the use of any devices utilizing Micro phonics which could interfere with equipment in the space.
  4. Small Area Ceiling Sensor
    - a. Small Area Ceiling Sensors must be provided for small spaces where the space is no larger than 500 square feet.
  5. Large Area Ceiling Sensor
    - a. Large Area Ceiling Sensors must be provided for large spaces where the space is no larger than 1200 square feet.
- D. Wall Mount Occupancy Sensors
1. General
    - a. Sensor must be designed for large spaces where the occupants work area is up to 40 feet from the sensor. Sensor must be mounted 8 to 10 feet above the floor, out of occupants reach. Sensor shall be mounted either flat against the wall or in a corner.
    - b. Photo sensor override shall be factory set in the off mode, but be field adjustable. All adjustments shall be concealed once installed.

## SECTION 26 09 23 LIGHTING CONTROL DEVICES

- c. Optional 2-Pole units must be available. Additional photo sensor override of either pole shall also be available. Power switching shall be performed with a mechanical relay in parallel with an AC Semiconductor to allow relay contacts to switch under a no load condition.
- d. PIR sensing must incorporate a nominal one inch focal length Fresnel lens designed to minimize beam spacing, providing no more than a 20 inch gap when measured at a 40 foot distance. The sensor must provide a 117 degree multi-level beam pattern.
- e. Sensors shall not require an electrical connection to neutral so that the device may be directly wired in series with local override switches. Sensors must be capable of parallel wiring for multi-sensor applications.
- f. Where conditions exceed maximum allowable distances, areas, or other field conditions require additional control in the space, such control will be designed and installed as needed.

### E. Hallway Sensors

#### 1. General

- a. Sensor must be mounted 8 to 10 feet above the floor, out of occupants reach.
- b. Photo sensor override shall be factory set in the off mode, but be field adjustable. All adjustments shall be concealed once installed.
- c. Optional 2-Pole units must be available. Additional photo sensor override of either pole shall also be available. Power switching shall be performed with a mechanical relay in parallel with an AC Semiconductor to allow relay contacts to switch under a no load condition.
- d. Sensors shall not require an electrical connection to neutral so that the device may be directly wired in series with local override switches. Sensors must be capable of parallel wiring for multi-sensor applications.
- e. Where conditions exceed maximum allowable distances, areas, or other field conditions require additional control in the space, such control will be designed and installed as needed.

#### 2. Hallway Sensors

- a. Hallway sensors shall use PIR sensing technology in conjunction with a Fresnel lens designed specifically for long range sensing. Sensor shall detect tangential walking motions up to 130 linear feet.

## 2.3 POWER PACKS AND SLAVE PACKS

- A. Power Packs and Slave Packs must be designed to power and accept signals from remote Low Voltage Sensors, or other control devices, and directly switch the line voltage of the desired load controlled.
- B. Power Packs must accept 120 or 277 VAC utilizing a dual tap transformer.
- C. Power Pack and Slave Pack relay switching shall not require more than 3 milliamps of current at 15 to 30 VDC.
- D. Power Pack and Slave Pack relay switching shall be performed with a mechanical relay in parallel with an AC Semiconductor to allow relay contacts to switch under a no load condition. Switching capacity shall be 20 amps of all types of loads: Incandescent, Electronic Ballast, Magnetic, or Motor.
- E. Power Packs shall be available in combination 2-Pole units capable of switching two independent loads, 20 amps each.

## 2.4 PHOTO SENSORS AND DIMMING SENSORS

- A. Photocell and dimming sensors shall control the light level in the space by monitoring both the artificial light as well as available natural light.

## SECTION 26 09 23 LIGHTING CONTROL DEVICES

- B. Photo sensors shall provide an On set point and a separate Off set point, thereby creating a dead band to prevent unnecessary cycling of the artificial lights. Set point setting shall be verified with a digital volt meter connected to test leads provided by the sensor. Sensor shall send an electronic, low voltage signal to a remote power pack or other control device which is directly connected to the load.
- C. Dimming sensors shall interface with a 0 to 10 VDC controllable electronic ballast. Dimming sensor shall connect directly to the ballast with 2 low voltage wires. A third test lead may be provided to allow setup adjustments. With the test lead disconnected, the sensor shall react instantly to changes in the set point adjustment. Once set, the test lead shall be connected to the control wire for normal operation. Photo sensing element shall be a photodiode positioned to view out of the side of the sensor or in an adjustable mounting for more accurate sensing of the space. Photo sensors designed to view straight down on the work space will not be accepted due to varying light absorbing characteristics.

### 2.5 DAYLIGHT ZONE MULTI-LEVEL SWITCHING CONTROL

- A. The lighting fixtures in this room configuration shall be controlled by manual wall switches and automatic controls in response to occupancy and daylight contribution. The wall switches and occupancy sensor together shall control all normal power lighting circuits in the room. The photo sensor shall control 50% of the lamps located in the daylight zone by switching them off in response to available daylight. The light fixtures located in the daylight zone shall be indicated in the Contract Drawings.
- B. Wall switches
  - 1. As specified in Section 26 27 26 - Wiring Devices.
- C. Electronic ballasts
  - 1. As specified in Section 26 51 00 - Interior Lighting, quantity as required to control each lamp of each fixture individually as specified in Section 260650.16 Lighting Fixture Schedule.
- D. Occupancy sensor
  - 1. Occupancy sensor shall be a ceiling-mounted low voltage device, powered by the DC voltage supplied by a remote power pack or other control device which is directly connected to the load.
  - 2. Provide quantity of power pack and slave packs with control relays as required to control all designated circuits in the enclosed area.
- E. Photo sensor
  - 1. Photo sensor shall be a low voltage device, powered by the DC voltage supplied by a remote power pack or other control device which is directly connected to the load.
  - 2. Provide quantity of power pack and slave packs with control relays as required to control all designated circuits in the daylight area.

### 2.6 OUTDOOR PHOTOCELL SWITCHES

- A. Solid state with DPDT dry contacts rated for 1800 VA tungsten or 1000 VA inductive, to operate connected relay, contactor coils, microprocessor input, and complying with UL 773A.
  - 1. Light-Level Monitoring Range: 1.5 to 20 fc, with an adjustment for turn-on and turn-off levels within that range.
  - 2. Time Delay: 15-second minimum, to prevent false operation.
  - 3. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
  - 4. Mounting: Twist lock complying with IEEE C136.10, with base. Provide with stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

## SECTION 26 09 23 LIGHTING CONTROL DEVICES

### 2.7 MULTIPLE CONTACTORS

- A. Description: Electrically operated and electrically held, complying with NEMA ICS 2 and UL 508.
  - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballasts (ballast with 15 percent or less total harmonic distortion of normal load current).
  - 2. Control-Coil Voltage: Match low voltage lighting control power source.
  - 3. Enclosure: Outdoor NEMA 3R.

### 2.8 CONTROL RELAYS

- A. General Purpose Relays: Rated 120/ 240 volt, 10A. Square D Class 8501 Type K plug in series with screw terminal socket.

### 2.9 LOW VOLTAGE CONTROL

- A. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
  - 1. Cabinet: Steel with hinged, locking door.
    - a. Barriers to separate low-voltage and line-voltage components.
    - b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
    - c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
  - 2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
    - a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
    - b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
    - c. Endurance: 50,000 cycles at rated capacity.
    - d. Mounting: Provision for easy removal and installation in relay cabinet.
  - 3. PLC for relay programming.

### 2.10 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Section 26 05 19 - Conductors and Cables.
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 22 AWG, complying with Section 26 05 19 - Copper Conductors and Cables.
- C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 - Copper Conductors and Cables.
- D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 26 05 19 - Copper Conductors and Cables.

## PART 3 EXECUTION

### 3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in Manufacturer's written instructions.

### 3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 26 05 19 - Copper Conductors and Cables.

## SECTION 26.09.23 LIGHTING CONTROL DEVICES

- B. Size conductors according to lighting control device Manufacturer's written instructions, unless otherwise indicated.
- C. Provide time clock input from DDC system to relay control panel.

### 3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26.05.53 - Identification For Electrical Systems.
- B. Label time switches and contactors with a unique designation.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
  - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional Work with specified requirements.

### 3.5 SYSTEM STARTUP AND COMMISSIONING

- A. Commissioning shall take place prior to demonstration of system to Owner. After the system has been installed the Contractor shall provide Manufacturer's recommended commissioning with factory trained and authorized technicians on-site, to:
  - 1. Verify that the Contractor has properly installed and interconnected all necessary components.
  - 2. Verify correct operation of all system components.
  - 3. Verify that all switch and contact inputs are in compliance with Contract requirements.
  - 4. Aim and adjust all occupancy sensors and photocell devices for proper operation.

### 3.6 OWNER'S INSTRUCTIONS AND SYSTEM DEMONSTRATION

- A. System Demonstration
  - 1. Schedule demonstration a minimum of two-weeks prior to system turn over and substantial completion. Schedule with Owner's Representative and Electrical Engineer.
  - 2. Demonstrate complete system operation and Contract compliance to designated Owner's Representative and Engineer to prove system is functional and ready for comprehensive training.
- B. System Instruction
  - 1. The Contractor shall after one week (minimum) written notification to Architect conduct an instruction session during which all maintenance and operational aspects of the system will be described and demonstrated to personnel selected by the Owner. The session shall be conducted by a Contractor's Representative thoroughly familiar with the characteristics of the system. O & M manual information regarding the system shall be turned over to the Architect prior to scheduling the instruction session.
  - 2. Training shall utilize the following Draft Documents:
    - a. Draft O&M Manual
    - b. Contractor's Record Drawings
  - 3. The training effort shall validate the O&M Manual and Record Drawing Documentation.

END OF SECTION



## SECTION 26 11 16 SECONDARY UNIT SUBSTATIONS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION

- A. Provide complete substation assemblies as described in this Section and as shown on Drawings.

#### 1.3 STANDARDS

Each unit substation shall be designed, manufactured, installed and tested in conformance with the following Standards and Publications:

- A. American National Standards Institute (ANSI) :
  - C2 National Electrical Safety Code
  - C12.1 Code for Electricity Metering
  - C37.121 Switchgear - Unit Substations - Requirements
  - C62.11 Metal-Oxide Surge Arresters for Alternating Current Power Circuits
- B. National Electrical Testing Association (NETA):
  - ATS Electrical Power Distribution Equipment and Systems
- C. National Electrical Manufacturers Association (NEMA) :
  - PB2 Deadfront Distribution Switchboards
  - PB2.1 Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600V or less
  - ST 20 Dry Type Transformers for General Applications
- D. National Fire Protection Association (NFPA):
  - 70 National Electrical Code
- E. Underwriters Laboratories, Inc. (UL):
  - 1062 Unit Substations

#### 1.4 COORDINATION

- A. Coordinate layout and installation with other construction elements to ensure adequate headroom, working clearance and access under Provisions of Section 01 31 13.

#### 1.5 SUBMITTALS

- A. Submit under Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results For Electrical.
- B. Manufacturers' Data: Shall be submitted for the following:
  - 1. Meters
  - 2. Fuses
  - 3. Surge arresters
  - 4. Switches
  - 5. Circuit Breakers
- C. Shop Drawings: Submit prior to manufacture. Provide all information required to demonstrate conformance with Contract Documents. Verify space available with equipment sizes and code required working clearances prior to submittal of Shop Drawings. Shall indicate, but shall not be limited to, the following:
  - 1. Overall dimensions, plan, front view, and sectional views.
  - 2. Bus arrangements including sectional dimensions and ampere ratings of all bus bars.
  - 3. Type and spacing of bus supports.
  - 4. Maximum short circuit bracing.
  - 5. Switch type, interrupting rating, trip setting, and layout.

## SECTION 26 11 16 SECONDARY UNIT SUBSTATIONS

6. Ratings and sizes of lugs.
  7. Elementary diagrams and wiring diagrams having their terminals identified, and indicating the internal wiring for each item of equipment and the interconnection between the items.
  8. Layout and function of metering.
  9. Nameplates.
  10. Time-Current curves.
- D. Operating and Maintenance Instructions under the Provisions of Section 01 78 23: Instructions for operating and maintenance shall be furnished for the following equipment:
1. Substation Equipment (meters, etc.)
  2. Switches
  3. Transformer
  4. Infra Red Survey

### PART 2 PRODUCTS

#### 2.1 GENERAL

- A. Provide unit substation(s) complete from the incoming line connection to the outgoing feeder connections. Any items not specifically mentioned but obviously necessary for proper operation are implied in this description.
- B. Each unit substation shall consist of a high voltage incoming line section, a transformer section and a low voltage switchboard section, each separated from the others by steel barriers but electrically connected and physically joined to form a single, metal enclosed structure.
- C. Conform with applicable Seismic requirements per Structured Drawings, General Notes.

#### 2.2 MANUFACTURER

- A. Square D.

#### 2.3 ENCLOSURE

- A. Enclosure shall be freestanding, steel with steel angle or channel framework with adequate strength and rigidity as necessary to resist all conditions of use to which it may be subjected and to support all equipment, devices and appurtenances contained therein; front plates installed in sections so that all parts of the board are front accessible without disturbing other parts. A removable lifting angle shall be provided at the top and bottom of each shipping section and each section shall have jacking pads designed to be flush with the enclosure. The base is to be constructed of structural steel members to permit skidding or rolling in any direction. All ventilating openings shall be in accordance with NEMA and National Electrical Code standards for ventilated enclosures. The enclosure and internal barriers shall be finished with factory applied medium gray paint applied over a rust inhibiting phosphate primer for all interior and exterior painted surfaces. Construction shall prevent entry of rodents into the substation interior.
- B. Indoor enclosure shall be NEMA 1.
- C. Exterior enclosure shall weatherproof (NEMA 3R). Provide thermostatically controlled strip heater to prevent condensation.
- D. Dimensions: Length and depth shall not exceed dimensions as indicated on Drawings. Manufacturers whose equipment dimensions exceed those indicated on the Drawings shall obtain approval from the Architect in writing 10 days prior to Bid date. Cost of building modifications or other additional Work required to fit larger size enclosures than those shown on Drawings shall be at Contractor's expense.

#### 2.4 INCOMING SECTION

- A. The incoming line section shall terminate the incoming medium-voltage feeder. Provide adequate cable bending space.

## SECTION 26 11 16 SECONDARY UNIT SUBSTATIONS

- B. The incoming section shall consist of an air insulated steel enclosure separated from the transformer section by steel barriers and containing:
  - 1. Provide one terminal per phase, consisting of a landing pad and clamp-type terminal supported by and insulated from the section enclosure. Provide pre-molded stress cone cable termination for each medium voltage conductor. Lug size and terminal arrangement shall be compatible with the cable terminations.
  - 2. Provide one distribution class surge arrester per phase, connected between the terminals and the substation ground. Voltage rating per Manufacturer's recommendations.
  - 3. Fused Load Interrupter Switch: Three-pole, single-throw, deadfront, metal-enclosed with manual stored energy operator. Rated for 95-kV BIL, with continuous current rating and short current ratings suitable for application. Provide with current-limiting fuses sized suitable for transformer size and auxiliary contacts to indicate switch position. Shall include inspection window and provisions for pad-locking in open position. Interrupting rating shall be suitable for available fault current. Coordinate fuse rating with switchboard main disconnect.
  - 4. Provide barriers between phases to isolate live bus during fuse replacement.
- C. Conductors or bussing extended to the transformer shall be flexible for vibration isolation, and shall be braced for the available fault current.
- D. Ground bus for landing incoming grounding conductors, surge arresters and stress cones.

### 2.5 TRANSFORMER SECTION

- A. Type: Air-cooled dry type, fully enclosed in a ventilated metal enclosure.
- B. Rating:
  - KVA: Self cooled rating as shown on drawings. Provisions for future fans.
  - Phase: 3
  - Frequency: 60 Hz
  - Temperature Rise: 150 degrees C above 40 degrees ambient.
  - Primary Voltage: 12,470, 3 phase delta.
  - Primary Insulation Class: 15 kV.
  - Primary BIL: 95 kV.
  - Secondary Voltage: 480Y/277V. Grounded wye, 3 phase, 4 wire.
  - Secondary Insulation Class: 1.2 kV
  - Impedance: 5.50% (+/- 0.25%)
  - Sound Level: 66 decibels maximum.
  - Primary Taps: Two 2 1/2% full capacity above and two 2 1/2% full capacity below normal rated primary voltage.
- C. CORE AND COIL ASSEMBLY
  - 1. Provide separate primary and secondary windings. All insulating materials used shall be Class H for a 220 degrees C. insulation system. The temperature rise shall be designated on the transformer nameplate. Coils and core assembly shall be treated and built to resist the effects of dirt and moisture.
  - 2. Copper Bus.
  - 3. Taps shall be alterable, with transformer de-energized, so as to provide the tap ratings shown above. Taps shall be clearly labeled.
  - 4. Provisions shall be made to completely isolate the core and coil from the enclosure. There shall be no metal-to-metal contact. Rubber vibration isolating pads shall be installed by the Manufacturer between the core and coil and the enclosure.
  - 5. Conductors or bussing between the transformer terminals and the low voltage section shall be flexible copper type.

## SECTION 26 11 16 SECONDARY UNIT SUBSTATIONS

### D. TRANSFORMER ACCESSORIES

1. Provide ground pad on low-voltage end of enclosure. Connect to substation ground bus.
2. Provide winding temperature sensor.
3. Transformer shall have stainless steel or corrosion resistant aluminum diagrammatic nameplate.

### 2.6 LOW VOLTAGE SWITCHBOARD SECTION

- A. Deadfront, metal-enclosed, self-supported type conforming fully with Section 26 24 13 - Switchboards. Short circuit rating suitable for full capacity of transformer plus motor contribution. Shall include a main breaker, metering and feeder breakers.
- B. Service entrance rated.
- C. All control wiring shall be stranded copper conductors, type SIS. All incoming control wiring shall terminate at terminal blocks behind hinged doors.
- D. Provide bus connection to transformer. Utilize braided copper jumper straps to meet noise level requirements and to minimize transmission of vibration.

### 2.7 GROUND BUS

- A. Provide a ground bus for the full length of the substation, including the low voltage section.

### 2.8 SUBSTATION ACCESSORIES

- A. Provide "DANGER HIGH VOLTAGE" signs on front of incoming line section and transformer enclosures.
- B. (3) Spare fuses of each size and type used.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Substation and accessories shall be installed and connected as indicated on Contract Drawings, the reviewed Shop Drawings and as specified herein. Layout dimension at Project Site prior to roughin. Verify Code required clearances and overhead raceway access space.
- B. All equipment and enclosures shall be anchored to building structure to prevent overturning in the event of earthquake. Provide a rebar reinforced housekeeping pad per Section 26 05 00 - Common Work Results For Electrical.
- C. Completely vacuum interior of all sections prior to energization.

### 3.2 NAMEPLATES

- A. Provide for each device per Section 26 05 53 - Identification For Electrical Systems.

### 3.3 VOLTAGE TAP CONNECTIONS

- A. Connect all transformers at "normal" tap. After facility is completely energized, measure secondary voltages at all transformers. Submit a list to Architect including service switchboard voltmeter reading at the time of the test for evaluation. Reconnect taps as subsequently directed.

### 3.4 FIELD TESTS AND INSPECTIONS

- A. Provide visual and mechanical inspection to verify that correct equipment has been provided and properly installed. Testing shall be in accordance with Section 01 45 21 - Testing Laboratory Services and Section 26 01 26 - Maintenance Testing for Electrical Systems and NETA ATS requirements. The Contractor shall show by demonstration in service that all equipment and devices are in good operating condition. Tests shall be such that each item of control equipment will function not less than three times. The Contractor shall notify the Electrical Engineer of Record 5 days before the dates and times scheduled for tests and inspections.

SECTION 26 11 16 SECONDARY UNIT SUBSTATIONS

- B. After substation has been in operation for 3 months, and at a time of maximum load, provide an infrared survey of all bussing and connections. Provide load banks as required.

END OF SECTION



## SECTION 26 13 16 MEDIUM VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION

- A. Provide complete and fully operational pad mounted switches, dead-front, air or oil-filled compartmental type designed for underground entrance of conductors. Provide multiple switches with interconnected bussing where indicated.

#### 1.3 STANDARDS

Pad Mounted switches shall be designed, manufactured, installed and tested in conformance with the following Standards and Publications:

- A. American National Standards Institute (ANSI) :
  - C2 National Electrical Safety Code
  - C37.46 Power Fuses and Fuse Disconnecting Switches
  - C57.12.28 Switchgear and Transformers - Enclosure Integrity
- B. National Electrical Manufacturers Association (NEMA):
  - C37.72 Manually-Operated, Dead-Front Padmounted Switchgear
- C. National Electrical Testing Association (NETA):
  - ATS Electrical Power Distribution Equipment and Systems
- D. National Fire Protection Association (NFPA):
  - 70 National Electrical Code

#### 1.4 SUBMITTALS

- A. Product Data: Provide for switch and accessories. Shall indicate unit dimensions, weights and standards conformance.
- B. Shop Drawings: Provide for switch and accessories, including dimensioned front view, plan, section views, wiring diagrams, accessory locations, nameplates, and all other information required to demonstrate conformance with Contract Documents.
- C. Drawing of switch pad with dimensions.
- D. Factory Test Reports: Perform factory-certified design and routine tests according to NEMA C37.72.
- E. O&M Manuals: Per Section 26 05 00 - Common Work Results For Electrical.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURER

- A. Square D.

#### 2.2 SWITCH RATINGS

Voltage:	15 kV
Phase:	3
Frequency:	60 Hz
Impulse Level (BIL):	95 kV
Continuous Current:	200 A minimum
Momentary Current Withstand:	20 kA asym

## SECTION 26 13 16 MEDIUM VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR

### 2.3 SWITCH AND FUSING

- A. Switch (each): Fused load interrupter switch. Switch shall be air or oil type. Switching operation shall be provided by an operating handle or pushbutton (hook-stick operation is not acceptable). Switch shall utilize stored energy to simultaneously open or close all phases.
- B. Fuses: Provide current limiting power fuses, rated for applied voltage, sized as indicated and suitable for circuit where applied.

### 2.4 ENCLOSURE

- A. There shall be no screws, bolts, or other fastening devices which are externally removable. There shall be no openings through which foreign objects such as sticks, rods, or wire might contact live parts. There shall be means for padlocking the compartment doors.
- B. Lifting eyes and jacking pads shall be provided.
- C. Enclosure shall be primed and painted. Paint shall be factory-applied, olive green for all exterior and interior painted surfaces. All surfaces in contact with the concrete pad shall be undercoated to prevent corrosion.

### 2.5 TERMINATIONS

- A. Cable terminations shall be elbow type connectors per Section 26 05 19 - Medium Voltage Cables.

### 2.6 ACCESSORIES

- A. Provide the following accessories:
  - 1. Operating handle.
  - 2. (3) Spare fuses of each size and type used.
  - 3. Warning Signs: Provide self-adhesive warning sign on the outside of each high voltage compartment door. Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. Decal shall be Panduit No. PPSO710D72 or approved equal.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Handling and installation shall be per Manufacturer's recommendations. Coordinate installation with site Work. Verify 6'-0" clearance in front of all access doors prior to excavation.
- B. Provide concrete pad and bolt unit to pad with four galvanized bolts minimum. Provide enclosure extension ring to permit adequate cable pulling space.
  - 1. Mount on concrete pad sized for equipment supplied. Unless otherwise indicated, the pad shall be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh placed uniformly 4 inches from the top of the pad. Pad shall be placed on a 6 inch thick, well-compacted gravel base. The top of the concrete pad shall be approximately 4 inches above the finished grade. Edges above grade shall have 1/2 inch chamfer. The pad shall be of adequate size to Project at least 8 inches beyond the equipment. Provide cutouts for conduit entry. Cut off and bush conduits 3 inches above pad surface. Concrete shall be 3000 psi minimum and shall conform with Division 3 Specifications.
  - 2. Pad shall be installed level (except rain slope) and placed as early as possible to allow for settlement. Where settlement occurs, re-level as required.
- C. Final installation shall consist of a sealed concrete and steel environment with no openings larger than 1/2 square inch susceptible to rodent entry.

SECTION 26 13 16 MEDIUM VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR

3.2 GROUNDING

- A. Per Section 26 05 26 - Grounding. Provide 2 ground rods spaced 6'-0" apart and connect with #3/0 copper ground cable. Connect to enclosure grounding point(s).

3.3 TESTING

- A. Before energizing, test per NETA ATS and per Section 26 01 26 - Maintenance Testing for Electrical Systems requirements.
- B. Visually inspect physical and mechanical condition of unit. Verify tightness of bolted joints, lubricate as required and test for proper operation. Verify that unit is properly grounded.
- C. Perform electrical insulation-resistance test.

END OF SECTION



## SECTION 26 22 00 LOW VOLTAGE TRANSFORMERS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes dry type transformers rated 600 volts and below.
- B. Drawings and General Provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 REFERENCES

Transformers shall be manufactured, tested and installed in accordance with the latest revision of the following Standards and Publications.

- A. American National Standards Institute (ANSI)
  - 1. ANSI C57.12.91 IEEE Standard Test Code for Dry Type Distribution and Power Transformers.
- B. National Electrical Manufacturer's Association (NEMA)
  - 1. NEMA ST-20 Dry-Type Transformers for General Applications
  - 2. NEMA TP-1 Guide for Determining Energy Efficiency for Distribution Transformers
  - 3. NEMA TR-1 Transformers, Regulators and Reactors R2000.
  - 4. NEMA TP-3 Standard for the Labeling of Distribution Transformer Efficiency.
  - 5. NEMA 250 Enclosures for Electrical Equipment 1,000 volts maximum.
- C. Underwriters Laboratories, Inc. (UL)
  - 1. UL 506 Standard for Specialty Transformers (for transformers rated 10 kVA and below)
  - 2. UL 1561 Standard for Dry Type General Purpose and Power Transformers (for transformers rated 10 to 1500 kVA)
- D. American Association of State Highway and Transportation Officials (AASHTO)

#### 1.3 SUBMITTALS

- A. Submit under Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results For Electrical, and additional requirements described in this Specification Section.
- B. Demonstrate conformance with Specification requirements. Provide typical load losses for each transformer size at 50%, 75% and 100% of full load rating.
- C. Include dimensioned front plan and section views, wiring and connection diagrams and bolting template. Submit information indicating minimum clearance requirements around transformer, and anchor bolt patterns. Indicate mounting methods and demonstrate loading compatibility with mounting surface.
- D. Submit lug schedule showing proposed lugs for each transformer.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to Manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURER

- A. Square D.

#### 2.2 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20 and list and label as complying with UL 1561.
- B. Provide transformers that are internally braced to withstand seismic forces specified in Section 26 05 29 - Hangers And Supports For Electrical Systems.

## SECTION 26 22 00 LOW VOLTAGE TRANSFORMERS

### 2.3 ENCLOSURE

- A. Steel panel enclosure over core, coil and terminal chamber with louvered openings for convection cooling. Cooling and terminal access shall be possible with both sides and rear of enclosure obstructed. Minimum 14 gage steel with appropriate reinforcement and lifting lugs
- B. Indoor: Ventilated, NEMA 250, Type 2.
- C. Finish: Comply with NEMA 250 for "Indoor Corrosion Protection" Manufacturer's standard gray finish.

### 2.4 WINDINGS

- A. Separate primary and secondary. Windings shall have Class H insulation and shall be rated for continuous operation at rated kVA with temperature rise of not over 150 degrees C above a 40 degree C ambient, with a maximum hot spot temperature of 220 degrees C.
- B. Core and coil mounted on rubber isolation mounting pads. Windings and core and coil assembly shall be treated and built to resist the effects of dirt and moisture.
- C. Unless noted otherwise three phase transformers shall have a 480 volt delta connected primary and 208Y/120 volt, three phase, four wire secondary. Single phase transformers shall be 480 volt, single phase, primary, 120/240 volt, single phase, three wire secondary.
- D. Windings shall be copper.
- E. Grounded electrostatic shield to reduce capacitive coupling where noted on the Drawings. Include primary surge suppression and secondary filters similar to Square D Class 7450-FIL. Common mode noise attenuation: -65db, 1.5 to 100kHz.
- F. Encapsulate windings with resin compound to seal out moisture and air for transformers indicated on the Drawings.

### 2.5 PRIMARY TAPS

- A. Transformers rated 15 KVA and larger shall have full capacity taps, minimum of two 2-1/2 percent above and four 2-1/2 percent below normal (rated) primary voltage.

### 2.6 RATINGS

- A. Continuous capacity rating not less than size noted.
- B. Efficiency
  - 1. Transformers shall comply with Class 1 efficiencies as set forth in NEMA TP-1, when tested in accordance with NEMA TP-2. Provide Energy Star label in accordance with NEMA TP-3.

### 2.7 CONNECTIONS

- A. Provisions for external connections shall be made by means of a terminal board employing lugs conforming to Section 260519 - Conductors and Cables which are compatible with the external conductors installed. All connections shall be accessible from front of cabinet.

### 2.8 NOISE LEVEL

- A. Manufacturer shall test for noise level compliance in accordance with ANSI C57.12.91, IEEE Standard Test Code for Dry Type Distribution and Power Transformers.
- B. Noise level shall not exceed 45 db for sizes less than 51 kVA, 50 db for 51-150 kVA, 55 db for 151-300 kVA and 60 db for sizes greater than 300 kVA.
- C. Quiet type reduced noise level transformers shall have noise levels not exceeding 42db for sizes less than 51 kVA, 47 db for 51-150 kVA and 52 db for 151 to 300 kVA and 57db for greater than 300 kVA.

## SECTION 26 22 00 LOW VOLTAGE TRANSFORMERS

- D. Ultra quiet type transformers shall have a noise level shall not exceeding 35 db for all sizes through 300 kVA. Shall be similar to Tierney Quietran, specially constructed low-noise models. All ultra-quiet transformers shall be individually factory certified to have noise levels not exceeding 35 db. Forward certification to Engineer and include copy in the O&M Manual.

### 2.9 CONTROL AND SIGNAL TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty, complying with NEMA ST 1, and listed and labeled as complying with UL 506.
- B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

### 2.10 VIBRATION ISOLATORS

- A. Approved Manufacturers: Mason Industries, Inc., Cal-Dyn, or Korfund. Mason Industries design series numbers used as references.
- B. Isolators shall be sized to safely accommodate weight of transformer.
- C. Pads
  1. Vibration isolation shall exceed 95%.
  2. Pads shall be constructed of Bridge Bearing neoprene rubber as defined by AASHTO.
  3. When mounted on concrete, type SW pad, with standard dimensions used to match or exceed the footprint of the transformer base rail. Alternatively, and for other non-suspended applications, provide type SWM pad with steel plate to disperse weight and rubber grommet to isolate plate from mounting bolt.
- D. Combination Isolators
  1. Combination construction of rubber and spring. Vibration isolation shall exceed 98%. Furnish vibration isolation calculations with Submittal.
  2. Bridge Bearing neoprene rubber as defined by AASHTO.
  3. Ceiling suspension: Type DNHS spring and double deflection neoprene hangers. Cable for sway bracing shall be stainless steel with tensile strength exceeding transformer weight by 1000%.
  4. Pad or wall mounting: Type SSLFH single spring steel mount suitable for seismic and restrained service.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Comply with Manufacturer's requirements for storage, handling, and installation. Include copy of Manufacturer's recommendation in Operations and Maintenance Manual.
- B. Remove all shipping blocks prior to installation.

### 3.2 MOUNTING

- A. General
  1. Attach to the building structure to prevent overturning in the event of earthquake. All attachment nuts to have split and flat washer.
  2. Mount on floor, wall or suspended from ceiling as indicated or as needed to coordinate with adjacent equipment. Set transformers level and plumb within 1/2 degree.
  3. Compress pad or combination isolators to optimize vibration isolation at 60 Hz.
- B. Floor mounting
  1. Refer to Section 260500 - Common Work Results For Electrical for housekeeping pad requirements.
  2. Secure floor mounted types to floor via rubber pad isolators.
  3. Mount transformer on combination isolator.

## SECTION 26 22 00 LOW VOLTAGE TRANSFORMERS

### 3.3 CONNECTIONS

- A. Provide raceway rough-in to allow for cable pulling and minimum cable bending requirements.
- B. 208/120 volt three phase and 120/240 volt single phase secondary transformers shall be considered "grounded neutral separately derived systems" and neutral shall be grounded per Code.
- C. Transformer raceway connections shall be flexible metal conduit as specified in Section 260533 - Raceways and Boxes For Electrical Systems.
- D. Voltage Tap Connections: Connect all transformers at "normal" tap. After facility is completely energized, measure secondary voltages and phase current at all transformers and service switchboard. Forward a list to Engineer and Architect for evaluation. Include copy in O&M Manual. Reconnect taps as subsequently directed. All costs associated with this Work to be included in base Bid.

### 3.4 IDENTIFICATION

- A. Provide permanently attached engraved nameplates per Section 26 05 53 - Identification For Electrical Systems for each transformer.

END OF SECTION

## SECTION 26 24 13 SWITCHBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes service and distribution switchboards rated 600 V and less.

#### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RMS: Root mean square.
- D. SPDT: Single pole, double throw.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switchboard and related equipment. Submit under Provisions of Section 01 33 00 and Section 26 05 00.
  - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Enclosure types and details for types other than NEMA 250, Type 1.
    - b. Bus configuration, current, and voltage ratings.
    - c. Short-circuit current rating of switchboards and overcurrent protective devices.
    - d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
    - e. Utility company's metering provisions with indication of approval by utility company.
    - f. Mimic-bus diagram.
    - g. UL listing for series rating of installed devices.
    - h. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: Representative portion of mimic bus with specified finish, for color selection.
- D. Manufacturer Seismic Qualification Certification: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 25 29 Electrical Supports and Seismic Restraints. Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## SECTION 26 24 13 SWITCHBOARDS

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 26 05 00 Common Work Results for Electrical, include the following:
1. Routine maintenance requirements for switchboards and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  3. Time-current curves, including selectable ranges for each type of overcurrent protective device.
- 1.5 QUALITY ASSURANCE
- A. Source Limitations: Obtain switchboards through one source from a single manufacturer.
  - B. Product Selection for Restricted Space: Maximum 92 inches (not including base channels). Length and depth: Not exceeding dimensions as scaled or noted in contract documents. Equipment exceeding dimensions not allowed. Base Bid on equipment complying with Contract Documents.
  - C. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver in sections or lengths that can be moved past obstructions in delivery path.
  - B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
  - C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.
  - D. Handle switchboards according to NEMA PB 2.1 and NECA 400.
- 1.7 PROJECT CONDITIONS
- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
  - B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
    1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
    2. Altitude: Not exceeding 6600 feet (2000 m).
- 1.8 COORDINATION
- A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels. Coordinate Work so piping, ducts, etc. are routed around dedicated spaces above and in front of switchboards per Code.
  - B. Coordinate size and location of concrete bases per Section 26 05 00 Common Work Results for Electrical.

## PART 2 PRODUCTS

### 2.1 MANUFACTURER

- A. Square D

## SECTION 26 24 13 SWITCHBOARDS

### 2.2 SWITCHBOARD STRUCTURE

- A. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.
- B. Front- and Side-Accessible Switchboard: Fixed, individually mounted main device; panel-mounted branches; and sections rear aligned.
- C. Front- and Rear-Accessible Switchboard: Front and rear aligned, with features as follows:
  - 1. Main Devices: Fixed, individually mounted.
  - 2. Branch Devices: Fixed, individually mounted.
- D. Enclosure: Steel, NEMA 250, Type 1.
- E. Enclosure Finish
  - 1. Indoor Units: Factory-applied finish in Manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- F. Barriers: Provide barriers between adjacent switchboard sections.
- G. Space for future fused switches or breakers noted including complete bussing and required hardware for mounting devices. Space for conductor current limiters when noted.
- H. Cleats for securing conductors. Miscellaneous appurtenances as required for complete installation.
- I. When serving as a Service Switchboard:
  - 1. UL 869 and Service Entrance UL labels.
  - 2. Surge suppression per Section 26 43 13 Transient-Voltage Suppression for Low Voltage Electrical Power Circuits.
  - 3. Surge Arrestors: Peak current rating per phase 240 kA, with L-N, L-L, L-G, and N-G protection modes.
  - 4. Utility Metering Compartment: Fabricated compartment for current transformer space, meter base(s), metering conductors and miscellaneous appurtenances required by serving utility. Complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.
- J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- K. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- M. Pull Box on Top of Switchboard:
  - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
  - 2. Set back from front to clear circuit-breaker removal mechanism.
  - 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
  - 4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
  - 5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

### 2.3 SWITCHBOARD BUSBARS

- A. Three phase, four wire, unless otherwise indicated. Brace switchboard components for symmetrical fault current shown plus asymmetrical offset (50,000 amp symmetrical bracing minimum).

## SECTION 26 24 13 SWITCHBOARDS

- B. At the Manufacturers option, provide one of the following:
  - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
- C. Circuit Breaker Connections
  - 1. Use copper for feeder circuit-breaker line connections.
- D. Contact Surfaces: Silver plated
- E. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.
- F. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extension from one end.
- G. Vertical Section Bus: Match main phase bus. For drawout or individually mounted circuit breakers, match the ampacity of the sum of the circuit breaker frame sizes.
- H. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- I. Ground Bus: Full length ground bus bonded to frame conforming with U.L. 891 for minimum size except larger as required by Code for grounding neutral conductor. Hard drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
- J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

### 2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following discrete (field-adjustable) settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time delay adjustments.
    - d. Ground-fault pickup level, time delay, and I2t response.
  - 4. Electronic trip-units shall provide local trip indication, i.e. overload, short circuit or ground fault.
  - 5. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  - 6. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
  - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

## SECTION 26 24 13 SWITCHBOARDS

2. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  3. Communication Capability: Din-rail-mounted communication module with functions and features compatible with power monitoring and control system.
  4. Shunt Trip: 120 VAC trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
  5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- C. Solid-State Electronic Trip Circuit Breaker: Solid-state, overcurrent trip-device system consisting of one of two current transformers or sensors per phase, a release mechanism, and the following features:
1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
  2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg. C.
  3. Field adjustable, time-current characteristics.
  4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
  5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
  6. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip functions for switchable  $I^2t$  operation.
  7. Pickup Points: Five minimum, for instantaneous-trip functions.
  8. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
    - a. Three-wire circuit or system.
    - b. Four-wire circuit or system.
    - c. Four-wire, double-ended substation.Tripp Indication: Labeled, batter-powered lights or mechanical targets on trip device to indicate type of fault.
- D. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
  2. Two-step, stored-energy closing.
  3. Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments with  $I^2t$  response.
    - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
  4. Remote trip indication and control.
  5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified.
  6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  7. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  8. Control Voltage: 40-V, dc.

## SECTION 26 24 13 SWITCHBOARDS

- E. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
1. Manufacturers:
    - a. Boltswitch, Inc.
    - b. Cutler-Hammer Products; Eaton Corporation.
    - c. Pingle Electrical Mfg. Co.
    - d. Siemens Energy & Automation, Inc.
    - e. Square D.
- F. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.
1. Manufacturers:
    - a. General Electric Co.
  2. Main Contact Interrupting Capability: 12 times the switch current rating, minimum.
  3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for closing and opening.
    - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
  4. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
  5. Service-Rated Switches: Labeled for use as service equipment.
  6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
    - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
    - c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    - d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
- G. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
- H. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

### 2.5 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
  2. Current Transformers: Ratios shall be as indicated with revenue metering accuracy class and burden suitable for connected relays, meters, and instruments.
  3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

## SECTION 26 24 13 SWITCHBOARDS

4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 1 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - d. Megawatts: Plus or minus 2 percent.
    - e. Megavars: Plus or minus 2 percent.
    - f. Power Factor: Plus or minus 2 percent.
    - g. Frequency: Plus or minus 0.5 percent.
    - h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes. Accumulated values unaffected by power outages up to 72 hours.
    - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
    - j. Maximum ampere demand per phase.
    - k. Capable of MOD-BUS RTU communication.
  2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

### 2.6 CONTROL POWER

- A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.
- B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
- C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

### 2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- C. Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.
- D. Furnish overhead circuit-breaker lifting device, mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

## SECTION 26 24 13 SWITCHBOARDS

### 2.8 IDENTIFICATION

- A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.
- B. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

### 2.9 NAMEPLATES

- A. Provide permanently attached engraved nameplates per Section 26 05 53 - Identification For Electrical Systems for each switchboard, every instrument, and protective device and disconnect device. For each switchboard include name (3/8" letters), voltage, phase and U.L. short circuit rating (1/4" letters). For each protective device and disconnect include load (1/4" letters) and area served (1/8" letters) and fuse size and type when fused (1/8" letters).
- B. Provide one job nameplate with the following information:
  - 1. Project Name (3/8" lettering, all other 1/4")
  - 2. Architect
  - 3. Electrical Consultant (Sparling)
  - 4. Electrical Contractor
  - 5. Year of Manufacture
- C. Nameplate color shall be: Normal System - white on black; Emergency System - white on red.
- D. Provide engraved nameplate (3/8" lettering) at service entrance equipment indicating type and location of on-site emergency power sources (e.g., Emergency Power: Diesel Generator, Location: Ground Floor, Room 14).

## PART 3 EXECUTION

### 3.1 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

### 3.2 EXAMINATION

- A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.
- B. Install and anchor switchboards level on concrete bases as specified in Section 26 05 00-Common Work Results for Electrical. Bolt to floor using 1/2" diameter drilled in concrete anchors with 4 1/2" minimum inbedment in structural floor slab.
- C. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- D. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges in accordance with Coordination Study.

## SECTION 26 24 13 SWITCHBOARDS

### 3.4 WIRING

- A. Conform with applicable Specification Sections. Conductors and terminations shall conform with Section 26 05 19 - Copper Conductors and Cables. Secure all conductors to switchboard structure.

### 3.5 GROUNDING

- A. Provide per Section 26 05 26 - Grounding.

### 3.6 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 - Identification for Electrical Systems.
- B. Switchboard Nameplates: Label each switchboard component with engraved laminated-plastic nameplate mounted with corrosion-resistant screws.

END OF SECTION



## SECTION 26 24 16 PANELBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION

- A. Dead front type, conforming with U.L. 67 and NEMA PB 1.1.

#### 1.3 SUBMITTALS

- A. Submit shop drawings for review prior to manufacture. Include complete description, front view, dimensions, device sizes and layout, and ground bus(s).
- B. Dimensions: Not exceeding dimensions noted or shown.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURER

- A. Square D, General Electric, Cutler Hammer, Siemens..

#### 2.2 PANELBOARD TYPE

- A. Rated at proper voltage and current, bus bars of copper or aluminum, 3 phase, 4 wire, 100 percent neutral, unless noted otherwise. Multiple lugs where conductors in parallel or "feed through" or double lugs are shown.
- B. Bolted busbar to busbar connections. Conductor connectors to conform with Section 26 05 19 - Copper Conductors and Cables, bolted to busbars using Grade 5 bolts, belleville and flat washers.
- C. Separate ground bus bonded to panelboard cabinet.

#### 2.3 CIRCUIT BREAKERS AND FUSED SWITCHES

- A. U.L. interrupting rating labeled. Ratings as noted on Drawings.
- B. Circuit breakers: Conform with UL 489, labeled for 75°C conductors. Mount per panel schedules. Pre-threaded, bolt on type. Common trip on multiple pole breakers. Labeled 'SWD' when utilized for switching loads.
- C. Spares and spaces: Complete for future circuits. Where "Space" is indicated, provide space, bussing, device mounting hardware and steel knockouts in dead front.
- D. Where SW is indicated on the drawings, provide main circuit breaker without thermal tripping mechanism. Main circuit breaker is to act like a main disconnect switch without thermal overload protection.

#### 2.4 CABINET AND FRONTS

- A. Flush or surface, as noted. Tight closing doors without play, when latched. Where two cabinets are located adjacent to each other in finished areas, provide matching trim, same height. Where remote controlled switch or contactor is mounted in panelboard, mount on same frame as panelboard interior, with dedicated access door and key lock
- B. Fronts: Lifting rest. Door-in-door, hinged at right side in addition to hinged door with flush key lock over dead front. Key identically. Match existing key system where applicable.
- C. Finish: Factory prime coat for cabinets located in finished areas. When located in unfinished areas, factory standard lacquer or enamel finish, gray or blue-gray color, over prime coat.

## SECTION 26 24 16 PANELBOARDS

### 2.5 NAMEPLATES

- A. Engraved nameplates per Section 260553 - Identification for Electrical Systems permanently attached to panelboard front. Include panel name with 1/4" letters, area served, voltage, phase and wire (e.g., 2N1, 208Y/120, 3 phase, 4 wire, 480Y/277, 3 phase, 4 wire) in 1/8 inch characters. When project has more than one switchboard include switchboard fed from (e.g., Fed from SWBD. 4BP).
- B. Nameplate color: Normal system - white letters on black. Emergency system - white letters on red.

### 2.6 SYSTEM OF NUMBERING AND BUS ARRANGEMENT

- A. As noted on Panel Schedules.
- B. Panelboards rated for 400 or 600 amps shall accept 225 amp frame circuit breakers.

## PART 3 EXECUTION

### 3.1 MOUNTING

- A. Firmly anchor cabinets directly or with concealed bracing to building structure, level, 6'-6" above finished floor unless otherwise required. When not located directly on wall, provide support frame of formed steel channel anchored to floor and ceiling structure. Install interiors after structure is enclosed.

### 3.2 WIRING

- A. Conform to applicable sections of these specifications and NEMA PB 1.1. Conductors and terminations per Section 26 05 19 - Copper Conductors and Cables. Coverplates in open knockouts.

### 3.3 CIRCUIT INDEX AND LABELS

- A. Typed circuit index with odd circuits on left, even circuits on right, listing each circuit by number with complete load designation, (i.e. Receptacle room \_\_\_\_, lights room \_\_\_\_, etc.). Room names/numbers per actual room identification assigned by Owner at Project completion (assigned room numbers may differ from Drawings). Mount inside door with transparent protective cover. Provide number labels on circuit breakers to match index.

### 3.4 WORK CLEARANCE

- A. Verify space available with equipment sizes and Code required working clearances prior to submitting Shop Drawings.

### 3.5 GROUNDING

- A. Provide per Section 26 05 26 - Grounding and Bonding for Electrical Systems.

### 3.6 FEED THROUGH AND DOUBLE LUGS

- A. Provide feeder with amperage equal to incoming feeder to panels and sections fed via feed through or double lugs.

### 3.7 DEDICATED SPACE

- A. Locate in dedicated spaces. Coordinate Project construction so piping, ducts, etc. are routed around dedicated spaces above and in front of panelboards per Code.

END OF SECTION

SECTION 26 24 12 - PANEL SCHEDULES

Sparting, Inc.		277/480V		3Ø 4W		400A Main lugs only		Dist Pnl	
Name: IHDP3EA						Surface Mounted		Type: Distribution Panel	
Location: Chiller Room 1092						Single Lugs		14,000 AIC	
Serves: Equipment								Deep	
#	Description	Load	Overcurrent device		Remarks				
			Size	* Type					
1	Spare	0.00 KVA	15A/3P	CB	2HP				
2	Motors ACU-1A	2.80 KVA	15A/3P	CB	2HP				
3	Mech ACU-1B	28.00 KVA	50A/3P	CB	28KW				
4	Motors ACU-2A	0.90 KVA	15A/3P	CB	1/2HP				
5	Mech ACU-2B	10.80 KVA	20A/3P	CB	10.8KW				
6	Mech ACU-3B	10.80 KVA	20A/3P	CB	10.8KW				
7	Motors AHU-11	9.14 KVA	20A/3P	CB	7.5HP				
8	Motors AHU-12	6.32 KVA	20A/3P	CB	5HP				
9	Panel 1L3EA Sect. 1	30.54 KVA	80A/3P	CB					
10	Motors ACU-3A, IS Rm. 2136	0.90 KVA	15A/3P	CB	1/2HP				
11	Motors ACU-4A, IS Rm. 3136	0.90 KVA	15A/3P	CB	1/2HP				
12	Space 50A/3P Frame Space	0.00 KVA	0A/3P						
13	Space 50A/3P Frame Space	0.00 KVA	0A/3P						
14	Space 50A/3P Frame Space	0.00 KVA	0A/3P						
15	Mech P-18	6.32 KVA	20A/1P	CB	5HP				
16	Mech P-19	6.32 KVA	20A/1P	CB	5HP				

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Equip	17.70	x 100%	17.70	21	x 100%	21
Lighting	0.50	x 100%	0.50	1	x 125%	1
Mech	62.24	x 100%	62.24	75	125% of Largest	83
Misc	10.00	x 100%	10.00	12	x 100%	12
Motors	20.96	x 100%	20.96	25	125% of Largest	28
Recept	2.34	10 KVA @ 100%, rest @ 50%	2.34	3	x 100%	3
	113.74	137 Amps	113.74	137		148

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare ED\_CCE.PNL

Notes: Internal TVSS

\* Circuit Breaker Code  
 S = Shunt Trip  
 M = Motor Ckt Prot.  
 F = Fused Switch  
 # = see note

CB = Circuit Breaker  
 G = GFCI  
 H = HID Rated  
 C = HACR Rated

SECTION 26 24 12 - PANEL SCHEDULES

Spartling, Inc.		277/480V		3Ø 4W		400A Main lugs only Surface Mounted Single Lugs		Dist Pnl Type: Distribution Panel 14,000 AIC Deep	
Name: 1HDP3EB									
Location: Mechanical Room 1091									
Serves: Equipment									
#	Description	Load	Overcurrent device Size	* Type	Remarks				
1	Panel ELEVATOR #22	79.50 KVA	150A/3P	CB	75HP				
2	Motors GEF-1	17.50 KVA	40A/3P	CB	15 HP				
3	Motors P-1	17.50 KVA	40A/3P	CB	15HP				
4	Motors P-2	17.50 KVA	40A/3P	CB	15HP				
5	Motors P-3	17.50 KVA	40A/3P	CB	15HP				
6	Mech HVU-2	1.80 KVA	15A/3P	CB	1HP				
7	Motors BWP-1	27.50 KVA	50A/3P	CB	(3) 10HP				
8	Motors CP-1	1.80 KVA	15A/3P	CB	(2) 1/2HP				
9	Motors CP-2	2.70 KVA	15A/3P	CB	(2) 3/4HP				
10	Motors P-14	1.00 KVA	15A/3P	CB	1/2HP				
11	Motors P-15	1.00 KVA	15A/3P	CB	1/2HP				
12	Motors Sump Pump P1A/B	12.60 KVA	20A/3P	CB	(2) 5HP				
13	Motors Sump Pump P2A/B	3.49 KVA	15A/3P	CB	(2) 1HP				
14	Space 50A/3P Frame Space	0.00 KVA	0A/3P						
15	Space 50A/3P Frame Space	0.00 KVA	0A/3P						
16	Space 50A/3P Frame Space	0.00 KVA	0A/3P						

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare ED\_CCE.PNL  
 Notes: Internal TVSS

\* Circuit Breaker Code  
 CB = Circuit Breaker  
 G = GFCI  
 H = HID Rated  
 C = HACR Rated  
 S = Shunt Trip  
 M = Motor Ckt Prot.  
 F = Fused Switch  
 # = see note

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Elevator	79.50	Up to 72% per 620-14	79.50	96	x 100%	96
Mech	1.80	x 100%	1.80	2	125% of Largest	3
Motors	120.09	x 100%	120.09	144	125% of Largest	153
	201.39	242 Amps	201.39	242		251

SECTION 26 24 12 - PANEL SCHEDULES

Spartling, Inc.		277/480V		3Ø 4W		1,600A Main lugs only		Dist Pnl	
Name: IHDPA						Surface Mounted		Type: Distribution Panel	
Location: Chiller Room 1092						Single Lugs		65,000 AIC	
Serves: Equipment								Deep	
#	Description	Load	Overcurrent device		Remarks				
			Size	* Type					
1	Mech Chiller-1	195.60 KVA	400A/3P	C	176KW @ 0.9PF = 195.6				
2	Mech Chiller-2	195.60 KVA	400A/3P	C	176KW @ 0.9PF = 195.6				
3	Mech Chiller-3	195.60 KVA	400A/3P	C	176KW @ 0.9PF = 195.6				
4	Spare Chiller-4 Future	0.00 KVA	400A/3P	C	Future				
5	Motors P-4	17.45 KVA	40A/3P	CB	15 HP				
6	Motors P-5	17.45 KVA	40A/3P	CB	15 HP				
7	Motors P-6	17.45 KVA	40A/3P	CB	15 HP				
8	Spare P-7 Future	0.00 KVA	40A/3P	CB	Future				
9	Motors P-8	28.25 KVA	60A/3P	CB	25 HP				
10	Motors P-9	28.25 KVA	60A/3P	CB	25 HP				
11	Motors P-10	28.25 KVA	60A/3P	CB	25 HP				
12	Spare P-11 Future	0.00 KVA	60A/3P	CB	Future				
13	Motors SF-1	6.30 KVA	15A/3P	CB	5HP				
14	Space 400A/3P Frame Space	0.00 KVA	0A/3P						
15	Space 400A/3P Frame Space	0.00 KVA	0A/3P						
16	Space 400A/3P Frame Space	0.00 KVA	0A/3P						

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare ED\_CCE.PNL

\* Circuit Breaker Code  
 CB = Circuit Breaker  
 G = GFCI  
 H= HIID Rated  
 C = HACR Rated  
 S = Shunt Trip  
 M = Motor Ckt Prot.  
 F = Fused Switch  
 # = see note

Notes:	Internal TVSS								
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps			
Mech	586.80	x 100%	586.80	706	125% of Largest	765			
Motors	143.40	x 100%	143.40	172	125% of Largest	181			
	730.20		730.20	878		946			

SECTION 26 24 12 - PANEL SCHEDULES

Sparling, Inc. Name: 1HDPB Location: Mechanical Room 1091 Serves: Equipment		277 / 480V		3 Ø	4W	800A Main lugs only Surface Mounted Single Lugs	Type: Distribution Panel 65,000 AIC Deep
#	Description	Load	Overcurrent device		Remarks		
			Size	* Type			
1	Spare	0.00 KVA	50A/3P	CB			
2	Panel ELEVATOR #21	79.50 KVA	200A/3P	CB			
3	Space 400A/3P Frame Space	0.00 KVA	0A/3P				
4	Space 400A/3P Frame Space	0.00 KVA	0A/3P				
5	Space 400A/3P Frame Space	0.00 KVA	0A/3P				
6	Space 400A/3P Frame Space	0.00 KVA	0A/3P				
7	Space 400A/3P Frame Space	0.00 KVA	0A/3P				
Rev: Revised circuits marked † Existing circuits marked ‡ Project #: B13608 File: N:\B13608\shed\B13608 multicare ED_CCE.PNL						* Circuit Breaker Code CB = Circuit Breaker G = GFCI H = HID Rated C = HACR Rated S = Shunt Trip M = Motor Ckt Prot. F = Fused Switch # = see note	
Notes: Internal TVSS							
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps	
Elevator	79.50	Up to 72%, per 620-14	79.50	96	x 100%	96	
	79.50	96 Amps	79.50	96		96	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		1H1E		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 25,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting West Corridors	1.77	20/1 CB	•			20/1 CB	0.06	Lighting Exit Signs	2			
3	Lighting West Exit Signs	0.10	20/1 CB	•			20/1 CB	3.22	Lighting Parking, mech, elev lobbies	4			
5	Lighting East Corridors	1.28	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Lighting East Exit Signs	0.10	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\shed\B13608 multicare ED\_CCE.PNL

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

Notes:	Internal TVSS	Demand KVA	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	6.52	6.52	6.52	8	x 125%	10
	6.52	6.52	6.52	8		10

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		1H2EB		277 / 480V		3Ø		4W		225A Main CB		Panel	
Name:		Electrical Transformer Room 1083		Surface Mounted		Single Lugs		Single Lugs		Surface Mounted		Type: Panelboard	
Location:		Critical		277 / 480V		3Ø		4W		225A Main CB		25,000 AIC	
Serves:		Critical		277 / 480V		3Ø		4W		225A Main CB		25,000 AIC	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting Elec Rooms 1093 and 1094	1.86	20/1 CB	•			20/1 CB	2.82	Lighting Patient Rooms, Nurse Station	2			
3	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	4			
5	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev:		* Circuit Breaker Code											
Revised circuits marked † Existing circuits marked ‡		G = GFCI											
Project #: B13608		H = HID Rated											
File: N:\B13608\sched\B13608 multicare		S = Shunt Trip											
ED_CCE.PNL		D = Switching Duty											
		A = AFCI											
Notes:		Internal TVSS											
Load Type		Conn KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Lighting		4.68		x 100%		4.68		6		x 125%		7	
		4.68		6 Amps		4.68		6				7	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep	
Name: 1HA		Location: Electrical Transformer Room 1083		Normal							
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Lighting elec rooms, mech rooms, elev lobby	2.90	20/1 CB	•			20/1 CB	2.68	Lighting West Corridors	2	
3	Lighting parking elev lobby, storage	3.04	20/1 CB	•			20/1 CB	0.65	Lighting West Corridors	4	
5	Spare	0.00	20/1 CB				20/1 CB	2.04	Lighting RMS 1011,1086,1088,1089,1017,1016	6	
7	Lighting L-Wing Corridor	2.38	20/1 CB	•			20/1 CB	2.99	Lighting RT rm 1028, Offices	8	
9	Lighting L-Wing Core	2.31	20/1 CB	•			20/1 CB	2.87	Lighting Exam Rooms and Support Areas	10	
11	Spare	0.00	20/1 CB				20/1 CB	2.00	Lighting Conf. Rm. 1037, Support Areas	12	
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			80/3 CB	6.56	Panel 1LA	38	
39	Spare	0.00	20/1 CB	•			-----1LA	5.57	-----1LA	40	
41	Spare	0.00	20/1 CB	•			-----1LA	5.11	-----1LA	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated D = Switching Duty # = see note A = AFCI		
Project #: B13608		17.51		14.43	9.15						
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		Demand Amps		Demand Amps		Demand Amps		NEC Feeder Factors	
Notes: Internal TVSS		27.21		33		33		33		NEC Feed Amps	
Lighting	27.21	x 100%		8		8		8		x 125%	
Receipt Equip	6.66	10 KVA @ 100%, rest @ 50%		7		7		7		x 100%	
Misc	1.00	x 100%		1		1		1		x 100%	
41.08 49 Amps		41.08		49		49		49		58	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		1HB		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	CB	CB *	CB	Load	Description	#
1	Spare	0.00	20/1	CB	•		20/3	CB			2.11	Motors Water Feature Pump 1006	2
3	Spare	0.00	20/1	CB	•						2.11	Water Feature Pump 1006	4
5	Spare	0.00	20/1	CB	•						2.11	Water Feature Pump 1006	6
7	Spare	0.00	20/1	CB	•		20/3	CB			2.11	Motors Water Feature Pump 1006	8
9	Spare	0.00	20/1	CB	•						2.11	Water Feature Pump 1006	10
11	Spare	0.00	20/1	CB	•						2.11	Water Feature Pump 1006	12
13	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	14
15	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	16
17	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	18
19	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	20
21	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	22
23	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	24
25	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	26
27	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	28
29	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	30
31	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	32
33	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	34
35	Spare	0.00	20/1	CB	•		20/1	CB			0.00	Spare	36
37	Spare	0.00	20/1	CB	•		125/3	CB			18.48	Panel 1LC - SECT 1	38
39	Spare	0.00	20/1	CB	•						15.30	1LC - SECT 1	40
41	Spare	0.00	20/1	CB	•						14.82	1LC - SECT 1	42
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC							
Project #: B13608		Demand KVA		22.70	19.52	19.04							
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL		Demand KVA		0.25	18.79	9.39							
Notes: Internal TVSS		Demand KVA		13.06	4.39								
Lighting		Demand KVA		61.26	74 Amps								
Receipt		Demand KVA		0.25									
Equip		Demand KVA		18.79									
Motors		Demand KVA		9.39									
Pat. Room		Demand KVA		13.06									
		Demand KVA		10.98									
		Demand KVA		4.39									
		Demand KVA		45.88									
		Demand KVA		55									
		Demand KVA		0									
		Demand KVA		23									
		Demand KVA		11									
		Demand KVA		16									
		Demand KVA		5									
		Demand KVA		55									
		Demand KVA		0									
		Demand KVA		23									
		Demand KVA		11									
		Demand KVA		18									
		Demand KVA		5									
		Demand KVA		57									

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		IHXR		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 25,000 AIC Deep		
#	Description	Load	CB *	A	B	C	CB *	CB *	CB *	CB *	CB *	Load	Description	#
1	X-Ray Lin Acc 1028 OBI	4.62	60/3	•			150/3	CB				33.00	X-Ray CT HDR 1062	2
3	-----Lin Acc 1028 OBI	4.62	-----	•			-----	---				33.00	-----CT HDR 1062	4
5	-----Lin Acc 1028 OBI	4.62	-----	•			-----	---				33.00	-----CT HDR 1062	6
7	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	8
9	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	10
11	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	12
13	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	14
15	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	16
17	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	18
19	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	20
21	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	22
23	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	24
25	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	26
27	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	28
29	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	30
31	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	32
33	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	34
35	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	36
37	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	38
39	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	40
41	Spare	0.00	20/1	•			20/1	CB				0.00	Spare	42
Rev: Revised circuits marked † Existing circuits marked ‡														
Project #: B13608														
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL														
Notes: Internal TVSS														
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	Demand Amps		NEC Feeder Factors	NEC Feed Amps						
X-Ray	112.86	Largest @ 50%, next @ 25%, rest @ 10%	52.96	64	64	64	x 100%	64	64					
	112.86	136 Amps	52.96	64	64	64								

\* Circuit Breaker Code  
 G = GFCI  
 H = HID Rated  
 S = Shunt Trip  
 C = HACR Rated  
 # = see note  
 D = Switching Duty  
 A = AFCI

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		175A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	CB	Description	Load	#
1	Equip 1st Floor Medical Gas Alarm Panel	0.50	20/1	•			20/1	CB	Spare	0.00	2
3	Equip Auto-Door E1112	1.00	20/1	•			20/1	CB	Spare	0.00	4
5	Equip Auto-Door E1112	1.00	20/1	•			20/1	CB	Spare	0.00	6
7	Equip Auto-Door AGVS 1086/1088	1.00	20/1	•			20/1	CB	Spare	0.00	8
9	Equip Auto-Door Corridor 1014	1.00	20/1	•			20/1	CB	Spare	0.00	10
11	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	12
13	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	14
15	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	16
17	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	18
19	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	20
21	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	22
23	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	24
25	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	26
27	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	28
29	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	30
31	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	32
33	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	34
35	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	36
37	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	38
39	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	40
41	Spare	0.00	20/1	•			20/1	CB	Spare	0.00	42
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI		
Project #: B13608		1.50		2.00	1.00						
File: N:\B13608\ sched\ B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Equip	4.50	x 100%	4.50	12	x 100%	12					
	4.50		4.50	12		12					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		11L2EA		120/208V		3Ø		4W		400A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:		Electrical Transformer Room 1083		Load		CB *		A B C		CB *		Description	
Location:		Critical		Load		CB *		A B C		CB *		Description	
Serves:		Critical		Load		CB *		A B C		CB *		Description	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Recept Electrical Rm. 1093	0.36	20/1 CB	•			20/1 CB	1.20	Misc AGVS Control Panel	2			
3	Recept Electrical Rm. 1093	0.36	20/1 CB	•			20/1 CB	0.00	Spare	4			
5	Recept Electrical Rm. 1094	0.54	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Recept Mech Rm 1095	0.54	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Recept Electrical Rm. 1083	0.36	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev:		* Circuit Breaker Code											
Revised circuits marked † Existing circuits marked ‡		G = GFCI											
Project #: B13608		H = HID Rated											
File: N:\B13608\sched\B13608 multicare		S = Shunt Trip											
ED_CCE.PNL		D = Switching Duty											
		A = AFCI											
Notes:		Internal TVSS											
Load Type		Conn KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Recept		2.16		10 KVA @ 100%, rest @ 50%		2.16		6		x 100%		6	
Misc		1.20		x 100%		1.20		3		x 100%		3	
		3.36		9 Amps		3.36		9				9	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		400A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Pat. Room Exam Rm. 1048	0.36	20/1 CB	•			20/1 CB	1.92	Equip Ice Machine, Clean Rm 1039	2	
3	Pat. Room Exam Rm. 1049	0.36	20/1 CB	•			20/1 CB	0.18	Recept Alcove 1071A	4	
5	Pat. Room Exam Rm. 1051	0.36	20/1 CB	•			20/1 CB	1.00	Equip Pyxis, Corridor 1038	6	
7	Pat. Room Exam Rm. 1054	0.36	20/1 CB	•			20/1 CB	0.36	Recept Alcove 1032B	8	
9	Pat. Room Exam Rm. 1055	0.36	20/1 CB	•			20/1 CB	0.54	Recept Storage 1004	10	
11	Pat. Room Exam Rm. 1056	0.36	20/1 CB	•			20/1 CB	0.54	Recept Equip/Storage 1016	12	
13	Pat. Room Exam Rm. 1058	0.36	20/1 CB	•			20/1 CB	1.20	Equip UH-1, Storage 1004 Heater	14	
15	Pat. Room Exam Rm. 1059	0.36	20/1 CB	•			20/1 CB	0.54	Recept Electrical Rm 1044	16	
17	Pat. Room Pediatric Exam Rm. 1072	0.18	20/1 CB	•			20/1 CB	0.40	Recept Control Room 1061	18	
19	Pat. Room Hold Rm. 1073A	0.36	20/1 CB	•			20/1 CB	0.60	Recept Control Room 1061	20	
21	Pat. Room Hold Rm. 1073A	0.36	20/1 CB	•			20/1 CB	0.60	Recept Control Room 1027	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.60	Recept Control Room 1027	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.60	Recept Control Room 1027	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated # = see note D = Switching Duty A = AFCI		
Project #: B13608		6.12		3.30	3.44						
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Recept	4.96	10 KVA @ 100%, rest @ 50%	4.96	14	x 100%	14					
Equip	4.12	x 100%	4.12	11	x 100%	11					
Pat. Room	3.78	50 KVA @ 40%, rest @ 20%	1.51	4	x 100%	4					
	12.86	36 Amps	10.59	29		29					

SECTION 26 24 12 - PANEL SCHEDULES

Spartling		120/208V		3Ø		4W		400A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.18	Receipt IS 1087	2	
3	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.18	Receipt IS 1087	4	
5	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.18	Receipt IS 1087	6	
7	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.18	Receipt IS 1087	8	
9	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.18	Receipt IS 1087	10	
11	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.18	Receipt IS 1087	12	
13	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Equip IS Rack, IS Rm. 1087	1.80	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 1036	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 1036	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 1036	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated # = see note D = Switching Duty A = AFCI		
Project #: B13608				5.94	5.94	5.94					
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL				5.94	5.94	5.94					
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Receipt	1.62	10 KVA @ 100%, rest @ 50%	1.62	4	x 100%	4					
Equip	16.20	x 100%	16.20	45	x 100%	45					
	17.82	49 Amps	17.82	49		49					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		1L3EA Sect. 1		120/208V		3Ø		4W		175A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Equip DWH-1, Mech Rm 1091	1.80	20/1 CB	•			20/1 CB	0.50	Equip DDC Control Panel, Mech 1091	2			
3	Equip DWH-2, Mech Rm 1091	1.80	20/1 CB	•			20/1 CB	0.50	Equip Chemical Control Panel, Mech 1095	4			
5	Equip DWH-3, Mech Rm 1091	1.80	20/1 CB	•			20/1 CB	0.50	Equip Leak Detection System, Chiller 1092	6			
7	Equip DWH-4, Mech Rm 1091	1.80	20/1 CB	•			20/1 CB	1.00	Equip Trap Primers, Mech Rm 1091/1092	8			
9	Equip Pre-Action Compressor, Mech Rm 1091	1.80	20/1 CB	•			20/1 CB	1.00	Equip Trap Primers, Storage 1004	10			
11	Equip Dry-System Compressor, Mech Rm 1091	1.80	20/1 CB	•			20/1 CB	1.00	Receipt Elev Mach Rm 1003	12			
13	Receipt Chiller Rm 1092	0.54	20/1 CB	•			20/1 CB	0.43	<Multi> Elev 22 Cab Ltg and Rec	14			
15	Receipt Chiller Rm 1092	0.54	20/1 CB	•			20/1 CB	0.50	Equip Elev 22 Cab HVAC	16			
17	Receipt Mech Rm 1091	0.54	20/1 CB	•			20/1 CB	0.18	Receipt Elev Mach Rm 1003	18			
19	Misc DDC Control Pnl Room 1004	0.50	20/1 CB	•			20/1 CB	0.43	<Multi> Elev 21 Cab Ltg and Rec	20			
21	Misc DDC Control Pnl Room 1036	0.50	20/1 CB	•			20/1 CB	0.50	Equip Elev 22 Cab HVAC	22			
23	Misc DDC Control Pnl Room 2033	0.50	20/1 CB	•			20/1 CB	1.00	Equip UH-1	24			
25	Misc DDC Control Pnl Room 3152	0.50	20/1 CB	•			20/1 CB	1.00	Equip Chemical Pumps	26			
27	Misc Heat Trace	1.00	20/2 G	•			20/1 CB	0.40	Equip CHU-1, Vestibule 2001	28			
29	-----	1.00	-----	---			20/1 CB	0.00	Equip Trap Primer	30			
31	Misc Heat Trace	1.00	20/2 G	•			20/1 CB	0.00	Equip Trap Primer	32			
33	-----	1.00	-----	---			20/1 CB	0.00	Spare	34			
35	Misc Heat Trace	1.00	20/2 G	•			20/1 CB	0.00	Spare	36			
37	-----	1.00	-----	---			20/1 CB	0.00	Spare	38			
39	Misc Heat Trace	1.00	20/2 G	•			20/1 CB	0.00	Spare	40			
41	-----	1.00	-----	---			20/1 CB	0.00	Spare	42			
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated D = Switching Duty A = AFCI # = see note				
Project #: B13608		Demand KVA		10.50	10.54	9.50							
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		0.50	2.34	17.70							
Notes: Internal TVSS		Demand KVA		10.00	10.00	30.54							
Load Type		Conn KVA		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps			
Lighting	0.50	100%		100%		1		x 125%		2			
Receipt	2.34	100%		100%		6		x 100%		6			
Equip	17.70	100%		100%		49		x 100%		49			
Misc	10.00	100%		100%		28		x 100%		28			
30.54		85 Amps		30.54		85				85			

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		175A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name: 1L3EA Sect. 2		Location: Chiller Room 1092		Serves: Equipment		Description		Load		#	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
43	Misc Heat Trace	0.00	20/2 G	.	.	.	20/2 G	0.00	Misc Heat Trace	44	
45	-----	0.00	-----	.	.	.	-----	0.00	-----	46	
47	Misc Heat Trace	0.00	20/2 G	.	.	.	20/2 G	0.00	Misc Heat Trace	48	
49	-----	0.00	-----	.	.	.	-----	0.00	-----	50	
51	Misc Heat Trace	0.00	20/2 G	.	.	.	20/2 G	0.00	Misc Heat Trace	52	
53	-----	0.00	-----	.	.	.	-----	0.00	-----	54	
55	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	56	
57	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	58	
59	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	60	
61	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	62	
63	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	64	
65	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	66	
67	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	68	
69	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	70	
71	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	72	
73	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	74	
75	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	76	
77	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	78	
79	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	80	
81	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	82	
83	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	84	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC	ØC	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI			
Project #: B13608		Demand KVA		0.00	0.00	0.00	0.00				
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		0.00	0.00	0.00	0.00	NEC Feeder Factors			
Notes:		Demand Amps		0	0	0	0	NEC Feed Amps			
Load Type		Conn KVA		0.00	0.00	0.00	0.00	Space			
Space		Demand Factor		0.00	0.00	0.00	0.00	0			
Space		Demand Amps		0	0	0	0	0			

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		200A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep			
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting RT-3 Room 1028	1.20	20/1 CB	•			20/1 CB	0.36	Recept Toilet 1012, 1013	2			
3	Lighting Simul2/HDR Room 1062	1.20	20/1 CB	•			20/1 CB	1.08	Recept Staff Lounge 1011	4			
5	Lighting Conference Rm 1037	0.60	20/1 CB	•			20/1 CB	1.80	Equip Coffee Maker, Staff Lounge 1011	6			
7	Misc Gate Connection	1.00	20/1 CB	•			20/1 CB	1.38	<Multi> Refrigerator, Staff Lounge 1011	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	1.21	Equip Microwave, Staff Lounge 1011	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Recept Rms. 1086, 1088, 1089	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.90	Recept Shelled Space 1017	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Recept Storage 1016	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Recept Corridors, Pat Toilet 1015	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Recept Garage Parking	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.36	Recept North Elev Lobby	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.61	<Multi> Elev 19 & 20 Pit Rec and Lighting	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	1.00	Equip Elev 19 Sump	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	1.00	Equip Elev 20 Sump	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.30	<Multi> Elev 19 & 20 Pit Rec and Lighting	30			
31	Spare	0.00	20/1 CB				20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB				20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated D = Switching Duty A = AFCI # = see note				
Project #: B13608		Demand KVA		6.56	5.57	5.11							
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Internal TVSS		Demand KVA		Demand Amps		NEC Demand Factor		NEC Feeder Factors		NEC Feed Amps	
Lighting	3.37	3.37	100%	3.37	9					x 125%		12	
Recept	6.66	6.66	10 KVA @ 100%, rest @ 50%	6.66	18					x 100%		18	
Equip	6.21	6.21	100%	6.21	17					x 100%		17	
Misc	1.00	1.00	100%	1.00	3					x 100%		3	
	17.24	48 Amps		17.24	48							50	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		200A Main lugs only Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name: 1LC - SECT 1											
Location: Electrical Room 1044											
Services: Normal											
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Pat. Room Exam Rm. 1048	1.08	20/1 CB	•			20/1 CB	0.72	Receipt Counsel Rm. 1043	2	
3	Pat. Room Exam Rm. 1049	1.08	20/1 CB	•			20/1 CB	0.54	Receipt Counsel Rm. 1043	4	
5	Pat. Room Exam Rm. 1051	1.08	20/1 CB	•			20/1 CB	0.72	Receipt Storage 1042	6	
7	Pat. Room Exam Rm. 1054	1.08	20/1 CB	•			20/1 CB	0.90	Receipt Support 1052, Hall 1047	8	
9	Pat. Room Exam Rm. 1055	1.08	20/1 CB	•			20/1 CB	0.54	Receipt Alcove 1046A, Pat. Toilet 1045	10	
11	Pat. Room Exam Rm. 1056	1.08	20/1 CB	•			20/1 CB	1.20	Equip Water Cooler Hall 1046	12	
13	Pat. Room Exam Rm. 1058	1.08	20/1 CB	•			20/1 CB	1.08	Receipt Soiled Rm 1041, Alcove 1071A	14	
15	Pat. Room Exam Rm. 1059	1.08	20/1 CB	•			20/1 CB	1.08	Receipt Clean Rm 1039	16	
17	Pat. Room Pediatric Exam Rm. 1072	0.72	20/1 CB	•			20/1 CB	1.64	Equip Blanket Warmer, Clean Rm 1039	18	
19	Pat. Room Pediatric Exam Rm. 1072	0.90	20/1 CB	•			20/1 CB	1.50	Equip Coffee Maker, Clean Rm 1039	20	
21	Pat. Room Patient Holding Rm. 1073A	0.72	20/1 CB	•			20/1 CB	0.80	Equip Undercounter Ref, Clean Rm 1039	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.36	Receipt Alcove 1057B, Printer	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	1.26	Receipt Hall 1057, Toilet 1064, Wait 1065	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Receipt Nurse Station 1035	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Receipt Nurse Station 1035	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	1.20	Receipt Pyxis, NS 1035	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Receipt S. Garage, Pump Rooms	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Receipt Storage 1004	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.80	Equip Pneumatic Tube Diverter	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.25	Equip Irrigation Controller	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡											
Project #: B13608											
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Lighting	0.25	x 100%	0.25	1	x 125%	1					
Receipt	27.58	10 KVA @ 100%, rest @ 50%	18.79	52	x 100%	52					
Equip	9.39	x 100%	9.39	26	x 100%	26					
Motors	0.40	x 100%	0.40	1	125% of Largest	1					
Pat. Room	10.98	50 KVA @ 40%, rest @ 20%	4.39	12	x 100%	12					
	48.60	135 Amps	33.22	92		93					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		200A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name: ILC - SECT 2											
Location: Electrical Room 1044											
Serves: Normal											
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
43	Recept HDR Room 1062	0.80	20/1 CB	•			20/1 CB	0.90	Recept Conference Rm. 1037	44	
45	Recept HDR Room 1062	0.80	20/1 CB	•			20/1 CB	1.08	Recept Conference Rm. 1037	46	
47	Recept HDR Room 1062	0.80	20/1 CB	•			20/1 CB	1.12	<Multi> Conference Rm. 1037, Motorized Screen	48	
49	Recept HDR Room 1062	0.60	20/1 CB	•			20/1 CB	1.26	Recept Office 1029 & 1031	50	
51	Recept HDR Room 1062	0.60	20/1 CB	•			20/1 CB	1.26	Recept Office 1029 & 1031	52	
53	Recept Control Room 1061	0.40	20/1 CB	•			20/1 CB	0.90	Recept Office 1029, Corridor 1034, Wait 1026	54	
55	Recept Control Room 1061	0.40	20/1 CB	•			20/1 CB	0.72	Recept Alcove 1032A, Storage 1033, Hskp E119	56	
57	Recept Control Room 1061	0.80	20/1 CB	•			20/1 CB	0.61	<Multi> Elev 21 & 22 Pit Lighting and Rec	58	
59	Recept Control Room 1061	0.80	20/1 CB	•			20/1 CB	1.00	Equip Elev 21 Pit Pump	60	
61	Recept Control Room 1027	0.60	20/1 CB	•			20/1 CB	1.00	Equip Elev 22 Pit Pump	62	
63	Recept Control Room 1027	0.40	20/1 CB	•			20/1 CB	0.18	Recept Elev South Lobby	64	
65	Recept RT-3 Room 1028	0.60	20/1 CB	•			20/1 CB	0.00	Spare	66	
67	Recept RT-3 Room 1028	0.60	20/1 CB	•			20/1 CB	0.00	Spare	68	
69	Recept RT-3 Room 1028	0.60	20/1 CB	•			20/1 CB	0.00	Spare	70	
71	Recept RT-3 Room 1028	0.60	20/1 CB	•			20/1 CB	0.00	Spare	72	
73	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	74	
75	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	76	
77	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	78	
79	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	80	
81	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	82	
83	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	84	

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare  
 ED\_CCE.PNL

Notes:  
 \* Circuit Breaker Code  
 G = GFCI  
 H = HID Rated  
 S = Shunt Trip  
 C = HACR Rated  
 D = Switching Duty  
 A = AFCI  
 # = see note

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	0.25	x 100%	0.25	1	x 125%	1
Recept	16.78	10 KVA @ 100%, rest @ 50%	13.39	37	x 100%	37
Equip	2.00	x 100%	2.00	6	x 100%	6
Motors	0.40	x 100%	0.40	1	125% of Largest	1
	19.43	54 Amps	16.04	45		45

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		400A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep		
#	Description	Load	CB *	A	B	C	CB *	CB	CB	Load	Description	#
1	X-Ray Lin Acc 1028	33.00	150/3	•			20/3	CB		1.20	X-Ray CT HDR 1062	2
3	-----Lin Acc 1028	33.00	-----	•			-----	---		1.20	-----CT HDR 1062	4
5	-----Lin Acc 1028	33.00	-----	•			-----	---		1.20	-----CT HDR 1062	6
7	Space	0.00	0/1	•			0/1			0.00	Space	8
9	Space	0.00	0/1	•			0/1			0.00	Space	10
11	Space	0.00	0/1	•			0/1			0.00	Space	12
13	Space	0.00	0/1	•			0/1			0.00	Space	14
15	Space	0.00	0/1	•			0/1			0.00	Space	16
17	Space	0.00	0/1	•			0/1			0.00	Space	18
19	Space	0.00	0/1	•			0/1			0.00	Space	20
21	Space	0.00	0/1	•			0/1			0.00	Space	22
23	Space	0.00	0/1	•			0/1			0.00	Space	24
25	Space	0.00	0/1	•			0/1			0.00	Space	26
27	Space	0.00	0/1	•			0/1			0.00	Space	28
29	Space	0.00	0/1	•			0/1			0.00	Space	30
31	Space	0.00	0/1	•			0/1			0.00	Space	32
33	Space	0.00	0/1	•			0/1			0.00	Space	34
35	Space	0.00	0/1	•			0/1			0.00	Space	36
37	Space	0.00	0/1	•			0/1			0.00	Space	38
39	Space	0.00	0/1	•			0/1			0.00	Space	40
41	Space	0.00	0/1	•			0/1			0.00	Space	42
Rev:		* Circuit Breaker Code										
Revised circuits marked ‡ Existing circuits marked †		G = GFCI H= HIID Rated S = Shunt Trip C = HACR Rated # = see note D= Switching Duty A = AFCI										
Project #: B13608												
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL												
Notes: Internal TVSS												
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps						
X-Ray	102.60	Largest @ 50%, next @ 25%, rest @ 10%	50.40	140	x 100%	140						
	102.60	285 Amps	50.40	140		140						

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		2HIE		277/480V		3Ø		4W		400A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 25,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	CB	CB	CB	Load	Description	#
1	Lighting East Exit Signs	0.19	20/1 CB	•			20/1 CB				0.06	Lighting West Exit Signs	2
3	Lighting East Corridors	1.72	20/1 CB	•			20/1 CB				2.35	Lighting West Corridors	4
5	Lighting East Corridors	2.16	20/1 CB	•			20/1 CB				2.21	Lighting K-Wing Corridors	6
7	Spare	0.00	20/1 CB	•			20/1 CB				0.05	Lighting K-Wing Exit Signs	8
9	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	10
11	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	12
13	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	14
15	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	16
17	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	18
19	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	20
21	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	22
23	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	24
25	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	26
27	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	28
29	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	30
31	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	32
33	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	34
35	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	36
37	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	38
39	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	40
41	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	42
Rev: Revised circuits marked † Existing circuits marked ‡													
Project #: B13608													
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL													
Notes: Internal TVSS													
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	Demand Amps		NEC Feeder Factors	NEC Feed Amps					
Lighting	15.26	x 100%	15.26	18	18	18	x 125%	23	23				
	15.26	18 Amps	15.26	18	18	18		23	23				

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		277/480V		3Ø		4W		225A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 25,000 AIC Deep			
#	Description	Load	CB *	A	B	C	CB *	CB *	CB *	CB *	#		
1	Lighting Pharmacy, Nurse Stations	2.76	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	2		
3	Lighting East Exam Rooms	2.53	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	4		
5	Lighting East Exam Rooms, Nurse Stations	2.03	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	6		
7	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	8		
9	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	10		
11	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	12		
13	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	14		
15	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	16		
17	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	18		
19	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	20		
21	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	22		
23	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	24		
25	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	26		
27	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	28		
29	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	30		
31	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	32		
33	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	34		
35	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	36		
37	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	38		
39	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	40		
41	Spare	0.00	20/1 CB	.	.	.	20/1 CB	20/1 CB	20/1 CB	20/1 CB	42		
Rev:		* Circuit Breaker Code											
Revised circuits marked † Existing circuits marked ‡		G = GFCI											
Project #: B13608		H = HID Rated											
File: N:\B13608\sched\B13608 multicare		S = Shunt Trip											
ED_CCE.PNL		D = Switching Duty											
		A = AFCI											
Notes:		Internal TVSS											
Load Type		Conn KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Lighting		23.84		x 100%		23.84		29		x 125%		36	
		23.84		29 Amps		23.84		29				36	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	Load	#
1	Lighting West Corridors	2.89	20/1 CB	•			20/1 CB	3.19	Lighting East Corridors	3.19	2
3	Lighting West Corridors	1.38	20/1 CB	•			20/1 CB	2.02	Lighting East Corridors	2.02	4
5	Lighting West Nurse Stations	1.73	20/1 CB	•			20/1 CB	2.24	Lighting East Nurse Stations	2.24	6
7	Lighting East Exam Rooms	2.37	20/1 CB	•			20/1 CB	2.83	Lighting North Core Rooms	2.83	8
9	Lighting Triage Core Rooms	1.03	20/1 CB	•			20/1 CB	2.67	Lighting West Exam Rooms	2.67	10
11	Lighting West Waiting Room	2.21	20/1 CB	•			20/1 CB	3.10	Lighting Core Exam Rooms	3.10	12
13	Lighting East Waiting Room	1.98	20/1 CB	•			20/1 CB	2.89	Lighting South Exterior	2.89	14
15	Lighting K-Wing Corridor	2.99	20/1 CB	•			20/1 CB	3.54	Lighting Exterior	3.54	16
17	Lighting K-Wing Corridor	2.92	20/1 CB	•			20/1 CB	0.51	Lighting Exterior	0.51	18
19	Lighting K-Wing Offices	2.08	20/1 CB	•			20/1 CB	0.07	Lighting Exterior	0.07	20
21	Lighting K-Wing Offices	2.36	20/1 CB	•			20/1 CB	0.70	Lighting Exterior	0.70	22
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	0.00	24
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	0.00	26
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	0.00	28
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	0.00	30
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	0.00	32
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	0.00	34
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	0.00	36
37	Spare	0.00	20/1 CB	•			80/3 CB	21.84	Panel 2LA - SECT 1	21.84	38
39	Spare	0.00	20/1 CB	•			-----2LA - SECT 1	20.60	-----2LA - SECT 1	20.60	40
41	Spare	0.00	20/1 CB	•			-----2LA - SECT 1	21.01	-----2LA - SECT 1	21.01	42
Rev: Revised circuits marked † Existing circuits marked ‡											
Project #: B13608											
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Lighting	47.68	x 100%	47.68	57	x 125%	72					
Receipt	25.72	10 KVA @ 100%, rest @ 50%	17.86	21	x 100%	21					
Equip	11.17	x 100%	11.17	13	x 100%	13					
Misc	1.00	x 100%	1.00	1	x 100%	1					
Pat. Room	25.56	50 KVA @ 40%, rest @ 20%	10.22	12	x 100%	12					
	111.13	134 Amps	87.93	106		120					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		2HXR		277/480V		3Ø		4W		400A Main CB Surface Mounted		Panel	
Name:		Electrical Room 2105		277/480V		3Ø		4W		400A Main CB Surface Mounted		Type: Panelboard 25,000 AIC Deep	
Location:		Electrical Room 2105		277/480V		3Ø		4W		400A Main CB Surface Mounted		Type: Panelboard 25,000 AIC Deep	
Serves:		X-Ray		277/480V		3Ø		4W		400A Main CB Surface Mounted		Type: Panelboard 25,000 AIC Deep	
#	Description	Load	CB *	A B C	CB *	Load	CB *	A B C	CB *	Load	Description	#	
1	X-Ray CT 2296	33.00	150/3 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	2	
3	-----CT 2296	33.00	-----	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	4	
5	-----CT 2296	33.00	-----	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	6	
7	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	8	
9	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	10	
11	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	12	
13	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	14	
15	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	16	
17	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•	20/1 CB	0.00	20/1 CB	•	20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC					* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note		
Project #: B13608		33.00		33.00	33.00	33.00							
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL		Demand KVA		75.64	75.64	75.64	91		91		NEC Feeder Factors x 100%		
Notes: Internal TVSS		Demand KVA		75.64	75.64	75.64	91		91		NEC Feeder Factors x 100%		
Load Type		Conn KVA		211.86	211.86	211.86	255 Amps		255 Amps		NEC Feeder Factors x 100%		
X-Ray		Largest @ 50%, next @ 25%, rest @ 10%		211.86	211.86	211.86	255 Amps		255 Amps		NEC Feeder Factors x 100%		

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		175A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Equip Auto-Doors, Vestibule 2001	1.00	20/1 CB	•			20/1 CB	1.00	Equip Auto-Doors, Corridor 2028	2	
3	Equip Auto-Doors, Vestibule 2001	1.00	20/1 CB	•			20/1 CB	1.00	Equip Auto-Doors, Corridor 2138	4	
5	Equip Auto-Doors, Corridor 2016	1.00	20/1 CB	•			20/1 CB	1.00	Equip Auto-Doors, Corridor 2138	6	
7	Equip Auto-Doors, Corridor 2047	1.00	20/1 CB	•			20/1 CB	1.00	Equip Auto-Doors, AGVS Soiled 2135	8	
9	Equip Medical Gas Alarm Panel, Corridor 2079	0.50	20/1 CB	•			20/1 CB	1.00	Equip Auto-Doors Corridors 2106, 52	10	
11	Equip Medical Gas Alarm Panel, K-Wing	0.50	20/1 CB	•			20/1 CB	0.00	Spare	12	
13	Equip Auto-Doors, K-Wing	1.00	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC		* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip D = Switching Duty A = AFCI			
Project #: B13608		5.00	3.50	2.50							
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL		Demand KVA		15.50	15.50	43					
Notes: Internal TVSS		Demand KVA		15.50	15.50	43					
Load Type		Conn KVA		15.50	15.50	43					
Equip		NEC Demand Factor		x 100%							
		Demand Amps		43	43	43					
		NEC Feeder Factors		x 100%							
		NEC Feed Amps		43	43	43					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V			3Ø 4W			400A Main CB Surface Mounted Feed thru & Double Lugs			Panel Type: Panelboard 10,000 AIC Deep		
#	Description	Load	CB *	A	B	C	CB *	CB	CB	CB	Description	Load	#
1	Recept South Nurse Station 2078	0.90	20/1 CB	•			20/1 CB				Equip Meds Refrigerator 2158	0.80	2
3	Recept South Nurse Station 2078	0.72	20/1 CB	•			20/1 CB				Equip Pyxis, Meds 2158	1.00	4
5	Recept North Nurse Station 2078	0.90	20/1 CB	•			20/1 CB				Equip Blanket Warmer, Alcove 2159A	1.64	6
7	Recept North Nurse Station 2078	0.90	20/1 CB	•			20/1 CB				<Multi> UC Refrigerator, Alcove 2159A	0.98	8
9	Recept Nurse Station 2081	0.72	20/1 CB	•			20/1 CB				Equip Pyxis, Meds 2163	1.00	10
11	Recept Nurse Station 2081	0.72	20/1 CB	•			20/1 CB				Equip Meds Refrigerator 2163	0.80	12
13	Equip Floor Copier, Nurse Station 2081	1.38	20/1 CB	•			20/1 CB				Recept Pharmacy 2101	0.36	14
15	Recept Phys. Work 2086	0.90	20/1 CB	•			20/1 CB				Recept Equip Rm 2102	0.18	16
17	Recept Phys. Work 2086	0.90	20/1 CB	•			20/1 CB				Recept Alcove 2099A & 2098A	0.36	18
19	Equip Ice Machine, Storage 2153	1.92	20/1 CB	•			20/1 CB				Equip Pharmacy Hood	1.90	20
21	Recept Storage 2153, Corridor 2144	0.54	20/1 CB	•			20/1 CB				Equip Pharmacy Double Refrigerator	1.50	22
23	Recept South Nurse Station 2116 Desks	0.72	20/1 CB	•			20/1 CB				Equip Pharmacy Pyxis	1.00	24
25	Recept South Nurse Station 2116 Desks	0.72	20/1 CB	•			20/1 CB				Recept Electrical Rm 2105	0.54	26
27	Equip Floor Copier, Nurse Station 2116	1.38	20/1 CB	•			20/1 CB				Misc AGV5 Control Panel	1.20	28
29	Recept North Nurse Station 2116	0.90	20/1 CB	•			20/1 CB				Spare	0.00	30
31	Recept North Nurse Station 2116	0.90	20/1 CB	•			20/1 CB				Spare	0.00	32
33	Recept Phys. Work 2113	0.72	20/1 CB	•			20/1 CB				Spare	0.00	34
35	Recept Phys. Work 2113	0.90	20/1 CB	•			20/1 CB				Spare	0.00	36
37	Recept Nurse Station 2111	1.26	20/1 CB	•			20/1 CB				Spare	0.00	38
39	Recept Nurse Station 2111	0.90	20/1 CB	•			20/1 CB				Spare	0.00	40
41	Recept Nurse Station 2111	1.08	20/1 CB	•			20/1 CB				Spare	0.00	42
Rev: Revised circuits marked † Existing circuits marked ‡													
Project #: B13608													
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL													
Notes: Internal TVSS													
Demand KVA		Demand Amps		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps			
Recept	38.68	10 KVA @ 100%, rest @ 50%	24.34	68	24.34	68	x 100%						68
Equip	17.12	x 100%	17.12	48	17.12	48	x 100%						48
Misc	2.40	x 100%	2.40	7	2.40	7	x 100%						7
Pat. Room	32.40	50 KVA @ 40%, rest @ 20%	12.96	36	12.96	36	x 100%						36
	90.60	251 Amps	56.82	158	56.82	158							158

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V			3Ø			4W			400A Main lugs only Surface Mounted Feed Thru Lugs			Panel Type: Panelboard 10,000 AIC Deep	
Name: 2L2EA - SECT 2		Description		Load	CB *	A	B	C	CB *	Load	Description	#			
Location: Electrical Room 2105		Recept Trauma Rm. 2161, Ckt 'C1'		1.08	20/1 CB	•			20/1 CB	0.40	Recept Control Room 2297	44			
Serves: Critical		Recept Trauma Rm. 2161, Ckt 'C2'		1.08	20/1 CB	•			20/1 CB	0.40	Recept Control Room 2297	46			
		Recept Trauma Rm. 2161, Ckt 'C3'		1.08	20/1 CB	•			20/1 CB	0.40	Recept Control Room 2297	48			
		Equip Pyxis, Trauma Rm. 2161, Ckt 'C4'		1.00	20/1 CB	•			20/1 CB	0.60	Recept Control Room 2297	50			
		Recept Trauma Rm. 2161, Ckt 'C5'		0.54	20/1 CB	•			20/1 CB	0.80	Recept Control Room 2297	52			
		Recept Trauma Rm. 2161, Ckt 'C6'		0.54	20/1 CB	•			20/1 CB	0.80	Recept Control Room 2297	54			
		Recept Trauma Rm. 2161, Ckt 'C7'		0.54	20/1 CB	•			20/1 CB	0.60	Recept CT Room 2296	56			
		Recept Trauma Rm. 2161, Ckt 'C11'		1.08	20/1 CB	•			20/1 CB	0.00	Spare	58			
		Recept Trauma Rm. 2161, Ckt 'C12'		0.72	20/1 CB	•			20/1 CB	0.00	Spare	60			
		Recept Trauma Rm. 2161, Ckt 'C13'		1.08	20/1 CB	•			20/1 CB	0.00	Spare	62			
		Equip Pyxis, Trauma Rm. 2161, Ckt 'C14'		1.00	20/1 CB	•			20/1 CB	0.00	Spare	64			
		Recept Trauma Rm. 2161, Ckt 'C15'		0.54	20/1 CB	•			20/1 CB	0.00	Spare	66			
		Recept Trauma Rm. 2161, Ckt 'C16'		0.54	20/1 CB	•			20/1 CB	0.00	Spare	68			
		Recept Trauma Rm. 2161, Ckt 'C17'		0.54	20/1 CB	•			20/1 CB	0.00	Spare	70			
		Spare		0.00	20/1 CB	•			20/1 CB	0.00	Spare	72			
		Spare		0.00	20/1 CB	•			20/1 CB	0.00	Spare	74			
		Spare		0.00	20/1 CB	•			20/1 CB	0.00	Spare	76			
		Spare		0.00	20/1 CB	•			20/1 CB	0.00	Spare	78			
		Spare		0.00	20/1 CB	•			20/1 CB	0.00	Spare	80			
		Spare		0.00	20/1 CB	•			20/1 CB	0.00	Spare	82			
		Spare		0.00	20/1 CB	•			20/1 CB	0.00	Spare	84			
Rev: Revised circuits marked † Existing circuits marked ‡				Connected KVA		ØA	ØB	ØC							
Project #: B13608				5.84	5.84	5.44	4.08								
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL															
Notes: * Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated D = Switching Duty A = AFCI															
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps									
Recept	19.60	10 KVA @ 100%, rest @ 50%	14.80	41	x 100%	41									
Equip	2.00	x 100%	2.00	6	x 100%	6									
Pat. Room	32.40	50 KVA @ 40%, rest @ 20%	12.96	36	x 100%	36									
	54.00	150 Amps	29.76	83		83									

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		120/208V		3Ø		4W		400A Main CB Surface Mounted Feed thru & Double Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name: 2L2EB - SECT 1											
Location: Electrical Room 2105											
Serves: Critical											
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Pat. Room Exam Rm. 2104	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Isolation Exam Rm. 2082	2	
3	Pat. Room Exam Rm. 2104	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Isolation Exam Rm. 2082	4	
5	Pat. Room Exam Rm. 2103	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Isolation Exam Rm. 2085	6	
7	Pat. Room Exam Rm. 2103	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Isolation Exam Rm. 2085	8	
9	Pat. Room Exam Rm. 2114	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2088	10	
11	Pat. Room Exam Rm. 2114	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2088	12	
13	Pat. Room Exam Rm. 2115	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2089	14	
15	Pat. Room Exam Rm. 2115	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2089	16	
17	Pat. Room Isolation Exam Rm. 2118	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2091	18	
19	Pat. Room Isolation Exam Rm. 2118	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2091	20	
21	Pat. Room Isolation Exam Rm. 2122	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2092	22	
23	Pat. Room Isolation Exam Rm. 2122	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2092	24	
25	Pat. Room Exam Rm. 2154	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2093	26	
27	Pat. Room Exam Rm. 2154	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2093	28	
29	Pat. Room Exam Rm. 2155	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Secure Exam Rm. 2145	30	
31	Pat. Room Exam Rm. 2155	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Secure Exam Rm. 2148	32	
33	Pat. Room Exam Rm. 2157	0.72	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2146	34	
35	Pat. Room Exam Rm. 2157	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2146	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2149	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2149	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡											
Project #: B13608											
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Lighting	23.56	x 100%	23.56	65	x 125%	82					
Recept Equip	24.04	10 KVA @ 100%, rest @ 50%	17.02	47	x 100%	47					
Pat. Room	16.36	x 100%	16.36	45	x 100%	45					
	45.90	50 KVA @ 40%, rest @ 20%	18.36	51	x 100%	51					
	109.86	305 Amps	75.30	209		225					

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		2L2EB - SECT 2		120/208V		3Ø		4W		400A Main lugs only Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	Location:	Serves:	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
43	Lighting Control Room 2297			0.90	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2165	44	
45	Lighting Trauma Room 2251			0.77	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2165	46	
47	Lighting Trauma 2254			1.50	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2166	48	
49	Lighting Trauma 2258			1.50	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2166	50	
51	Lighting Trauma 2264			1.50	20/1 CB	•			20/1 CB	0.72	Pat. Room Exam Rm. 2095	52	
53	Spare			0.00	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2095	54	
55	Spare			0.00	20/1 CB	•			20/1 CB	1.08	Recept Trauma Rm. 2109, Ckt 'C1'	56	
57	Spare			0.00	20/1 CB	•			20/1 CB	1.08	Recept Trauma Rm. 2109, Ckt 'C2'	58	
59	Spare			0.00	20/1 CB	•			20/1 CB	1.08	Recept Trauma Rm. 2109, Ckt 'C3'	60	
61	Spare			0.00	20/1 CB	•			20/1 CB	1.00	Equip Pyxis, Trauma Rm. 2109, Ckt 'C4'	62	
63	Spare			0.00	20/1 CB	•			20/1 CB	0.54	Recept Trauma Rm. 2109, Ckt 'C5'	64	
65	Spare			0.00	20/1 CB	•			20/1 CB	0.54	Recept Trauma Rm. 2109, Ckt 'C6'	66	
67	Spare			0.00	20/1 CB	•			20/1 CB	0.54	Recept Trauma Rm. 2109, Ckt 'C7'	68	
69	Spare			0.00	20/1 CB	•			20/1 CB	1.08	Recept Trauma Rm. 2109, Ckt 'C11'	70	
71	Spare			0.00	20/1 CB	•			20/1 CB	1.08	Recept Trauma Rm. 2109, Ckt 'C12'	72	
73	Spare			0.00	20/1 CB	•			20/1 CB	1.08	Recept Trauma Rm. 2109, Ckt 'C13'	74	
75	Spare			0.00	20/1 CB	•			20/1 CB	1.00	Equip Pyxis, Trauma Rm. 2109, Ckt 'C14'	76	
77	Spare			0.00	20/1 CB	•			20/1 CB	0.54	Recept Trauma Rm. 2109, Ckt 'C15'	78	
79	Spare			0.00	20/1 CB	•			20/1 CB	0.54	Recept Trauma Rm. 2109, Ckt 'C16'	80	
81	Spare			0.00	20/1 CB	•			20/1 CB	0.54	Recept Trauma Rm. 2109, Ckt 'C17'	82	
83	Spare			0.00	20/1 CB	•			20/1 CB	0.00	Spare	84	
Rev:	Revised circuits marked † Existing circuits marked ‡												
Project #:	B13608												
File:	N:\B13608\sched\B13608 multicare ED_CCE.PNL												
Notes:	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note												
Load Type	Comm KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Lighting	23.56	x 100%	23.56	65	x 125%	82							
Recept	19.08	10 KVA @ 100%, rest @ 50%	14.54	40	x 100%	40							
Equip	12.24	x 100%	12.24	34	x 100%	34							
Pat. Room	7.56	50 KVA @ 40%, rest @ 20%	3.02	8	x 100%	8							
	62.44	173 Amps	53.36	148		164							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V				3Ø				4W				400A Main CB Surface Mounted Feed Thru Lugs				Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Pat. Room Exam Rm. 2017	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Pat. Room Exam Rm. 2041	2			
3	Pat. Room Exam Rm. 2017	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Pat. Room Exam Rm. 2041	4			
5	Pat. Room Exam Rm. 2018	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Pat. Room Exam Rm. 2039	6			
7	Pat. Room Exam Rm. 2018	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Pat. Room Exam Rm. 2039	8			
9	Pat. Room Exam Rm. 2021	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Pat. Room Exam Rm. 2038	10			
11	Pat. Room Exam Rm. 2021	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Pat. Room Exam Rm. 2038	12			
13	Pat. Room Exam Rm. 2022	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Pat. Room Exam Rm. 2037	14			
15	Pat. Room Exam Rm. 2022	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Pat. Room Exam Rm. 20437	16			
17	Pat. Room Exam Rm. 2071	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Pat. Room Exam Rm. 2124	18			
19	Pat. Room Exam Rm. 2071	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Pat. Room Exam Rm. 2124	20			
21	Pat. Room Exam Rm. 2075	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Pat. Room Exam Rm. 2123	22			
23	Pat. Room Exam Rm. 2075	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Pat. Room Exam Rm. 2123	24			
25	Pat. Room Exam Rm. 2076	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Pat. Room Exam Rm. 2035	26			
27	Pat. Room Exam Rm. 2076	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Pat. Room Exam Rm. 2035	28			
29	Pat. Room Exam Rm. 2077	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Pat. Room Exam Rm. 2132	30			
31	Pat. Room Exam Rm. 2077	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Pat. Room Exam Rm. 2132	32			
33	Pat. Room Exam Rm. 2025	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Spare	34			
35	Pat. Room Exam Rm. 2025	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Spare	36			
37	Pat. Room Exam Rm. 2143	0.72	20/1	CB	•		20/1	CB	0.72				20/1	CB	Spare	38			
39	Pat. Room Exam Rm. 2143	1.08	20/1	CB	•		20/1	CB	1.08				20/1	CB	Spare	40			
41	Spare	0.00	20/1	CB	•		20/1	CB	0.00				20/1	CB	Spare	42			

Rev:	Revised circuits marked † Existing circuits marked ‡	* Circuit Breaker Code H = HID Rated C = HACR Rated # = see note
Project #:	B13608	G = GFCI S = Shunt Trip D = Switching Duty A = AFCI
File:	N:\B13608\shed\B13608 multicare ED_CCE.PNL	

Notes:	Internal TVSS
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Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Receipt	6.24	10 KVA @ 100%, rest @ 50%	6.24	17	x 100%	17
Pat. Room	32.40	50 KVA @ 40%, rest @ 20%	12.96	36	x 100%	36
	38.64	107 Amps	19.20	53		53

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		212EC - SECT 2		120/208V		3 Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep				
Name: Electrical Room 2061		Location: Critical		Load		CB *		A B C		CB *		Description				
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#						
43	Recept Room 2026	1.20	20/1 CB	•			20/1 CB	0.36	Recept Aquarium, Elev Lobby 2007	44						
45	Recept Room 2027	0.80	20/1 CB	•			20/1 CB	0.36	Recept Aquarium, Elev Lobby 2007	46						
47	Recept Room 2029	0.40	20/1 CB	•			20/1 CB	0.36	Recept Aquarium, Waiting 2003	48						
49	Recept Room 2031	1.20	20/1 CB	•			20/1 CB	0.36	Recept Aquarium, Waiting 2003	50						
51	Recept Room 2032	1.20	20/1 CB	•			20/1 CB	0.00	Spare	52						
53	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	54						
55	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	56						
57	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	58						
59	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	60						
61	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	62						
63	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	64						
65	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	66						
67	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	68						
69	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	70						
71	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	72						
73	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	74						
75	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	76						
77	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	78						
79	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	80						
81	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	82						
83	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	84						
Rev: Revised circuits marked † Existing circuits marked ‡		Project #: B13608		Connected KVA		ØA	ØB	ØC	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI							
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL				3.12	2.36	0.76										
Notes:													NEC Feeder Factors		NEC Feed Amps	
Load Type		Conn KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps				
Recept		6.24		10 KVA @ 100%, rest @ 50%		6.24		17		x 100%		17				
		6.24		17 Amps		6.24		17				17				

SECTION 26 24 12 - PANEL SCHEDULES

Sparting		120/208V		3Ø		4W		400A Main CB		Panel	
Name: 2L2ED		Electrical Room 2061		Surface Mounted		Single Lugs		Type: Panelboard		10,000 AIC	
Location: Critical		Description		Load		CB *		A B C		CB *	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Equip Metal Detector, Security 2004	0.50	20/1 CB	•			20/1 CB	0.90	Receipt Phys. Work 2072	2	
3	Receipt Security Desk 2004	0.36	20/1 CB	•			20/1 CB	0.90	Receipt Phys. Work 2072	4	
5	Receipt Front Desk Reception 2006	0.36	20/1 CB	•			20/1 CB	0.90	Receipt Nurse Station 2074	6	
7	Pat. Room Triage 2062	0.54	20/1 CB	•			20/1 CB	0.90	Receipt Nurse Station 2074	8	
9	Pat. Room Triage 2059	0.54	20/1 CB	•			20/1 CB	1.00	Equip Pyxis, Meds 2142	10	
11	Pat. Room Triage 2052	0.54	20/1 CB	•			20/1 CB	1.60	Equip (2) Meds refrigerators, Meds 2142	12	
13	Pat. Room Triage 2048	0.54	20/1 CB	•			20/1 CB	0.90	Receipt Storage 2134, Clean 2137	14	
15	Equip Ice Machine, Work 2055	1.92	20/1 CB	•			20/1 CB	1.92	Equip Ice machine, AGVS Clean 2137	16	
17	Lighting Cold Cathode at Reception Desk	1.00	20/1 CB	•			20/1 CB	1.00	Equip Pyxis, Meds 2131	18	
19	Lighting X-Ray Room 2026	0.90	20/1 CB	•			20/1 CB	0.80	Equip Meds Refrigerator, Meds 2131	20	
21	Lighting X-Ray Room 2032	0.90	20/1 CB	•			20/1 CB	0.90	Receipt Phys. Work 2127	22	
23	Lighting Ex Rms 2114,2115,2118	1.15	20/1 CB	•			20/1 CB	0.90	Receipt Phys. Work 2127	24	
25	Lighting Ex Rms 2122,2123,2124,2037	1.54	20/1 CB	•			20/1 CB	0.90	Receipt Nurse Station 2125	26	
27	Lighting Ex Rms 2038,2039,3041	1.15	20/1 CB	•			20/1 CB	0.90	Receipt Nurse Station 2125	28	
29	Lighting Ex Rms 2095,2166,2165	1.15	20/1 CB	•			20/1 CB	1.54	Lighting Ex Rms 2093,2092,2091,2089	30	
31	Lighting Ex Rms 2104,2103,2161	1.54	20/1 CB	•			20/1 CB	1.54	Lighting Ex Rms 2088,2085,2082,2077	32	
33	Lighting Ex Rms 2157,2155,2154	1.15	20/1 CB	•			20/1 CB	1.54	Lighting Ex Rms 2076,2075,2071,2022	34	
35	Lighting Ex Rms 2146,2149,2143	1.15	20/1 CB	•			20/1 CB	1.15	Lighting Ex Rms 2021,2018,2017,2025	36	
37	Receipt Electrical Rm 2061	0.54	20/1 CB	•			20/1 CB	1.50	Equip Ambulance Gate	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H= HID Rated S = Shunt Trip C = HACR Rated D= Switching Duty # = see note A = AFCI		
Project #: B13608		Demand KVA		13.53	13.18	12.44					
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		17.39	9.36	10.24					
Notes: Internal TVSS		Internal TVSS		Demand KVA		Demand Amps		NEC Demand Factor		NEC Feeder Factors	
Lighting	17.39	17.39	48	x 100%				10 KVA @ 100%, rest @ 50%		x 125%	
Receipt	9.36	9.36	26	x 100%				50 KVA @ 40%, rest @ 20%		x 100%	
Equip	10.24	10.24	28	x 100%						x 100%	
Pat. Room	2.16	2.16	2	x 100%						x 100%	
39.15 109 Amps		37.85		105						117	

SECTION 26 24 12 - PANEL SCHEDULES

Spurling		120/208V		3Ø		4W		400A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep		
Name:	2L2EE	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
Location:	IS Room 2136	Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Receipt IS Rm 2136	2	
Serves:	Critical	Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Receipt IS Rm 2136	4	
		Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Receipt IS Rm 2136	6	
		Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Receipt IS Rm 2136	8	
		Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Receipt IS Rm 2136	10	
		Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Receipt IS Rm 2136	12	
		Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Receipt IS Rm 2136	14	
		Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Spare	16	
		Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Spare	18	
		Equip IS Rack, IS Rm 2136	1.50	20/1	CB	•		20/1	CB	Spare	20	
		Equip IS Rack, LV Rm. 2033	1.50	20/1	CB	•		20/1	CB	Spare	22	
		Equip IS Rack, LV Rm. 2033	1.50	20/1	CB	•		20/1	CB	Spare	24	
		Equip IS Rack, LV Rm. 2033	1.50	20/1	CB	•		20/1	CB	Spare	26	
		Equip Rm 2270	0.36	20/1	CB	•		20/1	CB	Spare	28	
		Equip Rm 2270	0.36	20/1	CB	•		20/1	CB	Spare	30	
		Equip Rm 2270	0.36	20/1	CB	•		20/1	CB	Spare	32	
		Equip Rm 2270	0.36	20/1	CB	•		20/1	CB	Spare	34	
		Spare	0.00	20/1	CB	•		20/1	CB	Receipt LV Rm 2033	36	
		Spare	0.00	20/1	CB	•		20/1	CB	Receipt LV Rm 2033	38	
		Spare	0.00	20/1	CB	•		20/1	CB	Receipt LV Rm 2033	40	
		Spare	0.00	20/1	CB	•		20/1	CB	Spare	42	
Rev:	Revised circuits marked † Existing circuits marked ‡	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note										
Project #:	B13608											
File:	N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes:	Internal TVSS	Connected KVA	ØA	ØB	ØC							
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Receipt	4.68	10 KVA @ 100%, rest @ 50%	4.68	13	13	x 100%	13					
Equip	37.14	x 100%	37.14	103	103	x 100%	103					
	41.82	116 Amps	41.82	116	116		116					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		150A Main CB		Panel	
Name: 21A - SECT 1								Surface Mounted		Type: Panelboard	
Location: Electrical Room 2105								Feed Thru Lugs		10,000 AIC	
Serves: Normal										Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Receipt South Nurse Station 2078	0.54	20/1 CB	•			20/1 CB	0.54	Receipt Phys Work 2113	2	
3	Receipt South Nurse Station Desks 2078	0.54	20/1 CB	•			20/1 CB	0.54	Receipt Phys Work 2113	4	
5	Receipt South Nurse Station Desks 2078	0.54	20/1 CB	•			20/1 CB	1.64	Equip Copier, Phys Work 2113	6	
7	Receipt North Nurse Station Desks 2078	0.72	20/1 CB	•			20/1 CB	0.72	Receipt Nurse Station 2111	8	
9	Receipt North Nurse Station Desks 2078	0.72	20/1 CB	•			20/1 CB	0.72	Receipt Nurse Station 2111	10	
11	Receipt Nurse Station 2081	0.72	20/1 CB	•			20/1 CB	0.72	Receipt Meds 2158	12	
13	Receipt Nurse Station 2081	0.72	20/1 CB	•			20/1 CB	1.26	Receipt Meds 2163, Hskp. 2164	14	
15	Equip Floor Copier, Nurse Station 2081	1.38	20/1 CB	•			20/1 CB	0.90	Receipt Pat. Toilet 2096-97, Storage 2098	16	
17	Receipt Phy. Work 2086	0.54	20/1 CB	•			20/1 CB	1.26	Receipt Corridor 2087, 2094, Alcove 2064A	18	
19	Receipt Phy. Work 2086	0.54	20/1 CB	•			20/1 CB	1.08	Receipt Pharmacy 2101	20	
21	Receipt Storage 2153, East Wall	1.08	20/1 CB	•			20/1 CB	1.08	Receipt Pharmacy 2101, Alcove 2099A	22	
23	Receipt Soiled 2151	0.90	20/1 CB	•			20/1 CB	0.90	Receipt Pharmacy 2101 Island	24	
25	Receipt Chart 2144A	0.36	20/1 CB	•			20/1 CB	0.54	Receipt Equip Rm. 2102	26	
27	Equip Microwave, Storage 21	1.20	20/1 CB	•			20/1 CB	0.54	Receipt Equip Rm. 2102	28	
29	Equip Coffee Maker, Storage 2153	1.52	20/1 CB	•			20/1 CB	0.90	Receipt Corridors 2108-62, Elev Lobby 2107	30	
31	<Multi> Refrigerator, Storage 2153	1.56	20/1 CB	•			20/1 CB	1.00	Equip Pneumatic Tube System Diverter	32	
33	Receipt South Nurse Station Desks 2116	0.72	20/1 CB	•			20/1 CB	0.18	Receipt Outside East	34	
35	Receipt South Nurse Station Desks 2116	0.72	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Equip Floor Copier, Nurse Station 2116	1.38	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Receipt North Nurse Station Desks 2116	0.72	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Receipt North Nurse Station Desks 2116	0.72	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡											
Project #: B13608											
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Receipt	25.72	10 KVA @ 100%, rest @ 50%	17.86	50	x 100%	50					
Equip	11.17	x 100%	11.17	31	x 100%	31					
Misc	1.00	x 100%	1.00	3	x 100%	3					
Pat. Room	25.56	50 KVA @ 40%, rest @ 20%	10.22	28	x 100%	28					
	63.45	176 Amps	40.25	112		112					

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Spartling		2LA - SECT 2		120/208V		3Ø		4W		150A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	Location:	Normal	Revised	Existing	Marked †	Marked ‡	Marked †	Marked ‡	Marked †	Marked ‡	Marked †	Marked ‡	Marked †
#	Description	Load	CB *	A	B	C	CB *	ØA	ØB	ØC	Load	Description	#
43	Pat. Room Exam Rm. 2104	1.08	20/1 CB	•			20/1 CB				0.90	Pat. Room Isolation Exam Rm. 2082	44
45	Pat. Room Exam Rm. 2103	1.08	20/1 CB	•			20/1 CB				1.18	<Multi> Isolation Exam Rm. 2082, 2084, 2085	46
47	Pat. Room Exam Rm. 2114	1.08	20/1 CB	•			20/1 CB				0.90	Pat. Room Isolation Exam Rm. 2085	48
49	Pat. Room Exam Rm. 2115	1.08	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2088	50
51	Pat. Room Isolation Exam Rm. 2118	0.90	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2089	52
53	<Multi> Isolation Exam Rm. 2118, 2121, 2122	1.18	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2091	54
55	Pat. Room Isolation Exam Rm. 2122	0.90	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2092	56
57	Pat. Room Exam Rm. 2154	1.08	20/1 CB	•			20/1 CB				1.00	Misc Bariatric Lift, Exam Rm. 2092	58
59	Pat. Room Exam Rm. 2155	1.08	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2093	60
61	Pat. Room Exam Rm. 2132	1.08	20/1 CB	•			20/1 CB				0.72	Pat. Room Secure Exam Rm. 2145	62
63	Recept Trauma Rm 2109	0.36	20/1 CB	•			20/1 CB				0.72	Pat. Room Secure Exam Rm. 2148	64
65	Recept Trauma Rm 2161	0.36	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2146	66
67	Recept CT Room 2296	0.80	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2149	68
69	Recept CT Room 2296	0.80	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2165	70
71	Spare	0.00	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2166	72
73	Spare	0.00	20/1 CB	•			20/1 CB				1.08	Pat. Room Exam Rm. 2195	74
75	Spare	0.00	20/1 CB	•			20/1 CB				1.00	Equip Pneumatic Tube System Diverter	76
77	Spare	0.00	20/1 CB	•			20/1 CB				1.00	Equip Pneumatic Tube System Diverter	78
79	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	80
81	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	82
83	Spare	0.00	20/1 CB	•			20/1 CB				0.00	Spare	84
Rev:		* Circuit Breaker Code											
Revised circuits marked † Existing circuits marked ‡		G = GFCI											
Project #: B13608		H= HID Rated											
File: N:\B13608\sched\B13608 multicare		C = HACR Rated											
ED_CCE.PNL		# = see note											
Notes:													
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Recept	2.32	10 KVA @ 100%, rest @ 50%	2.32	6	x 100%	6							
Equip	2.20	x 100%	2.20	6	x 100%	6							
Misc	1.00	x 100%	1.00	3	x 100%	3							
Pat. Room	25.56	50 KVA @ 40%, rest @ 20%	10.22	28	x 100%	28							
	31.08	86 Amps	15.74	44		44							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		2LB - SECT 1		120/208V		3Ø		4W		225A Main CB		Panel	
Name:		Electrical Rm. 2061		Surface Mounted		Feed Thru Lugs		Type: Panelboard		10,000 AIC		Deep	
Location:		Normal		Load		CB *		A B C		CB *		Description	
Serves:		Normal		Load		CB *		A B C		CB *		Description	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Pat. Room Exam Rm. 2017	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2041	2			
3	Pat. Room Exam Rm. 2018	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2039	4			
5	Pat. Room Exam Rm. 2021	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2038	6			
7	Pat. Room Exam Rm. 2022	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2037	8			
9	Pat. Room Exam Rm. 2071	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2124	10			
11	Pat. Room Exam Rm. 2075	1.08	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Rm 2124	12			
13	Pat. Room Exam Rm. 2076	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2123	14			
15	Pat. Room Exam Rm. 2077	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2035	16			
17	Pat. Room Exam Rm. 2025	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 2132	18			
19	Pat. Room Exam Rm. 2143	1.08	20/1 CB	•			20/1 CB	0.40	Recept Room 2029	20			
21	Recept Water Feature	0.50	20/1 CB	•			20/1 CB	0.60	Recept Room 2026	22			
23	Recept Water Feature	0.50	20/1 CB	•			20/1 CB	0.60	Recept Room 2029	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.60	Recept Room 2031	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev:		Revised circuits marked † Existing circuits marked ‡											
Project #:		B13608											
File:		N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes:		Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Recept	28.76	10 KVA @ 100%, rest @ 50%	19.38	54	x 100%	54							
Equip	11.74	x 100%	11.74	33	x 100%	33							
Misc	1.00	x 100%	1.00	3	x 100%	3							
Pat. Room	20.88	50 KVA @ 40%, rest @ 20%	8.35	23	x 100%	23							
	62.38	173 Amps	40.47	112		112							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		2LB - SECT 2		120/208V		3Ø		4W		225A Main lugs only Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	Location:	Serves:	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
			Receipt VP Support 2008	0.54	20/1 CB	•			20/1 CB	0.90	Receipt Reception Desk 2006	44	
			Equip W. Kiosk, Self Check 2005	0.50	20/1 CB	•			20/1 CB	0.72	Receipt Reception Desk 2006, Work 2054	46	
			Equip E. Kiosk, Self Check 2005	0.50	20/1 CB	•			20/1 CB	1.38	Equip Floor Copier, Work 2054	48	
			Spare	0.00	20/1 CB	•			20/1 CB	0.72	Pat. Room Triage Rms 2059 & 2062	50	
			Spare	0.00	20/1 CB	•			20/1 CB	0.72	Pat. Room Triage Rms 2048 & 2052	52	
			Receipt Waiting 2009	1.08	20/1 CB	•			20/1 CB	1.08	Receipt Work 2055	54	
			Equip Bubble Wall, Waiting 2009	0.18	20/1 CB	•			20/1 CB	0.90	Receipt Discharge Rm 2063	56	
			Receipt Waiting 2009, Elevator Lobby 2007	0.90	20/1 CB	•			20/1 CB	0.90	Receipt Discharge Rm 2049	58	
			Equip Vending Machine, Vend. 2011	1.20	20/1 CB	•			20/1 CB	1.08	Receipt Quiet Rm 2015 & 2045, Staff Toilet 2053	60	
			Equip Vending Machine, Vend. 2011	1.20	20/1 CB	•			20/1 CB	0.90	Receipt Hall 2064, Pat Toilet 2023 & 2034	62	
			Receipt Public Toilet, 2013, 2014	0.36	20/1 CB	•			20/1 CB	0.90	Receipt Office 2058	64	
			Spare	0.00	20/1 CB	•			20/1 CB	0.72	Receipt Office 2058 & 2056	66	
			Spare	0.00	20/1 CB	•			20/1 CB	0.90	Receipt Office 2056	68	
			Receipt Waiting 2002	1.26	20/1 CB	•			20/1 CB	1.08	Receipt South Corridors	70	
			Equip Bubble Wall, Waiting 2002	0.18	20/1 CB	•			20/1 CB	0.18	Receipt Eastside Outside	72	
			Equip Water Chiller, Hall 2044	1.20	20/1 CB	•			20/1 CB	0.00	Spare	74	
			Equip Vending Machine, Vend 2046	1.20	20/1 CB	•			20/1 CB	0.00	Spare	76	
			Equip Vending Machine, Vend 2046	1.20	20/1 CB	•			20/1 CB	0.00	Spare	78	
			Receipt Public Toilets 2042 & 2043	0.36	20/1 CB	•			20/1 CB	0.00	Spare	80	
			Equip Water Cooler Drinking Fountain 2012	1.20	20/1 CB	•			20/1 CB	0.00	Spare	82	
			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	84	
Rev:	Revised circuits marked ‡ Existing circuits marked †												
Project #:	B13608												
File:	N:\B13608\sched\B13608 multicare ED_CCE.PNL												
Notes:	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note												
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Receipt	25.56	10 KVA @ 100%, rest @ 50%	17.78	49	x 100%	49							
Equip	11.74	x 100%	11.74	33	x 100%	33							
Pat. Room	1.44	50 KVA @ 40%, rest @ 20%	0.58	2	x 100%	2							
	38.74	108 Amps	30.10	84		84							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		21B - SECT 3		120/208V		3 Ø		4W		225A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	Location:	Serves:	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
85	Electrical Room 2061	Normal	Receipt Phys. Work 2072	0.90	20/1 CB	•			20/1 CB	0.90	Receipt Storage 2134	86	
87			Receipt Phys. Work 2072	0.90	20/1 CB	•			20/1 CB	0.72	Receipt AGVS Clean	88	
89			Receipt Nurse Station 2074	0.72	20/1 CB	•			20/1 CB	0.90	Receipt Meds 2131	90	
91			Receipt Nurse Station 2074	0.54	20/1 CB	•			20/1 CB	0.54	Receipt Phys. Work 2127	92	
93			Equip Printer, Nurse Station 2074	0.80	20/1 CB	•			20/1 CB	0.54	Receipt Phys. Work 2127	94	
95			Receipt Meds 2142	0.90	20/1 CB	•			20/1 CB	0.72	Receipt Nurse Station 2125	96	
97			Receipt Toilet 2128-29, 2139-41, Storage 2134	0.90	20/1 CB	•			20/1 CB	0.72	Receipt Nurse Station 2125	98	
99			Receipt AGVS Soiled	0.90	20/1 CB	•			20/1 CB	1.00	Equip Pneumatic Tube Divertor	100	
101			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	102	
103			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	104	
105			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	106	
107			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	108	
109			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	110	
111			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	112	
113			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	114	
115			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	116	
117			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	118	
119			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	120	
121			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	122	
123			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	124	
125			Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	126	
Rev: Revised circuits marked † Existing circuits marked ‡				Connected KVA		ØA	ØB	ØC	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note				
Project #: B13608				Demand KVA		4.50	4.86	3.24					
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL													
Notes:													
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Receipt	10.80	10 KVA @ 100%, rest @ 50%	10.40	29	x 100%	29							
Equip	1.80	x 100%	1.80	5	x 100%	5							
	12.60	35 Amps	12.20	34		34							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		400A Main CB Surface Mounted Feed thru & Double Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name: 2LXR		Location: Electrical Room 2105		Serves: X-Ray		Description		Load		#	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	2	
3	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	4	
5	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	6	
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8	
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10	
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12	
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked ‡ Existing circuits marked †		Project #: B13608		File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI					
Notes: Internal TVSS		Demand KVA		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
X-Ray		102.60		Largest @ 50%, next @ 25%, rest @ 10%		50.40		140		140	
		102.60		285 Amps		50.40		140		140	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		3HIE		277/480V		3 Ø		4W		400A Main CB		Panel	
Name:		Electrical Room 3105		Surface Mounted		Feed Thru Lugs						Type: Panelboard	
Location:		Life Safety										25,000 AIC	
Serves:												Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Spare	0.00	20/1 CB	•			20/1 CB	2.56	Lighting Corridor	2			
3	Spare	0.00	20/1 CB	•			20/1 CB	2.01	Lighting Corridor	4			
5	Spare	0.00	20/1 CB	•			20/1 CB	1.47	Lighting Corridor	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev:		Revised circuits marked † Existing circuits marked ‡										* Circuit Breaker Code	
Project #:		B13608										H= HID Rated	
File:		N:\B13608\sched\B13608 multicare										C = HACR Rated	
		ED_CCE,PNL										# = see note	
Notes:		Internal TVSS										G = GFCI	
												S = Shunt Trip	
												D = Switching Duty	
												A = AFCI	
Load Type		Conn KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Lighting		21.30		x 100%		21.30		26		x 125%		32	
		21.30		26 Amps		21.30		26				32	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		3H2EA		277/480V		3 Ø		4W		225A Main CB		Panel	
Name:		Electrical Room 3105		Surface Mounted		Single Lugs						Type: Panelboard	
Location:		Critical										25,000 AIC	
Serves:												Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Spare	0.00	20/1 CB	.	.	.	20/1 CB	3.66	Lighting Exam Rooms	2			
3	Spare	0.00	20/1 CB	.	.	.	20/1 CB	2.99	Lighting Exam Rooms	4			
5	Spare	0.00	20/1 CB	.	.	.	20/1 CB	2.59	Lighting Exam Rooms	6			
7	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	42			
Rev: Revised circuits marked † Existing circuits marked ‡													
Project #: B13608													
File: N:\B13608\sched\B13608 multicare													
ED_CCE.PNL													
Notes:		Internal TVSS											
Load Type		Conn KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Lighting		9.25		x 100%		9.25		11		x 125%		14	
		9.25		11 Amps		9.25		11				14	

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		3HB		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep		
#	Description	Load	CB *	A	B	C	CB *	CB *	CB *	CB *	CB *	Load	Description	#
1	Lighting	3.68	20/1	CB	•		20/1	CB				1.77	Lighting	2
3	Lighting	3.75	20/1	CB	•		20/1	CB				1.51	Lighting	4
5	Lighting	3.99	20/1	CB	•		20/1	CB				0.63	Lighting	6
7	Lighting	3.96	20/1	CB	•		20/1	CB				1.51	Lighting	8
9	Lighting	4.14	20/1	CB	•		20/1	CB				0.90	Lighting	10
11	Lighting	2.71	20/1	CB	•		20/1	CB				0.00	Spare	12
13	Lighting	2.91	20/1	CB	•		20/1	CB				0.00	Spare	14
15	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	16
17	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	18
19	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	20
21	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	22
23	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	24
25	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	26
27	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	28
29	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	30
31	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	32
33	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	34
35	Spare	0.00	20/1	CB	•		20/1	CB				0.00	Spare	36
37	Spare	0.00	20/1	CB	•		150/3	CB				34.27	Panel 3LB-SECT 1	38
39	Spare	0.00	20/1	CB	•		-----	---				33.93	-----3LB-SECT 1	40
41	Spare	0.00	20/1	CB	•		-----	---				25.86	-----3LB-SECT 1	42
Rev: Revised circuits marked † Existing circuits marked ‡		Project #: B13608		File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Notes: Internal TVSS		* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI		H = HID Rated C = HACR Rated # = see note				
Demand KVA		Demand KVA		Demand KVA		Demand Amps		NEC Demand Factor		NEC Feeder Factors		NEC Feed Amps		
Lighting	31.45	31.45	38	38	38	38	38	38	x 100%	x 125%	x 125%	47		
Recept	27.22	18.61	22	22	22	22	22	22	10 KVA @ 100%, rest @ 50%	x 100%	x 100%	22		
Equip	19.00	19.00	23	23	23	23	23	23	x 100%	x 100%	x 100%	23		
Misc	23.00	23.00	28	28	28	28	28	28	x 100%	x 100%	x 100%	28		
Pat. Room	23.76	9.50	11	11	11	11	11	11	50 KVA @ 40%, rest @ 20%	x 100%	x 100%	11		
Spare	1.08	1.08	1	1	1	1	1	1	x 100%	x 100%	x 100%	1		
125.50		151 Amps		102.64		123						133		

SECTION 26 24 12 - PANEL SCHEDULES

Spurling		Name: 3HXR		277/480V		3 Ø		4W		400A Main CB		Panel	
		Location: Electrical Room 3105								Surface Mounted		Type: Panelboard	
		Serves: X-Ray								Feed thru & Double Lugs		25,000 AIC	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	Deep		
1	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	2			
3	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	4			
5	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev:		* Circuit Breaker Code											
Revised circuits marked † Existing circuits marked ‡		G = GFCI											
Project #: B13608		H = HID Rated											
File: N:\B13608\sched\B13608 multicare		S = Shunt Trip											
ED_CCE.PNL		D = Switching Duty											
		A = AFCI											
Notes:		Internal TVSS											
Load Type		Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors		NEC Feed Amps					
X-Ray	211.86	Largest @ 50%, next @ 25%, rest @ 10%	75.64	91	x 100%		91						
	211.86	255 Amps	75.64	91			91						

SECTION 26 24 12 - PANEL SCHEDULES

Spartling		120/208V		3Ø		4W		175A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	3L1E										
Location:	Electrical Room 3007										
Serves:	Life Safety										
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Equip Medical Gas Alarm Panel, Corridor 3071	0.50	20/1 CB	.	.	.	20/1 CB	3.14	Equip Auto-Door AGV5 Soiled	2	
3	Equip Medical Gas Alarm Panel, Corridor 3126C	0.50	20/1 CB	.	.	.	20/1 CB	3.14	Equip Auto-Door AGV5 Clean	4	
5	Equip Auto-door, Corridor 3046	1.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	6	
7	Equip Auto-door, Corridor 3023	1.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	8	
9	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	10	
11	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	12	
13	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	14	
15	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	16	
17	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	42	
Rev:	Revised circuits marked † Existing circuits marked ‡										
Project #:	B13608										
File:	N:\B13608\sched\B13608 multicare ED_CCE.PNL										
Notes:	Internal TVSS										
Load Type	Cornt KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Equip	24.78	x 100%	24.78	69	x 100%	69					
	24.78	69 Amps	24.78	69		69					

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HIID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparting		120/208V		3Ø		4W		400A Main CB Surface Mounted		Panel Type: Panelboard 10,000 AIC Deep	
Name: 3L2EA		Location: Electrical Rm 3105		Critical		Feed thru & Double Lugs					
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Spare	0.00	20/1 CB	•			20/1 CB	1.26	Recept Nurse Station 3079	2	
3	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Recept Nurse Station 3079	4	
5	Equip Refrigerators, Meds 3153	1.60	20/1 CB	•			20/1 CB	0.36	Recept Electrical Rm 3105	6	
7	Equip Pyxis, Meds 3153	1.00	20/1 CB	•			20/1 CB	1.20	Recept X-Ray Room 3117	8	
9	Recept Alcove 3125A	0.18	20/1 CB	•			20/1 CB	0.80	Recept X-Ray Room 3117	10	
11	Recept Nurse Station 3125	0.90	20/1 CB	•			20/1 CB	0.00	Spare	12	
13	Recept Nurse Station 3125	0.72	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Recept Nurse Station 3136	0.90	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Recept Nurse Station 3136	1.08	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Equip Copier, Nurse Station 3136	1.38	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Recept Storage 3139	0.90	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Recept Phys Work 3138	0.90	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Recept Phys Work 3138	0.90	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Equip Ice Machine, AGVS Clean Rm 3143	1.92	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Equip Pyxis, Meds 3144	1.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Equip Refrigerators, Meds 3144	1.60	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Recept Phys Work 3069	1.08	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Recept Phys Work 3069	0.72	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Recept Nurse Station 3072	1.08	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Recept Nurse Station 3072	0.90	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code		
Project #: B13608		9.14		7.76	6.56			G = GFCI			
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL									H = HIID Rated		
									C = HACR Rated		
									# = see note		
									D = Switching Duty		
									A = AFCI		
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Recept	53.64	10 KVA @ 100%, rest @ 50%	31.82	88	x 100%	88					
Equip	25.62	x 100%	25.62	71	x 100%	71					
Misc	2.40	x 100%	2.40	7	x 100%	7					
Pat. Room	51.84	50 KVA @ 40%, rest @ 20%	20.37	57	x 100%	57					
	133.50	371 Amps	80.20	223		223					

SECTION 26 24 12 - PANEL SCHEDULES

Spartling		120/208V		3Ø		4W		400A Main CB Surface Mounted		Panel Type: Panelboard 10,000 AIC Deep	
Name: 3L2EB - SECT 1		Location: Electrical Rm 3105		Critical		Feed thru & Double Lugs					
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Pat. Room Exam Rm. 3073	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3147	2	
3	Pat. Room Exam Rm. 3073	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3147	4	
5	Pat. Room Exam Rm. 3074	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3148	6	
7	Pat. Room Exam Rm. 3074	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3148	8	
9	Pat. Room Exam Rm. 3077	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3149	10	
11	Pat. Room Exam Rm. 3077	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3149	12	
13	Pat. Room Exam Rm. 3078	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3121	14	
15	Pat. Room Exam Rm. 3078	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3121	16	
17	Pat. Room Exam Rm. 3082	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3123	18	
19	Pat. Room Exam Rm. 3082	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3123	20	
21	Pat. Room Exam Rm. 3086	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3127	22	
23	Pat. Room Exam Rm. 3086	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3127	24	
25	Pat. Room Exam Rm. 3087	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3128	26	
27	Pat. Room Exam Rm. 3087	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3128	28	
29	Pat. Room Exam Rm. 3092	0.54	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Pat. Room Exam Rm. 3092	1.08	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Pat. Room Exam Rm. 3099	0.54	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Pat. Room Exam Rm. 3099	1.08	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev:	Revised circuits marked † Existing circuits marked ‡										
Project #:	B13608										
File:	N:\B13608\sched\B13608 multicare ED_CCE.PNL										
Notes:	Internal TVSS										
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Lighting	25.95	x 100%	25.95	72	x 125%	90					
Receipt	26.58	10 KVA @ 100%, rest @ 50%	18.29	51	x 100%	51					
Equip	20.00	x 100%	20.00	56	x 100%	56					
Pat. Room	81.00	50 KVA @ 40%, rest @ 20%	26.20	73	x 100%	73					
Elevator	1.92	Up to 72%, per 620-14	1.92	5	x 100%	5					
	155.45	431 Amps	92.36	256		274					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		400A Main lugs only Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	3L2EB - SECT 2										
Location:	Electrical Rm 3105										
Serves:											
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
43	Pat. Room Exam Room 3135	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Room 3131	44	
45	Pat. Room Exam Room 3135	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Room 3131	46	
47	Pat. Room Exam Room 3140	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Room 3132	48	
49	Pat. Room Exam Room 3140	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Room 3132	50	
51	Recept Alcove 3126A	0.20	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Room 3129	52	
53	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Room 3129	54	
55	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	56	
57	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	58	
59	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	60	
61	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	62	
63	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	64	
65	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	66	
67	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	68	
69	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	70	
71	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	72	
73	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	74	
75	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	76	
77	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	78	
79	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	80	
81	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	82	
83	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	84	
Rev:		Revised circuits marked ‡ Existing circuits marked †									
Project #:		B13608									
File:		N:\B13608\sched\B13608 multicare ED_CCE.PNL									
Notes:		* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note									
		Connected KVA		ØA	ØB	ØC					
		3.24		2.90	2.16						
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Lighting	2.39	x 100%	2.39	7	x 125%	8					
Recept	2.54	10 KVA @ 100%, rest @ 50%	2.54	7	x 100%	7					
Equip	3.64	x 100%	3.64	10	x 100%	10					
Pat. Room	9.18	50 KVA @ 40%, rest @ 20%	3.67	10	x 100%	10					
Elevator	1.92	Up to 72%, per 620-14	1.92	5	x 100%	5					
	19.67	55 Amps	14.16	39		41					

SECTION 26 24 12 - PANEL SCHEDULES

Sparting		120/208V		3Ø		4W		400A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Pat. Room Exam Rm. 3026	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Isolation Exam Rm. 3043	2	
3	Pat. Room Exam Rm. 3026	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Isolation Exam Rm. 3043	4	
5	Pat. Room Exam Rm. 3027	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3047	6	
7	Pat. Room Exam Rm. 3027	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3047	8	
9	Pat. Room Isolation Exam Rm. 3032	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3048	10	
11	Pat. Room Isolation Exam Rm. 3032	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3048	12	
13	Pat. Room Isolation Exam Rm. 3036	0.54	20/1 CB	•			20/1 CB	0.54	Pat. Room Exam Rm. 3049	14	
15	Pat. Room Isolation Exam Rm. 3036	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3049	16	
17	Pat. Room Exam Rm. 3039	0.54	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Pat. Room Exam Rm. 3039	1.08	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Pat. Room Exam Rm. 3065	0.54	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Pat. Room Exam Rm. 3065	1.08	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Pat. Room Exam Rm. 3066	0.54	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Pat. Room Exam Rm. 3066	1.08	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Pat. Room Exam Rm. 3067	0.54	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Pat. Room Exam Rm. 3067	1.08	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note		
Project #: B13608		7.02		7.02	7.02	5.40					
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Notes: Internal TVSS		19.44		7.78		22		x 100%		22	
Load Type		50 KVA @ 40%, rest @ 20%		7.78		22				22	
Pat. Room		19.44		7.78		22				22	
		54 Amps		7.78		22				22	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		400A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Receipt Front Desk Reception 3011	0.36	20/1 CB	•			20/1 CB	0.54	Receipt Electrical Rm. 3007	2	
3	Pat. Room Triage Rm. 3053	0.54	20/1 CB	•			20/1 CB	0.00	Spare	4	
5	Pat. Room Triage Rm. 3061	0.54	20/1 CB	•			20/1 CB	0.00	Spare	6	
7	Equip Ice Machine Work 3054	1.92	20/1 CB	•			20/1 CB	0.00	Spare	8	
9	Receipt Pharmacy Island Desk 3022	0.18	20/1 CB	•			20/1 CB	0.00	Spare	10	
11	Receipt Pharmacy 3022	0.54	20/1 CB	•			20/1 CB	0.00	Spare	12	
13	Equip Med Dispenser, Pharmacy 3022	0.72	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Equip Pyxis, Pharmacy 3022	1.00	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Elevator Refrigerator, Pharmacy 3022	1.92	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Receipt Alcoves 3046A/B	0.36	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Receipt Alcove 3068	0.36	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Lighting X-Ray 3117	0.50	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Lighting Exams 3077,3078,3082	1.15	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Lighting Exams 3073,3074	0.74	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Lighting Exams 3026,3027,3065,3066	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note		
Project #: B13608		5.05		2.82	3.50						
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Lighting	2.39	x 100%	2.39	7	x 125%	8					
Receipt	2.34	10 KVA @ 100%, rest @ 50%	2.34	6	x 100%	6					
Equip	3.64	x 100%	3.64	10	x 100%	10					
Pat. Room	1.08	50 KVA @ 40%, rest @ 20%	0.43	1	x 100%	1					
Elevator	1.92	Up to 72%, per 620-14	1.92	5	x 100%	5					
11.37		32 Amps	10.72	30	31						

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V			3Ø 4W			400A Main CB Surface Mounted Feed Thru Lugs			Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#		
1	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 3142	2		
3	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 3142	4		
5	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 3142	6		
7	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 3142	8		
9	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 3142	10		
11	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 3142	12		
13	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 3142	14		
15	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.00	Spare	16		
17	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.00	Spare	18		
19	Equip IS Rack, IS Rm 3142	1.50	20/1 CB	•			20/1 CB	0.00	Spare	20		
21	Equip IS Rack, LV Rm 3152	1.50	20/1 CB	•			20/1 CB	0.00	Spare	22		
23	Equip IS Rack, LV Rm 3152	1.50	20/1 CB	•			20/1 CB	0.00	Spare	24		
25	Equip IS Rack, LV Rm 3152	1.50	20/1 CB	•			20/1 CB	0.00	Spare	26		
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28		
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30		
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32		
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34		
35	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 3152	36		
37	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 3152	38		
39	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 3152	40		
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42		
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip D = Switching Duty A = AFCI			
Project #: B13608		8.76	6.90	6.90								
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		7.74	56.64	157	Demand Amps		NEC Feeder Factors			
Notes: Internal TVSS		10 KVA @ 100%, rest @ 50% x 100%		7.74	56.64	157	21		x 100%			
Load Type		Conn KVA		64.38	179 Amps	179		157		179		
Receipt Equip		7.74		64.38		179		21		179		

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		225A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
3LA - SECT 1 Name: Location: Serves:		Electrical Rm 3007 Normal									
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Pat. Room Exam Rm. 3026	1.08	20/1 CB	•			20/1 CB	1.44	Pat. Room Isolation Exam Rm. 3043	2	
3	Equip Exam Rm. 3026 Auto-Shade	1.00	20/1 CB	•			20/1 CB	0.36	Pat. Room Ante 3042, Pat. T 3044	4	
5	Pat. Room Exam Rm. 3027	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3047	6	
7	Pat. Room Isolation Exam Rm. 3032	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3048	8	
9	Pat. Room Isolation Exam Rm. 3036	0.90	20/1 CB	•			20/1 CB	1.08	Pat. Room Exam Rm. 3049	10	
11	Pat. Room Ante 3034, Pat. T. 3033	0.36	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3026	12	
13	Pat. Room Exam Rm. 3039	1.08	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3027	14	
15	Pat. Room Exam Rm. 3065	1.08	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3065	16	
17	Pat. Room Exam Rm. 3066	1.08	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3066	18	
19	Equip Exam Rm. 3066 Auto-Shade	1.00	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3067	20	
21	Pat. Room Exam Rm. 3067	1.08	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3032	22	
23	Equip Exam Rm. 3067 Auto-Shade	1.00	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3036	24	
25	Misc Bariatric Lift Exam Room 3048	1.00	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3039	26	
27	Misc Bariatric Lift Exam Room 3049	1.00	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3043	28	
29	Misc Rollershade Shelled Room 3025	1.50	20/1 CB	•			20/1 CB	1.00	Misc Bariatric Lift Exam Room 3047	30	
31	Misc Rollershade Waiting Room 3020	1.50	20/1 CB	•			20/1 CB	0.50	Receipt Water Feature	32	
33	Misc Rollershade Waiting Room 3020	1.50	20/1 CB	•			20/1 CB	0.50	Receipt Water Feature	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated D = Switching Duty # = see note A = AFCI		
Project #: B13608		12.76	11.50	10.10							
File: N:\B13608\ sched\B13608 multicare ED_CCE.PNL		Demand KVA		Demand Amps							
Notes: Internal TVSS		15.58		43							
Load Type	Conn KVA	10 KVA @ 100%, rest @ 50%		Demand Amps		NEC Demand Factor		NEC Feeder Factors		NEC Feed Amps	
Receipt	21.16	x 100%		13.88		x 100%		x 100%		43	
Equip	13.88	x 100%		16.50		x 100%		x 100%		39	
Misc	16.50	x 100%		5.98		x 100%		x 100%		46	
Pat. Room	14.94	50 KVA @ 40%, rest @ 20%		17		17		17		17	
66.48 185 Amps		51.94		144		144		144		144	

SECTION 26 24 12 - PANEL SCHEDULES

Spartling		120/208V	3 Ø	4W	225A Main lugs only Surface Mounted Single Lugs			Panel Type: Panelboard 10,000 AIC Deep		
Name: 3LA - SECT 2										
Location: Electrical Rm 3007										
Serves: Normal										
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#
43	Recept Chapel Lobby and Storage 3015,3014	0.90	20/1 CB	•			20/1 CB	1.08	Recept Rms 3054,3057, 3055, 3058	44
45	Recept Office 3016	1.08	20/1 CB	•			20/1 CB	0.90	Recept Office 3059	46
47	Recept Elev Lobby, Waiting 3010	0.72	20/1 CB	•			20/1 CB	1.08	Recept Discharge 3058, 3055	48
49	Recept Waiting 3010, 3009	0.72	20/1 CB	•			20/1 CB	0.72	Recept Storage 3051, Alcove 3046B	50
51	Recept Waiting 3010, 3009	0.72	20/1 CB	•			20/1 CB	0.72	Recept SE Corridors, Pat. Toilet 3038	52
53	Equip Bubble Wall, Waiting 3020	0.50	20/1 CB	•			20/1 CB	0.72	Recept SW Corridors, Toilet 3031,3028	54
55	Recept Waiting 3020	0.90	20/1 CB	•			20/1 CB	0.54	Recept Equip. Rm. 3037	56
57	Recept Shelled Space 3025	0.72	20/1 CB	•			20/1 CB	1.08	Recept Pharmacy 3022 SW Desks	58
59	Recept WC 3008, Waiting 3005	0.90	20/1 CB	•			20/1 CB	0.90	Recept Pharmacy 3022 SE Desks	60
61	Recept Corridor 3002, Skybridge, Storage 3045	0.72	20/1 CB	•			20/1 CB	1.08	Recept Pharmacy 3022 N Wall	62
63	Equip Vending Machine	1.00	20/1 CB	•			20/1 CB	0.72	Recept Office 3024	64
65	<Multi> Womens Bathroom 3004	0.98	20/1 CB	•			20/1 CB	0.90	Recept Office 3024	66
67	<Multi> Mens Bathroom 3003	0.98	20/1 CB	•			20/1 CB	1.00	Equip Pneumatic Tube System Diverter	68
69	Equip Water Cooler 3002A	1.20	20/1 CB	•			20/1 CB	1.00	Equip Pneumatic Tube System Diverter	70
71	Recept Reception Desk 3011	0.72	20/1 CB	•			20/1 CB	0.54	Recept Exterior SW Planters	72
73	Recept Reception Desk 301L, Work 3011A	0.72	20/1 CB	•			20/1 CB	1.20	Equip Exterior SE Signage	74
75	Equip Copy Machine, Work 3011A	1.38	20/1 CB	•			20/1 CB	1.00	Equip Pneumatic Tube System Diverter	76
77	Pat. Room Triags 3053	0.54	20/1 CB	•			20/1 CB	1.00	Equip Pneumatic Tube System Diverter	78
79	Pat. Room Triags 3061	0.54	20/1 CB	•			20/1 CB	0.00	Spare	80
81	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	82
83	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	84

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare ED\_CCE.PNL

Notes:

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Recept	20.16	10 KVA @ 100%, rest @ 50%	15.08	42	x 100%	42
Equip	10.88	x 100%	10.88	30	x 100%	30
Pat. Room	1.08	50 KVA @ 40%, rest @ 20%	0.43	1	x 100%	1
	32.12	89 Amps	26.39	73		73

\* Circuit Breaker Code  
 G = GFCI  
 H = HID Rated  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		31B - SECT 1		120/208V		3 Ø		4W		225A Main CB		Panel			
Name:		Electrical Rm 3105		Surface Mounted		Feed Thru Lugs		Type: Panelboard		10,000 AIC		Deep			
Location:		Normal		Load		CB *		A B C		CB *		Description			
#	Description	Load	CB *	A	B	C	CB *	Load	Description	Load	Description	#			
1	Pat. Room Exam Rm. 3073	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3147	2				
3	Pat. Room Exam Rm. 3074	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3148	4				
5	Equip Exam Rm. 3074 Auto-Shade	1.00	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3149	6				
7	Pat. Room Exam Rm. 3077	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3121	8				
9	Equip Exam Rm. 3077 Auto-Shade	1.00	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3123	10				
11	Pat. Room Exam Rm. 3078	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3127	12				
13	Pat. Room Exam Rm. 3082	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3128	14				
15	Pat. Room Exam Rm. 3086	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3131	16				
17	Pat. Room Exam Rm. 3087	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3132	18				
19	Pat. Room Exam Rm. 3092	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3135	20				
21	Pat. Room Exam Rm. 3099	1.08	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3140	22				
23	Misc Bariatric Lift Exam Room 3121	1.00	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3129	24				
25	Misc Bariatric Lift Exam Room 3123	1.00	20/1 CB	•			20/1	CB	1.08	Pat. Room Exam Rm. 3129	26				
27	Misc Bariatric Lift Exam Room 3127	1.00	20/1 CB	•			20/1	CB	1.00	Misc Bariatric Lift Exam Room 3135	28				
29	Misc Bariatric Lift Exam Room 3128	1.00	20/1 CB	•			20/1	CB	1.00	Misc Bariatric Lift Exam Room 3140	30				
31	Misc Bariatric Lift Exam Room 3131	1.00	20/1 CB	•			20/1	CB	1.50	Misc Rollershade Shell 3085	32				
33	Misc Bariatric Lift Exam Room 3132	1.00	20/1 CB	•			20/1	CB	1.50	Misc Rollershade Shell 3085	34				
35	Spare	0.00	20/1 CB	•			20/1	CB	0.00	Spare	36				
37	Spare	0.00	20/1 CB	•			20/1	CB	0.00	Spare	38				
39	Spare	0.00	20/1 CB	•			20/1	CB	0.00	Spare	40				
41	Spare	0.00	20/1 CB	•			20/1	CB	0.00	Spare	42				
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code						
Project #: B13608		13.22		13.06	10.48			G = GFCI		H = HID Rated					
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL									S = Shunt Trip		C = HACR Rated				
									D = Switching Duty		# = see note				
									A = AFCI						
Notes: Internal TVSS															
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps									
Receipt	27.22	10 KVA @ 100%, rest @ 50%	18.61	52	x 100%	52									
Equip	19.00	x 100%	19.00	53	x 100%	53									
Misc	23.00	x 100%	23.00	64	x 100%	64									
Pat. Room	23.76	50 KVA @ 40%, rest @ 20%	9.50	26	x 100%	26									
Spare	1.08	x 100%	1.08	3	x 100%	3									
	94.06	261 Amps	71.19	198		198									

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		225A Main lugs only Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	3LB - SECT 2	Description	Load	CB *	A	B	C	CB *	Load	Description	#
Location:	Electrical Rm 3105	<Multi> Corridor 3107, Toilets 3108, 3109	1.72	20/1	•	•	•	20/1	0.72	Recept Nurse Station 3125	44
Serves:	Normal	Equip Copier, Storage 3103	1.38	20/1	•	•	•	20/1	0.72	Recept Nurse Station 3125	46
		Recept Storage 3103	0.72	20/1	•	•	•	20/1	0.54	Recept Nurse Station 3136	48
		Recept Office 3102	0.90	20/1	•	•	•	20/1	0.36	Recept Nurse Station 3136	50
		Recept Office 3098	0.72	20/1	•	•	•	20/1	0.72	Recept Nurse Station 3136	52
		Recept Office 3098	0.90	20/1	•	•	•	20/1	0.90	Recept Storage 3139	54
		Recept Rms 3101, 3096, 3090	0.90	20/1	•	•	•	20/1	0.90	Recept AGVS Soiled 3141	56
		Recept Dining 3088	1.26	20/1	•	•	•	20/1	0.72	Recept Phys Work 3138	58
		Recept Shelled Space 3085	1.08	20/1	•	•	•	20/1	0.72	Recept Phys Work 3138	60
		<Multi> Microwave, Kitchen 3089	1.38	20/1	•	•	•	20/1	0.80	Equip UC Refrigerator, Phys Work 3138	62
		Equip Coffee Machine, Kitchen 3089	1.52	20/1	•	•	•	20/1	0.72	Recept Hskp. 3145, Meds 3144	64
		<Multi> Refrigerator, Kitchen 3089	0.98	20/1	•	•	•	20/1	0.72	Recept AGVS Clean 3143	66
		Equip Microwave, Alcove 3126A	1.21	20/1	•	•	•	20/1	0.80	Recept Refrigerator, AGVS Clean 3143	68
		Equip Coffee Machine, Alcove 3126A	1.52	20/1	•	•	•	20/1	0.54	Recept Phys Work 3069	70
		Equip Refrigerator, Alcove 3126A	0.98	20/1	•	•	•	20/1	0.54	Recept Phys Work 3069	72
		Recept Alcove 3125, Meds 3153	0.72	20/1	•	•	•	20/1	0.90	Recept Nurse Station 3072	74
		Equip Refrigerator, Meds 3153	0.80	20/1	•	•	•	20/1	0.72	Recept Nurse Station 3072	76
		Recept Corridor 3119, 3093, Toilet 3151	0.54	20/1	•	•	•	20/1	1.38	Equip Copier, Nurse Station 3072	78
		Recept Corridor 3071	0.72	20/1	•	•	•	20/1	1.26	Recept Nurse Station 3079	80
		Recept Pat Toilet 3075, HSKP 3084	0.54	20/1	•	•	•	20/1	1.08	Spare Nurse Station 3079	82
		Spare	0.00	20/1	•	•	•	20/1	0.00	Spare	84
Rev:	Revised circuits marked † Existing circuits marked ‡										
Project #:	B13608										
File:	N:\B13608\shed\B13608 multicare ED_CCE.PNL										
Notes:											
		Connected KVA	ØA	ØB	ØC	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps		
Recept	27.22	13.29	12.97	10.00	18.61	52	x 100%		52		
Equip	17.00				17.00	47	x 100%		47		
Misc	12.00				12.00	33	x 100%		33		
Spare	1.08				1.08	3	x 100%		3		
	57.30				48.69	135			135		

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		225A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	31B - SECT 3										
Location:	Electrical Room 3105										
Serves:	Normal										
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
85	Equip Rms 3112, 3111, 3118, 3115	0.90	20/1 CB	.	.	.	20/1 CB	0.36	Receipt NE Exterior	86	
87	Receipt Office 3115, 3113	1.08	20/1 CB	.	.	.	20/1 CB	0.72	Receipt North Exterior	88	
89	Receipt Office 3115, 3113	1.08	20/1 CB	.	.	.	20/1 CB	0.50	Equip Irrigation Controller, Exterior North	90	
91	Misc Bariatric Lift Exam Room 3073	1.00	20/1 CB	.	.	.	20/1 G	1.50	Equip Hand Dryer Toilet Room 3108	92	
93	Misc Bariatric Lift Exam Room 3074	1.00	20/1 CB	.	.	.	20/1 G	1.50	Equip Hand Dryer Toilet Room 3109	94	
95	Misc Bariatric Lift Exam Room 3077	1.00	20/1 CB	.	.	.	20/1 CB	0.80	Receipt Toilet Rooms 3124,3134,Alcove 3126A	96	
97	Misc Bariatric Lift Exam Room 3078	1.00	20/1 CB	.	.	.	20/1 CB	1.00	Misc Bariatric Lift Exam Room 3086	98	
99	Misc Bariatric Lift Exam Room 3082	1.00	20/1 CB	.	.	.	20/1 CB	1.00	Misc Bariatric Lift Exam Room 3087	100	
101	Misc Bariatric Lift Exam Room 3147	1.00	20/1 CB	.	.	.	20/1 CB	1.00	Misc Bariatric Lift Exam Room 3092	102	
103	Misc Bariatric Lift Exam Room 3148	1.00	20/1 CB	.	.	.	20/1 CB	1.00	Misc Bariatric Lift Exam Room 3099	104	
105	Misc Bariatric Lift Exam Room 3149	1.00	20/1 CB	.	.	.	20/1 CB	0.60	Receipt X-Ray Room 3117	106	
107	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	108	
109	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	110	
111	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	112	
113	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	114	
115	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	116	
117	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	118	
119	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	120	
121	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	122	
123	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	124	
125	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	126	
Rev:	Revised circuits marked † Existing circuits marked ‡										
Project #:	B13608										
File:	N:\B13608\shed\B13608 multicare ED_CCE.PNL										
Notes:	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note										
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Receipt	4.64	10 KVA @ 100%, rest @ 50%	4.64	13	x 100%	13					
Equip	4.40	x 100%	4.40	12	x 100%	12					
Misc	12.00	x 100%	12.00	33	x 100%	33					
	21.04	58 Amps	21.04	58		58					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		400A Main CB		Panel	
Name: 3LXR		Electrical Room 3105		Surface Mounted		Feed thru & Double Lugs		Type: Panelboard		10,000 AIC	
Location: X-Ray		Load		CB *		A B C		CB *		Description	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	Deep
1	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	2	
3	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	4	
5	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	6	
7	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	8	
9	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	10	
11	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	12	
13	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	14	
15	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	16	
17	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	.	.	.	20/1 CB	0.00	Spare	42	

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare ED\_CCE.PNL

Notes: Internal TVSS

Load Type	Conn KVA	NEC Demand Factor
X-Ray	102.60	Largest @ 50%, next @ 25%, rest @ 10%
	102.60	285 Amps
	50.40	140
	50.40	140

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		4HIE		277/480V		3Ø		4W		400A Main CB		Panel	
Name:		Electrical Room 4111		Surface Mounted		Feed Thru Lugs				Type: Panelboard		25,000 AIC	
Location:		Life Safety										Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting	2.60	20/1 CB	•			20/1 CB	0.00	Spare	2			
3	Lighting	1.41	20/1 CB	•			20/1 CB	0.00	Spare	4			
5	Lighting	1.40	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev:		Revised circuits marked ‡ Existing circuits marked †											
Project #:		B13608											
File:		N:\B13608\sched\B13608 multicare ED_CCE,PNL											
Notes:		Internal TVSS											
Load Type		Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps						
Lighting		26.72	x 100%	26.72	32	x 125%	40						
		26.72	32 Amps	26.72	32		40						

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		4H2EA		277/480V		3Ø		4W		225A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 25,000 AIC Deep	
Name: Electrical Room 4111		Critical		277/480V		3Ø		4W		225A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 25,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	A	B	C	Load	Description	#
1	Lighting Exam Rooms	3.18	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	2
3	Lighting Exam Rooms	3.82	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	4
5	Lighting Exam Rooms	3.41	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	6
7	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	8
9	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	10
11	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	12
13	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	14
15	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	16
17	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	18
19	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	20
21	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	22
23	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	24
25	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	26
27	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	28
29	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	30
31	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	32
33	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	34
35	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	36
37	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	38
39	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	40
41	Spare	0.00	20/1 CB	.	.	.	20/1 CB	.	.	.	0.00	Spare	42
Rev: Revised circuits marked ‡ Existing circuits marked †		Project #: B13608		File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI		H = HID Rated C = HACR Rated # = see note					
Notes: Internal TVSS		Demand KVA		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps			
Lighting		19.66		19.66		24		x 125%		30			
24 Amps		19.66		19.66		24				30			

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		4HA		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting Waiting, Admitting	2.72	20/1 CB	•			20/1 CB	2.85	Lighting Corridors Southwest	2			
3	Lighting Blood Draw, Resource Center	3.32	20/1 CB	•			20/1 CB	3.72	Lighting Exam Rooms, Staff Lounge	4			
5	Lighting Infusion	2.53	20/1 CB	•			20/1 CB	2.88	Lighting Exam Rooms East	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	2.87	Lighting Exam Rooms Northeast	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	3.87	Lighting Exam Rooms North Central	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	3.82	Lighting Corridor Northwest	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	1.43	Lighting Offices, Exam Rooms	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			150/3 CB	34.96	Panel 4LA - SECT 1	38			
39	Spare	0.00	20/1 CB	•			-----4LA - SECT 1	34.42	-----4LA - SECT 1	40			
41	Spare	0.00	20/1 CB	•			-----4LA - SECT 1	30.34	-----4LA - SECT 1	42			
Rev: Revised circuits marked ‡ Existing circuits marked †												* Circuit Breaker Code H= HID Rated C = HACR Rated # = see note	
Project #: B13608												G = GFCI S = Shunt Trip D= Switching Duty A = AFCI	
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL													
Notes: Internal TVSS													
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Lighting	29.99	x 100%	29.99	36	x 125%	45							
Recept	43.56	10 KVA @ 100%, rest @ 50%	26.78	32	x 100%	32							
Equip	15.86	x 100%	15.86	19	x 100%	19							
Misc	16.00	x 100%	16.00	19	x 100%	19							
Pat. Room	19.80	50 KVA @ 40%, rest @ 20%	7.92	10	x 100%	10							
Spare	4.50	x 100%	4.50	5	x 100%	5							
	129.71	156 Amps	101.05	122		131							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		175A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name: 4L1E		Electrical Room 4025		Life Safety		Description		Load		#	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Equip Medical Gas Alarm Panel, Corridor 4095	0.50	20/1 CB	•			20/1 CB	0.00	Spare	2	
3	Equip Auto-door, Corridor 4095	1.00	20/1 CB	•			20/1 CB	0.00	Spare	4	
5	Equip Auto-door, Corridor 4089	1.00	20/1 CB	•			20/1 CB	0.00	Spare	6	
7	Equip Auto-door, waiting 4003	1.00	20/1 CB	•			20/1 CB	0.00	Spare	8	
9	Equip Auto-door, Blood Draw 4006	1.00	20/1 CB	•			20/1 CB	0.00	Spare	10	
11	Equip Auto-door, Corridor 4109	1.00	20/1 CB	•			20/1 CB	0.00	Spare	12	
13	Equip Auto-door, Pharm Ante 4042	1.00	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC					
Project #: B13608		2.50		2.00	2.00	2.00					
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Equip	31.28	x 100%	31.28	87	x 100%	87					
	31.28		31.28	87		87					

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		400A Main CB Surface Mounted Feed thru & Double Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	4L2EA										
Location:	Electrical Room 4111										
Serves:	Critical										
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Recept Nurse Station 4132	0.72	20/1 CB	•			20/1 CB	0.36	Recept Electrical Rm 4111	2	
3	Recept Nurse Station 4097	0.36	20/1 CB	•			20/1 CB	1.20	Misc AGVS Control Panel	4	
5	Recept Nurse Station 4076	0.36	20/1 CB	•			20/1 CB	0.00	Spare	6	
7	Equip Aquarium, Waiting 4144	0.50	20/1 CB	•			20/1 CB	0.00	Spare	8	
9	Equip Aquarium, Waiting 4144	0.50	20/1 CB	•			20/1 CB	0.00	Spare	10	
11	Spare	0.00	20/1	•			20/1 CB	0.00	Spare	12	
13	Spare	0.00	20/1	•			20/1 CB	0.00	Spare	14	
15	Recept Reception Desk 4001	0.90	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Recept AGVS 4151, 4154, Alcove 4039B	0.54	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Recept Storage 4064	0.72	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Equip Refrigerator, AGVS Clean 4154	0.84	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Equip Microwave, AGVS Clean 4154	1.21	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Equip Ice Machine, AGVS Clean 4154	1.92	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Space	0.00	0/1				20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code H= HID Rated C = HACR Rated # = see note G = GFCI S = Shunt Trip D= Switching Duty A = AFCI		
Project #: B13608		4.22		3.80	2.11						
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Recept	57.60	10 KVA @ 100%, rest @ 50%	33.80	94	x 100%	94					
Equip	33.59	x 100%	33.59	93	x 100%	93					
Misc	3.60	x 100%	3.60	10	x 100%	10					
Pat. Room	82.44	50 KVA @ 40%, rest @ 20%	26.49	74	x 100%	74					
		177.23	492 Amps	97.47	271	271					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		400A Main CB Surface Mounted Feed thru & Double Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Pat. Room Exam Rm 4065	0.36	20/1 CB	•			20/1 CB	0.36	Pat. Room Exam Rm 4123	2	
3	Pat. Room Exam Rm 4066	0.36	20/1 CB	•			20/1 CB	0.36	Pat. Room Exam Rm 4124	4	
5	Pat. Room Exam Rm 4067	0.36	20/1 CB	•			20/1 CB	0.36	Pat. Room Exam Rm 4125	6	
7	Pat. Room Exam Rm 4082	0.36	20/1 CB	•			20/1 CB	0.36	Pat. Room Exam Rm 4129	8	
9	Pat. Room Exam Rm 4083	0.36	20/1 CB	•			20/1 CB	0.36	Pat. Room Exam Rm 4137	10	
11	Pat. Room Exam Rm 4084	0.36	20/1 CB	•			20/1 CB	0.36	Pat. Room Exam Rm 4138	12	
13	Pat. Room Exam Rm 4092	0.36	20/1 CB	•			20/1 CB	0.36	Pat. Room Procedure Rm 4129	14	
15	Pat. Room Exam Rm 4094	0.36	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Pat. Room Exam Rm 4098	0.36	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Pat. Room Exam Rm 4106	0.36	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Pat. Room Exam Rm 4107	0.36	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Pat. Room Exam Rm 4108	0.36	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Pat. Room Exam Rm 4157	0.36	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Pat. Room Exam Rm 4158	0.36	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Pat. Room Exam Rm 4159	0.36	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB				20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB				20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB				20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB				20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB				20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB				20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC	Ø	* Circuit Breaker Code H= HID Rated C = HACR Rated # = see note			
Project #: B13608				2.88	2.52	2.52		G = GFCI S = Shunt Trip D= Switching Duty A = AFCI			
File: N:\B13608\sched\B13608 multicare ED_CCE,PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Lighting	25.95	x 100%	25.95	72	x 125%	90					
Receipt Equip	30.72	10 KVA @ 100%, rest @ 50%	20.36	57	x 100%	57					
Pat. Room Elevator	41.42	x 100%	41.42	115	x 100%	115					
	88.92	50 KVA @ 40%, rest @ 20%	27.78	77	x 100%	77					
	1.92	Up to 72%, per 620-14	1.92	5	x 100%	5					
	188.93	524 Amps	117.43	326		344					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		4L2EC - SECT 1		120/208V		3Ø		4W		400A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Pat. Room Infusion 4014 East	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4029 South	2			
3	Pat. Room Infusion 4014 East	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4029 South	4			
5	Pat. Room Infusion 4014 East	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4029 South	6			
7	Pat. Room Infusion 4014 East	0.72	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4029 North	8			
9	Pat. Room Infusion 4014.4015	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4029 North	10			
11	Pat. Room Infusion 4014.4015	1.08	20/1 CB	•			20/1 CB	1.00	Equip Pyxis, Nurse Station 4029	12			
13	Pat. Room Infusion 4014.4015	0.72	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4035 South	14			
15	Pat. Room Infusion 4015 West	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4035 South	16			
17	Pat. Room Infusion 4022 East	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4035 South	18			
19	Pat. Room Infusion 4022 East, 4015 West	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4035 North	20			
21	Pat. Room Infusion 4015 West	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4035 North	22			
23	Pat. Room Infusion 4022 West	1.08	20/1 CB	•			20/1 CB	1.00	Equip Pyxis, Nurse Station 4035	24			
25	Pat. Room Infusion 4022 West	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4062 South	26			
27	Pat. Room Infusion 4022 West	1.08	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4062 South	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4062 South	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4062 North	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Pat. Room Infusion 4062 North	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	1.00	Equip Pyxis, Nurse Station 4062	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev: Revised circuits marked † Existing circuits marked ‡												* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI	
Project #: B13608												H = HID Rated C = HACR Rated # = see note	
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL													
Notes: Internal TVSS													
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Equip	3.00	x 100%	3.00	8	x 100%	8							
Pat. Room	30.60	50 KVA @ 40%, rest @ 20%	12.24	34	x 100%	34							
	33.60	93 Amps	15.24	42		42							

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		4L2EC - SECT 2		120/208V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name:	Location:	Serves:	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	44	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	46	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	48	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	50	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	52	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	54	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	56	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	58	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	60	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	62	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	64	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	66	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	68	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	70	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	72	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	74	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	76	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	78	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	80	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	82	
			Spare	0.00	20/1 CB	.			20/1 CB	0.00	Spare	84	
Rev:	Revised circuits marked † Existing circuits marked ‡												
Project #:	B13608												
File:	N:\B13608\sched\B13608 multicare ED_CCE.PNL												
Notes:													
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	ØA	ØB	ØC	Demand Amps	NEC Feeder Factors	NEC Feed Amps				
Space	0.00		0.00	0.00	0.00	0.00	0		0				
	0.00		0.00	0.00	0.00	0.00	0		0				

\* Circuit Breaker Code  
 H= HID Rated  
 C = HACR Rated  
 # = see note  
 G = GFCI  
 S = Shunt Trip  
 D= Switching Duty  
 A = AFCI

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		400A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Recept Nurse Station 4014	0.36	20/1 CB	•			20/1 CB	0.36	Recept Nurse Station 4029	2	
3	Equip Pyxis, Nurse Station 4014	1.00	20/1 CB	•			20/1 CB	0.80	Equip UC Refrigerator, Nurse Station 4029	4	
5	Equip UC Refrigerator, Nurse Station 4014	0.80	20/1 CB	•			20/1 CB	0.82	Equip Blanket Warmer, Nurse Station 4029	6	
7	Equip Blanket Warmer, Nurse Station 4014	0.82	20/1 CB	•			20/1 CB	0.54	Recept Nurse Station 4035, Stor. 4032	8	
9	Equip Blanket Warmer, Nurse Station 4015	0.82	20/1 CB	•			20/1 CB	0.80	Equip UC Refrigerator, Nurse Station 4035	10	
11	Recept Nurse Station 4015	0.36	20/1 CB	•			20/1 CB	0.82	Equip Blanket Warmer, Nurse Station 4035	12	
13	Equip Pyxis, Nurse Station 4015	1.00	20/1 CB	•			20/1 CB	0.54	Recept Nurse Station 4035, Stor. 4062	14	
15	Equip UC Refrigerator, Nurse Station 4015	0.80	20/1 CB	•			20/1 CB	0.80	Equip UC Refrigerator, Nurse Station 4062	16	
17	Equip Blanket Warmer, Nurse Station 4022	0.82	20/1 CB	•			20/1 CB	0.82	Equip Blanket Warmer, Nurse Station 4062	18	
19	Recept Nurse Station 4022	0.36	20/1 CB	•			20/1 CB	0.54	Recept Alcove 4039A, 4049A/B	20	
21	Equip Pyxis, Nurse Station 4022	1.00	20/1 CB	•			20/1 CB	0.36	Recept Electrical Room 4025	22	
23	Equip UC Refrigerator, Nurse Station 4022	0.80	20/1 CB	•			20/1 CB	0.80	Equip UC Refrigerator	24	
25	Equip Biological Safety Cabinet	1.90	20/1 CB	•			20/1 CB	1.40	Equip Pharmacy 4042 Freezer Connection	26	
27	Equip Biological Safety Cabinet	1.90	20/1 CB	•			20/1 CB	0.80	Equip Pharmacy 4042 Refrigerator Connection	28	
29	Equip Biological Safety Cabinet	1.90	20/1 CB	•			20/1 CB	0.72	Recept Pharmacy 4042	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC	ØC	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI			
Project #: B13608		7.82		9.08	8.66						
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Recept	4.14	10 KVA @ 100%, rest @ 50%	4.14	11	x 100%	11					
Equip	21.42	x 100%	21.42	59	x 100%	59					
	25.56	71 Amps	25.56	71		71					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		400A Main CB Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 4152	2	
3	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 4152	4	
5	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 4152	6	
7	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 4152	8	
9	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 4152	10	
11	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 4152	12	
13	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.36	Receipt IS Rm 4152	14	
15	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Equip IS Rack, IS Rm. 4152	1.50	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 4060	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 4060	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.18	Receipt LV Rm 4060	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC	ØC				
Project #: B13608				5.76	5.40	5.40	5.40				
File: N:\B13608\shed\B13608 multicare ED_CCE.FNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors		NEC Feed Amps				
Receipt	10.80	10 KVA @ 100%, rest @ 50%	10.40	29	x 100%		29				
Equip	70.14	x 100%	70.14	195	x 100%		195				
	80.94	225 Amps	80.54	224			224				

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V			3Ø 4W			225A Main CB Surface Mounted Feed Thru Lugs			Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#		
1	Pat. Room Exam Rm. 4065	0.90	20/1 CB	•			20/1 CB	0.90	Pat. Room Exam Rm. 4123	2		
3	Equip Exam Rm. 4065 Auto-Shade	1.00	20/1 CB	•			20/1 CB	0.90	Pat. Room Exam Rm. 4124	4		
5	Pat. Room Exam Rm. 4066	0.90	20/1 CB	•			20/1 CB	0.90	Pat. Room Exam Rm. 4125	6		
7	Pat. Room Exam Rm. 4067	0.90	20/1 CB	•			20/1 CB	0.90	Pat. Room Exam Rm. 4129	8		
9	Pat. Room Exam Rm. 4082	0.90	20/1 CB	•			20/1 CB	0.90	Pat. Room Exam Rm. 4137	10		
11	Pat. Room Exam Rm. 4083	0.90	20/1 CB	•			20/1 CB	0.90	Pat. Room Exam Rm. 4138	12		
13	Pat. Room Exam Rm. 4084	0.90	20/1 CB	•			20/1 CB	0.90	Pat. Room Procedure Rm. 4139	14		
15	Equip Exam Rm. 4084 Auto-Shade	1.00	20/1 CB	•			20/1 CB	0.00	Spare	16		
17	Pat. Room Exam Rm. 4092	0.90	20/1 CB	•			20/1 CB	0.00	Spare	18		
19	Pat. Room Exam Rm. 4094	0.90	20/1 CB	•			20/1 CB	0.00	Spare	20		
21	Pat. Room Exam Rm. 4098	0.90	20/1 CB	•			20/1 CB	0.00	Spare	22		
23	Pat. Room Exam Rm. 4106	0.90	20/1 CB	•			20/1 CB	0.00	Spare	24		
25	Pat. Room Exam Rm. 4107	0.90	20/1 CB	•			20/1 CB	0.00	Spare	26		
27	Pat. Room Exam Rm. 4108	0.90	20/1 CB	•			20/1 CB	0.00	Spare	28		
29	Pat. Room Exam Rm. 4157	0.90	20/1 CB	•			20/1 CB	0.00	Spare	30		
31	Pat. Room Exam Rm. 4158	0.90	20/1 CB	•			20/1 CB	0.00	Spare	32		
33	Pat. Room Exam Rm. 4159	0.90	20/1 CB	•			20/1 CB	0.00	Spare	34		
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36		
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38		
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40		
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42		
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code			
Project #: B13608		8.10		7.40	6.30			G = GFCI				
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL								S = Shunt Trip				
								D = Switching Duty				
								A = AFCI				
Notes: Internal TVSS												
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps						
Receipt	43.56	10 KVA @ 100%, rest @ 50%	26.78	74	x 100%	74						
Equip	15.86	x 100%	15.86	44	x 100%	44						
Misc	16.00	x 100%	16.00	44	x 100%	44						
Pat. Room	19.80	50 KVA @ 40%, rest @ 20%	7.92	22	x 100%	22						
Spare	4.50	x 100%	4.50	12	x 100%	12						
	99.72	277 Amps	71.06	197		197						

SECTION 26.24.12 - PANEL SCHEDULES

Sparting		120/208V			3Ø			4W			225A Main bays only Surface Mounted Feed Thru Lugs			Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#					
43	Recept Corridor 4109, Elev Lobby and Skybridge	0.54	20/1 CB	•			20/1 CB	1.08	Recept office 4085 east desks	44					
45	Recept Office 4113	1.08	20/1 CB	•			20/1 CB	1.08	Recept office 4085 South desks	46					
47	Recept Staff Toilets 4114, 4115, Office 4113	0.72	20/1 CB	•			20/1 CB	1.08	Recept office 4085 South desks	48					
49	Recept Counsel 4122	0.90	20/1 CB	•			20/1 CB	0.36	Recept Office 4085 Island	50					
51	Recept Lounge 4116	0.90	20/1 CB	•			20/1 CB	1.08	Recept Office 4085 North Desks	52					
53	Recept Lounge 4116	0.54	20/1 CB	•			20/1 CB	0.90	Recept Office 4085 North Desks	54					
55	Equip Refrigerator, Lounge 4116	1.20	20/1 CB	•			20/1 CB	0.90	Recept Pat. Toilet 4081, Storage 4078, 4069	56					
57	Equip Refrigerator, Lounge 4116	1.20	20/1 CB	•			20/1 CB	1.08	Recept Office 4077	58					
59	Equip Coffee Maker, Lounge 4116	1.40	20/1 CB	•			20/1 CB	1.08	Recept Office 4071	60					
61	<Multi> Microwave, Lounge 4116	1.38	20/1 CB	•			20/1 CB	1.08	Recept Nurse Station 4076	62					
63	<Multi> Microwave, Lounge 4116	1.38	20/1 CB	•			20/1 CB	0.90	Recept Nurse Station 4076	64					
65	Recept Corridor 4095, HSKP 4103, Pat T 4101	1.08	20/1 CB	•			20/1 CB	0.54	Recept Pat Toilet 4072 Hall 4075, office 4073	66					
67	Recept Nurse Station 4097	0.90	20/1 CB	•			20/1 CB	1.26	Recept Office 4073	68					
69	Recept Nurse Station 4097	0.90	20/1 CB	•			20/1 CB	1.08	Recept Toilet 4128, Hall 4131, Storage 4126 4165	70					
71	Recept Rms. 4102, 4104, 4096, 4091, Corr. 4089	1.44	20/1 CB	•			20/1 CB	1.08	Recept Office 4133	72					
73	Recept Office 4102	1.26	20/1 CB	•			20/1 CB	1.08	Recept Office 4134	74					
75	Recept Office 4096	0.90	20/1 CB	•			20/1 CB	1.08	Recept Nurse Station 4132	76					
77	Recept Hall 4088, Work 4087	0.90	20/1 CB	•			20/1 CB	1.08	Recept Nurse Station 4132	78					
79	Recept Office 4086	1.26	20/1 CB	•			20/1 CB	1.00	Equip Pneumatic Tube System Diverter	80					
81	Equip Copier, Work 4087	1.38	20/1 CB	•			20/1 CB	0.00	Spare	82					
83	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	84					
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated # = see note D = Switching Duty A = AFCI						
Project #: B13608		14.20	14.04	11.84											
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps							
Recept	43.56	26.78		74		x 100%		74							
Equip	13.86	13.86		38		x 100%		38							
Misc	16.00	16.00		44		x 100%		44							
Spare	4.50	4.50		12		x 100%		12							
77.92 216 Amps		61.14		170				170							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		4LA - SECT 3		120/208V		3Ø		4W		225A Main lugs only Surface Mounted		Panel Type: Panelboard 10,000 AIC Deep	
Name: Electrical Room 4111		Location: Normal		Description		Load		CB *		A B C		Single Lugs	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
85	Receipt Admin 4002, Work 4147	1.08	20/1 CB	•			20/1 CB	0.18	Receipt AGVS Clean 4154 Island	86			
87	Receipt Discharge 4143,4143, Wait 4141A	1.26	20/1 CB	•			20/1 CB	1.80	Equip Coffee Maker, AGVS Clean 4154	88			
89	Receipt Waiting, 4000, 4144, S. Skybridge	1.26	20/1 CB	•			20/1 CB	1.26	Receipt Office 4153	90			
91	Equip Copier, File 4145	1.38	20/1 CB	•			20/1 CB	1.26	Receipt Office 4149	92			
93	Receipt File 4145, Work 4146	0.90	20/1 CB	•			20/1 CB	1.26	Receipt AGVS Soiled 4151, Corr. 4148, 4039	94			
95	Receipt Reception Desk 4001	1.08	20/1 CB	•			20/1 CB	0.90	Receipt Storage 4064	96			
97	<Multi> Toilet 4155, 4156, Hand Dryer	1.26	20/1 CB	•			20/1 G	1.50	Spare Hand Dryer Toilet Room 4155	98			
99	Receipt AGVS Clean 4154	1.26	20/1 CB	•			20/1 G	1.50	Spare Hand Dryer Toilet Room 4114	100			
101	Equip Water Cooler, Drinking fountain 4148A	1.20	20/1 CB	•			20/1 G	1.50	Spare Hand Dryer Toilet Room 4115	102			
103	Misc Rollershade Room 4069	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4144	104			
105	Misc Rollershade Room 4071	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4135	106			
107	Misc Rollershade Room 4077	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4134	108			
109	Misc Rollershade Room 4078	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4116	110			
111	Misc Rollershade Room 4085	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4126	112			
113	Misc Rollershade Room 4085	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4135	114			
115	Misc Rollershade Room 4085	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4088	116			
117	Spare	0.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4087	118			
119	Spare	0.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Room 4086	120			
121	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	122			
123	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	124			
125	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	126			
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated # = see note D = Switching Duty A = AFCI				
Project #: B13608		12.66		12.98	12.20								
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL													
Notes:													
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Receipt	12.06	10 KVA @ 100%, rest @ 50%	11.03	31	x 100%	31							
Equip	5.28	x 100%	5.28	15	x 100%	15							
Misc	16.00	x 100%	16.00	44	x 100%	44							
Spare	4.50	x 100%	4.50	12	x 100%	12							
	37.84	105 Amps	36.81	102		102							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V			3Ø			4W			225A Main CB Surface Mounted Feed Thru Lugs			Panel Type: Panelboard 10,000 AIC Deep		
Name: 4LB - SECT 1		Location: Electrical Room 4025		Normal		Description		Load	CB *	A	B	C	CB *	Description	Load	#
1	Recept Elev	0.18	20/1	CB	•	20/1	CB	1.15	CB				<Multi> Resource center 4007	1.15	2	
3	Recept Office 4053	1.08	20/1	CB	•	20/1	CB	0.90	CB				Recept Resource center 4007	0.90	4	
5	Recept Office 4053	1.08	20/1	CB	•	20/1	CB	1.08	CB				Recept Resource center 4007	1.08	6	
7	Recept Office 4053, Corridor 4032	0.72	20/1	CB	•	20/1	CB	1.08	CB				Recept Pharm. Work 4041	1.08	8	
9	Recept Office 4053	1.08	20/1	CB	•	20/1	CB	0.90	CB				Recept Pharm. Work 4041	0.90	10	
11	Recept Office 4053	1.08	20/1	CB	•	20/1	CB	1.08	CB				Recept Pharm Ante 4042, Clean 4043	1.08	12	
13	Recept Office 4053	1.08	20/1	CB	•	20/1	CB	1.08	CB				Recept Pharm Ante 4042, Chemo 4044	1.08	14	
15	Recept Office 4053	1.08	20/1	CB	•	20/1	CB	0.90	CB				Recept Nurse Station 4013	0.90	16	
17	Recept Office 4052	1.26	20/1	CB	•	20/1	CB	0.90	CB				Recept Nurse Station 4013	0.90	18	
19	Recept Office 4052, 4051	1.08	20/1	CB	•	20/1	CB	0.90	CB				Recept Nurse Station 4016	0.90	20	
21	Recept Quiet/Counsel 4046	1.26	20/1	CB	•	20/1	CB	0.90	CB				Recept Nurse Station 4016	0.90	22	
23	Recept Waiting 4045, Scale 4049B	0.90	20/1	CB	•	20/1	CB	1.26	CB				Recept Counsel 4018	1.26	24	
25	Recept Quiet/Counsel 4009	1.26	20/1	CB	•	20/1	CB	0.90	CB				Recept Nurse Station 4021	0.90	26	
27	Recept Quiet/Counsel 4009	1.44	20/1	CB	•	20/1	CB	0.90	CB				Recept Nurse Station 4021	0.90	28	
29	Recept Blood Draw 4006	1.08	20/1	CB	•	20/1	CB	0.90	CB				Recept Toilets 4019, 4017, 4012, Corr. 4011	0.90	30	
31	Recept Blood Draw 4006	1.08	20/1	CB	•	20/1	CB	0.72	CB				Recept Nurse Station 4029	0.72	32	
33	Recept Waiting 4003, Pat Toilet 4004	1.26	20/1	CB	•	20/1	CB	0.72	CB				Recept Nurse Station 4029	0.72	34	
35	Recept Blood Draw 4006	1.08	20/1	CB	•	20/1	CB	0.90	CB				Recept Nurse Station 4034	0.90	36	
37	Recept Blood Draw 4006	0.90	20/1	CB	•	20/1	CB	0.72	CB				Recept Nurse Station 4034	0.72	38	
39	Space	0.00	0/1		•	20/1	CB	0.00	CB				Spare	0.00	40	
41	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB				Spare	0.00	42	
Rev: Revised circuits marked ‡ Existing circuits marked †																
Project #: B13608																
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL																
Notes: Internal TVSS																
* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI																
H = HID Rated C = HACR Rated # = see note																
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps										
Recept	39.24	10 KVA @ 100%, rest @ 50%	24.62	68	x 100%	68										
Equip	3.25	x 100%	3.25	9	x 100%	9										
Misc	19.00	x 100%	19.00	53	x 100%	53										
Pat. Room	11.16	50 KVA @ 40%, rest @ 20%	4.46	12	x 100%	12										
	72.65	202 Amps	51.33	142		142										

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		225A Main lugs only Surface Mounted		Panel Type: Panelboard 10,000 AIC Deep			
Name: 4LB - SECT 2		Location: Electrical Room 4025		Normal		Feed Thru Lugs		Description		#			
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
43	Pat. Room Infusion 4014, East	0.72	20/1 CB	•			20/1 CB	0.90	Receipt Nurse Station 4062	44			
45	Misc Rollershade Infusion Room 4014	1.00	20/1 CB	•			20/1 CB	0.72	Receipt Nurse Station 4062	46			
47	Misc Rollershade Infusion Room 4014	1.00	20/1 CB	•			20/1 CB	0.50	Equip Infusion 4014 Patient TV's	48			
49	Pat. Room Infusion 4014 West, Infusion 4015 East	0.72	20/1 CB	•			20/1 CB	0.50	Equip Infusion 4015 Patient TV's	50			
51	Pat. Room Infusion 4015 West	0.72	20/1 CB	•			20/1 CB	0.50	Equip Infusion 4022 Patient TV's	52			
53	Spare	0.00	20/1 CB	•			20/1 CB	0.50	Equip Infusion 4029 Patient TV's	54			
55	Pat. Room Private Infusion 4023	0.90	20/1 CB	•			20/1 CB	0.50	Equip Infusion 4035 Patient TV's	56			
57	Pat. Room Infusion 4022, East & West	1.08	20/1 CB	•			20/1 CB	0.50	Equip Infusion 4062 Patient TV's	58			
59	Spare	0.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4022	60			
61	Pat. Room Infusion 4029 South, Pat Toilet 4027	0.90	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4022	62			
63	Spare	0.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4022	64			
65	Pat. Room Private Infusion 4031	0.72	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4015	66			
67	Pat. Room Infusion 4029 North	0.72	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4015	68			
69	Pat. Room Infusion 4035 South	1.26	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4015	70			
71	Spare	0.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4014	72			
73	Pat. Room Infusion 4035 North, Priv. Inf. 4036	1.08	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4014	74			
75	Pat. Room Infusion 4062 South	1.26	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion Room 4014	76			
77	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	78			
79	Pat. Room Infusion 4062 North, Priv. Inf. 4063	1.08	20/1 CB	•			20/1 CB	0.00	Spare	80			
81	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	82			
83	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	84			
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC	ØC		* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated # = see note D = Switching Duty A = AFCI				
Project #: B13608		11.02		10.04	5.72	5.72							
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL		Demand KVA		Demand Amps		Demand Amps		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Receipt	1.62	10 KVA @ 100%, rest @ 50%	1.62	4	4				x 100%			4	
Equip	3.00	x 100%	3.00	8	8				x 100%			8	
Misc	19.00	x 100%	19.00	53	53				x 100%			53	
Pat. Room	11.16	50 KVA @ 40%, rest @ 20%	4.46	12	12				x 100%			12	
	34.78	97 Amps	28.08	78	78							78	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		4LB - SECT 3		120/208V		3Ø		4W		225A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
85	Misc Rollershade Infusion 4029	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion 4062	86			
87	Misc Rollershade Infusion 4029	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion 4062	88			
89	Misc Rollershade Infusion 4029	1.00	20/1 CB	•			20/1 CB	1.00	Misc Rollershade Infusion 4029	90			
91	Misc Rollershade Infusion 4035	1.00	20/1 CB	•			20/1 CB	0.00	Spare	92			
93	Misc Rollershade Infusion 4035	1.00	20/1 CB	•			20/1 CB	0.00	Spare	94			
95	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	96			
97	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	98			
99	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	100			
101	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	102			
103	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	104			
105	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	106			
107	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	108			
109	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	110			
111	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	112			
113	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	114			
115	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	116			
117	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	118			
119	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	120			
121	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	122			
123	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	124			
125	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	126			
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC	ØC	* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated D = Switching Duty # = see note A = AFCI					
Project #: B13608		3.00		3.00	3.00	2.00							
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL		Demand KVA		Demand Amps		Demand Amps		Demand Amps		Demand Amps		Demand Amps	
Notes:		8.00		22		22		22		22		22	
Load Type		8.00		8.00		8.00		8.00		8.00		8.00	
Conn KVA		8.00		8.00		8.00		8.00		8.00		8.00	
NEC Demand Factor		x 100%		x 100%		x 100%		x 100%		x 100%		x 100%	
Misc		22 Amps		22 Amps		22 Amps		22 Amps		22 Amps		22 Amps	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling, Inc. Name: 5H3EA Location: Electrical Room 5007 Serves: Equipment		277/480V		3Ø 4W		600A Main lugs only Surface Mounted Single Lugs		Type: Distribution Panel 42,000 AIC Deep	
#	Description	Load	Overcurrent device		Remarks				
			Size	* Type					
1	Panel 5L3EA	10.07 KVA	80A/3P	CB					
2	Mech AHU-1	28.27 KVA	50A/3P	CB	25HP				
3	Mech AHU-2	66.51 KVA	100A/3P	CB	(2) 30HP				
4	Mech REF-1	33.30 KVA	80A/3P	CB	30HP				
5	Mech EF-2	54.00 KVA	100A/3P	CB	50HP				
6	Mech EF-5	2.50 KVA	15A/3P	CB	1.5HP				
7	Motors PSF-3	22.40 KVA	60A/3P	CB	20HP				
8	Motors PSF-1	54.00 KVA	100A/3P	CB	50HP				
9	Motors PSF-2	33.30 KVA	80A/3P	CB	30HP				
10	Mech P-16	6.32 KVA	15A/3P	CB	5HP				
11	Mech ACU-6A	2.83 KVA	20A/3P	CB	2HP				
12	Mech ACU-6B	28.00 KVA	50A/3P	CB	28KW				
13	Mech P-17	6.32 KVA	15A/3P	CB	5HP				
14	Mech EF-4A	2.49 KVA	15A/3P	CB	1.5HP				
15	Mech EF-4B	0.91 KVA	15A/3P	CB	0.5HP				
16	Mech EF-11	1.75 KVA	15A/3P	CB	1HP				
17	Spare	0.00 KVA	0A/1P						
18	Mech EF-10	2.83 KVA	15A/3P	CB	2HP				
19	Mech RTU-1	6.13 KVA	15A/3P	CB	3.5HP				
20	Space 100A/3P Frame Space	0.00 KVA	0A/3P						
21	Space 100A/3P Frame Space	0.00 KVA	0A/3P						
22	Space 100A/3P Frame Space	0.00 KVA	0A/3P						
23	Space 100A/3P Frame Space	0.00 KVA	0A/3P						

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare  
 ED\_CCE.PNL

\* Circuit Breaker Code  
 S = Shunt Trip  
 M = Motor Ckt Prot.  
 F = Fused Switch  
 # = see note

CB = Circuit Breaker  
 G = GFCI  
 H = HID Rated  
 C = HACR Rated

Notes: Internal TVSS

SECTION 26 24 12 - PANEL SCHEDULES

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Equip	1.50	x 100%	1.50	2	x 100%	2
Lighting	2.49	x 100%	2.49	3	x 125%	4
Mech	243.16	x 100%	243.16	292	125% of Largest	312
Misc	4.00	x 100%	4.00	5	x 100%	5
Motors	109.70	x 100%	109.70	132	125% of Largest	148
Receipt	1.08	10 KVA @ 100%, rest @ 50%	1.08	1	x 100%	1
	361.93	435 Amps	361.93	435		472

SECTION 26 24 12 - PANEL SCHEDULES

Sparling, Inc. 5H3EB Dist Pnl  
 Name: 5H3EB Type: Distribution Panel  
 Location: Electrical Room 5007 800A Main lugs only Surface Mounted 42,000 AIC  
 Serves: Equipment Single Lugs Deep

#	Description	Load	Overcurrent device		Remarks
			Size	* Type	
1	Panel 5L3EB	8.90 KVA	80A/3P	CB	
2	Mech AHU-9	2.83 KVA	15A/3P	CB	2HP
3	Mech AHU-4	83.10 KVA	125A/3P	CB	(2) 40HP
4	Mech REF-4	33.30 KVA	80A/3P	CB	30HP
5	Mech EF-3	54.00 KVA	100A/3P	CB	50HP
6	Mech EF-4	9.10 KVA	20A/3P	CB	7.5HP
7	Mech EF-1	2.50 KVA	15A/3P	CB	1.5HP
8	Mech AHU-3	83.10 KVA	125A/3P	CB	(2) 40HP
9	Motors ACU-5A	0.90 KVA	15A/3P	CB	0.5HP
10	Mech ACU-4B	13.50 KVA	30A/3P	CB	10.8KW
11	Mech ACU-5B	13.50 KVA	30A/3P	CB	10.8KW
12	Mech PCH-1	182.80 KVA	300A/3P	CB	220FLA
13	Mech AHU-10	2.83 KVA	15A/3P	CB	2HP
14	Mech AHU-5	2.83 KVA	15A/3P	CB	2HP
15	Mech EF-9	2.50 KVA	15A/3P	CB	1.5HP
16	Mech P-12	17.50 KVA	40A/3P	CB	15HP
17	Mech P-13	17.50 KVA	40A/3P	CB	15HP
18	Space 100A/3P Frame Space	0.00 KVA	0A/3P		
19	Space 100A/3P Frame Space	0.00 KVA	0A/3P		
20	Space 100A/3P Frame Space	0.00 KVA	0A/3P		
21	Space 100A/3P Frame Space	0.00 KVA	0A/3P		
22	Space 100A/3P Frame Space	0.00 KVA	0A/3P		

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare ED\_CCE.PNL

Notes: Internal TVSS

\* Circuit Breaker Code  
 CB = Circuit Breaker  
 G = GFCI  
 H = HID Rated  
 C = HACR Rated  
 S = Shunt Trip  
 M = Motor Ckt Prot.  
 F = Fused Switch  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Equip	5.50	x 100%	5.50	7	x 100%	7
Lighting	0.40	x 100%	0.40	0	x 125%	1
Mech	521.89	x 100%	521.89	628	125% of Largest	683
Misc	2.00	x 100%	2.00	2	x 100%	2
Motors	0.90	x 100%	0.90	1	125% of Largest	1
	530.69	638 Amps	530.69	638		694

SECTION 26 24 12 - PANEL SCHEDULES

<b>Sparting, Inc.</b> Name: 5HDPXR Location: Electrical Room 5007 Serves: X-Ray		277/480V	3Ø	4W	400A Main lugs only Surface Mounted Feed thru & Double Lugs	Dist Pnl Type: Distribution Panel 42,000 AIC Deep
#	Description	Load	Overcurrent device		Remarks	
			Size	*Type		
1	Space	0.00 KVA	0A/1P			
2	Space	0.00 KVA	0A/1P			
3	Space	0.00 KVA	0A/1P			
4	Panel 3LXR	102.60 KVA	200A/3P	CB		
Rev: Revised circuits marked † Existing circuits marked ‡ Project #: B13608 File: N:\B13608\sched\B13608 multicare ED_CCE.PNL						
Notes: Internal TVSS						
Load Type X-Ray		Conn KVA 314.46	NEC Demand Factor Largest @ 50%, next @ 25%, rest @ 10%	Demand KVA 85.90	Demand Amps 103	NEC Feeder Factors x 100%
		314.46	378 Amps	85.90	103	103

\* Circuit Breaker Code  
 S = Shunt Trip  
 M = Motor Ckt Prot.  
 F = Fused Switch  
 # = see note

CB = Circuit Breaker  
 G = GFCI  
 H = HID Rated  
 C = HACR Rated

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		5H1E		277/480V		3Ø		4W		400A Main CB		Panel	
Name:		Electrical Room 5007		Surface Mounted		Feed thru & Double Lugs		Type: Panelboard		42,000 AIC		Deep	
Location:		Life Safety											
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	-Res Lighting North Exit Signs	0.04	20/1 CB	•			20/1 CB	0.04	Lighting South Exit Signs	2			
3	Lighting North Mechanical 5005	1.04	20/1 CB	•			20/1 CB	1.72	Lighting South Mechanical 5005	4			
5	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Space	0.00	0/1	•			0/1	0.00	Space	26			
27	Space	0.00	0/1	•			0/1	0.00	Space	28			
29	Space	0.00	0/1	•			0/1	0.00	Space	30			
31	Space	0.00	0/1	•			0/1	0.00	Space	32			
33	Space	0.00	0/1	•			0/1	0.00	Space	34			
35	Space	0.00	0/1	•			0/1	0.00	Space	36			
37	Space	0.00	0/1	•			80/3 CB	15.64	Panel 5L1E	38			
39	Space	0.00	0/1	•			-----5L1E	11.14	-----5L1E	40			
41	Space	0.00	0/1	•			-----5L1E	6.50	-----5L1E	42			
Rev:		* Circuit Breaker Code											
Revised circuits marked † Existing circuits marked ‡		G = GFCI											
Project #: B13608		H = HID Rated											
File: N:\B13608\shed\B13608 multicare		S = Shunt Trip											
ED_CCE.PNL		D = Switching Duty											
		A = AFCI											
Notes:		Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
.0 KSP@3W+Sm. Appl	0.00	3 KVA @ 100%, 117 KVA @ 35%, rest @ 25%	0.00	0	x 100%	0							
Lighting	29.51	x 100%	29.51	35	x 125%	44							
Equip	31.28	x 100%	31.28	38	x 100%	38							
Misc	2.00	x 100%	2.00	2	x 100%	2							
	62.80	76 Amps	62.80	76		84							

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep				
Name: 5H2EA		Location: Electrical Room 5007		Serves: Critical		Description		Load	CB *	A B C	CB *	Load	Description	#
1	Lighting Elec Rooms 5007, 5009	1.67	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	2
3	Lighting Elev Machine Rms 9002, 9003	0.74	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	4
5	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	6
7	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	8
9	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	10
11	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	12
13	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	14
15	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	16
17	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	18
19	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	20
21	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	22
23	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	24
25	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	26
27	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	28
29	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	30
31	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	32
33	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	34
35	Spare	0.00	20/1	CB	•	20/1	CB	0.00	CB			0.00	Spare	36
37	Spare	0.00	20/1	CB	•	60/3	CB	2.28	CB			2.28	Panel 5L2EA	38
39	Spare	0.00	20/1	CB	•	-----	---	1.08	---			1.08	-----5L2EA	40
41	Spare	0.00	20/1	CB	•	-----	---	0.90	---			0.90	-----5L2EA	42
Rev: Revised circuits marked † Existing circuits marked ‡		Project #: B13608		File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Notes: Internal TVSS		* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI		H = HID Rated C = HACR Rated # = see note				
Lighting		2.42	10 KVA @ 100%, rest @ 50%		2.42	3	3	2.42	3	2.42	3	2.42	x 125%	4
Receipt		3.06	x 100%		3.06	4	4	3.06	4	3.06	4	3.06	x 100%	4
Misc		1.20	x 100%		1.20	1	1	1.20	1	1.20	1	1.20	x 100%	1
8 Amps		6.68	8 Amps		6.68	8	8	6.68	8	6.68	8	6.68		9

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		5HA		277/480V		3Ø		4W		200A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting South Mechanical 5005	1.74	20/1 CB	•			20/1 CB	2.22	Lighting North Mechanical 5005	2			
3	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	4			
5	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			80/3 CB	5.04	Panel 5LA	38			
39	Spare	0.00	20/1 CB	•			-----5LA	4.68	-----5LA	40			
41	Spare	0.00	20/1 CB	•			-----5LA	4.86	-----5LA	42			

Rev:	Revised circuits marked † Existing circuits marked ‡
Project #:	B13608
File:	N:\B13608\sched\B13608 multicare ED_CCE.PNL

Notes:	Internal TVSS
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Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	3.97	x 100%	3.97	5	x 125%	6
Receipt	14.58	10 KVA @ 100%, rest @ 50%	12.29	15	x 100%	15
	18.55	22 Amps	16.26	20		21



SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		150A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
Name: 5L2EA		Electrical Room 5007		Serves: Critical		Description		Load		#	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Misc AGVS Control Panel	1.20	20/1 CB	•			20/1 CB	0.36	Recept Electrical Rm. 6002	2	
3	Spare	0.00	20/1 CB	•			20/1 CB	0.36	Recept Electrical Rm. 7002	4	
5	Spare	0.00	20/1 CB	•			20/1 CB	0.54	Recept Mechanical Rm 9003	6	
7	Spare	0.00	20/1 CB	•			20/1 CB	0.36	Recept Electrical 5007	8	
9	Spare	0.00	20/1 CB	•			20/1 CB	0.36	Recept Electrical 5007	10	
11	Spare	0.00	20/1 CB	•			20/1 CB	0.36	Recept Electrical 5011	12	
13	Spare	0.00	20/1 CB	•			20/1 CB	0.36	Recept Electrical 5009	14	
15	Spare	0.00	20/1 CB	•			20/1 CB	0.36	Recept Electrical 5009	16	
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI S = Shunt Trip D= Switching Duty A = AFCI		
Project #: B13608		2.28		1.08	0.90						
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		Demand Amps		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Notes: Internal TVSS		3.06		8		8		x 100%		8	
Load Type		1.20		3		3		x 100%		3	
Recept		4.26		12 Amps		12				12	
Misc											

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		5L3EA		120/208V		3 Ø		4W		150A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting AHU-1 Lighting	0.20	20/1 CB	•			20/1 CB	0.18	Receipt Elev. Machine Rm 9002	2			
3	Lighting AHU-2 Lighting	0.20	20/1 CB	•			20/1 CB	0.43	<Multi> Elevator #19 Cab Ltg and Rec	4			
5	Lighting EF-2	0.20	20/1 CB	•			20/1 CB	0.50	Equip Elevator #19 Cab HVAC	6			
7	Lighting EF-3	0.20	20/1 CB	•			20/1 CB	0.55	<Multi> Elev. Machine Rm 9002 and Ltg	8			
9	Mech UH-3	1.00	20/1 CB	•			20/1 CB	0.43	<Multi> Elevator #20 Cab Ltg and Rec	10			
11	Lighting AHU-5	0.20	20/1 CB	•			20/1 CB	0.50	Equip Elevator #20 Cab HVAC	12			
13	Misc Heat Trace	1.00	20/2 G	•			20/1 CB	0.55	<Multi> Elev Mach Rm 6001 and LTG	14			
15	-----	1.00	-----	•			20/1 CB	0.43	<Multi> Lift F Cab Ltg and Rec	16			
17	Misc Heat Trace	1.00	20/2 G	•			20/1 CB	0.50	Equip Lift F Cab HVAC	18			
19	-----	1.00	-----	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			

Rev:	Revised circuits marked † Existing circuits marked ‡
Project #:	B13608
File:	N:\B13608\shed\B13608 multicare ED_CCE.PNL

Notes:	Internal TVSS
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Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Lighting	2.49	x 100%	2.49	7	x 125%	9
Receipt	1.08	10 KVA @ 100%, rest @ 50%	1.08	3	x 100%	3
Equip	1.50	x 100%	1.50	4	x 100%	4
Misc	4.00	x 100%	4.00	11	x 100%	11
Mech	1.00	x 100%	1.00	3	125% of Largest	3
	10.07	28 Amps	10.07	28		30

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		150A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Lighting AHU-3 Lights	0.20	20/1 CB	•			20/1 CB	1.50	Equip 4th Floor Bio Safety Cabinet 4043	2	
3	Lighting AHU-4 Lights	0.20	20/1 CB	•			20/1 CB	1.50	Equip 4th Floor Bio Safety Cabinet 4044	4	
5	Misc DDC Control Pnl Room 4060	0.50	20/1 CB	•			20/1 CB	1.50	Equip 4th Floor Bio Safety Cabinet 4044	6	
7	Misc DDC Control Pnl Room 5005	0.50	20/1 CB	•			20/1 CB	1.00	Mech UH-4	8	
9	Misc DDC Control Pnl Room 5005	0.50	20/1 CB	•			20/1 CB	1.00	Equip Trap Primer	10	
11	Misc DDC Control Pnl Room 9003	0.50	20/1 CB	•			20/1 CB	0.00	Spare	12	
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC	ØC	* Circuit Breaker Code H= HID Rated C= HACR Rated # = see note			
Project #: B13608		3.20		3.20	3.20	2.50					
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		Demand KVA	Demand Amps	NEC Demand Factor	NEC Feeder Factors				
Notes: Internal TVSS		0.40		0.40	1	x 100%	x 125%				
Lighting		5.50		5.50	15	x 100%	x 100%				
Equip		2.00		2.00	6	x 100%	x 100%				
Misc		1.00		1.00	3	x 100%	125% of Largest				
Mech		8.90		8.90	25						
		25 Amps									

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3 Ø		4W		150A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 10,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Recept Elev Lobby 5013, Corridor 5012	0.36	20/1 CB	•			20/1 CB	0.00	Spare	2	
3	Recept Mech Rm 5005	0.54	20/1 CB	•			20/1 CB	0.00	Spare	4	
5	Recept East Roof, 5th floor	0.72	20/1 CB	•			20/1 CB	0.00	Spare	6	
7	Recept Mech Rm 5005, Westside	0.90	20/1 CB	•			20/1 CB	0.00	Spare	8	
9	Recept Northwest Roof, 5th floor	0.72	20/1 CB	•			20/1 CB	0.00	Spare	10	
11	Recept Southwest Roof, 5th floor	0.72	20/1 CB	•			20/1 CB	0.00	Spare	12	
13	Recept Mech Rm 5005, Southwest side	0.36	20/1 CB	•			20/1 CB	0.00	Spare	14	
15	Recept Mech Rm 5005, Southeast side	0.72	20/1 CB	•			20/1 CB	0.00	Spare	16	
17	Recept South Roof, 5th floor	0.72	20/1 CB	•			20/1 CB	0.00	Spare	18	
19	Recept South Roof, 5th floor	0.54	20/1 CB	•			20/1 CB	0.00	Spare	20	
21	Recept Hskp, Storage 5001	0.72	20/1 CB	•			20/1 CB	0.00	Spare	22	
23	Recept Hskp, Storage 5001	0.90	20/1 CB	•			20/1 CB	0.00	Spare	24	
25	Recept East Roof top, 6th Floor	0.90	20/1 CB	•			20/1 CB	0.00	Spare	26	
27	Recept West Roof top, 6th Floor	0.90	20/1 CB	•			20/1 CB	0.00	Spare	28	
29	Recept Elev Lobby 6004, 7004	0.90	20/1 CB	•			20/1 CB	0.00	Spare	30	
31	Recept Storage 7002	1.26	20/1 CB	•			20/1 CB	0.00	Spare	32	
33	Recept Storage 8001	1.08	20/1 CB	•			20/1 CB	0.00	Spare	34	
35	Recept Storage 8001, Elev Lobby 8002	0.90	20/1 CB	•			20/1 CB	0.00	Spare	36	
37	Recept Rooftop 9th & 10th	0.72	20/1 CB	•			20/1 CB	0.00	Spare	38	
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40	
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42	
Rev: Revised circuits marked † Existing circuits marked ‡											
Project #: B13608											
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes: Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Recept	14.58	10 KVA @ 100%, rest @ 50%	12.29	34	x 100%	34					
	14.58	40 Amps	12.29	34		34					

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		6HIE		277/480V		3Ø		4W		400A Main CB		Panel	
Name:		Electrical Room 6002		Surface Mounted		Feed Thru Lugs				Type: Panelboard		25,000 AIC	
Location:		Life Safety										Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting 6th Floor Exit Signs	0.01	20/1 CB	•			20/1 CB	0.00	Spare	2			
3	Lighting Corridor 6003, Elev Lobby 6004	0.46	20/1 CB	•			20/1 CB	0.00	Spare	4			
5	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev:		Revised circuits marked ‡ Existing circuits marked †											
Project #:		B13608											
File:		N:\B13608\sched\B13608 multicare ED_CCE.PNL											
Notes:		Internal TVSS											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps							
Lighting	1.48	x 100%	1.48	2	x 125%	2							
	1.48	2 Amps	1.48	2		2							

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		6HA		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep	
Name: Electrical Room 6002		Location: Normal		Load		CB *		A B C		CB *		Description	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	Panel #			
1	Lighting Corridor 6003, Elev Lobby 6004	1.31	20/1 CB	•			20/1 CB	0.00	Spare	2			
3	Lighting Exterior	0.43	20/1 CB	•			20/1 CB	0.00	Spare	4			
5	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev: Revised circuits marked ‡ Existing circuits marked †		Project #: B13608		File: N:\B13608\sched\B13608 multicare		ED_CCE.PNL						* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note	
Notes: Internal TVSS		Demand KVA		Demand Amps		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Lighting		1.74		x 100%		1.74		2		x 125%		3	
		1.74		2 Amps		1.74		2				3	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		7H1E		277 / 480V		3 Ø		4W		400A Main CB Surface Mounted Single Lugs		Panel Type: Panelboard 25,000 AIC Deep	
Name: Electrical Room 7001		Life Safety		Lighting 7th Floor Exit Signs		Lighting 8th Floor Exit Signs		Lighting Elevator Lobby 8002		Spare		Spare	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#			
1	Lighting 7th Floor Exit Signs	0.01	20/1 CB	•			20/1 CB	0.01	Lighting 8th Floor Exit Signs	2			
3	Lighting Corridor 7003, Elev Lobby 7004	0.62	20/1 CB	•			20/1 CB	0.36	Lighting Elevator Lobby 8002	4			
5	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	6			
7	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	8			
9	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	10			
11	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	12			
13	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	14			
15	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	16			
17	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	18			
19	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	20			
21	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	22			
23	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	24			
25	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	26			
27	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	28			
29	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	30			
31	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	32			
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	34			
35	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	36			
37	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	38			
39	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	40			
41	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Spare	42			
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC	ØC	* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI		H = HID Rated C = HACR Rated # = see note			
Project #: B13608		Demand KVA		0.02	0.98	0.00							
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		1.00	1.00	1	Demand Amps		NEC Feeder Factors		NEC Feed Amps		
Notes: Internal TVSS		Conn KVA		1.00	1.00	1	Demand Amps		NEC Demand Factor		NEC Feed Amps		
Lighting		1.00		x 100%		1		x 125%		2		2	
1.00		1 Amps		1		1		1		2		2	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		7HA		277/480V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 42,000 AIC Deep		
#	Description	Load	CB *	A	B	C	CB *	CB *	CB *	CB *	CB *	Load	Description	#
1	Lighting Corridor 7003, Elev Lobby 7004	0.96	20/1	•			20/1	CB				1.02	Lighting Elevator Lobby 8002	2
3	Spare	0.00	20/1		•		20/1	CB				0.00	Spare	4
5	Spare	0.00	20/1			•	20/1	CB				0.00	Spare	6
7	Spare	0.00	20/1				20/1	CB				0.00	Spare	8
9	Spare	0.00	20/1		•		20/1	CB				0.00	Spare	10
11	Spare	0.00	20/1				20/1	CB				0.00	Spare	12
13	Spare	0.00	20/1		•		20/1	CB				0.00	Spare	14
15	Spare	0.00	20/1			•	20/1	CB				0.00	Spare	16
17	Spare	0.00	20/1				20/1	CB				0.00	Spare	18
19	Spare	0.00	20/1		•		20/1	CB				0.00	Spare	20
21	Spare	0.00	20/1				20/1	CB				0.00	Spare	22
23	Spare	0.00	20/1				20/1	CB				0.00	Spare	24
25	Spare	0.00	20/1		•		20/1	CB				0.00	Spare	26
27	Spare	0.00	20/1			•	20/1	CB				0.00	Spare	28
29	Spare	0.00	20/1				20/1	CB				0.00	Spare	30
31	Spare	0.00	20/1		•		20/1	CB				0.00	Spare	32
33	Spare	0.00	20/1			•	20/1	CB				0.00	Spare	34
35	Spare	0.00	20/1				20/1	CB				0.00	Spare	36
37	Spare	0.00	20/1		•		20/1	CB				0.00	Spare	38
39	Spare	0.00	20/1			•	20/1	CB				0.00	Spare	40
41	Spare	0.00	20/1				20/1	CB				0.00	Spare	42
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC							* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI	
Project #: B13608		Demand KVA		1.98	0.00	0.00							H = HID Rated C = HACR Rated # = see note	
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Demand KVA		1.98	0.00	0.00								
Notes: Internal TVSS		Demand KVA		1.98	0.00	0.00								
Load Type		Conn KVA		1.98	0.00	0.00								
Lighting		Internal TVSS		1.98	0.00	0.00								
NEC Demand Factor		Demand KVA		1.98	0.00	0.00								
x 100%		Demand Amps		2	0.00	0.00								
NEC Feeder Factors		Demand Amps		2	0.00	0.00								
x 125%		Demand Amps		2	0.00	0.00								
NEC Feed Amps		Demand Amps		2	0.00	0.00								
3		Demand Amps		2	0.00	0.00								
3		Demand Amps		2	0.00	0.00								

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		277/480V		3Ø		4W		200A Shunt trip main CB Surface Mounted Single Lugs		Panel Type: Panelboard 25,000 AIC Deep		
#	Description	Load	CB *	CB	A	B	C	CB *	CB	Load	Description	#
1	Elevator ELEVATOR #19, 100HP	34.00	200/3	CB	•			0/1		0.00	Space	2
3	-----ELEVATOR #19, 100HP	34.00	-----	-----	•			0/1		0.00	Space	4
5	-----ELEVATOR #19, 100HP	34.00	-----	-----		•		0/1		0.00	Space	6
7	Space	0.00	0/1		•			0/1		0.00	Space	8
9	Space	0.00	0/1		•			0/1		0.00	Space	10
11	Space	0.00	0/1		•			0/1		0.00	Space	12
Rev: Revised circuits marked † Existing circuits marked ‡ Project #: B13608 File: N:\B13608\sched\B13608 multicare ED_CCE.PNL												
Notes: DO NOT ISSUE - NOT FOR CONSTRUCTION.												
Load Type		Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors		NEC Feed Amps				
Elevator		102.00	Up to 72%, per 620-14	102.00	123	x 100%		123				
		102.00	123 Amps	102.00	123			123				

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		277/480V		3Ø		4W		200A Shunt trip main CB Surface Mounted Single Lugs		Panel Type: Panelboard 25,000 AIC Deep		
#	Description	Load	CB *	CB	A	B	C	CB *	Load	Description	#	
1	Elevator ELEVATOR #20, 100HP	34.00	200/3	CB	•			0/1	0.00	Space	2	
3	-----ELEVATOR #20, 100HP	34.00	-----	---	•			0/1	0.00	Space	4	
5	-----ELEVATOR #20, 100HP	34.00	-----	---		•		0/1	0.00	Space	6	
7	Space	0.00	0/1		•			0/1	0.00	Space	8	
9	Space	0.00	0/1		•			0/1	0.00	Space	10	
11	Space	0.00	0/1			•		0/1	0.00	Space	12	
Rev: Revised circuits marked † Existing circuits marked ‡												
Project #: B13608												
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL												
Notes: DO NOT ISSUE - NOT FOR CONSTRUCTION.												
Load Type	Comm KVA	NEC Demand Factor	Demand KVA	KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Elevator	102.00	Up to 72%, per 620-14	102.00	123	123	x 100%	123					123
	102.00	123 Amps	102.00	123	123		123					123

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		ELEVATOR #21		277/480V		3 Ø		4W		200A Shunt trip main CB Surface Mounted Single Lugs		Panel Type: Panelboard 25,000 AIC Deep	
#	Description	Load	CB *	CB	A	B	C	CB *	CB	ØA	ØB	ØC	#
1	Elevator ELEVATOR #21, 75HP	26.50	125/3	CB	•			0/1		26.50	26.50	26.50	2
3	-----ELEVATOR #21, 75HP	26.50	-----	-----	•			0/1		26.50	26.50	26.50	4
5	-----ELEVATOR #21, 75HP	26.50	-----	-----	•			0/1		26.50	26.50	26.50	6
7	Space	0.00	0/1		•			0/1		0.00	0.00	0.00	8
9	Space	0.00	0/1		•			0/1		0.00	0.00	0.00	10
11	Space	0.00	0/1		•			0/1		0.00	0.00	0.00	12
Rev:		* Circuit Breaker Code											
Revised circuits marked † Existing circuits marked ‡		G = GFCI											
Project #: B13608		S = Shunt Trip											
File: N:\B13608\shed\B13608 multicare		D = Switching Duty											
ED_CCE.PNL		A = AFCI											
Notes: DO NOT ISSUE - NOT FOR CONSTRUCTION.													
Load Type		Conn KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Elevator		79.50		Up to 72%, per 620-14		79.50		96		x 100%		96	
		79.50		96 Amps		79.50		96				96	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		ELEVATOR #22		277/480V		3 Ø		4W		200A Shunt trip main CB Surface Mounted Single Lugs		Panel Type: Panelboard 25,000 AIC Deep		
#	Description	Load	CB *	CB	A	B	C	CB *	CB	Load	Description	#		
1	Elevator ELEVATOR #22, 75HP	26.50	125/3	CB	•			0/1	0/1	0.00	Space	2		
3	ELEVATOR #22, 75HP	26.50			•			0/1	0/1	0.00	Space	4		
5	ELEVATOR #22, 75HP	26.50			•			0/1	0/1	0.00	Space	6		
7	Space	0.00	0/1		•			0/1	0/1	0.00	Space	8		
9	Space	0.00	0/1		•			0/1	0/1	0.00	Space	10		
11	Space	0.00	0/1		•			0/1	0/1	0.00	Space	12		
Rev: Revised circuits marked ‡ Existing circuits marked † Project #: B13608 File: N:\B13608\sched\B13608 multicare ED_CCE.PNL													* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated # = see note	
Notes: DO NOT ISSUE - NOT FOR CONSTRUCTION.														
Load Type		Conn KVA	NEC Demand Factor	Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps				
Elevator		79.50	Up to 72%, per 620-14	79.50	96	x 100%		96		96				
		79.50	96 Amps	79.50	96									

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		LIFT F		277/480V		3Ø		4W		200A Main fuse Surface Mounted Single Lugs		Panel Type: Panelboard 14,000 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	A	B	C	CB *	Load	Description
1	Elevator LIFT 'F' 50HP	17.18	100/3 S	•			0/1					0.00	Space
3	-----LIFT 'F' 50HP	17.18	-----		•		0/1					0.00	Space
5	-----LIFT 'F' 50HP	17.18	-----			•	0/1					0.00	Space
7	Space	0.00	0/1				0/1					0.00	Space
9	Space	0.00	0/1				0/1					0.00	Space
11	Space	0.00	0/1				0/1					0.00	Space
Rev: Revised circuits marked ‡ Existing circuits marked †													
Project #: B13608													
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL													
Notes: DO NOT ISSUE - NOT FOR CONSTRUCTION.													
Load Type		Conn KVA	NEC Demand Factor	Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps			
Elevator		51.54	Up to 72%, per 620-14	51.54	62	51.54	62	x 100%		62			
		51.54	62 Amps	51.54	62	51.54	62			62			

\* Circuit Breaker Code  
H= HID Rated  
C = HACR Rated  
# = see note

G = GFCI  
S = Shunt Trip  
D= Switching Duty  
A = AFCI

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		200A Main lugs only Surface Mounted		Panel Type: Panelboard 10,000 AIC Deep	
Name: 11F		Location:		Serves:		Single Lugs		Description		#	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Lighting RT Rm 1128	1.20	20/1 CB	•			20/1 CB	0.54	Recept Work Rm 1115	2†	
3	Lighting RT Rm 1129	1.20	20/1 CB	•			20/1 CB	1.08	Recept Work Rm 1115, Recept 1114	4†	
5†	Lighting Existing Load	0.00	20/1 CB	•			20/1 CB	0.90	Recept Reception 1114	6†	
7	Equip Copier Work Room 1115	1.00	20/1 CB	•			20/1 CB	1.08	Recept Waiting 1113 & Corridor E1127	8†	
9	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Recept Rms. 1182, 1181, 1179	10†	
11	Spare	0.00	20/1 CB	•			20/1 CB	0.90	Recept Office 1182	12†	
13	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Recept Office 1177	14†	
15	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Recept Soiled Rm. 1176	16†	
17	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Recept Office 1175	18†	
19	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Recept Clean Rm 1174	20†	
21	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Recept Rms 1172, 1069, 1165	22†	
23	Spare	0.00	20/1 CB	•			20/1 CB	1.08	Recept Office 1165	24†	
25	Spare	0.00	20/1 CB	•			20/1 CB	1.44	Recept DOS Work Rm 1162	26†	
27	Spare	0.00	20/1 CB	•			20/1 CB	1.26	Recept DOS Work Rm 1162	28†	
29	Spare	0.00	20/1 CB	•			20/1 CB	1.44	Recept DOS Work Rm 1162	30†	
31	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Recept Equip Closet Dos Work Rm 1162	32†	
33	Spare	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	34†	
35	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Recept Office 1161	36†	
37	Spare	0.00	20/1 CB	•			20/1 CB	0.72	Recept Office 1161, NS 131C	38†	
39†	Recept Office 1164	1.08	20/1 CB	•			20/1 CB	0.72	Recept Nurse Station 131C	40†	
41†	Recept Office 1164	0.90	20/1 CB	•			20/1 CB	0.00	Spare	42†	
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC	ØC				
Project #: B13608		8.86		8.22	7.02						
File: N:\B13608\sched\B13608 multicare ED_CC.EPNL											
Notes:											
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps					
Lighting	2.40	x 100%	2.40	7	x 125%	8					
Recept	20.70	10 KVA @ 100%, rest @ 50%	15.35	43	x 100%	43					
Equip	1.00	x 100%	1.00	3	x 100%	3					
	24.10	67 Amps	18.75	52		54					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		11J L-Wing		120/208V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 0 AIC Deep		
#	Description	Load	CB *	A	B	C	CB *	CB *	CB *	CB *	CB *	Description	Load	#
1	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	2
3	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	4
5	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	6
7	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	8
9	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	10
11	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	12
13	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	14
15	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	16
17	Space	0.00	0/1	•			20/1	CB				Receipt Existing Load	0.00	18
19	Space	0.00	0/1	•			0/1					Space	0.00	20
21	Space	0.00	0/1	•			0/1					Space	0.00	22
23	Space	0.00	0/1	•			0/1					Space	0.00	24
25	Space	0.00	0/1	•			0/1					Space	0.00	26
27	Space	0.00	0/1	•			0/1					Space	0.00	28
29	Space	0.00	0/1	•			0/1					Space	0.00	30
31	Misc Existing LinAcc	0.00	0/3	•			0/1					Space	0.00	32
33	-----	0.00	-----	•			0/1					Space	0.00	34
35	-----	0.00	-----	•			0/1					Space	0.00	36
37	Misc Existing LinAcc	0.00	0/3	•			0/1					Space	0.00	38
39	-----	0.00	-----	•			0/1					Space	0.00	40
41	-----	0.00	-----	•			0/1					Space	0.00	42
Rev: Revised circuits marked † Existing circuits marked ‡		Connected KVA		ØA	ØB	ØC								
Project #: B13608		0.00		0.00	0.00	0.00								
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL														
Notes:														
Load Type		Comm KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps		
Space		0.00				0.00		0				0		
		0.00				0.00		0				0		

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		2H K-Wing		277/480V		3Ø		4W		200A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 0 AIC Deep			
#	Description	Load	CB *	A	B	C	CB *	CB	CB	CB	CB	Description	Load	#	
1	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	2	
3	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	4	
5	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	6	
7	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	8	
9	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	10	
11	Lighting Existing Load	0.00	20/1	CB	•		20/1	CB				Lighting Existing Load	0.00	12	
13	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	14	
15	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	16	
17	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	18	
19	Lighting Existing Load	0.00	20/1	CB	•		20/1	CB				Lighting Existing Load	0.00	20	
21	Lighting Existing Load	0.00	20/1	CB	•		0/1					Space	0.00	22	
23	Space	0.00	0/1				0/1					Space	0.00	24	
25	Space	0.00	0/1				0/1					Space	0.00	26	
27	Space	0.00	0/1				0/1					Space	0.00	28	
29	Space	0.00	0/1				20/1	CB				Lighting Existing Load	0.00	30	
31	Space	0.00	0/1				0/1					Space	0.00	32	
33	Space	0.00	0/1				0/1					Space	0.00	34	
35	Space	0.00	0/1				0/1					Space	0.00	36	
37	Lighting Panel 4H	0.00	0/3				0/1					Space	0.00	38	
39	-----	0.00	-----				0/1					Space	0.00	40	
41	-----	0.00	-----				0/1					Space	0.00	42	
Rev: Revised circuits marked † Existing circuits marked ‡		Project #: B13608		File: N:\B13608\shed\B13608 multicare ED_CCE.PNL		* Circuit Breaker Code G = GFCI S = Shunt Trip D = Switching Duty A = AFCI		H = HID Rated C = HACR Rated # = see note							
Notes:		Demand KVA		Demand Amps		NEC Demand Factor		NEC Feeder Factors		NEC Feed Amps					
Space		0.00		0		0.00		0		0					
Space		0.00		0 Amps		0.00		0		0					

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		277/480V		3Ø		4W		100A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 0 AIC Deep	
Name: 2H1E K-Wing											
Location:											
Serves:											
#	Description	Load	CB *	A	B	C	CB *	CB	Load	Description	#
1	Lighting Existing Load	0.00	20/1	•			20/1	CB	0.60	Lighting Existing Load	2
3	Lighting Existing Load	0.00	20/1	•			20/1	CB	2.43	Lighting Existing Load	4
5	Lighting Existing Load	0.00	20/1	•			0/1		0.00	Space	6
7	Space	0.00	0/1	•			20/1	CB	0.00	Lighting Existing Load	8
9	Space	0.00	0/1	•			0/1		0.00	Space	10
11	Lighting Existing Load	0.00	20/1	•			20/1	CB	0.00	Lighting Existing Load	12
13	Space	0.00	0/1	•			20/1	CB	0.00	Lighting Existing Load	14
15	Space	0.00	0/1	•			0/1		0.00	Space	16
17	Space	0.00	0/1	•			0/1		0.00	Space	18
19	Space	0.00	0/1	•			20/1	CB	0.00	Lighting Existing Load	20
21	Space	0.00	0/1	•			0/1		0.00	Space	22
23	Space	0.00	0/1	•			0/1		0.00	Space	24
25	Space	0.00	0/1	•			0/1		0.00	Space	26
27	Space	0.00	0/1	•			0/1		0.00	Space	28
29	Space	0.00	0/1	•			0/1		0.00	Space	30
31	Space	0.00	0/1	•			0/1		0.00	Space	32
33	Space	0.00	0/1	•			0/1		0.00	Space	34
35	Space	0.00	0/1	•			0/1		0.00	Space	36
37	Space	0.00	0/1	•			0/1		0.00	Space	38
39	Space	0.00	0/1	•			0/1		0.00	Space	40
41	Space	0.00	0/1	•			0/1		0.00	Space	42
Rev: Revised circuits marked † Existing circuits marked ‡											
Project #: B13608											
File: N:\B13608\shed\B13608 multicare											
ED_CCE.PNL											
Notes:											
G = GFCI										* Circuit Breaker Code	
S = Shunt Trip										H = HID Rated	
D = Switching Duty										C = HACR Rated	
A = AFCI										# = see note	
Demand KVA		Demand KVA		Demand KVA		Demand KVA		Demand Amps		NEC Feeder Factors	
3.03		3.03		3.03		3.03		4		x 125%	
3.03		3.03		3.03		3.03		4		5	
4 Amps		4 Amps		4 Amps		4 Amps		4		5	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		400A Main lugs only Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 0 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1†	Recept Shelled Space 2999	0.90	20/1 CB	•			20/1 CB	0.36	Recept Trauma Rm. 2254	2†	
3†	Recept Shelled Space 2999	0.90	20/1 CB	•			20/1 CB	0.36	Recept Trauma Rm. 2258	4†	
5†	Recept Toilet 2292/2294, Alcove 2293	0.72	20/1 CB	•			20/1 CB	0.36	Recept Trauma Rm. 2264	6†	
7†	Equip Ref, Lounge 2289	0.80	20/1 CB	•			20/1 CB	0.18	Recept Trauma Rm. 2251	8†	
9†	Equip Ref, Lounge 2289	0.80	20/1 CB	•			20/1 CB	1.08	Recept Phys Work 2253	10†	
11†	Equip Coffee Machine, Lounge 2289	1.80	20/1 CB	•			20/1 CB	1.00	Misc Hand Dryer 2275	12†	
13†	Equip Microwave, Lounge 2289	1.21	20/1 CB	•			20/1 CB	1.44	Recept Nurse Station 2255	14†	
15†	Equip Microwave, Lounge 2289	1.21	20/1 CB	•			20/1 CB	1.26	Recept Nurse Station 2257	16†	
17†	Recept Lounge 2289	1.44	20/1 CB	•			20/1 CB	1.08	Recept Meds 2261	18†	
19†	Equip Coffee Machine, EMT 2288	1.80	20/1 CB	•			20/1 CB	0.54	Recept Corridor 2259	20†	
21†	Equip UC REF, EMT 2288	0.80	20/1 CB	•			20/1 CB	1.64	Equip Blanket Warmer, Alcove 2259A	22†	
23†	Equip Microwave, EMT 2288	1.21	20/1 CB	•			20/1 CB	0.90	Recept Clean/Soiled 2262/2265	24†	
25†	Recept EMT 2288	1.26	20/1 CB	•			20/1 CB	1.92	Equip Refrigerator, Clean 2262	26†	
27†	Recept Ambulance Bay 2286	0.72	20/1 CB	•			20/1 CB	0.54	Recept Toilet 2266, HSKP. 2267	28†	
29†	Equip Baritic Lift, Ambulance Bay 2286	1.00	20/1 CB	•			20/1 CB	1.64	Equip Blanket Warmer, Alcove 2252A	30†	
31†	Recept Vestibule 2285	0.90	20/1 CB	•			20/1 CB	1.26	Recept Alcove 2252A/B	32†	
33†	Recept Office 2283,2282	1.26	20/1 CB	•			20/1 CB	1.26	Recept Chart 2194A	34†	
35†	Recept Office 2283	1.26	20/1 CB	•			20/1 CB	0.54	Recept Rm 2279	36†	
37†	Recept Office 2282	1.44	20/1 CB	•			20/1 CB	0.72	Recept Rm 2270, 2271	38†	
39†	Recept Rm 2281	0.90	20/1 CB	•			20/1 CB	1.08	Recept Room 2279	40	
41†	Recept Rm 2279	0.90	20/1 CB	•			20/1 CB	1.08	Recept Room 2279	42	

Rev: Revised circuits marked † Existing circuits marked ‡  
 Project #: B13608  
 File: N:\B13608\sched\B13608 multicare ED\_CCE.PNL

\* Circuit Breaker Code  
 G = GFCI  
 S = Shunt Trip  
 D = Switching Duty  
 A = AFCI  
 H = HID Rated  
 C = HACR Rated  
 # = see note

Notes: 1) CIRCUITS MARKED REVISED SHALL UTILIZE EXISTING BREAKERS MADE SPARE IN DEMO. CONTRACTOR TO CONFIRM SPARE BREAKERS AND PROVIDE BREAKERS WHERE REQUIRED.

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Recept	30.42	10 KVA @ 100%, rest @ 50%	20.21	56	x 100%	56
Equip	17.34	x 100%	17.34	48	x 100%	48
Misc	1.00	x 100%	1.00	3	x 100%	3
	48.76	135 Amps	38.55	107		107

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		2L1E K-Wing		120/208V		3Ø		4W		200A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 0 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	CB	CB	CB	Load	Description	#
1†	Recept Trauma Rm. 2258, C1	1.08	20/1	•			20/1	CB			1.08	Recept Trauma Rm. 2254, C1	2†
3†	Recept Trauma Rm. 2258, C2	1.08	20/1	•			20/1	CB			1.08	Recept Trauma Rm. 2254, C2	4†
5†	Recept Trauma Rm. 2258, C3	1.08	20/1	•			20/1	CB			1.08	Recept Trauma Rm. 2254, C3	6†
7†	Equip Pyxis, Trauma Rm. 2258, C4	1.00	20/1	•			20/1	CB			1.00	Equip Pyxis, Trauma Rm. 2254, C4	8†
9†	Recept Trauma Rm. 2258, C5	0.54	20/1	•			20/1	CB			0.54	Recept Trauma Rm. 2254, C5	10†
11†	Recept Trauma Rm. 2258, C6	0.54	20/1	•			20/1	CB			0.54	Recept Trauma Rm. 2254, C6	12†
13†	Recept Trauma Rm. 2258, C7	0.54	20/1	•			20/1	CB			0.54	Recept Trauma Rm. 2254, C7	14†
15†	Recept Trauma Rm. 2258, C11	1.08	20/1	•			20/1	CB			1.08	Recept Trauma Rm. 2254, C11	16†
17†	Recept Trauma Rm. 2258, C12	1.08	20/1	•			20/1	CB			1.08	Recept Trauma Rm. 2254, C12	18†
19†	Recept Trauma Rm. 2258, C13	1.08	20/1	•			20/1	CB			1.08	Recept Trauma Rm. 2254, C13	20†
21†	Equip Pyxis, Trauma Rm. 2258, C14	1.00	20/1	•			20/1	CB			1.00	Equip Pyxis, Trauma Rm. 2254, C14	22†
23†	Recept Trauma Rm. 2258, C15	0.54	20/1	•			20/1	CB			0.54	Recept Trauma Rm. 2254, C15	24†
25†	Recept Trauma Rm. 2258, C16	0.54	20/1	•			20/1	CB			0.54	Recept Trauma Rm. 2254, C16	26†
27†	Recept Trauma Rm. 2258, C17	0.54	20/1	•			20/1	CB			0.54	Recept Trauma Rm. 2254, C17	28†
29	Recept Existing Load	0.00	20/1	•			20/1	CB			1.08	Recept Phys Work 2253	30†
31	Recept Existing Load	0.00	20/1	•			20/1	CB			1.08	Recept Phys Work 2253	32†
33	Recept Existing Load	0.00	20/1	•			20/1	CB			1.08	Recept NS 2255	34†
35	Recept Existing Load	0.00	20/1	•			20/1	CB			1.08	Recept NS 2255	36†
37	Misc Panel 2L1EA	0.00	0/3	•			20/1	CB			1.08	Recept NS 2257	38†
39	-----	0.00	-----	•			20/1	CB			1.08	Recept NS 2257	40†
41	-----	0.00	-----	•			20/1	CB			0.00	Recept Existing Load	42
Rev: Revised circuits marked † Existing circuits marked ‡		ØA		ØB		ØC						* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated D = Switching Duty # = see note A = AFCI	
Project #: B13608		Connected KVA		10.64		10.64		8.64					
File: N:\B13608\shed\B13608 multicare ED_CCE.PNL													
Notes: 1) CIRCUITS MARKED REVISED SHALL UTILIZE EXISTING BREAKERS MADE SPARE IN DEMO. CONTRACTOR TO CONFIRM SPARE BREAKERS AND PROVIDE BREAKERS WHERE REQUIRED.													
Load Type		Conn KVA		NEC Demand Factor		Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Recept		25.92		10 KVA @ 100%, rest @ 50%		17.96		50		x 100%		50	
Equip		4.00		x 100%		4.00		11		x 100%		11	
		29.92		83 Amps		21.96		61				61	

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		120/208V		3Ø		4W		100A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 0 AIC Deep		
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#		
1	Misc Existing Main Circuit Breaker	0.00	100/3	•			20/1	CB	Recept Trauma Rm. 2264, C1	2†		
3	-----	0.00	-----	•			20/1	CB	Recept Trauma Rm. 2264, C2	4†		
5	-----	0.00	-----	•			20/1	CB	Recept Trauma Rm. 2264, C3	6†		
7‡	Recept Trauma Rm 2251, C1	1.08	20/1	•			20/1	CB	Equip Pyxis, Trauma Rm. 2264, C4	8‡		
9‡	Recept Trauma Rm 2251, C2	1.08	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C5	10‡		
11‡	Recept Trauma Rm 2251, C3	1.08	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C6	12‡		
13‡	Recept Pyxis, Trauma Rm 2251, C4	1.00	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C7	14‡		
15‡	Recept Trauma Rm 2251, C5	0.54	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C11	16‡		
17‡	Recept Trauma Rm 2251, C6	0.54	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C12	18‡		
19‡	Recept Trauma Rm 2251, C7	0.54	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C13	20‡		
21‡	Recept Trauma Rm 2251, C8	0.54	20/1	•			20/1	CB	Equip Pyxis, Trauma Rm. 2264, C14	22‡		
23	Recept Existing Load	0.00	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C15	24‡		
25	Recept Existing Load	0.00	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C16	26‡		
27	Recept Existing Load	0.00	20/1	•			20/1	CB	Recept Trauma Rm. 2264, C17	28‡		
29	Recept Existing Load	0.00	20/1	•			20/1	CB	Recept 2259	30		
31	Recept Alcove 2252	0.36	20/1	•			20/1	CB	Misc Pyxis Connection	32		
33	Recept Alcove 2293/2196A	0.36	20/1	•			20/1	CB	Recept 2261,2262	34		
35	Space	0.00	0/1	•			20/1	CB	Recept 2265	36		
37	Space	0.00	0/1	•			20/1	CB	Recept Existing Load	38		
39	Space	0.00	0/1	•			20/1	CB	Recept Existing Load	40		
41	Space	0.00	0/1	•			20/1	CB	Recept Existing Load	42		
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code G = GFCI H = HIID Rated S = Shunt Trip C = HACR Rated # = see note D = Switching Duty A = AFCI			
Project #: B13608		8.58	7.52	7.32								
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL		Notes:		1) CIRCUITS MARKED REVISED SHALL UTILIZE EXISTING BREAKERS MADE SPARE IN DEMO. CONTRACTOR TO CONFIRM SPARE BREAKERS AND PROVIDE BREAKERS WHERE REQUIRED.								
Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps						
Recept	22.22	10 KVA @ 100%, rest @ 50%	16.11	45	x 100%	45						
Equip	0.20	x 100%	0.20	1	x 100%	1						
Misc	1.00	x 100%	1.00	3	x 100%	3						
	23.42	65 Amps	17.31	48		48						

SECTION 26 24 12 - PANEL SCHEDULES

Sparing		120/208V		3Ø		4W		400A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 0 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
43†	Recept Office 2278	0.90	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	44	
45†	Recept Office 2277	0.90	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	46	
47†	Recept Office 2277	1.26	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	48	
49†	<Multi> Office 2274, Toilet 2275	1.22	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	50	
51†	Equip Pneumatic Tube System Diverter	1.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	52	
53	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	54	
55	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	56	
57	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	58	
59	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	60	
61	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	62	
63	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	64	
65	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	66	
67	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	68	
69	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	70	
71	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	72	
73	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	74	
75	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	76	
77	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	78	
79	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	80	
81	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	82	
83	Recept Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Recept Existing Load	84	

Rev:	Revised circuits marked ‡ Existing circuits marked †
Project #:	B13608
File:	N:\B13608\sched\B13608 multicare ED_CCE.PNL

Notes: 1) CIRCUITS MARKED REVISED SHALL UTILIZE EXISTING BREAKERS MADE SPARE IN DEMO. CONTRACTOR TO CONFIRM SPARE BREAKERS AND PROVIDE BREAKERS WHERE REQUIRED.

Load Type	Conn KVA	NEC Demand Factor	Demand KVA	Demand Amps	NEC Feeder Factors	NEC Feed Amps
Recept	3.78	10 KVA @ 100%, rest @ 50%	3.78	10	x 100%	10
Equip	1.50	x 100%	1.50	4	x 100%	4
	5.28	15 Amps	5.28	15		15

SECTION 26 24 12 - PANEL SCHEDULES

Sparling		2L2E-1 K-Wing		120/208V		3Ø		4W		250A Main lugs only Surface Mounted Feed Thru Lugs		Panel Type: Panelboard 0 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	Load	Description	#	
1	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	2	
3	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	4	
5	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	6	
7	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	8	
9	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	10	
11	Space	0.00	0/1				20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	12	
13	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	14	
15	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	16	
17	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	18	
19	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	20	
21	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	22	
23	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	24	
25	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	26	
27	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	28	
29	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	30	
31	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	32	
33	Space	0.00	0/1				20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	34	
35	Space	0.00	0/1				20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	36	
37	Misc Panel 4L2E	0.00	0/3	•			20/1 CB	0.00	Receipt Existing Load	0.00	Receipt Existing Load	38	
39	*****	0.00	*****	•			0/1	0.00	Space	0.00	Space	40	
41	*****	0.00	*****	•			0/1	0.00	Space	0.00	Space	42	
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC			* Circuit Breaker Code				
Project #: B13608		Connected KVA		0.00	0.00	0.00			G = GFCI				
File: N:\B13608\ sched\B13608 multicare		Connected KVA		0.00	0.00	0.00			S = Shunt Trip				
ED_CCE.PNL		Connected KVA		0.00	0.00	0.00			D= Switching Duty				
		Connected KVA		0.00	0.00	0.00			A = AFCI				
Notes:		Demand KVA		0.00	0.00	0.00							
Load Type		Demand Amps		0	0	0			NEC Feeder Factors		NEC Feed Amps		
Space		Demand Amps		0	0	0					0		
		Demand Amps		0	0	0					0		

SECTION 26 24 12 - PANEL SCHEDULES

Sparling Name: 2L2E-2 K-Wing		120/208V		3 Ø		4W		250A Main lugs only Surface Mounted Single Lugs		Panel Type: Panelboard 0 AIC Deep	
#	Description	Load	CB *	A	B	C	CB *	Load	Description	#	
1	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	2	
3	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	4	
5	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	6	
7	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	8	
9	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	10	
11	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	12	
13	Space	0.00	0/1	•			20/1 CB	0.00	Receipt Existing Load	14	
15	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	16	
17	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	18	
19	Receipt Existing Load	0.00	20/1 CB	•			0/1	0.00	Space	20	
21	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	22	
23	Receipt Existing Load	0.00	20/1 CB	•			0/1	0.00	Space	24	
25	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	26	
27	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	28	
29	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	30	
31	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	32	
33	Receipt Existing Load	0.00	20/1 CB	•			20/1 CB	0.00	Receipt Existing Load	34	
35	Space	0.00	0/1	•			20/1 CB	0.00	Receipt Existing Load	36	
37	Space	0.00	0/1	•			0/1	0.00	Space	38	
39	Space	0.00	0/1	•			0/1	0.00	Space	40	
41	Space	0.00	0/1	•			0/1	0.00	Space	42	
Rev: Revised circuits marked ‡ Existing circuits marked †		Connected KVA		ØA	ØB	ØC	ØC	* Circuit Breaker Code G = GFCI H = HID Rated S = Shunt Trip C = HACR Rated D = Switching Duty A = AFCI			
Project #: B13608				0.00	0.00	0.00	0.00				
File: N:\B13608\sched\B13608 multicare ED_CCE.PNL				Demand KVA		Demand Amps		NEC Feeder Factors		NEC Feed Amps	
Notes:				0.00		0				0	
				0.00		0 Amps				0	



## SECTION 26 25 00 ENCLOSED BUS ASSEMBLIES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION

- A. Provide a complete prefabricated, low-impedance busway distribution system as shown on the Drawings with all necessary termination components, fittings, hanging devices and accessories. All busway and components shall be U.L. listed for mounting in any position, or through walls, or through floors without derating.

#### 1.3 SUBMITTALS

- A. Submit Shop Drawings for approval prior to manufacture factory Shop Drawings demonstrating conformance with all requirements of these Specifications and the Drawings. These Shop Drawings shall include catalog cuts of all system components and a completely dimensioned system layout with all component parts identified by catalog numbers. Shall indicate conformance with utility requirements where applicable.
- B. Submit Joint Torque Certification.

#### 1.4 OPERATION AND MAINTENANCE MANUAL

- A. The busway section of the maintenance manual (refer to Section 26 05 00 - Common Work Results For Electrical) shall contain copies of the Shop Drawings described above and the Manufacturer's recommended maintenance procedures, including joint torque inspection intervals.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURER

- A. General Electric, Cutler Hammer or Square D. Where the busway system directly terminates or originates in electrical equipment, this equipment shall be of the same manufacture as the busway system. Responsibility for coordinating the connection rests solely with the Manufacturer.

#### 2.2 HOUSING

- A. Shall be totally enclosed over entire length.
- B. Shall be of fabricated, galvanized sheet steel to provide protection against corrosion from water and other contaminants.
- C. All hardware shall be plated to prevent corrosion.
- D. Welds shall be closely spaced along both sides of the full length of the busway to insure that the conductor insulation is held in continuous contact with the housing.
- E. Steel dividers between housing sides shall brace housing and bus bars.
- F. Busway shall be finished in grey enamel.

#### 2.3 JOINTS

- A. The busway joints shall be of the one-bolt type. The busway joint design shall permit safe, practical testing of joints for tightness without de-energizing the run. This operation must be possible without exposing maintenance men to any electrical hazard and without downtime of the busway or the equipment it feeds.
- B. Access shall be required to only one side of the busway for tightening joint bolts.
- C. It shall be possible to remove any one length in a run without disturbing adjacent lengths.
- D. Joints shall utilize belleville washers to maintain positive pressure.

## SECTION 26 25 00 ENCLOSED BUS ASSEMBLIES

### 2.4 BUSBARS

- A. Busbars shall be copper and shall be silver or tin plated at all joints and contact surfaces, insulated over entire length. Insulation shall be NEMA Class B (130 degrees C.).
- B. The maximum hot-spot temperature rise at any point in the busway at continuous rated load shall not exceed 55 degrees C above a maximum ambient temperature of 40 degrees C in any mounting position.
- C. Provide busway with internal ground bus conforming with the larger of U.L. 891 or 30% of busway rating for minimum size except larger as required by Code for grounding neutral conductor.

### 2.5 SHORT CIRCUIT RATING

- A. The busway system shall be braced to withstand, without damage or permanent distortion, short circuit currents of 100,000 amps symmetrical or as shown on the Drawings when tested in accordance with the current NEMA standards.

### 2.6 BUSWAY SUPPORT

- A. Horizontal runs use patented hanger.
- B. Vertical runs use patent spring type hanger.
- C. Bus penetrations through the building floors and walls shall have 3 hour firestops as a part of the busway or as shown.
- D. Support busway with hangers, brackets and components specifically designed for busway support per Manufacturer's recommendations.

### 2.7 FIRE RATED PENETRATIONS

- A. Provide rated penetrations matching the rating of the floor or wall penetrated.

### 2.8 UTILITY REQUIREMENTS

- A. Where busway terminates in a service utility's space the termination shall conform to all serving utility requirements. Provide all barriers, fire rated penetrations, termination holes and fittings and other accessories as required.

### 2.9 PLUG-IN OPENINGS

- A. Ten plug in openings shall be provided per 10 foot section, five to a side and all usable simultaneously.
- B. Plug in units shall make a positive ground connection to the housing and shall not be connectable or removable while the unit is in the "on" position. Plug-in units shall be rated for the available fault current and conform with other applicable Sections of these Specifications.
- C. Plug-in units not directly accessible from the floor shall be equipped with suitable means for operation from the floor.

## PART 3 EXECUTION

### 3.1 RESPONSIBILITY FOR ROUTING AND MEASUREMENT

- A. Responsibility for routing and measurement is entirely the Contractor's.
- B. Contractor shall coordinate busway routing to clear work of other trades.
- C. Contractor shall make final field measurements prior to release of busway for fabrication to assure measurements and coordination.

### 3.2 BUSWAY

- A. Install parallel to walls, floors and ceilings. Horizontal and vertical offsets shall be made with manufactured fittings.
- B. Prior to on site assembly busway shall be stored indoors in a dust and moisture free environment.

## SECTION 26 25 00 ENCLOSED BUS ASSEMBLIES

### 3.3 BUSWAY SUPPORT

- A. Provide flatwise, edgewise or vertical hangers per Manufacturer's recommendations. Horizontal runs shall have hangers at five foot intervals. Provide adjustable vertical spring hangers for vertical rises of two or more floors to evenly distribute busway weight on each floor.

### 3.4 WALL AND FLOOR PENETRATIONS

- A. When busway passes through a fire rated wall or floor, provide a firestop or barrier to match the fire rating of the floor or wall.
- B. Provide a cement curb 5" high around all busway floor penetrations to help protect the busway and lower floors from possible water damage.

### 3.5 JOINT TORQUE CERTIFICATION

- A. Upon job completion the Manufacturer shall furnish the Architect with written conformation that all joints have been installed and torqued to the Manufacturer's Specifications.

### 3.6 PLUG-IN BUSWAY

- A. Hangers shall not be installed so as to block plug-in openings.
- B. Hangers shall be sway braced for unbalanced weight of plug-in units plus weight of a 250 lb. man on a ladder at the height of the busway installation.
- C. Provide flexible raceway connection to plug-in units to permit removal.

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 General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes switches, receptacles, dimmers, device plates and multi-outlet assemblies.
- B. Related sections include 26 09 23 - Lighting Control Devices.

#### 1.3 REFERENCES

- A. National Electrical Manufacturers Association (NEMA).
- B. Underwriters Laboratories (UL).

#### 1.4 SUBMITTALS

- A. Submit under Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results For Electrical. Submit product data for each device utilized in the Project.

#### 1.5 COORDINATION

- A. Provide receptacles to match plug configurations for Owner-furnished equipment.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURER

- A. Subject to compliance with requirements, provide products by one of the Manufacturers listed in the following paragraphs. All devices utilized on the Project shall be from the same Manufacturer.

#### 2.2 RECEPTACLES

- A. Specification Grade: Duplex NEMA 5-20R configuration (20 amp, 120V), back and side wired, nylon face, unless shown otherwise. Bryant 5262-I, Cooper BR20V, Hubbell HBL5262I, Leviton 5262-I, or Pass & Seymour 5262-I.
- B. Ground Fault Circuit Interrupter (GFCI) Receptacle: Specification Grade, NEMA 5-20R configuration, duplex receptacle with 4-6 milliamps leakage current trip level. Feed through type to protect downstream receptacles on the same circuit. Cooper GF20V, Hubbell GF-5262-I, Leviton 6599-I, or Pass & Seymour 2091-SI.
- C. Safety Receptacles: Safety type receptacles for designated areas shall be hospital grade, with safety shutters to make it necessary for both plug blades to be inserted to complete a circuit. NEMA 5-15R configuration. Cooper TR8200V, Hubbell #HBL8200SGI, Pass & Seymour TR62HI, Leviton 8200-SGI Safety receptacles are the same as tamperproof receptacles.

#### 2.3 SWITCHES

- A. Specification Grade, back and side wired, rated 277 volt, 20 amp. Single pole, double pole, keyed, 3- way, pilot light, locking type as required or as noted. Bryant 4901-I, Cooper 1221V, Hubbell 1221-I, Leviton 1221-I, or Pass & Seymour 20AC1-I. Provide keyed switch as shown on drawings.
- B. Interchangeable type rated same as above.
- C. Momentary Contact Line Voltage Switches: Single pole, double throw, 3-wire, spring return to open. Rating same as above.
- D. Pilot light switches: Lighted handle when "ON", or with separate pilot light.

## SECTION 26 27 26 WIRING DEVICES

### 2.4 WALL BOX DIMMERS

- A. Incandescent Dimmers: Incandescent wall box dimmers rated for incandescent, inductive or low voltage loads, as required by the load served. Dimmer shall have slider control with full off at bottom of slide, power failure memory, and RFI filter. Dimmer shall have thin profile heat-sink, screw less face plate and gang with other switches and dimmers utilizing a continuous faceplate. Provide dimmer rated for 100% of the maximum wattage that can be installed in the controlled fixtures (minimum). Lightolier Vega Series, or Lutron Nova T\* Series.
- B. Fluorescent Dimmers: Fluorescent dimmers shall be compatible with the fluorescent dimming ballasts installed in the fixtures to be controlled. Dimmer shall have slider control with full off at the bottom of slide, power failure memory, and RFI filter. Dimmer shall have thin profile heat-sink, screw less face plate and gang with other switches and dimmers utilizing a continuous face plate. Lightolier Vega Series, or Lutron Nova T\* Series.

### 2.5 COLOR

- A. Ivory for switch handles and receptacle faces except as follows;
  - 1. Red for emergency circuits.
  - 2. Orange for isolated ground circuits.

### 2.6 DEVICE PLATES

- A. Configuration: Single and combination type to match corresponding wiring devices.
- B. Attachment Screws: Metal with head color to match plate finish.
- C. Interior Recessed Boxes: High impact nylon or thermo plastic, color to match corresponding wiring device.
- D. Interior Surface Boxes: Pressed raised steel to match size of outlet box.
- E. Exterior: Rain tight while in use hinged cover, Hubbell Bell 5752-0, Leviton 5977-CL, Cooper 4966. For other receptacles provide cover to match receptacle.
- F. Identification: For receptacles other than 15 and 20 amp, 120 volts, engrave coverplate or provide separate nameplate with ampere rating, voltage and phase. Minimum lettering size 3/16".

### 2.7 CEILING CORD DROPS

- A. Description: Matching, locking type, plug and receptacle body connector, NEMA, Configurations L5-20P and L5-20R, Heavy-Duty grade.
  - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
  - 2. External Cable Grip: Woven wire-mesh type made of high strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

## PART 3 EXECUTION

### 3.1 MOUNTING

- A. Rigidly fasten (without play) outlet boxes and devices at proper position with wall to bring receptacle flush with plate or switch handle the proper distance through plate. Align devices and plates plumb.

### 3.2 RECEPTACLES

- A. Hospital Grade: Provide hospital grade receptacles in all patient care areas, operating rooms, patient corridors, work rooms, equipment rooms, utility rooms, patient preparation rooms, exam rooms and nurses stations. Provide 15 amp receptacles in all locations except provide 20 amp receptacles on dedicated 20 amp circuits.
- B. Heavy Duty Hospital Grade: Provide in the locations indicated on the Drawings.
- C. Provide surge protection receptacles in the locations shown on the Drawings.

## SECTION 26 27 26 WIRING DEVICES

- D. Provide isolated ground receptacles in the locations shown on the Drawings.
- E. Provide exterior GFCI receptacle within 25'-0" of each roof mounted mechanical equipment, for all outdoor receptacles, and other locations shown on the Drawings.
- F. Provide safety receptacles in pediatric care areas, alcoholism and substance abuse treatment areas, all exam rooms, all trauma rooms, and waiting areas.

### 3.3 ORIENTATION

- A. Set switches with handle operating vertically, up position "ON". Set receptacles vertically with ground pin up or when construction requires horizontal mounting ground pin left.

### 3.4 DEVICE PLATES

- A. Provide for wiring devices, telephone and signal outlets. Plate to cover cutout for device outlet box.
- B. For remodel projects or for additions to existing construction provide new plates on existing outlet boxes unless the existing plate matches new plates in construction and appearance.
- C. Install device plates after painting is complete.
- D. Provide exterior rain tight while in use covers for exterior receptacles in wet locations. Otherwise provide weather resistant covers.

### 3.5 DIMMERS

- A. Install wall box dimmers to achieve circuit rating after derating for ganging as required by Manufacturer.
- B. Do not share neutral conductor on load side of dimmers.

### 3.6 CLEANING

- A. Remove excess plaster from interior of outlet boxes.
- B. Clean devices and coverplates after painting is complete. Replace stained or improperly painted devices or coverplates.

END OF SECTION



## SECTION 26 28 13 FUSES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the specifications for fuses (600V and below) and spare fuse cabinet.

#### 1.3 REFERENCES

- A. American National Standards Institute (ANSI)
- B. National Electrical Manufacturers Association (NEMA)
- C. Underwriters Laboratories (UL)

#### 1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 00 - Common Work Results For Electrical. Submit product data for each fuse type and size.
- B. Submit the following information:
  - 1. Descriptive data and time-current curves
  - 2. Let-through current curves for fuses with current-limiting characteristics
  - 3. Coordination charts and tables and related data

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from one source and by a single Manufacturer.

#### 1.6 SPARE FUSES

- A. At completion of Project, furnish to the Owner a quantity of spare fuses equal to 10% of the total quantity of each size and type of fuse used on the Project, with a minimum of three (3) fuses of any one size and type.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide fuses by one of the following:
  - 1. Bussmann
  - 2. Eagle Electric Mfg. Co
  - 3. Edison
  - 4. General Electric
  - 5. Gould Shawmut
  - 6. Littelfuse
- B. Submit requests for substitution of alternate Manufacturers with a complete short circuit and coordination study for evaluation.

#### 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.
- B. Current limiting, 200,000 AIC minimum interrupting capacity, unless noted otherwise.
- C. Circuits 601-6000 amps: Class L time delay
- D. Circuits 600 amps and less: Class RK1 or Class J
- E. Motor Circuits: Class RK5 dual element time delay or Class L (601-6000A)
- F. Transformer Primary Circuits: Class RK5

## SECTION 26 28 13 FUSES

### 2.3 SPARE FUSE CABINET

- A. Wall-mounted 0.05-inch-(1.27-mm-) thick steel unit with full-length, recessed piano-hinged door key-coded cam lock and pull. Cabinet front and lock to match panelboard equipment specified in Section 262416 - Panelboards.
  - 1. Size: Adequate for orderly storage of spare fuses specified with 10 percent spare capacity minimum.
  - 2. Finish: Gray baked enamel.
  - 3. Nameplate: Engraved "SPARE FUSES" in 1/2 inch letters on door.
  - 4. Fuse Pullers: For each size fuse.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install fuses in fusible devices at job site just prior to energization. Do not accept equipment with fuses installed at factory.
- B. Arrange fuses so fuse ratings are readable without removing fuse.
- C. Install spare fuse cabinet in main electrical room or as shown on Drawings.

#### 3.3 CLEANING AND INSPECTION

- A. Clean fuses, tighten connections and inspect fuse holders prior to energization of the equipment.

END OF SECTION

## SECTION 26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes separately mounted switches and circuit breakers.
- B. Provide all disconnects required by Code for equipment furnished under this and other Divisions of these Specifications unless disconnects are integral with equipment and acceptable to the authority having jurisdiction.

#### 1.3 REFERENCES

- A. National Electrical Manufacturers Association (NEMA)
- B. Underwriters Laboratories (UL)

#### 1.4 SUBMITTALS

- A. Submit under Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results For Electrical. Submit product data for disconnect switches, fused disconnect switches, enclosed circuit breakers and accessories specified in this Section.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following (same Manufacturer for all products):
  - 1. Square D

#### 2.2 DISCONNECT SWITCHES

- A. NON-FUSED: Heavy duty, quick make, quick break, single throw, horsepower rated with poles to open all ungrounded conductors. AIC rating same as upstream protective device with 10,000 AIC minimum. NEMA KS1. Toggle switches with padlocking provisions acceptable for circuits rated 20 amps or less.
- B. FUSED: As specified above with addition of fuse clips to accept only Class R fuses. Service entrance labeled for service disconnect switches.
- C. OPERATING HANDLE: Lockable in off position. Interlocked with cover to prevent opening when switch is closed. (Interlock to include defeating mechanism).

#### 2.3 ENCLOSED CIRCUIT BREAKERS

- A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.
- B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current.
- C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
- D. Manufacture same as Section 26 24 16 Panelboards.
- E. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
- F. Circuit Breakers, 400A and Larger: Field-adjustable, short time and continuous-current settings.
- G. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.

## SECTION 26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- H. Molded Case Switch: Where indicated, molded case circuit breaker without trip units.
- I. Accessories: Provide shunt trip, under voltage and other accessories where indicated.

### 2.4 ENCLOSURE

- A. NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
- B. Outdoor Locations: Type 3R.
- C. Provide flush mounted enclosures for circuit breakers where indicated on the Drawings.

### 2.5 NAMEPLATES

- A. Provide nameplates per Section 26 05 53 - Identification For Electrical Systems.
- B. Provide permanently attached nameplates (with mechanical fasteners) constructed of plastic (black on white) laminated material engraved through black surface material to white sublayer. Exception: Emergency distribution system component labeling - white letters on red background.
- C. Include the following information: Load name, voltage and phase and fuse size and type (when applicable).

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install disconnect switches and enclosed circuit breakers level and plumb according to Manufacturer's written instructions.
- B. Securely mount adjacent to equipment on wall or acceptable mounting frame. Disconnect switches shall be mounted independent from the equipment they serve. Disconnects supported only by raceway are not acceptable.
- C. Wiring space within Disconnects, Fused Switches or Enclosed Circuit Breakers shall not be used for splices.
- D. Tighten electrical connectors and terminals according to Manufacturer's published torque-tightening values. Where Manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.2 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION

## PART 1 GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
    - a. Surge suppression.
    - b. Input harmonics reduction.
    - c. Rectifier-charger.
    - d. Inverter.
    - e. Static bypass transfer switch.
    - f. Battery and battery disconnect device.
    - g. External maintenance bypass/isolation switch.
    - h. Output isolation transformer.
    - i. Remote UPS monitoring provisions.
    - j. Battery monitoring.
    - k. Remote monitoring.

## 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. PC: Personal computer.
- E. THD: Total harmonic distortion.
- F. UPS: Uninterruptible power supply.

## 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include data on features, components, ratings, and performance.
- B. Shop Drawings: For UPS. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: For UPS equipment, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

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- E. Manufacturer Certificates: For each product, from manufacturer.
- F. Factory Test Reports: Comply with specified requirements.
- G. Field quality-control reports.
- H. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.
- I. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals.
- J. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

- A. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in "Performance Testing" Article.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. UL Compliance: Listed and labeled under UL 1778 by an NRTL.
- E. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

1.7 WARRANTY

- A. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in performance, materials or workmanship within specified warranty period.
  - 1. Warranted Cycle Life for Valve-Regulated, Lead-Calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	6 cycles
30 minutes	30 minutes	1.67	20 cycles
15 minutes	45 seconds	1.67	120 cycles

- B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.
  - 1. Special Warranty Period: Two years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
  - 2. Cabinet Ventilation Filters: One complete set.

## PART 2 PRODUCTS

## 2.1 OPERATIONAL REQUIREMENTS

- A. Automatic operation includes the following:
1. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output. The UPS shall be a double-conversion style system.
  2. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
  3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.
  4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
  5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
  6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
  7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
  8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
  9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.
- B. Manual operation includes the following:
1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
  2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.
- C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions in subparagraphs below without interrupting supply to the load during switching:
1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
  2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
  3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

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- D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
1. Ambient Temperature for Electronic Components: 32 to 104 deg F (0 to 40 deg C).
  2. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).
  3. Relative Humidity: 0 to 95 percent, noncondensing.
  4. Altitude: Sea level to 4000 feet (1220 m).

2.2 PERFORMANCE REQUIREMENTS

- A. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
1. Inverter is switched to battery source.
  2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
  3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
  4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
  5. Load is 30 percent unbalanced continuously.
- B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is 30 minutes.
- C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15 percent from nominal voltage.
- D. Overall UPS Efficiency: Equal to or greater than 95 percent at 100 percent load, 90 percent at 75 percent load, and 90 percent at 50 percent load.
- E. Maximum Energizing Inrush Current: Six times the full-load current.
- F. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.
- G. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.
- H. Limitation of harmonic distortion of input current to the UPS shall be as follows:
1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5 percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.
- I. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.
- J. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.
- K. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:
1. 50 Percent: Plus or minus 5 percent.
  2. 100 Percent: Plus or minus 5 percent.
  3. Loss of AC Input Power: Plus or minus 1 percent.
  4. Restoration of AC Input Power: Plus or minus 1 percent.

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- L. Input Power Factor: A minimum of 0.9 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.
- M. EMI Emissions: Comply with FCC Rules and Regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Liebert Corporation; a division of Emerson.
- B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.
- C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.
- D. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.
  - 1. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, Category B.
  - 2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.
- E. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.
- F. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future 25 percent increase in UPS capacity.
- G. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.
- H. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.
- I. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 RATING OF UPS

Continuous Output Rating:	160 KVA
Input Voltage:	480Y/277 volts , AC, 3 phase, 3 wire, 60 Hz +/- 5%
Output Voltage:	480Y/277 volts, AC, 3 phase, 4 wire, 60 Hz
Fault Current Rating	35kAIC
Elevation	Sea level to 4000 feet (1220 m).

2.5 RECTIFIER-CHARGER

- A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.
- B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

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- C. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.
    - 1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.
  - D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.
- 2.6 INVERTER
- A. Description: Pulse-width modulated, with sinusoidal output.
  - B. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.
- 2.7 STATIC BYPASS TRANSFER SWITCH
- A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.
  - B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.
- 2.8 BATTERY
- A. Description: Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch. Cabinet shall match the UPS cabinet in depth and color.
    - 1. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.
  - B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1. C&D Technologies, Inc.; Standby Power Division.
    - 2. Eaton Corporation; Powerware Division.
    - 3. EnerSys.
    - 4. Panasonic Corporation of North America; Panasonic Industrial Company.
  - C. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.
  - D. Provide electrolyte containment per local AHJ requirements.
- 2.9 CONTROLS AND INDICATIONS
- A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.
  - B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.
  - C. Indications: Plain-language messages on a digital LCD or LED.
    - 1. Quantitative indications shall include the following:
      - a. Input voltage, each phase, line to line.
      - b. Input current, each phase, line to line.
      - c. Bypass input voltage, each phase, line to line.
      - d. Bypass input frequency.
      - e. System output voltage, each phase, line to line.
      - f. System output current, each phase.
      - g. System output frequency.
      - h. DC bus voltage.
      - i. Battery current and direction (charge/discharge).

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- j. Elapsed time discharging battery.
  - 2. Basic status condition indications shall include the following:
    - a. Normal operation.
    - b. Load-on bypass.
    - c. Load-on battery.
    - d. Inverter off.
    - e. Alarm condition.
  - 3. Alarm indications shall include the following:
    - a. Bypass ac input overvoltage or undervoltage.
    - b. Bypass ac input overfrequency or underfrequency.
    - c. Bypass ac input and inverter out of synchronization.
    - d. Bypass ac input wrong-phase rotation.
    - e. Bypass ac input single-phase condition.
    - f. Bypass ac input filter fuse blown.
    - g. Internal frequency standard in use.
    - h. Battery system alarm.
    - i. Control power failure.
    - j. Fan failure.
    - k. UPS overload.
    - l. Battery-charging control faulty.
    - m. Input overvoltage or undervoltage.
    - n. Input transformer overtemperature.
    - o. Input circuit breaker tripped.
    - p. Input wrong-phase rotation.
    - q. Input single-phase condition.
    - r. Approaching end of battery operation.
    - s. Battery undervoltage shutdown.
    - t. Maximum battery voltage.
    - u. Inverter fuse blown.
    - v. Inverter transformer overtemperature.
    - w. Inverter overtemperature.
    - x. Static bypass transfer switch overtemperature.
    - y. Inverter power supply fault.
    - z. Inverter transistors out of saturation.
    - aa. Identification of faulty inverter section/leg.
    - bb. Inverter output overvoltage or undervoltage.
    - cc. UPS overload shutdown.
    - dd. Inverter current sensor fault.
    - ee. Inverter output contactor open.
    - ff. Inverter current limit.
  - 4. Controls shall include the following:
    - a. Inverter on-off.
    - b. UPS start.
    - c. Battery test.
    - d. Alarm silence/reset.
    - e. Output-voltage adjustment.
- D. Dry-form "C" contacts shall be available for remote indication of the following conditions:
- 1. UPS on battery.
  - 2. UPS on-line.
  - 3. UPS load-on bypass.
  - 4. UPS in alarm condition.
  - 5. UPS off (maintenance bypass closed).

- E. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

#### 2.10 MAINTENANCE BYPASS/ISOLATION SWITCH

- A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
  - 1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
  - 2. Switch shall electrically isolate other UPS components to permit safe servicing.
  - 3. Switch shall have a fault current rating of 35kaic.
- B. Comply with NEMA PB 2 and UL 891.
- C. Switch Rating: Continuous duty at rated full UPS load current.
- D. Mounting Provisions: Separate wall- or floor-mounted unit.
- E. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

#### 2.11 OUTPUT ISOLATION TRANSFORMER

- A. Description: Shielded unit with low forward transfer impedance up to 3 kHz, minimum. Include the following features:
  - 1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately 13.
  - 2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
  - 3. Regulation: 5 percent, maximum, at rated nonlinear load current.
  - 4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
  - 5. Electrostatic Shielding of Windings: Independent for each winding.
  - 6. Coil Leads: Physically arranged for minimum interlead capacitance.
  - 7. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
  - 8. Capacitive Coupling between Primary and Secondary: 33 picofarads, maximum, over a frequency range of 20 Hz to 1 MHz.

#### 2.12 MONITORING BY REMOTE STATUS AND ALARM PANEL

- A. Description: Labeled LEDs on panel faceplate indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.
  - 1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

#### 2.13 MONITORING BY REMOTE COMPUTER

- A. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:
  - 1. Connectors and network interface units or modems for data transmission via RS-232 link.

2. Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computer are not included in this Section.
3. Software and Hardware: Compatible with that specified in Division 26 Section "Electrical Power Monitoring and Control."

#### 2.14 BASIC BATTERY MONITORING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Albercorp.
  2. BTECH, Inc.
  3. Eaton Corporation; Powerware Division.
- B. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
- C. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 deg C occurs within the compartment.
- D. Annunciation of Alarms: At UPS control panel.

#### 2.15 ADDITIONAL BATTERY MONITORING

- A. Monitoring features and components shall include the following:
  1. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
  2. Connections for data transmission via RS-232 link, network interface and external signal wiring to computer. External signal wiring and computer are not specified in this Section.
  3. PC-based software designed to store and analyze battery data. Software compiles reports on individual-cell parameters and total battery performance trends, and provides data for scheduling and prioritizing battery maintenance.
- B. Performance: Automatically measures and electronically records the following parameters on a routine schedule and during battery discharge events. During discharge events, records measurements timed to nearest second; includes measurements of the following parameters:
  1. Total battery voltage and ambient temperature.
  2. Individual-cell voltage, impedence, and temperature. During battery-discharging events such as utility outages, measures battery and cell voltages timed to nearest second.
  3. Individual-cell electrolyte levels.

#### 2.16 BATTERY-CYCLE WARRANTY MONITORING

- A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.
- B. Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on front panel display.
- C. Additional monitoring functions and features shall include the following:
  1. Measuring and Recording: Total voltage at battery terminals; initiates alarm for excursions outside the proper float-voltage level.
  2. Monitors: Ambient temperature at battery; initiates alarm if temperature deviates from normally acceptable range.
  3. Keypad on Device Front Panel: Provides access to monitored data using front panel display.

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4. Alarm Contacts: Arranged to initiate remote alarm for battery discharge events.
5. Memory: Stores recorded data in nonvolatile electronic memory.
6. RS-232 Port: Permits downloading of data to a portable PC.
7. Modem: Makes measurements and recorded data accessible to a remote PC via telephone line. Computer is not specified in this Section.

### 2.17 SOURCE QUALITY CONTROL

- A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation. Include the following:
  1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
  2. Full-load test.
  3. Transient-load response test.
  4. Overload test.
  5. Power failure test.
- B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's choice.
- C. Report test results. Include the following data:
  1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
  2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
  3. List of instruments and equipment used in factory tests.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Division 3 Section Cast-in-Place Concrete."
  1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

### 3.3 GROUNDING

- A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

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### 3.4 IDENTIFICATION

- A. Identify components and wiring according to Division 26 Section "Electrical Identification."
  - 1. Identify each battery cell individually.

### 3.5 BATTERY EQUALIZATION

- A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
  - 1. Comply with manufacturer's written instructions.
  - 2. Inspect interiors of enclosures, including the following:
    - a. Integrity of mechanical and electrical connections.
    - b. Component type and labeling verification.
    - c. Ratings of installed components.
  - 3. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
  - 4. Test manual and automatic operational features and system protective and alarm functions.
  - 5. Test communication of status and alarms to remote monitoring equipment.
  - 6. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
    - a. Simulate malfunctions to verify protective device operation.
    - b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
    - c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
    - d. Test output voltage under specified transient-load conditions.
    - e. Test efficiency at 50, 75, and 100 percent of rated loads.
    - f. Test remote status and alarm panel functions.
    - g. Test battery-monitoring system functions.
- E. Seismic-restraint tests and inspections shall include the following:
  - 1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
  - 2. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- F. The UPS system will be considered defective if it does not pass tests and inspections.
- G. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.
- H. Prepare test and inspection reports.

## 3.7 PERFORMANCE TESTING

- A. Engage the services of a qualified power quality specialist to perform tests and activities indicated for each UPS system.
- B. Monitoring and Testing Schedule: Perform monitoring and testing in a single 10-day period.
  - 1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
  - 2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.
- C. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:
  - 1. Current: Each phase and neutral and grounding conductors.
  - 2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
  - 3. Frequency transients.
  - 4. Voltage swells and sags.
  - 5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
  - 6. High-frequency noise.
  - 7. Radio-frequency interference.
  - 8. THD of the above currents and voltages.
  - 9. Harmonic content of currents and voltages above.
- D. Monitoring and Testing Procedures:
  - 1. Exploratory Period: For the first two days make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.
  - 2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
    - a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.
    - b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.
    - c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
    - d. Using loads and devices available as part of the facility's installed systems and equipment, create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.

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- e. Using temporarily connected resistive/inductive load banks, create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
  - f. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.
- E. Coordination with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this article.
- 1. Provide the temporary use of an appropriate PC and printer equipped with required connections and software for recording and printing if such units are not available on-site.
  - 2. Coordinate printouts with recordings for monitoring performed according to this article, and resolve and report any anomalies in and discrepancies between the two sets of records.
- F. Monitoring and Testing Assistance by Contractor:
- 1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
  - 2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.
  - 3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
  - 4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.
  - 5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.
- G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.
- H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in report:
- 1. Description of corrective actions performed during monitoring and survey work and their results.
  - 2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
  - 3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
  - 4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
  - 5. Recommendations for operating, adjusting, or revising UPS controls.
  - 6. Recommendation for alterations to the UPS installation.
  - 7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
  - 8. Recommendations for power distribution system revisions.

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9. Recommendations for adjusting or revising electrical loads, their connections, or controls.
    - I. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.
- 3.8 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION

## SECTION 26 36 24 BYPASS/ISOLATION TRANSFER SWITCHES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION

- A. Provide all automatic transfer switches complete with bypass isolation switches, fully operational and fully tested. Conform with UL Standard 1008.

#### 1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain transfer switches through one source from a single Manufacturer.
- B. Product Selection for Restricted Space: Maximum 92 inches (not including base channels). Length and depth: Not exceeding dimensions as scaled or noted in Contract Documents. Equipment exceeding dimensions not allowed. Base Bid on equipment complying with Contract Documents.

#### 1.4 SUBMITTALS

- A. Prepare and submit detailed Shop Drawings for review prior to manufacture under Provisions of Section 01 33 00 and Section 26 05 00 - Common Work Results For Electrical and requirements described in this Section. Include the following information: wiring diagrams, dimensions, front view and catalog information indicating complete electrical and mechanical characteristics.

#### 1.5 WARRANTY

- A. The Manufacturer shall warranty the transfer switches against failures which result, under normal use and service, from defects in workmanship and materials. Warranty shall be for parts and labor for two years from date of "Notice of Completion" and for parts for an additional three years after the expiration of the first two year period.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURER

Russelectric, Inc.

#### 2.2 TYPE

- A. Transfer and retransfer to normal source shall be automatic. Automatic transfer switches shall be electrically operated, mechanically held and supplied with positive mechanical interlocking. The main contacts shall be equipped with a safe manual override capability. UL 1008 listed meeting tables 21.1, 23.1, 23.2.
- B. Transfer switches serving fire pumps shall be U.L. 1008 listed for fire pump service and comply with the requirements of NFPA 20.

#### 2.3 RATING

- A. Shall have voltage, amperage and ampere withstand ratings as shown on the Drawings.
- B. Transfer switches used to transfer from normal to emergency power shall be approved for emergency service, full continuous ampere rated (no derating) with make rating at 20 times and break rating at 6 times full load current rating. Provide fully rated 4th pole for switching of neutral in addition to phase conductors when generator neutral is grounded at the generator, or as shown on the Drawings.

#### 2.4 AUTOMATIC TRANSFER SWITCH CONTROLS

- A. Each transfer switch shall be equipped with a control system, to provide all the operational functions of the automatic transfer switch.

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- B. Sensing and control logic shall utilize a microprocessor based control system, to provide all the operational functions of the automatic transfer switch. Each controller shall include the following:
1. Real time clock with NiCad battery back up.
  2. Self diagnostics which perform periodic checks of the memory I/O and communication circuits, with a watchdog/power fail circuit.
  3. Password protection required to limit access to qualified and authorized personnel.
  4. 20 character, LCD display, with a keypad, which allows access to the system.
  5. Three-phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.
  6. Capability of operating at nominal frequencies of 45 to 66 Hz.
  7. All setup parameters required by the controller for power monitoring shall be stored in non-volatile memory and retained in the event of a control power interruption
  8. Have two asynchronous serial ports.
  9. The Controller shall be capable of storing the following records in memory for access either locally or remotely:
    - a. Number of hours transfer switch is in the emergency position (total since record reset).
    - b. Number of hours emergency power is available (total since record reset).
    - c. Total transfer in either direction (total since record reset).
    - d. Date, time, and description of the last four source failures.
    - e. Date of the last exercise period.
    - f. Date of record reset.
  10. The Controller shall use industry standard open architecture communication protocol for high-speed serial communications via multidrop connection to other controllers and to a master terminal with up to 4000 ft of cable, or further, with the addition of a communication repeater. The serial communication port shall be RS422/485 compatible.
  11. The serial communication port shall allow interface to either the Manufacturer's or the Owner's furnished remote supervisory control via MODBUS RTU compatible communication protocol.

### 2.5 ACCESSORIES

The following accessories shall be provided as a minimum in addition to those normally required for proper operation.

- A. Full three phase voltage failure with adjustable drop out and pick up. Set at 80% dropout, 90% pick up.
- B. Indicating Lights: LED Pilot lights for indicating transfer position and power available. Green - normal, Red - emergency, Amber - emergency power available.
- C. Auxiliary Contacts: One set of auxiliary contacts closed in normal position and one set of auxiliary contacts closed in emergency position for remote indication of transfer switch position.
- D. Test switch. For simulating power failure.
- E. Time Delay Before Engine Starting. Adjustable ride through feature of approximately 0-10 seconds for start of engine generator and transfer on momentary loss of normal source. Set at 1 second. Include two auxiliary contacts, 1 N.O. and 1 N.C. for use for engine start signal.
- F. Retransfer. Adjustable time delay (with emergency failure by-pass) of 0 to 30 minutes for retransfer to normal. Set at 15 minutes.

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- G. Generator Condition. Voltage and frequency sensitive lockout relay. Prevents transfer until voltage and frequency of generator have reached preset rating. Set at 95%.
- H. Time Delay Neutral. Provide time delay with transfer switch in neutral position and load disconnected from either source, adjustable .2 to 50 seconds, to prevent transfer between sources when sources are significantly out of phase. Set at 50 seconds.
- I. Block Transfer and Load Shed Relays. Provide relays in transfer switches to prevent automatic transfer until a signal is received from the emergency generator control switchboard, and to initiate load shedding by driving the transfer switch to the neutral position.
- J. Phase Reversal Relay. Sensing relay to prevent transfer to new source when phases are reversed from designed phasing.

### 2.6 BYPASS/ISOLATION SWITCH

- A. General. A bypass isolation switch shall be provided with all transfer switches to conveniently electrically bypass and isolate the automatic transfer switch.
- B. Operation. The bypass/isolation switch shall have provision for operation by one person through the movement of a maximum of two handles at a common dead front panel.
- C. Bypass to Emergency. Operation of the bypass handle shall allow direct connection of the load to either source.
- D. Provisions shall be made to assure continuity of auxiliary circuits necessary for proper operation of the system.
- E. Indicating lights shall be provided to show the bypass isolation switch in the bypass position, and in the fully isolated position.
- F. Operation of the bypass isolation switch shall be assured regardless of the position of the automatic transfer switch.
- G. Isolation. Operation of the isolating handle shall isolate all live power conductors and neutral conductor on 4 pole switches to the automatic transfer switch.
- H. Interlocking. Positive sequencing of all contacts, with no possible intermediate position shall be accomplished through the manual operators from a dead front location.
- I. Padlocking. Provisions shall be included to padlock the isolating handle in the isolated position.
- J. Visual Verification. The isolation blades shall be visible in the isolated position.
- K. Testing. With the load bypassed it shall be possible to test the automatic transfer switch and engine generator without interruption of power to the load.
- L. Ratings. The electrical capabilities and ratings of the bypass/isolation switch shall be compatible with those of the associated automatic transfer switch.

### 2.7 ENCLOSURE

- A. Bypass/isolation switch and transfer switch combinations shall be enclosed in a 90" high free standing NEMA-1 general purpose enclosure with internal barrier. The automatic transfer switch shall be mounted on a drawout carriage. Provide enclosure suitable for front and side access only if rear access is not available. Refer to Drawings for which side is accessible.

### 2.8 NAMEPLATES

- A. Provide engraved phenolic nameplates per Section 26 05 53 - Identification For Electrical Systems. Include name, voltage, phase, source (switchboard fed from) and load served.

## SECTION 26 36 24 BYPASS/ISOLATION TRANSFER SWITCHES

### PART 3 EXECUTION

#### 3.1 MOUNTING

- A. Provide 2" thick housekeeping pad and bolt transfer switch to floor with four 1/2" diameter drilled in concrete anchors with 4-1/4" minimum embedment. Verify space available with equipment sizes and code required working clearances prior to submittal of Shop Drawings.

#### 3.2 WIRING AND GROUNDING

- A. Shall conform with applicable Sections of these Specifications.

#### 3.3 OPERATION TEST

- A. Provide testing of transfer system coordinated with generator set(s) and start control panel to insure proper operation of transfer devices under actual operating conditions. Monitor and verify correct operation and timing of the following applicable items:
  1. Normal voltage sensing relays.
  2. Emergency voltage sensing relays.
  3. Test switch.
  4. Time delay neutral.
  5. Engine start sequence.
  6. Time delay upon transfer.
  7. Interlocks and limit switch function.
  8. Timing delay and re-transfer upon normal power restoration.
  9. Engine cool-down time delay and shutdown.

#### 3.4 SEQUENCE

- A. Any automatic transfer switch sensing loss of power shall start the emergency generator set and the set shall continue to run until after all transfer switches have returned to normal power (engine cool-down timer part of emergency generator set).

#### 3.5 OPERATION AND MAINTENANCE MANUALS

- A. Provide per Section 26 05 00 - Common Work Results For Electrical. Manuals shall in addition contain the following information:
  1. Recommended test intervals.
  2. Recommended service intervals.
  3. Test and service record forms showing proper intervals for tests.
  4. Recommended maintenance.
  5. The first page of the manual shall contain the name, address and phone number of the local representative to be called for service and parts.

#### 3.6 INSTRUCTION

- A. The Contractor shall (after one week (minimum) written notification to Architect) conduct an instruction session during which all maintenance and operational aspects of the system will be described and demonstrated to personnel selected by the Owner in conjunction with instruction period for Section 26 32 13 - Engine Generators. The session shall be conducted by a Contractor's Representative thoroughly familiar with the characteristics of the system. O & M manual information regarding the system shall be turned over to the Architect prior to scheduling the instruction session.

END OF SECTION

SECTION 26 43 13 TRANSIENT VOLTAGE SUPPRESSION FOR VOLTAGE ELECTRICAL POWER  
CIRCUITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 26 05 00 - Common Work Results For Electrical apply to Work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of TVSS work is indicated by Drawings, Schedules and Specification herein. Work includes complete installation, electrical testing and commissioning.

1.3 QUALITY ASSURANCE

- A. Comply with the National Electrical Code (NEC), NEMA and IEEE Standards as applicable to wiring methods, construction and installation of TVSS devices. Comply with applicable requirements of ANSI/IEEE C62.41, C62.45; NFPA 20, 70, 75 and 78, and UL 1449. Provide complete packaged units, which have been UL listed and labeled by Underwriters Laboratory. UL surge ratings (UL 1449) must be permanently affixed to the TVSS device.
- B. The short circuit rating shall be indicated on the device per the National Electrical Code and UL requirements.

1.4 SUBMITTALS

- A. Drawings: Electrical and Mechanical Drawings shall be provided by the Manufacturer which show unit dimensions, weights, component and connection locations, mounting provisions, connection details and requirements, including breaker size, and wiring diagram.
- B. Equipment Manual: The Manufacturer shall furnish an installation manual with installation, start-up and operating instructions for the specified system.
- C. Installation instructions shall clearly state if the system requires an external overcurrent device to maintain the system's UL 1449 listing.
- D. A UL 1449 stipulation, signed by the Manufacturer's Authorized Representative, is required for all submittals. The stipulation shall:
  - 1. Certify that the TVSS system is UL 1449 listed.
  - 2. Indicate what internal or external fusing is incorporated in the TVSS system and what impact the fusing has on the performance of the device. (I.e. surge capacity and clamping levels).
- E. Provide minimum single pulse surge current testing documentation on each model proposed for locations per Specification.
- F. Documentation of filter performance for stand-alone and system requirements per Specification.
- G. Documentation showing operational test set which can verify the clamping voltage of unit. Factory -Trained Representative shall include start-up and testing as part of the requirements of this Specification. Copy of testing completed and operational integrity of units installed shall be forwarded to Owner and Architect/Engineer for review.
- H. Breaker and wire size requirements shall be indicated.

1.5 WARRANTY

- A. Manufacturer shall provide a product warranty for a period of not less than five (5) years from date of installation. Warranty shall cover unlimited replacement of TVSS modules during the warranty period. Those firms responding to this Specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of TVSS for not less than twenty (20) years.

SECTION 26 43 13 TRANSIENT VOLTAGE SUPPRESSION FOR VOLTAGE ELECTRICAL POWER CIRCUITS

PART 2 PRODUCTS

2.1 GENERAL

- A. Except as otherwise indicated, provide high-energy transient voltage surge suppression electronic filter devices, suitable for application in Category A, B and C environments as indicated. Provide types, sizes, ratings and electrical characteristics indicated which comply with Manufacturer's standard materials, design and construction in accordance with published information and as required for a complete installation.
- B. SPD stands for "surge protective device" where used herein.

2.2 TVSS SYSTEM DESCRIPTION

- A. Provide TVSS devices, which comply with the following:
  - 1. Have operating temperature of -40 to + 122 degrees F and operate reliably in environments with 0 to 95% humidity (non-condensing).
  - 2. Emit no audible noise and capable of operation of up to 12,000 feet above sea level and emit no appreciable magnetic field.
  - 3. Have a maximum continuous operating voltage not less than 125% of the nominal system operating voltage for 120/208 volt systems, 115% for 277/480 volt systems, and a frequency operating range of 47 to 63 Hertz.
  - 4. Provide protection modes for line-to-neutral, line-to-line, line to ground, and neutral-to-ground for three phase, 4-wire wye systems.
- B. The system protection modules shall contain a linear array of balanced metal oxide varistors (MOV). Each MOV will be individually fused. Silicon avalanche diodes and gas tubes are not to be used or other components, which may short or "crowbar" the AC line and lead to possible disruption of the normal AC power flow.
- C. All primary transient path wiring shall be of #6 minimum for service entrance units and #8 AWG copper minimum. No plug-in modules, components or printed circuit boards shall be used in surge carrying paths.
- D. Each protection module shall have a visual indicator that signifies the protection circuitry is on line. A redundant status indicator shall be mounted on the front of the panel.
- E. Each protection module shall have a capacitive filtering system connected in each Line to Neutral (L→N)(Wye) mode or Line to Line (L→L)(Delta) mode to provide sine wave tracking and better performance of the protection modules.
- F. The fusing elements must be capable of allowing the suppressor's minimum rated transient current to pass through suppressor, at a minimum 1,000 times, without fuse operation. No external current limiting devices shall be used.
- G. Manufacturers shall submit independent test data from a nationally recognized testing laboratory verifying that the TVSS unit can withstand its rated single impulse surge current. Testing shall be done per NEMA LS-1 requirements. Failure to do so will result in non-compliance.
- H. Protection modes: The TVSS shall provide Line to Neutral (L→N)(Wye), Line to Ground (L→G) (Wye or Delta), Line to Line (L→L)(Delta) and Neutral to Ground (N→G)(Wye) protection, except that (N→G) is not required in units at service entrance switchboards.
- I. Each unit shall include a UL 1283 listed filter, which shall reduce low-level fast rise-time electrical line noise as follows per NEMA LS-1/MIL STD 220A guidelines:

<u>Frequency</u>	<u>Insertion Loss</u>	<u>Frequency</u>	<u>Insertion Loss</u>
100 khz	34 dB	1 Mhz	51 dB
10 Mhz	54 dB	100 Mhz	48 dB
- J. Provide each unit with status indicators. Only where specifically indicated on Drawings, provide each unit with audible alarm, disturbance counters, and form C contacts as indicated on the Drawings.

SECTION 26 43 13 TRANSIENT VOLTAGE SUPPRESSION FOR VOLTAGE ELECTRICAL POWER CIRCUITS

K. The SPD shall be rated for the available fault current, and shall be labeled with its rating.

2.3 UNITS INSTALLED AT SERVICE ENTRANCE AS DEFINED BY THE NEC

A. Acceptable Manufacturers and Models:

1. LEA International Inc. - Gb200s
2. Current Technology - TG150
3. Liebert - SI032
4. Eaton - CPS200

No other Manufacturers will be accepted.

B. Device shall meet all specification requirements in Section 2.2, as well as the following:

Equipment shall be a multi-stage parallel protector rated for 480/277 VAC, 3 PHASE, 4 WIRE, plus ground. The equipment's minimum surge current capacity shall be 300,000 per phase (L-N plus L-G).

C. The system protection modules shall contain a linear array of balanced metal oxide varistors (MOV). Each MOV will be individually fused. Each protection module shall have a minimum surge current rating of 150,000 per mode. Each protection module shall be capable of withstanding over 1,000 sequential 10,000 Amp ANSI/IEEE C62.41 Category C3 impulses without degradation or failure.

D. The L-G mode is not required in service entrance units.

E. TVSS units shall be externally mounted to the switchboard. Verify that overcurrent protection is provided within the switchboard for TVSS units in sizes and types as recommended by the manufacturer for a UL-listed assembly.

2.4 UNITS INSTALLED FOR DISTRIBUTION PANELS DOWNSTREAM OF THE SERVICE ENTRANCE

A. Acceptable Manufacturers and Models:

1. LEA International Inc. - GB100
2. Current Technology - TG100
3. Liebert - LM100
4. Eaton - CPS200

No other Manufacturers will be accepted.

B. Device shall meet all Specification requirements in Section 2.2, as well as the following:

Equipment shall be a multi-stage parallel protector rated for 480/277 VAC, 3 PHASE, 4 WIRE, plus ground. The equipment's minimum surge current capacity shall be 200,000 per phase (L-N plus L-G).

C. The system protection modules shall contain a linear array of balanced metal oxide varistors (MOV). Each MOV will be individually fused. Each protection module shall have a minimum surge current rating of 100,000 per mode. Each protection module shall be capable of withstanding over 1,000 sequential 10,000 Amp ANSI/IEEE C62.41 Category C3 impulses without degradation or failure.

2.5 UNITS INSTALLED FOR PANELBOARDS

A. Acceptable Manufacturers and Models:

1. LEA International Inc. - GB-50S PBS
2. Current Technology - TG-80
3. Liebert - S-111
4. Eaton - CPS160

No other Manufacturers will be accepted.

## SECTION 26 43 13 TRANSIENT VOLTAGE SUPPRESSION FOR VOLTAGE ELECTRICAL POWER CIRCUITS

- B. Device shall meet all Specification requirements in Section 2, as well as the following:  

Equipment shall be a multi-stage parallel protector rated for 480/277 VAC, 3 PHASE, 4 WIRE, plus ground. The equipment's minimum surge current capacity shall be 160,000 per phase (L-N plus L-G).
- C. The system protection modules shall contain a linear array of balanced metal oxide varistors (MOV). Each MOV will be individually fused. Each protection module shall have a minimum surge current rating of 80,000 per mode. Each protection module shall be capable of withstanding over 1,000 sequential 10,000 Amp ANSI/IEEE C62.41 Category C3 impulses without degradation or failure
- D. TVSS units shall be mounted external to the panelboard. Provide over current protection for TVSS units in sizes and types as recommended by the Manufacturer for a UL-listed assembly.

### PART 3 INSTALLATION

#### 3.1 GENERAL

- A. The specified TVSS system shall be installed no further than eighteen (18) electrical inches from the power conductor(s) it is protecting, and must have a grounding of 25 ohms or less and shall avoid any unnecessary or sharp bends.
- B. Install devices in accordance with Manufacturer's written installation and operation manuals. Have factory-trained Representative provide factory start-up and initial clamp voltage testing to show each unit is clamping within tolerance, installed properly and functioning correctly.
- C. The installing Contractor shall install service entrance SPD with short and straight conductors as practically possible. The Contractor shall twist the SPD input conductors together to reduce input conductor inductance. The Contractor shall follow the SPD Manufacturer's recommended installation practices and comply with all applicable codes.
- D. When mounted internally to the power distribution equipment, the SPD shall be close nipped to the panel and be supplied by a breaker sized per the SPD Manufacturer's recommendation, and with the appropriate number of poles.
- E. The Contractor shall follow the SPD Manufacturer's recommended installation practices and comply with all applicable codes.
- F. Factory trained ISO 9001 certified service division employees shall be required to perform a site inspection prior to the Project being turned over to the owner. Site inspection shall include verification of proper SPD installation, correct SPD voltage application, and startup procedures. Documentation shall be submitted to the Engineer verifying site visit and findings of the above.
- G. Contractor to provide CB or molded case switch sized per Manufacturer's recommendations for units not provided with internal disconnects.
- H. Contractor to provide conduit and wiring from panel to TVSS device per Manufacturer's recommendations.

#### 3.2 ACCEPTANCE

- A. Manufacturer's Representative shall visit site, verify installation, and submit to Architect a letter stating equipment and installation meets intent of Contract Documents and Manufacturer's warranties and guarantees are in effect.

END OF SECTION

## SECTION 26 51 00 INTERIOR LIGHTING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Provide lighting system complete and fully operational.
- B. Substitutions:
  - 1. Bidders requesting approval to provide products other than those specifically listed in the Light Fixture Schedule shall submit requests in writing to the Architect and Lighting Designer ten days prior to the close of the Bid period. Approval will be in the form of an addendum to the Specifications issued to all registered plan holders. No requests for substitution will be considered after this date.
  - 2. Substitution request shall include all information required under Paragraph 1.4 SUBMITTALS. Requests for approval shall be accompanied by a working fixture sample (including lamps and a cord and plug). Provide the name of at least one installation where each proposed substitute has been installed for at least six months along with the name and phone number of the Architect, Owners Representative and the Lighting Designer of Record. If required by the Architect, the proposed substitutes must be installed at the bidders expense in a location selected by the Architect.

#### 1.3 REFERENCES

- A. National Electrical Manufacturer's Association (NEMA) LE5-1993:
  - 1. Procedure for determining Luminaire efficiency ratings.
- B. Underwriters Laboratories, Inc. (UL):
  - UL 496: Edison Base Lampholders
  - UL 542: Lampholders, Starter Holders for Fluorescent Lamps
  - UL 924: Emergency Lighting and Power Equipment
  - UL 935: Fluorescent Lamp Ballasts
  - UL 1029: HID Lamp Ballasts
  - UL 1570: Fluorescent Lighting Fixtures
  - UL 1571: Incandescent Lighting Fixtures
  - UL 1572: High Intensity Discharge Lighting Fixtures
  - UL 1574: Track Lighting Systems

#### 1.4 SYSTEM DESCRIPTION

- A. Light fixture schedule series numbers are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of lamp, ballast, finish trim, ceiling type, mounting hardware, ceiling trim or special requirements as specified hereinafter or as required by the particular installations. Provide complete fixtures to correspond with the number of lamps, wattage and/or size specified.
- B. If there are discrepancies between fixture illustrations and the written description in the fixture schedule, the written description in the fixture schedule shall take precedence.
- C. Light fixture voltage shall match voltage of circuit serving the light fixture.

#### 1.5 SUBMITTALS

- A. For standard catalog items, provide original product sheets, -neatly and clearly marked- to indicate that light fixture, ballasts and lamps fully comply with Contract Documents. Include photometric report by an independent certified testing laboratory when required in fixture schedule. Manufacturer's test report is not acceptable.

## SECTION 26 51 00 INTERIOR LIGHTING

- B. Submittals shall have fixture types and project name clearly indicated and shall be prepared by the authorized Manufacturer's representative serving the project area. A list of Manufacturer's Representatives (including address, telephone and fax numbers) identifying which light fixture types they represent shall be included with Submittals. Submittals or requests for substitutions not meeting these requirements will be rejected.
- C. For linear light sources (cold cathode or neon), submit scale plans and details of the lamp layout, method of installation of the lampholders, lamps, reflectors, transformer housings and locations, secondary feeds and a complete bill of materials. Field dimensions required to be furnished by the Contractor shall be shown on Shop Drawings. Shop Drawings shall be revised after receipt of field dimensions to show exact location of lamps and lamp holders. A copy of the final complete Shop Drawings shall be included in the Operation and Maintenance Manuals.
- D. For custom fixtures, modified fixtures or linear fluorescent fixtures mounted in continuous rows, submit scaled Drawings prepared by the Manufacturer showing details of construction, lengths of runs, pendant and power feed locations, accessory pieces, finishes, and list of materials. Contractor to provide Manufacturer with field dimensions where required.

### 1.6 QUALITY ASSURANCE

- A. Fixtures and components shall be new and listed by Underwriters Laboratories (UL) or other testing lab acceptable to local jurisdiction.

### 1.7 WARRANTY

- A. Ballasts: Provide Manufacturer's warranty for a period of not less than five years. Warranty shall include parts and labor to replace defective ballasts.
- B. Exit Signs Utilizing LED Lamp Technology: Provide Manufacturer's warranty for a period of not less than five years including parts and labor for full replacement of defective product.

### 1.8 EXTRA MATERIALS

- A. Ballasts: Provide one case or 10% (whichever is less) of each type used on the Project. Turn over to Owner and obtain signed receipt.
- B. Lamps: Provide one case or 10% (whichever is less) of each type used on the Project. Turn over to Owner and obtain signed receipt.
- C. Fuses: Provide one case or 10% (whichever is less) of each type used on the Project. Turn over to Owner and obtain signed receipt.
- D. Adjustable Accent Lights (track, recessed or surface mounted): Provide additional lenses, color filters and other accessories to be used during final focusing, as follows:
  - 1. 20% or one case (whichever is less) of each lamp type (type, beam spreads, and wattages to be determined by the lighting designer). A spot and a flood lamp of the same wattage are considered to be two different lamp types.
  - 2. 10% or one dozen each, (whichever is less) lenses, color filters and louvers (to be determined by the Lighting Designer).

## PART 2 PRODUCTS

### 2.1 GENERAL MATERIAL REQUIREMENTS

- A. Finish ferrous mounting hardware and accessories to prevent corrosion and discoloration to adjacent materials.
- B. For vaportight installations, painted finishes of fixtures and accessories shall be weather resistant enamel using proper primers or galvanized and bonderized epoxy, so that the entire assembly is completely corrosion resistant for the service intended. Where aluminum parts come into contact with bronze or steel parts, apply a coating material to both surfaces to prevent corrosion.

## SECTION 26 51 00 INTERIOR LIGHTING

- C. Fixtures shall be free of light leaks and designed to provide sufficient ventilation of lamps to provide the photometric performance required. Ballasts and transformers shall be adequately vented.
- D. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. Intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. Finish exposed edges so no sharp or ragged edges are exposed. All miters shall be in accurate alignment with abutting intersecting members.
- E. Lampholders shall hold lamps securely against normal vibrations and maintenance handling.
- F. Reflector Cones:
  - 1. Provide minimum 45° lamp and lamp image cut-off for all vertically mounted lamps. For horizontal lamps provide minimum 33° cut-off. There shall be no visible lamp flashing in the cone.
  - 2. Plastic materials shall not be used for reflector cones, unless noted otherwise in the Light Fixture Schedule.
  - 3. Reflector cones shall not be riveted or welded to housing and shall be removable without tools. Retention devices shall not deform the cone in any manner. Trim shall be flush with finished ceiling without gaps or light leaks. Where the flange trim is separate from the cone, it shall have the same finish as the cone.
  - 4. Reflector cones shall be of uniform gauge, not less than 0.032-inch thick, high purity aluminum Alcoa 3002 alloy, free of spin marks or other defects.
  - 5. Manufacture reflector under the Alzak process. Refer to fixture schedule for cone color and specular or diffuse finish requirements. For fixtures using compact fluorescent lamps, provide additional finish equivalent to Color-Chek that eliminates iridescence. Submit one sample of each cone type for review when required in the Fixture Schedule.
- G. Fresnel Lens and Door Assembly:
  - 1. Lens shall have uniform brightness throughout the entire visible area at angles from 45° to 90° from vertical, without bright spots or striations.
  - 2. Lens shall have opaque risers painted neutral gray unless otherwise specified in the Light Fixture Schedule.
  - 3. Finish of regress door shall be matte baked enamel paint in color as selected by the Architect.
- H. Light fixtures containing lamps which require protective shielding shall have tempered glass lenses.
- I. For adjustable fixtures, provide positive locking devices to fix aiming angle. Fixture shall be capable of being relamped without adjusting aiming angle.
- J. Fixtures recessed in suspended ceilings where the space above the ceiling is either an air supply or return plenum shall conform with NEC Article 300-22.
- K. Safety: Provide safety devices for removable fixture elements (cones, reflectors, lenses, etc.) to support removable elements when not in normal operating position. Safety devices shall be detachable if necessary and shall not interfere with fixture performance, maintenance or the seating of any fixture element, and not be visible during normal fixture operation.

### 2.2 FLUORESCENT FIXTURES

- A. Housing: Minimum code gauge steel or rigid aluminum construction painted after fabrication with high reflectance white paint (min. 89%).

## SECTION 26 51 00 INTERIOR LIGHTING

- B. Light Shields:
1. Parabolic Louvers: Provide Alzak aluminum, specular or semi-specular as specified, with a low-iridescent finish.
  2. Flat Translucent Diffusers: Shall be 100% virgin DR acrylic and have matte finish on exterior side (facing away from lamps). Diffuser shall be of thickness specified and shall be of sufficient density to completely obscure lamp image.
  3. Flat Clear Lenses: Injection molded 100% virgin DR acrylic or clear tempered glass, thickness as specified.
  4. Clear Patterned Lenses: Injection molded 100% virgin DR acrylic. For lenses with a male pattern of prisms or cones, specified minimum thickness refers to distance from flat surface to base of pyramids or cones, or to thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material. Lenses shall fully eliminate lamp image when viewed from all directions between 45-90° from vertical. From 0-45° the ratio of maximum brightness (under a lamp) to minimum brightness (mid-point between lamps) shall not exceed 3:1. Minimum thickness shall not be less than 0.125" with a minimum weight of 8 ounces per square foot.
- C. Frames:
1. Supply with concealed hinges and latching. Provide mitered corners with no gaps or light leaks.
- D. Lamp Mounting:
1. Mount lamps used in rapid start circuits 430 ma and below within 1/2" of grounded metal as long as the lamp. For 800 ma and 1500 ma lamps, mount within 1" of grounded metal as long as the lamp.
  2. For rapid start circuits using single lamp ballasts, provide one grounding lamp holder per lamp.

### 2.3 COLD CATHODE/NEON

- A. In the following description, "cold cathode" refers to lamps with an 18-25mm diameter and "neon" refers to lamps with an 8-15mm diameter.
1. Lamps: Color, size and shape shall be as specified, fully evacuated before filling with high purity gas. Maximum nominal lamp length shall be 8'-0". For continuous lamp runs, the space between lighted lamp ends shall not exceed 1/4".
  2. Lampholders: Glazed porcelain, UL listed for 7500 volts minimum. Phosphored bronze clip contacts to provide electrical contact and support the lamp. GTO cable connecting the lamps shall be enclosed in minimum 0.10" thick glass tubing and meet UL 48 IFAY requirements. All cold cathode lamps mounted in a hanging down position, shall be supported by a manufacturer supplied tie at each lampholder. Neon lamps shall be supported as required by code. When adjacent lampholders are of opposite polarity, they shall be located a minimum of 2" apart. "PK" and "spring contact" lamp holders are not acceptable.
  3. Neon Tube Bend Backs: Painted with black or gray block out paint as manufactured by Stazon. If paint color is required to match adjacent surfaces, it shall be applied only over block out paint.

## SECTION 26 51 00 INTERIOR LIGHTING

4. Transformers: For all non-dimming installations shall be high power factor (HPF) type, voltage as specified. For dimming installations, transformers shall be normal (low) power factor (NPF) type. Fixture manufacturer shall confirm compatibility of transformer with dimming system. Provide 115 volt, 60 cycle remote transformers with secondary voltage as required for lamp footage, cold weather usage and dimming. Transformers shall be UL listed, self contained in a 16 gauge steel housing, with separate secondary and primary wiring compartments and equipped with a disconnect switch which shall automatically disconnect the primary when the wiring compartment cover is removed. Transformers shall have a remote capacitor in a ventilated compartment so that the transformer does not have to be removed in the event of a capacitor failure. Transformers shall be installed in a ventilated and accessible area (100° maximum ambient temperature) with air circulation on all sides to dissipate 300 watts each. Each transformer or ballast shall be installed as close to the lamp as possible in order to keep secondary feeds as short as possible and equal in length. Wiring compartments shall be accessible.
5. Ballasts: HPF, 115 volt, 60 hertz. 200 ma secondary feeds, Instant start, Type I, 1.6 amp, VOC 990 VAC, auto reset thermal protection. Must be capable of operating two 96" 25mm lamps. Wiring, accessibility and heat dissipation requirements the same as transformers above.
6. Operating Current for Cold Cathode: 120 ma or 200 ma as specified. Ballasts shall only be used for 200 ma operation.
7. Neon - 30 or 60 ma as specified.
8. Watts per Linear Foot:
  - a. With High Power Factor transformers: 6.5/l.f.
  - b. With Low Power Factor transformers: 11.5/l.f.
  - c. With High Power Factor ballasts: 10.5/l.f.
9. Secondary Feeds: UL listed blue/black GT015 cable. Conduit shall be rigid PVC or aluminum as required by local code with only one cable in each 1/2" conduit. If plastic conduit is used, component parts shall be grounded. Aluminum conduit shall be isolated from all metal by foam tape or wood blocking with plastic conduit straps for hanging. Install conduits a minimum of 2" apart unless polarity is maintained. Cold cathode lamps not controlled by dimmers shall be mid-point grounded.
10. Reflectors: Adjustable snap on for cold cathode lamps, when specified, shall be of high reflectance white extruded plastic.

### 2.4 INCANDESCENT/TUNGSTEN HALOGEN FIXTURES

- A. Tungsten halogen and xenon are types of incandescent light sources and will herein be included under the heading of incandescent.
  1. Finish: Concealed parts (lamp holders, yokes, brackets, etc.) matte black.
  2. Tungsten Halogen Lamp Seal Temperature: Shall not exceed 350°C at ambient of 25°C when tested per UL Bulletin 57, Paragraph 328-334. Submit certified heat test by independent testing laboratory when required in Light Fixture Schedule.

### 2.5 HIGH INTENSITY DISCHARGE (HID) FIXTURES:

- A. Housing: Minimum code gauge steel, bonderized or equal rust protected or rigid aluminum construction.
- B. Finish: Visible surfaces. Powder coated paint unless otherwise specified. Color and finish as selected by architect. Concealed parts, (lamp holders, yokes, brackets, etc.) matte black.
- C. Lamp Holder Housing: Cast aluminum with integral heat radiating fins to assure cool lamp base operation.

## SECTION 26 51 00 INTERIOR LIGHTING

### 2.6 WIRING

- A. Wiring shall be as required by Code for fixture wiring.
- B. Flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105°C.
- C. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.
- D. No internal wiring shall be visible at normal viewing angles, i.e. above 45° from vertical.
- E. Master Slave Fixtures: Supply ballasts in adjacent fixtures to operate one or more lamps in the adjacent fixture where required in Drawings or Light Fixture Schedule. For single lamp fixtures, provide a two-lamp ballast for two adjacent fixtures. For three-lamp fixtures, provide one two-lamp ballast for the outboard lamps in each fixture and an additional two-lamp ballast for the center lamp in each of two adjacent fixtures.
- F. Tandem Wired Fixtures: For fixtures in continuous rows and where required in Drawings or Light Fixture Schedule, supply ballasts and wiring to control all top or inboard lamps together and control all bottom or outboard lamps together.
- G. Provide #18 AWG, 3-wire flexible conduit connections (whips) for dual level switching as shown on Drawings for light fixtures recessed in accessible suspended ceilings. Provide 3-wire whips for all dual level switching. Wire count on wire whips is not shown on Drawings and shall be the responsibility of the Contractor to provide proper wire count for the lighting control as shown on Drawings.

### 2.7 BALLASTS:

- A. Fluorescent General Requirements:
  - 1. Lamps shall be operated on the type of circuit the lamp was designed for (preheat, rapid start, instant start, programmed start, etc.). T8 lamps shall be operated on rapid start ballasts only. Ballasts shall provide normal rated lamp life as stated by lamp manufacturers.
  - 2. Ballasts shall be HPF (greater than 90%), UL listed, and ETL certified. Magnetic ballasts shall be CBM certified. For projects applying for utility funding, ballasts shall meet utility requirements. Provide ballasts with thermal protection unless otherwise specified. Ballasts shall be Class P.
  - 3. Confirm voltage requirements with Electrical Drawings. Ballasts shall operate lamps correctly within +/-10% voltage variation without damaging ballasts.
  - 4. Ratings:
    - a. "A" sound rating for 430 ma and 265 ma
    - b. "B" sound rating for 800 ma
    - c. "C" sound rating for 1500 ma
  - 5. Low temperature application: Provide ballasts suitable for low starting temperature where light fixture is located in a freezer or refrigerator or other location where ambient air temperature will be below 50 degrees F.
  - 6. Dimming Ballasts: Type required by dimmer Manufacturer for proper operation and to maintain UL listing of dimming system components utilized. Total harmonic distortion shall not exceed 20% at any point within the dimming range.
- B. Magnetic Fluorescent Ballasts: In addition to the general requirements, provide magnetic ballasts where required in the Light Fixture Schedule as follows:
  - 1. Energy saving type with a ballast factor not less than 95%.
  - 2. Each ballast individually protected by an in-line GMF fuse in a Bussman type HLR fuseholder.
  - 3. Manufacturers: Advance, GE/Magnatek, Robertson or Universal, or as specifically noted in the Light Fixture Schedule.

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- C. Electronic Fluorescent Ballasts: In addition to the general requirements, provide electronic ballasts where required in the Light Fixture Schedule as follows:
1. Ballasts in conformance with the following regulatory requirements:
    - a. EMI and RFI limits set by the FCC (CFR47, Part 18 and FCC Part 18,15j), IEEE Publication 587, Category A (transients).
    - b. Minimum efficiency standards of Public Law 100-357.
    - c. Starting sequence consistent with ANSI Standard C82.1-1993.
  2. Reduced light output ballasts (ballast factors below 87%) are not acceptable except as noted otherwise in the Light Fixture Schedule.
  3. Total harmonic distortion shall be less than 15% of the input current. Current crest factor shall be less than 1.7. Operating frequency shall be between 25 and 60 kHz with no visible flicker.
  4. Ballasts shall operate in ambient temperatures up to 105°F (40°C).
  5. Rapid start ballasts shall be wired in series (or in parallel if manufactured accordingly).
  6. Ballasts for single ended lamps shall be program start, with end of life protection.
  7. Manufacturers: Advance, GE/Magnatek, Osram/Sylvania, Universal.
- D. High Intensity Discharge:
1. HPF type (minimum power factor 90%).
  2. Sound Rating: "low noise" or "extra quiet".
  3. Each ballast shall be individually protected by an in-line fuse in a Bussman fuseholder type HLR for 120 and 277 volt, type HEX for 208, 240 and 480 volt.
  4. Metal Halide: Constant Wattage Autotransformer (CWA) except for lamps below 175 watts without ignitors where high resistance auto transformer type will be acceptable. Use Advance Transformer "Smart Cap" ballast where required by lamp selection.
  5. Manufacturers - Magnetic Ballasts: Sylvania, Holophane, Jefferson, Advance, Universal.
  6. Where ceramic metal halide lamps are specified, use electronic ballasts.
  7. Manufacturers - Electronic Ballasts: Aromat (for 39, 50, 70, 100 and 150 watts); Advance (for 39, 50, 70, 100 and 150 watts); Altman (150 watts), Innova (150 watt S/E T-6), Reliable (39WPAR20, 50, 70 and 100 watts), OSRAM (exMotorola) (70 watts) and Hatch (39 and 70 watts).

### 2.8 LAMPS

- A. Each lamp type in the Project shall be manufactured by the same Manufacturer.
- B. Fluorescent:
1. Medium Bi-pin, T5 program start, T8 rapid start, T12, compact TT, DTT and TRT; 3500K color temperature and 80+ Color Rendering Index (CRI) unless otherwise noted. Use TCLP compliant lamps unless they are unavailable for type of lamp specified (brand names are GE - Ecolux, Osram Sylvania - Ecologic and Phillips - ALTO).
  2. Where T5HO lamps are utilized on a dimmable circuit, only GE and Sylvania lamps may be used.
  3. Manufacturers: General Electric, Philips, Osram Sylvania or as specifically noted in the Light Fixture Schedule.

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- C. Cold Cathode Fluorescent Lamps: Shall produce a minimum of 460 lumens per foot when operating at 120 ma, 650 lumens per foot when operating at 200 ma and shall not depreciate more than 20% after 10,000 hours of normal operation. Lamps shall be 1" diameter tri-phosphor coated lead glass with 3500K color temperature and 70+ CRI or better unless otherwise noted. Lamps shall be fabricated in the shapes and sizes as shown on Drawings. Lamps shall be processed with a high speed mechanical pump with accurate gauges and meters for measuring and controlling pressures, temperatures, carrier gas and mercury. Completed lamps shall be silicon coated and aged for 15 hours in the factory before being shipped to the site. Lamps showing end darkening, stains, discoloration, spiraling or sputtering shall be rejected. For lamp color and acceptable manufacturers, refer to Light Fixture Schedule.
- D. Incandescent (Including Tungsten Halogen):
  - 1. General Service Lamps: Inside frosted, 120V, filament lamps with a minimum 1000 hours rated life.
  - 2. Lamps with diodes are not acceptable.
  - 3. At time of installation, provide HIR technology lamps for standard voltage PAR lamps and double ended tungsten halogen lamps, unless HIR technology is not available for specified lamps.
  - 4. For low voltage lamps with dichroic reflectors, use Constant Color type (by General Electric) or aluminum back finishes. Coating on back of lamp shall be sufficiently dense and even to prevent light and heat from escaping out the back side of the reflector.
  - 5. Manufacturers: General Electric, Philips, Osram Sylvania or as specifically noted in the Light Fixture Schedule.
- E. High Intensity Discharge Type:
  - 1. For indoor applications provide ceramic metal halide. For exterior applications provide clear metal halide unless specified otherwise.
  - 2. Refer to fixture schedule for specific metal halide lamps required. Mercury Vapor shall not be used.
  - 3. Acceptable manufacturers: General Electric, Osram Sylvania, Philips, Venture or as specifically noted in the Light Fixture Schedule.

### 2.9 SOCKETS

- A. Incandescent: Porcelain for medium or mogul screw base. For other lamp types, as required by base type.
- B. Fluorescent: Suitable for lamp and ballast type employed.

2.10 H.I.D.: Porcelain for mogul or medium base lamps, pulse rated as required. Keyed for all position oriented lamps. For other lamp types, as required by base type.

### 2.11 LIGHTING STANDARDS

- A. Pole/Luminaire Assemblies and Bollards: Supply luminaires, davit arms, brackets, poles, handhole covers, base components and all other accessories for a complete assembly. Manufacturer shall be responsible for proper fitting of all elements and the structural integrity of the unit.
- B. Provide insulating fuse and holder in the base of each lighting standard to individually protect each lighting fixture. Fuse holder similar to Buss style "HEX" (HEB permitted for 120V or 277V), with Buss fuse of appropriate ampacity and voltage. Provide fuse for each hot circuit wire; do not fuse neutral.

### 2.12 EMERGENCY BATTERY PACKS

- A. Where fluorescent fixtures are indicated or specified to have self-contained battery backup, provide battery pack(s) with 1100 lumen output for single lamp operation or as indicated. Unit shall be self-testing type with high temperature nickel cadmium battery, automatic transfer switch, battery charger high frequency inverter, installed test/charging indicator and switch, dual voltage, and be UL listed to standard 924. Provide normal switching connection where indicated.

## SECTION 26 51 00 INTERIOR LIGHTING

- B. Testing: Apply power for 24 hours, disconnect power observe, measure and record light output for specified 90 minute period. Continue to run on battery until automatic low battery cut-off circuit disconnects battery. Restore normal power and verify battery returns to charging mode.
- C. Warranty: Entire unit shall be warranted for 5 years, battery shall have 15 year life expectancy with 5 year full warranty and 7 additional years prorated warranty. Full warranty to cover labor and materials without charge. Prorated warranty to cover material only.

### PART 3 EXECUTION

#### 3.1 LIGHTING FIXTURES, GENERAL

- A. Provide mounting accessories and trims as required for wall and ceiling construction types shown in Finish Schedule and on Drawings.
- B. Verify weight and mounting method of fixtures and provide suitable supports. Fixture mounting assemblies shall comply with local seismic codes and regulations.
- C. Refer to architectural reflected ceiling plans for coordination of lighting fixture locations with mechanical and fire safety equipment. Where conflicts occur, coordinate with Architect prior to installing any of the systems.
- D. Install fixtures with vent holes free of air blocking obstacles.
- E. Lighting fixtures located in recessed ceilings with a fire resistive rating of 1-hour or more shall be enclosed in an approved fire-resistive rated box equal to that of the ceiling.
- F. Adjust aperture rings on all recessed fixtures to be flush with the finished ceiling.
- G. For fluorescent lamps operated on dimming ballasts, operate lamps at full output for 100 hours (continuous burn) before dimming.
- H. Adjust variable position lampholders for proper lamp position prior to fixture installation.
- I. Blemished, damaged or unsatisfactory fixtures or accessories shall be replaced.
- J. For pendant mounted fixtures, mounting height is from finished ceiling to top of pendant light fixture. For wall mounted fixtures, center on outlet box unless otherwise noted. Verify mounting provisions and other requirements prior to order of light fixtures and provide as required.
- K. In accessible suspended ceilings, provide 72" flexible conduit wiring connection (flexible tubing not permitted) from a rigidly supported junction box.
- L. All finishes shall be unmarred upon project completion. Repair or replace damaged finishes.
- M. Replace all burned out or inoperative lamps at the end of the construction prior to Owner occupancy.

#### 3.2 DIFFUSERS AND ENCLOSURES

- A. Remove protective plastic covers from lighting fixture diffusers only after construction work, painting and clean-up are completed. Remove all dirty lamps, reflectors and diffusers; clean and reinstall. When cleaning "Alzak" reflectors, use a Manufacturer recommended cleaning solution. Reflectors damaged or impregnated with fingerprints shall be replaced at no cost to Owner.

#### 3.3 ADJUSTMENT OF LIGHT FIXTURES

- A. Focus all adjustable light fixtures under the direction of the Lighting Designer during a scheduled period of time prior to the completion of the project, after normal business hours if required. Include all equipment and personnel expenses (including overtime) required for adjustment.

## SECTION 26 51 00 INTERIOR LIGHTING

### 3.4 SUPPORT OF INCANDESCENT AND COMPACT FLUORESCENT LIGHT FIXTURES

- A. Surface or Pendant Type: Attach heavy formed steel straps to the outlet box by means of threaded stems with locknuts, or directly to the outlet box where the light fixture is specifically so designed.
- B. Recessed Type: Mount in frames suitable for the ceiling, with recessed portion of the fixture securely supported from the ceiling framing. Bottom of light fixture to be flush with adjacent ceiling. Fixture trim shall totally conceal ceiling opening. Provide two #14 earthquake chains or #12 wires when fixture is supported by ceiling suspension system.

### 3.5 SUPPORT OF FLUORESCENT LIGHT FIXTURES

- A. Recessed type: For light fixtures supported by the ceiling suspension system, provide four Caddy #515 support clips (one each corner) which lock light fixture to ceiling tees after light fixture is installed. In addition, provide for each light fixture two #14 earthquake chains or #12 wires secured at diagonally opposite fixture corners (for fixtures weighing less than 56 pounds) to structural members above suspended ceiling. For plaster or gypsum board ceilings provide plaster frame compatible with light fixture. Contractor shall coordinate fixture trim with ceiling type.
- B. Surface Mounted Type:
  - 1. Where mounted on accessible ceilings, support from structural members above ceiling by means of hanger rods through ceiling or as approved.
  - 2. Continuous Runs of Fixtures: Laser sight to assure fixtures are straight when sighting from end to end, regardless of irregularities in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.
- C. Pendant Mounted Type:
  - 1. For fixtures with rigid pendants, supply swivel ball aligners at canopy to comply with local seismic requirements.
  - 2. Where suspended from accessible ceiling, support fixture from structural members above ceiling by means of hanger rods through ceiling or as accepted.
  - 3. Continuous Runs of Light Fixtures: Laser sight to assure fixtures are straight when sighting from end to end, regardless of irregularities in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.

### 3.6 SUPPORT OF HIGH INTENSITY DISCHARGE FIXTURES

- A. As specified for incandescent light fixtures, except provide access as required for ballast. Provide earthquake chains when light fixture is supported by the ceiling suspension system. For remote ballasts, isolate ballast from structure.

### 3.7 CEILING LIGHT FIXTURE SUPPORT

- A. Where ceiling is of insufficient strength to support weight of lighting fixtures installed, provide additional framing to support as required.

### 3.8 COLD CATHODE AND NEON

- A. All components shall be installed in strict accordance with the shop drawings and manufacturer's installation instructions. Lamps shall be kept a minimum of 2" from metal and make secure electrical contact with the lampholder. Switches or circuit breakers controlling cold cathode lighting transformers shall be capable of being locked in the open position.
- B. Supply electricity through transformers dedicated to lighting only, in order to prevent injection of electrical "noise" into electrical systems that may affect public address, radio, computer or other systems. Secondary feeds shall be installed in accordance with manufacturer's instructions when located near public address, computer or other associated low voltage wiring.

SECTION 26 51 00 INTERIOR LIGHTING

END OF SECTION



## SECTION 26 56 00 EXTERIOR LIGHTING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Provide lighting system complete and fully operational.
- B. Substitutions:
  - 1. Bidders requesting approval to provide products other than those specifically listed in the Light Fixture Schedule shall submit requests in writing to the Architect and Lighting Designer ten days prior to the close of the bid period. Approval will be in the form of an addendum to the specifications issued to all registered plan holders. No requests for substitution will be considered after this date.
  - 2. Substitution request shall include all information required under paragraph 1.4 SUBMITTALS. Requests for approval shall be accompanied by a working fixture sample (including lamps and a cord and plug). Provide the name of at least one installation where each proposed substitute has been installed for at least six months along with the name and phone number of the Architect, Owners Representative and the Lighting Designer of Record. If required by the Architect, the proposed substitutes must be installed at the bidders expense in a location selected by the Architect.

#### 1.3 REFERENCES

- A. National Electrical Manufacturer's Association (NEMA) LE5-1993:
  - 1. Procedure for determining Luminaire efficiency ratings.
- B. Underwriters Laboratories, Inc. (UL):
  - UL 496: Edison Base Lampholders
  - UL 542: Lampholders, Starter Holders for Fluorescent Lamps
  - UL 676: Underwater Lighting Fixtures
  - UL 924: Emergency Lighting and Power Equipment
  - UL 935: Fluorescent Lamp Ballasts
  - UL 1029: HID Lamp Ballasts
  - UL 1570: Fluorescent Lighting Fixtures
  - UL 1571: Incandescent Lighting Fixtures
  - UL 1572: High Intensity Discharge Lighting Fixtures

#### 1.4 SYSTEM DESCRIPTION

- A. Light fixture schedule series numbers are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of lamp, ballast, finish trim, ceiling type, mounting hardware, ceiling trim or special requirements as specified hereinafter or as required by the particular installations. Provide complete fixtures to correspond with the number of lamps, wattage and/or size specified.
- B. If there are discrepancies between fixture illustrations and the written description in the fixture schedule, the written description in the fixture schedule shall take precedence.
- C. Light fixture voltage shall match voltage of circuit serving the light fixture.

#### 1.5 SUBMITTALS

- A. For standard catalog items, provide original product sheets, -neatly and clearly marked- to indicate that light fixture, ballasts and lamps fully comply with Contract Documents. Include photometric report by an independent certified testing laboratory when required in Fixture Schedule. Manufacturer's test report is not acceptable.

## SECTION 26 56 00 EXTERIOR LIGHTING

- B. Submittals shall have fixture types and project name clearly indicated and shall be prepared by the authorized Manufacturer's Representative serving the project area. A list of Manufacturer's Representatives (including address, telephone and fax numbers) identifying which light fixture types they represent shall be included with Submittals. Submittals or Requests for Substitutions not meeting these requirements will be rejected.
- C. For custom or modified fixtures, submit scaled Drawings prepared by the Manufacturer showing details of construction, lengths of runs, pendant and power feed locations, accessory pieces, finishes, and list of materials. Contractor to provide Manufacturer with field dimensions where required.

### 1.6 QUALITY ASSURANCE

- A. Fixtures and components shall be new and listed by Underwriters Laboratories (UL) or other testing lab acceptable to local jurisdiction.

### 1.7 WARRANTY

- A. Ballasts: Provide Manufacturer's warranty for a period of not less than five years. Warranty shall include parts and labor to replace defective ballasts.
- B. Exit Signs Utilizing LED Lamp Technology: Provide Manufacturer's warranty for a period of not less than five years including parts and labor for full replacement of defective product.

### 1.8 EXTRA MATERIALS

- A. Ballasts: Provide one case or 10% (whichever is less) of each type used on the Project. Turn over to Owner and obtain signed receipt.
- B. Lamps: Provide one case or 10% (whichever is less) of each type used on the Project. Turn over to Owner and obtain signed receipt.
- C. Fuses: Provide one case or 10% (whichever is less) of each type used on the Project. Turn over to Owner and obtain signed receipt.
- D. Adjustable Accent Lights (recessed or surface mounted): Provide additional lenses, color filters and other accessories to be used during final focusing, as follows:
  - 1. 20% or one case (whichever is less) of each lamp type (type, beam spreads, and wattages to be determined by the lighting designer). A spot and a flood lamp of the same wattage are considered to be two different lamp types.
  - 2. 10% or one dozen each, (whichever is less) lenses, color filters and louvers (to be determined by the lighting designer).

## PART 2 PRODUCTS

### 2.1 GENERAL MATERIAL REQUIREMENTS

- A. Finish ferrous mounting hardware and accessories to prevent corrosion and discoloration to adjacent materials.
- B. For weatherproof or vaportight installations, painted finishes of fixtures and accessories shall be weather resistant enamel using proper primers or galvanized and bonderized epoxy, so that the entire assembly is completely corrosion resistant for the service intended. Where aluminum parts come into contact with bronze or steel parts, apply a coating material to both surfaces to prevent corrosion.
- C. Fixtures shall be free of light leaks and designed to provide sufficient ventilation of lamps to provide the photometric performance required. Ballasts and transformers shall be adequately vented.
- D. Lampholders shall hold lamps securely against normal vibrations and maintenance handling.

## SECTION 26 56 00 EXTERIOR LIGHTING

- E. Reflector Cones:
1. Provide minimum 45° lamp and lamp image cut-off for all vertically mounted lamps. For horizontal lamps provide minimum 33° cut-off. There shall be no visible lamp flashing in the cone.
  2. Plastic materials shall not be used for reflector cones, unless noted otherwise in the Light Fixture Schedule.
  3. Reflector cones shall not be riveted or welded to housing and shall be removable without tools. Retention devices shall not deform the cone in any manner. Trim shall be flush with finished ceiling without gaps or light leaks. Where the flange trim is separate from the cone, it shall have the same finish as the cone.
  4. Reflector cones shall be of uniform gauge, not less than 0.032-inch thick, high purity aluminum Alcoa 3002 alloy, free of spin marks or other defects.
  5. Manufacture reflector under the Alzak process. Refer to fixture schedule for cone color and specular or diffuse finish requirements. For fixtures using compact fluorescent lamps, provide additional finish equivalent to Color-Chek that eliminates iridescence. Submit one sample of each cone type for review when required in the Fixture Schedule.
- F. Fresnel Lens and Door Assembly:
1. Lens shall have uniform brightness throughout the entire visible area at angles from 45° to 90° from vertical, without bright spots or striations.
  2. Lens shall have opaque risers painted neutral gray unless otherwise specified in the Light Fixture Schedule.
  3. Finish of regress door shall be matte baked enamel paint in color as selected by the Architect.
- G. Light fixtures containing lamps which require protective shielding shall have tempered glass lenses.
- H. For adjustable fixtures, provide positive locking devices to fix aiming angle. Fixture shall be capable of being relamped without adjusting aiming angle.
- I. Fixtures recessed in suspended ceilings where the space above the ceiling is either an air supply or return plenum shall conform with NEC Article 300-22.
- J. Safety: Provide safety devices for removable fixture elements (cones, reflectors, lenses, etc.) to support removable elements when not in normal operating position. Safety devices shall be detachable if necessary and shall not interfere with fixture performance, maintenance or the seating of any fixture element, and not be visible during normal fixture operation.
- K. Finishes:
1. Painted surfaces shall have an outdoor life expectancy of not less than 20 years without any visible rust or corrosion.
  2. Finish colors shall be as specified.
- L. Diffusers: materials shall be UV stabilized.
- 2.2 FLUORESCENT FIXTURES
- A. Housing: Minimum code gauge steel or rigid aluminum construction painted after fabrication with high reflectance white paint (min. 89%).

## SECTION 26 56 00 EXTERIOR LIGHTING

- B. Light Shields:
1. Flat Translucent Diffusers: Shall be 100% virgin acrylic and have matte finish on exterior side (facing away from lamps). Diffuser shall be of thickness specified and shall be of sufficient density to completely obscure lamp image.
  2. Flat Clear Lenses: Injection molded 100% virgin acrylic or clear tempered glass, thickness as specified.
  3. Clear Patterned Lenses: Injection molded 100% virgin acrylic. For lenses with a male pattern of prisms or cones, specified minimum thickness refers to distance from flat surface to base of pyramids or cones, or to thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material. Lenses shall fully eliminate lamp image when viewed from all directions between 45-90° from vertical. From 0-45° the ratio of maximum brightness (under a lamp) to minimum brightness (mid-point between lamps) shall not exceed 3:1. Minimum thickness shall not be less than 0.125" with a minimum weight of 8 ounces per square foot.
- C. Frames:
1. Supply with concealed hinges and latching. Provide mitered corners with no gaps or light leaks.
- D. Lamp Mounting:
1. Mount lamps used in rapid start circuits 430 ma and below within 1/2" of grounded metal as long as the lamp. For 800 ma and 1500 ma lamps, mount within 1" of grounded metal as long as the lamp.
  2. For rapid start circuits using single lamp ballasts, provide one grounding lamp holder per lamp.

### 2.3 INCANDESCENT/TUNGSTEN HALOGEN FIXTURES

- A. Tungsten halogen and xenon are types of incandescent light sources and will herein be included under the heading of incandescent.
1. Finish: Concealed parts (lamp holders, yokes, brackets, etc.) matte black.
  2. Tungsten Halogen Lamp Seal Temperature: Shall not exceed 350°C at ambient of 25°C when tested per UL Bulletin 57, Paragraph 328-334. Submit certified heat test by independent testing laboratory when required in Light Fixture Schedule.

### 2.4 HIGH INTENSITY DISCHARGE (HID) FIXTURES:

- A. Housing: Minimum code gauge steel, bonderized or equal rust protected or rigid aluminum construction.
- B. Finish: Visible surfaces. Powder coated paint unless otherwise specified. Color and finish as selected by architect. Concealed parts, (lamp holders, yokes, brackets, etc.) matte black.
- C. Lamp Holder Housing: Cast aluminum with integral heat radiating fins to assure cool lamp base operation.

### 2.5 WIRING

- A. Wiring shall be as required by code for fixture wiring.
- B. Flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105°C.
- C. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.
- D. No internal wiring shall be visible at normal viewing angles, i.e. above 45° from vertical.

## SECTION 26 56 00 EXTERIOR LIGHTING

### 2.6 BALLASTS:

- A. General Requirements:
  - 1. Lamps shall be operated on the type of circuit the lamp was designed for (preheat, rapid start, instant start, programmed start, etc.). T8 lamps shall be operated on rapid start ballasts only. Ballasts shall provide normal rated lamp life as stated by Lamp Manufacturers.
  - 2. Ballasts shall be HPF (greater than 90%), UL listed, and ETL certified. Magnetic ballasts shall be CBM certified. For projects applying for utility funding, ballasts shall meet utility requirements. Provide ballasts with thermal protection unless otherwise specified. Ballasts shall be Class P.
  - 3. Confirm voltage requirements with Electrical Drawings. Ballasts shall operate lamps correctly within +/-10% voltage variation without damaging ballasts.
  - 4. Ratings:
    - a. "A" sound rating for 430 ma and 265 ma
    - b. "B" sound rating for 800 ma
    - c. "C" sound rating for 1500 ma
  - 5. Provide ballasts suitable for low starting temperature where light fixture is located outdoors or where ambient air temperature will be below 50 degrees F.
  - 6. Dimming Ballasts: Type required by dimmer manufacturer for proper operation and to maintain UL listing of dimming system components utilized. Total harmonic distortion shall not exceed 20% at any point within the dimming range.
- B. Magnetic Fluorescent Ballasts: In addition to the general requirements, provide magnetic ballasts where required in the Light Fixture Schedule as follows:
  - 1. Energy saving type with a ballast factor not less than 95%.
  - 2. Each ballast individually protected by an in-line GMF fuse in a Bussman type HLR fuseholder.
  - 3. Manufacturers: Advance, GE/Magnatek, Robertson, or Universal or as specifically noted in the Light Fixture Schedule.
- C. Electronic Fluorescent Ballasts: In addition to the general requirements, provide electronic ballasts where required in the Light Fixture Schedule as follows:
  - 1. Ballasts in conformance with the following regulatory requirements:
    - a. EMI and RFI limits set by the FCC (CFR47, Part 18 and FCC Part 18,15j), IEEE Publication 587, Category A (transients).
    - b. Minimum efficiency standards of Public Law 100-357.
    - c. Starting sequence consistent with ANSI Standard C82.1-1993.
  - 2. Reduced light output ballasts (ballast factors below 87%) are not acceptable except as noted otherwise in the Light Fixture Schedule.
  - 3. Total harmonic distortion shall be less than 15% of the input current. Current crest factor shall be less than 1.7. Operating frequency shall be between 25 and 60 kHz with no visible flicker.
  - 4. Ballasts shall operate in ambient temperatures up to 105°F (40°C).
  - 5. Rapid start ballasts shall be wired in series (or in parallel if manufactured accordingly).
  - 6. Ballasts for single ended lamps shall be program start, with end of life protection.
  - 7. Manufacturers: Advance, GE/Magnatek, Osram/Sylvania, Universal.
- D. High Intensity Discharge:
  - 1. HPF type (minimum power factor 90%).
  - 2. Sound Rating: "low noise" or "extra quiet".
  - 3. Each ballast shall be individually protected by an in-line fuse in a Bussman fuseholder type HLR for 120 and 277 volt, type HEX for 208, 240 and 480 volt.
  - 4. Metal Halide: Constant Wattage Autotransformer (CWA) except for lamps below 175 watts without ignitors where high resistance auto transformer type will be acceptable. Use Advance Transformer "Smart Cap" ballast where required by lamp selection.

## SECTION 26 56 00 EXTERIOR LIGHTING

5. Manufacturers - Magnetic Ballasts: Sylvania, Holophane, Jefferson, Advance, Universal.
6. Where ceramic metal halide lamps are specified, use electronic ballasts.
7. Manufacturers - Electronic Ballasts: Aromat (for 39, 50, 70, 100 and 150 watts); Advance (for 39, 50, 70, 100 and 150 watts); Altman (150 watts), Innova (150 watt S/E T-6), Reliable (39WPAR20, 50, 70 and 100 watts), OSRAM (exMotorola) (70 watts) and Hatch (39 and 70 watts).

### 2.7 LAMPS

- A. Each lamp type in the Project shall be manufactured by the same Manufacturer.
- B. Fluorescent:
  1. Medium Bi-pin, T5 program start, T8 rapid start, T12, compact TT, DTT and TRT; 3500K color temperature and 80+ Color Rendering Index (CRI) unless otherwise noted. Use TCLP compliant lamps unless they are unavailable for type of lamp specified (brand names are GE - Ecolux, Osram Sylvania - Ecologic and Phillips - ALTO).
  2. Where T5HO lamps are utilized on a dimmable circuit, only GE and Sylvania lamps may be used.
  3. Manufacturers: General Electric, Philips, Osram Sylvania or as specifically noted in the Light Fixture Schedule.
- C. Incandescent (Including Tungsten Halogen):
  1. General Service Lamps: Inside frosted, 120V, filament lamps with a minimum 1000 hours rated life.
  2. Lamps with diodes are not acceptable.
  3. At time of installation, provide HIR technology lamps for standard voltage PAR lamps and double ended tungsten halogen lamps, unless HIR technology is not available for specified lamps.
  4. For low voltage lamps with dichroic reflectors, use Constant Color type (by General Electric) or aluminum back finishes. Coating on back of lamp shall be sufficiently dense and even to prevent light and heat from escaping out the back side of the reflector.
  5. Manufacturers: General Electric, Philips, Osram Sylvania or as specifically noted in the Light Fixture Schedule.
- D. High Intensity Discharge Type:
  1. For exterior applications provide clear metal halide or ceramic metal halide.
  2. Refer to fixture schedule for specific metal halide and high pressure sodium lamps required. Mercury Vapor shall not be used.
  3. Acceptable manufacturers: General Electric, Osram Sylvania, Philips, Venture or as specifically noted in the Light Fixture Schedule.

### 2.8 SOCKETS

- A. Incandescent: Porcelain for medium or mogul screw base. For other lamp types, as required by base type.
- B. Fluorescent: Suitable for lamp and ballast type employed.
- C. H.I.D.: Porcelain for mogul or medium base lamps, pulse rated as required. Keyed for all position oriented lamps. For other lamp types, as required by base type.

### 2.9 LIGHTING STANDARDS

- A. Pole/Luminaire Assemblies and Bollards: Supply luminaires, davit arms, brackets, poles, handhole covers, base components and all other accessories for a complete assembly. Manufacturer shall be responsible for proper fitting of all elements and the structural integrity of the unit. Provide assembly to withstand 100 mph steady wind rated poles with 1.3 gust factor.

## SECTION 26 56 00 EXTERIOR LIGHTING

- B. Provide watertight insulating fuse and holder in the base of each lighting standard to individually protect each lighting fixture. Fuse holder similar to Buss style "HEX" (HEB permitted for 120V or 277V), with Buss fuse of appropriate ampacity and voltage. Provide fuse for each hot circuit wire; do not fuse neutral.

### 2.10 EMERGENCY BATTERY PACKS

- A. Where fluorescent fixtures are indicated or specified to have self-contained battery backup, provide battery pack(s) with 1100 lumen output for single lamp operation or as indicated. Unit shall have high temperature nickel cadmium battery, automatic transfer switch, battery charger high frequency inverter, installed test/charging indicator and switch, dual voltage, and be UL listed to standard 924. Provide normal switching connection where indicated.
- B. Testing: Apply power for 24 hours, disconnect power observe, measure and record light output for specified 90 minute period. Continue to run on battery until automatic low battery cut-off circuit disconnects battery. Restore normal power and verify battery returns to charging mode.
- C. Warranty: Entire unit shall be warranted for 5 years, battery shall have 15 year life expectancy with 5 year full warranty and 7 additional years prorated warranty. Full warranty to cover labor and materials without charge. Prorated warranty to cover material only.

## PART 3 EXECUTION

### 3.1 LIGHTING FIXTURES, GENERAL

- A. Provide mounting accessories and trims as required for wall and ceiling construction types shown in Finish Schedule and on Drawings.
- B. Verify weight and mounting method of fixtures and provide suitable supports. Fixture mounting assemblies shall comply with local seismic codes and regulations.
- C. Refer to landscape architecture, civil, and architectural plans for coordination of lighting fixture locations with other devices and site elements. Where conflicts occur, coordinate with Architect prior to installing any of the systems.
- D. Lighting fixtures located in recessed ceilings with a fire resistive rating of 1-hour or more shall be enclosed in an approved fire-resistive rated box equal to that of the ceiling.
- E. Adjust aperture rings on all recessed fixtures to be flush with the finished ceiling.
- F. For fluorescent lamps operated on dimming ballasts, operate lamps at full output for 100 hours (continuous burn) before dimming.
- G. Adjust variable position lampholders for proper lamp position prior to fixture installation.
- H. Blemished, damaged or unsatisfactory fixtures or accessories shall be replaced.
- I. For pendant mounted fixtures, mounting height is from finished ceiling to top of pendant light fixture. For wall mounted fixtures, center on outlet box unless otherwise noted. Verify mounting provisions and other requirements prior to order of light fixtures and provide as required.
- J. In accessible suspended ceilings, provide 72" flexible conduit wiring connection (flexible tubing not permitted) from a rigidly supported junction box.
- K. All finishes shall be unmarred upon project completion. Repair or replace damaged finishes.
- L. Replace all burned out or inoperative lamps at the end of the construction prior to Owner occupancy.

## SECTION 26 56 00 EXTERIOR LIGHTING

### 3.2 DIFFUSERS AND ENCLOSURES

- A. Remove protective plastic covers from lighting fixture diffusers only after construction work, painting and clean-up are completed. Remove all dirty lamps, reflectors and diffusers; clean and reinstall. When cleaning "Alzak" reflectors, use a Manufacturer recommended cleaning solution. Reflectors damaged or impregnated with fingerprints shall be replaced at no cost to Owner.

### 3.3 ADJUSTMENT OF LIGHT FIXTURES

- A. Focus all adjustable light fixtures under the direction of the Lighting Designer during a scheduled period of time prior to the completion of the project, after normal business hours if required. Include all equipment and personnel expenses (including overtime) required for adjustment.

### 3.4 SUPPORT OF INCANDESCENT AND COMPACT FLUORESCENT LIGHT FIXTURES

- A. Surface or Pendant Type: Attach heavy formed steel straps to the outlet box by means of threaded stems with locknuts, or directly to the outlet box where the light fixture is specifically so designed.
- B. Recessed Type: Mount in frames suitable for the ceiling, with recessed portion of the fixture securely supported from the ceiling framing. Bottom of light fixture to be flush with adjacent ceiling. Fixture trim shall totally conceal ceiling opening. Provide two #14 earthquake chains or #12 wires when fixture is supported by ceiling suspension system.

### 3.5 SUPPORT OF FLUORESCENT LIGHT FIXTURES

- A. Recessed type: For light fixtures supported by the ceiling suspension system, provide four Caddy #515 support clips (one each corner) which lock light fixture to ceiling tees after light fixture is installed. In addition, provide for each light fixture two #14 earthquake chains or #12 wires secured at diagonally opposite fixture corners (for fixtures weighing less than 56 pounds) to structural members above suspended ceiling. For plaster or gypsum board ceilings provide plaster frame compatible with light fixture. Contractor shall coordinate fixture trim with ceiling type.
- B. Surface Mounted Type:
  - 1. Where mounted on accessible ceilings, support from structural members above ceiling by means of hanger rods through ceiling or as approved.
  - 2. Continuous Runs of Fixtures: Laser sight to assure fixtures are straight when sighting from end to end, regardless of irregularities in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.

### 3.6 SUPPORT OF HIGH INTENSITY DISCHARGE FIXTURES

- A. As specified for incandescent light fixtures, except provide access as required for ballast. Provide earthquake chains when light fixture is supported by the ceiling suspension system. For remote ballasts, isolate ballast from structure.

### 3.7 CEILING LIGHT FIXTURE SUPPORT

- A. Where ceiling is of insufficient strength to support weight of lighting fixtures installed, provide additional framing to support as required.

### 3.8 LIGHTING BOLLARDS

- A. Provide galvanized anchor bolts and nuts, and plumb to true vertical using a nut above and below the base plate on the anchor bolts. Provide steel reinforced concrete footing with grout between base plate and concrete footings. Bollard footing shall be flush with grade when located in paved surface. Ground all components.

SECTION 26 56 00 EXTERIOR LIGHTING

3.9 LIGHTING STANDARDS

- A. Provide rebar reinforced concrete base. For bolted poles, provide galvanized anchor bolts and nuts and plumb to true vertical using a nut above and below the base plate on the anchor bolts. Pack grout between base plate and concrete base and provide drain hole below base plate to prevent accumulation of moisture inside pole base. Provide two piece or individual covers for nuts exposed above the baseplate of the same color as the pole. Ground pole and light fixture.

END OF SECTION



## SECTION 27 05 28 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes discrete J-Hooks, slings and related accessories for supporting low voltage cable bundles above accessible ceilings and below accessible raised floor systems.

#### 1.3 REFERENCES

- A. American National Standards Institute (ANSI)/ Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
  - 1. ANSI/TIA/EIA 568-B.1 Commercial Building Telecommunications Cabling Standard
  - 2. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces
  - 3. ANSI/NFPA 70 National Electrical Code
- B. Underwriter's Laboratories, Inc. (UL)
  - 1. UL 2043 Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
  - 2. UL 2239 Conduit, Tubing and Cable Support Hardware

#### 1.4 DEFINITIONS

- UTP Unshielded twisted pair
- Pathway A series of supports and accessories for placement of low voltage systems cables
- Main Pathway A low voltage systems pathway where the cable count exceeds 30 cables

#### 1.5 SUBMITTALS

- A. General: Provide Submittal information under Provisions of Section 01 33 00 and Section 27 05 00 - Common Work Results For Communications and supplementary requirements described in this Specification.
- B. Product Data: Submit product data on all cable support devices and accessories. Indicate materials, finishes, load ratings, dimensions, listings, approvals and attachment methods.
- C. Shop Drawings: For Projects where the low voltage systems cable pathways are not shown on the Drawings, they are to be Contractor designed per Part 3. The Contractor shall prepare and submit proposed main pathway layout Drawings for review and approval by the Owner's Representative prior to installing supports. Shop Drawings shall:
  - 1. Indicate pathways on plan view
  - 2. Include elevations and sections to indicate space allocations and coordination with work of other trades
  - 3. Include details to describe the different support configurations, accessories, attaching means and cable groupings

## SECTION 27 05 28 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

- D. Closeout Submittals
  - 1. Provide complete copy of approved Submittal documentation with the O&M Manuals.
  - 2. As-built Drawings: Provide marked up As-built Drawings of main pathways.

### 1.6 QUALITY ASSURANCE

- A. Low voltage system cable supports and accessories shall be listed to Underwriter's Laboratories, Inc Standard 2239.
- B. Low voltage system cable supports and accessories shall have the Manufacturer's name and part number stamped on the part for identification.
- C. Pre-Installation Meetings: Contractor shall set up a pre-installation meeting to discuss low voltage cable support layout work and installation guidelines. Contractor shall organize meeting a minimum of 30 days prior to initiating cable support installation work. Attendees shall include Contractor, appropriate Subcontractors, low voltage system Vendors, Architect and Engineer. Purpose of meeting shall be to coordinate work between the parties to have a consistent layout for all low voltage system cables, minimize interferences and to make cable system accessibility for future Owner modifications and maintenance high priority issue for all installers.

### 1.7 COORDINATION

- A. Coordinate layout and installation of low voltage cable bundle supports with other construction elements to ensure adequate headroom, working clearance and access. Revise locations and elevations for those indicated as required to suit field conditions and as approved by Engineer.
- B. Examine drawings and existing conditions above ceilings and include additional supports in bid price to avoid ducts, pipes, conduits, etc. Installation in existing ceilings if very difficult. Include extra labor time involved in Bid price.

## PART 2 PRODUCTS

### 2.1 WIDE BASE CABLE SUPPORTS

- A. J hooks complying with EIA/TIA 568-B.1 and 569-A structured cabling system requirements. Minimum size is 1-5/16 inch diameter loop for (50) 4-pair UTP or 2 strand fiber optic cable or inner duct. Provide larger size or multiple hooks where required. Minimum 1" width and flared edges where cables enter and leave support. 2 inch diameter loop for (80) 4-pair UTP or 2 strand fiber optic cable or inner duct. 4 inch diameter loop for (300) 4-pair UTP or 2 strand fiber optic cable or inner duct.
- B. Accessories: Provide applicable accessories to independently support "J" hooks from structure. This includes extender bracket for mounting multiple J hooks on a single support, fasteners and clamps for connecting to wall, beams, rods, dedicated support wires and C and Z Purlins as required for specific construction.
- C. Cable Retainers: Provide cable retainers at each "J" hook
- D. Finish
  - 1. Dry Locations, Above Lay-in Ceiling, Below Raised Floor - galvanized
  - 2. Wet and Damp Locations: stainless steel

## SECTION 27 05 28 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

- E. Manufacturer.
  - 1. ERICO Caddy CableCat™ series
  - 2. Chatsworth RapidTrak™ series
  - 3. Or approved equivalent.

### 2.2 SOFT CABLE SLING SUPPORTS

- A. Adjustable sling cable supports suitable for plenums and complying with EIA/TIA 568-B.1 and 569-A structured cabling system requirements. 4 inch diameter loop for (220) 4-pair UTP or 2-strand fiber optic cables or inner duct. 6 inch diameter loop for (425) 4-pair UTP or 2-strand fiber optic cables or inner duct.
- B. Accessories: Provide applicable accessories to independently support slings from structure. This includes fasteners and clamps for connecting to walls, beams, rods, ceiling tee bars, dedicated support wires and C and Z Purlins as required for specific construction
- C. Material
  - 1. Construction: Polyethylene strands woven and laminated, reinforced seams, connected steel mounting and fastening hardware.
  - 2. Suitable for plenum location installation
- D. Manufacturer.
  - 1. ERICO Caddy CableCat™ 425 series
  - 2. Or approved equal.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. All low voltage systems cables shall be supported. Provide supports along entire Pathway.
- B. Space supports a maximum of 48 inches apart and at each change of direction of the cables.
- C. Hang cable supports from 3/8" all thread rods, dedicated #8 galvanized ceiling drop wire or wall brackets connected directly to structure. Do not support from the ceiling grid or ceiling wire system.
- D. Where main pathways are indicated on the Drawings, Contractor shall follow the indicated pathways as closely as possible according to field conditions. Pathways for smaller cable counts shall be designed and documented on the as-built Drawings by the Contractor.
- E. Where specific main pathways are not indicated on the Drawings, the cable pathways for all low voltage systems shall be designed by the Contractor. The Contractor shall coordinate pathways with all other trades to achieve efficient utilization of available space, complete accessibility to allow maintenance of cable plant and economical future adds moves and changes. Contractor shall provide main pathway Shop Drawings for review and approval by the Owner's Representative
- F. Install support wires, brackets or rods to route cables parallel and perpendicular to building lines.
- G. Provide multiple hooks or slings at each hanger location as required by cable count and cable segregation requirements.

## SECTION 27 05 28 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

- H. Fill supports with cabling to 50% or less of the Manufacturer's recommended fill. Provide multiple supports where required cable count exceeds 50% fill.
- I. Group cabling in separate supports by the following systems:
- Voice and Data Cabling
  - CCTV/CATV/Video Systems/ Radio and Satellite Systems
  - Audio
  - Medical Telemetry Systems
  - Building Automation, Lighting Control Systems
  - Fire Alarm
- When total cable count to a small group of work stations or offices is less than 24, the cables may be installed grouped in a single support of appropriate size.
- J. Interface with Other Work: Coordinate installation of supports with mechanical ductwork, piping and sprinkler system piping so that supports remain accessible after installation.
- K. Install low voltage cable support system above accessible ceilings and below accessible raised floor systems only.
- L. Elevation of Cable Supports: Contractor shall coordinate the allocation of ceiling space and the mounting elevations of various systems to allow maintenance and accessibility for future modifications. Low voltage system cable supports shall be as close to the ceiling as possible while allowing ceiling tiles to be removed. Supports shall be located to avoid interference with maintenance access to other equipment.
- M. Cable installation and supports shall comply with applicable provisions of EIA/TIA 569-A and ANSI/NFPA 70.

END OF SECTION

## SECTION 27 05 29 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections
  - 1. Section 26 05 33 - Raceways and Boxes for Electrical Systems
- C. Other References

EIA/TIA-569A Commercial Building Standard for Telecommunications Pathways and Spaces

TIA/EIA/ANSI-J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

#### 1.2 DESCRIPTION

- A. Provide raceway systems for the installation of the telephone cables and computer wiring. Installation shall include raceways, outlet boxes, plaster rings, outlet box cover plates and terminal back boards.

### PART 2 PRODUCTS

#### 2.1 WALL OUTLETS

- A. Shall consist of a 4-11/16" square, 2-1/8" deep (minimum) box, with knockouts for 3/4", 1", and 1-1/4" conduits, as manufactured by Steel City, OZ/Gedney or equal.
- B. Surface wall outlets shall be 4" square, 2-3/4" deep (minimum) and shall match and be manufactured by the surface metal raceway Manufacturer.

#### 2.2 FLOOR OUTLETS

- A. See Section 26 05 33.10 - Flush Floor Outlets for flush floor outlets.

#### 2.3 OUTLET DEVICE RING

- A. Coordinate device ring requirements with cable/outlet Installer.

#### 2.4 DEVICE PLATES

- A. Provide device cover plates for all unwired or "future" outlets. Plates shall match device plates specified in Section 26 27 26 - Wiring Devices except with no device openings.

#### 2.5 PULL WIRE

- A. Shall be plastic having not less than 200-pound tensile strength.

#### 2.6 TELEPHONE TERMINAL BOARDS

- A. Shall be 3/4 inch plywood backboard 8' feet high by 4" wide or as indicated in plans. APA interior grade Douglas Fir A-C. Shall be fire retardant with flame spread rating not more than 25 when tested according to ASTM E84.

#### 2.7 TELECOM GROUND BAR, TELECOM MASTER GROUND BAR (TGB, TMGB)

- A. Copper bus bar, 10 x 4 x 1/4" with a minimum of six (6) 3/8-inch and four (4) 1/2-inch diameter holes on 2-inch centers with screw lugs to secure ground wire terminations. Suggested Product: Universal Bus Bar #10622-010 or similar by Everett Machine Works or as detailed on the Drawings. Mount with 4-inch insulated stand-off brackets.

### PART 3 EXECUTION

#### 3.1 WALL OUTLETS IN UNINSULATED INTERIOR WALLS WITH ACCESSABLE CEILINGS

- A. Provide an individual conduit from each communications outlet to an accessible location at cable tray or to a telephone terminal backboard.

SECTION 27 05 29 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

3.2 WALL OUTLETS IN UNINSULATED INTERIOR WALLS WITH NON-ACCESIBLE CEILINGS, EXTERIOR WALLS OR INSULATED INTERIOR WALLS

- A. Provide an individual conduit from each communications outlet to an accessible location at cable tray or to a telephone terminal backboard.

3.3 FLOOR MOUNTED OUTLETS

- A. All conduits from floor outlets shall terminate in a space on the same floor as the outlet.
- B. Provide an individual conduit from each communications outlet to an accessible location at cable tray or to a telephone terminal backboard.

3.4 FLOOR OUTLETS/ BOXES IN SLAB ON GRADE

- A. Provide an individual conduit from each outlet box to a consolidation point interior to the building within 25 feet of the point where the conduit exits the slab.
- B. Provide an individual conduit from each outlet box to the serving Telecom Room.

3.5 SYSTEM FURNITURE CONNECTIONS

- A. Provide an individual conduit from each wall connection outlet to an accessible location at cable tray or to a telephone terminal backboard.

3.6 SURFACE METAL RACEWAY CONNECTIONS

- A. Provide an individual conduit from each surface raceway to an accessible ceiling space.

3.7 CONDUIT SIZING TABLE

- A. Provide conduits for communications outlets sized as follows:

Wall Phones	1"
Wall Outlets (except wall phones)	1"
Single Gang Floor Mounted Outlets/Boxes	1"
Multiple Gang Recessed Floor Outlets/Boxes	1-1/4"
System Furniture - per every (2) workstations	1"
System Furniture - per every (3) workstations	1-1/4"
Surface Metal Raceway - per 12 ft of SMR	1"
Surface Metal Raceway - per 20 ft of SMR	1-1/4"

3.8 RACEWAYS

- A. Shall conform to specification Section 26 05 33 - Raceways and Boxes for Electrical Systems with the additional requirement that no length of run shall exceed 100 feet and shall not contain more than two 90-degree bends or the equivalent without a code size pull box. Provide pull boxes where necessary to comply with these requirements. Locate pull boxes in straight runs only, not as a replacement for an elbow.
- B. Conduits with an internal diameter of two inches or less shall have a bend radius at least 6 times the internal conduit diameter. Conduits greater than two inches shall have a bend radius at least 10 times the internal conduit diameter.
- C. Provide an insulated bushing on all conduits terminated in a cabinet and/ or pullboxes.
- D. Terminate conduits stubbed out above accessible ceiling space so that the conduit is parallel with the ceiling and provide an insulating bushing.
- E. Terminate conduit at cable trays at an accessible location within 6" of tray with an insulated bushing and provide bonding jumper or terminate conduit to the cable tray with an insulated bushing.

SECTION 27 05 29 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

3.9 PULL BOXES

A. Pull boxes shall be sized per the following table:

PULL BOX SIZING (inches)

Conduit Trade Size	Width	Length	Depth	Width increase for additional conduit
1	4	16	3	2
1-1/4	6	20	3	3
1-1/2	8	27	4	4
2	8	36	4	5
2-1/2	10	42	5	6
3	12	48	5	6
3-1/2	12	54	6	6
4	15	60	8	8

3.10 PULL CORDS

A. Nylon type shall be included in all raceways over 10 feet long. Leave not less than 12 inches of slack at each end of the pull wire.

3.11 GROUNDING

- A. Provide a Telecom Master Grounding Bar in the telecommunications entrance facility
- B. Provide a Telecom Grounding Bar in each telecom room.
- C. Telecom Bonding Conductor and Telecom Bonding Backbone (TBB)
  - 1. Provide a telecom bonding conductor between the building electrical service entrance equipment ground and the telecom main ground bar (TMGB).
  - 2. Provide a telecom bonding backbone conductor (TBB) between the TMGB and each telecom room ground bar (TMB). Unless otherwise indicated on the Grounding Riser, the TBB conductors shall follow the configuration of the telecom backbone.
- D. Panelboard Bonding: For each telecom room, provide a bonding conductor between the ground bus of each panelboard serving electrical equipment within the telecom room and the TGB serving the room.
- E. Structural Steel Bonding: Provide a minimum #6 conductor from the TMGB or TGB to a readily accessible point on a vertical member or permanently electrically bonded horizontal member of the structural steel system of the building.
- F. Pathway Bonding:
  - 1. Bond all metal pathways (conduits, cable tray, and cable runway) within telecom rooms to the TMGB or TGB, with the exception of floor and wall sleeves.
- G. Telecom Grounding/Bonding Conductor Sizing:
 

Maximum Length	Wire Size (AWG)
4m (13ft)	6
6m (20 ft)	4
8m (26 ft)	3
10m (33 ft)	2
13m (41 ft)	1
16m (52 ft)	1/0
20m (66 ft)	2/0
Over 20m (66 ft)	3/0
- H. Label each grounding and bonding conductor as follows: "IF THIS CONNECTOR OR CABLE IS LOOSE OR REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER."

## SECTION 27 05 29 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

- I. Refer to Section 26 05 26 - Grounding and Bonding For Electrical Systems, for additional grounding requirements.

### 3.12 RACEWAY RISER SLEEVES

- A. Riser raceways to be installed through floors with tops 6 inches above each floor to give continuous cable riser capability. Stuff sleeves with an approved non-combustible material such as rock wool to maintain floor fire separation.

### 3.13 REMODEL SPACES

- A. Remove in active and abandoned telephone and computer conductors that serve spaces remodeled, only after receiving approval from the Owner.
- B. Notify Owner in writing when active telephone and computer conductors serving occupied spaces and must be relocated due to the remodel.

END OF SECTION

## SECTION 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This section includes general electrical requirements for all Division 28 Work and is supplemental and in addition to the requirements of Division 1.
- B. It is the intention of this Division of the Specifications and the Contract Drawings to describe and provide for the furnishing, installing, testing and placing in satisfactory and fully operational condition all equipment, materials, devices and necessary appurtenances to provide a complete electrical system. Provide all materials, appliances and apparatus not specifically mentioned herein or shown on the Drawings, but which are necessary to make a complete, fully operational installation of all electrical systems shown on the Contract Drawings or described herein. Connect equipment and devices furnished and installed under other Divisions of this Specification (or the Owner) under this Division.
- C. Workmanship shall be of the best quality and competent and experienced Electricians shall be employed and shall be under the supervision of a competent and experienced Foreman.
- D. The Drawings and Specifications are complimentary and what is called for (or shown) in either is required to be provided as if called for in both.
- E. See Division 1 for sequence of Work.

#### 1.3 WORK IN OTHER DIVISIONS

- A. See all other Specifications for other Work which includes but is not limited to:
  - Communications
  - Conveying Systems
  - Cutting and Patching
  - Door Hardware
  - Equipment Wiring
  - Fire Protection
  - Mechanical Control Wiring
  - Painting, Refinishing and Finishes

#### 1.4 CODES, PERMITS, INSPECTION FEES

- A. The following Codes and Standards are referenced in the Division 28 Specifications. Perform all Work and provide materials and equipment in accordance with the latest referenced Codes and Standards of the following organizations:
  - 1. American National Standards Institute (ANSI)
  - 2. National Electrical Manufacturer's Association (NEMA)
  - 3. National Fire Protection Association (NFPA)
  - 4. Underwriter's Laboratories (UL)
- B. Install the electrical systems based on the following:
  - NFPA 70 National Electrical Code as adopted and amended by the Local Jurisdiction.
  - IBC International Building Code as adopted and amended by the Local Jurisdiction.

## SECTION 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

- C. The referenced Codes establish a minimum level of requirements. Where provision of the various Codes conflict with each other, the more stringent provision shall govern. If any conflict occurs between referenced Codes and this Specification, the Codes are to govern. Compliance with Code requirements shall not be construed as relieving the Contractor from complying with any requirements of the Drawings or Specifications which may be in excess of requirements of the governing Codes and rules and not contrary to same.
- D. Obtain and pay for all licenses, permits and inspections required by laws, ordinances and rules governing Work specified herein. Arrange for inspection of Work by the Inspectors and give the Inspectors all necessary assistance in their Work of inspection.

### 1.5 COORDINATION

- A. Coordinate Work with that of the other Contractors and/or other trades doing work on the Project. Examine all Drawings and Specifications of other trades for construction details and coordination. Make every reasonable effort to provide timely notice of Work affecting other trades to prevent conflicts or interference as to space requirements, dimensions, openings, block-outs, sleeving or other matters which will cause delays or necessitate work-around methods.
- B. Obtain submittals and shop drawings of all equipment with electrical connections furnished under other Divisions of the Specification and by the Owner. Provide all wiring in accordance with specific equipment requirements. Immediately advise the Architect of any changes which may affect the contract price.
- C. Special attention is called to the following items. Coordinate all conflicts prior to installation:
  - 1. Location of grilles, pipes, sprinkler heads, ducts and other mechanical equipment so that all electrical outlets and other electrical outlets and equipment are clear from and in proper relation to these items.
  - 2. Location of cabinets, counters and doors so that electrical outlets and equipment are clear from and in proper relation to these items.
  - 3. Recessing and concealing electrical materials in CMU walls, concrete construction and precast construction.
- D. Furnish, install and place in satisfactory condition all raceways, boxes, conductors and connections and all other materials required for the electronic safety and security systems shown or noted in the contract documents to be complete, fully operational and fully tested upon completion of the Project. Raceways, boxes and ground connections are shown diagrammatically only and indicate the general character and approximate location. The layout does not necessarily show the total number of raceways or boxes for the circuits required, nor are the locations of indicated runs intended to show the actual routing of the raceways.
- E. Consult the Architectural Drawings for the exact height and location of all electrical equipment not specified herein or shown on the Drawings. Make any minor changes (less than 6'-6" horizontal) in the location of the raceways, outlets, boxes, devices, wiring, etc., from those shown on the Drawings without extra charge, where coordination requires or if so directed by the Architect before rough-in.
- F. Provide inserts or sleeves for outlet boxes, conductors, cables and/or raceways as required. Coordinate the installation thereof with other trades.
- G. The Contractor will not be paid for relocation of work, cuttings, patching and finishing required for Work requiring reinstallation due to lack of coordination prior to installation.

SECTION 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

1.6 WARRANTY

- A. Refer to General Conditions of the Contract.

1.7 CORRECTION OF WORK

- A. Within one year after the date of Substantial Completion of the Work, the Contractor shall correct any work found to be not in conformance with the Contract Documents promptly after written notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive acceptance of the Work under this Contract and termination of the Contract. The Owner shall give such notice promptly after discovery of the condition.

1.8 ITEMIZED SCHEDULE OF COSTS

- A. Complete the Schedule of Values included at the end of this Section. This Schedule shall be adhered to for the Electrical Contractor to facilitate analysis and approval of the monthly progress billings. Refer to the Supplementary Conditions of General Contract and Division 1 - General Requirements for details, and conform thereto. Provide a copy directly to Sparling.

1.9 SUBMITTALS AND SHOP DRAWINGS

- A. Submittals and Shop Drawings: Schedule so as not to delay Construction Schedule and no later than 60 days after award of Contract, submit common brochure(s) with index and divider tabs by Specification Section, containing all required catalog cuts. Allow two weeks for review for each Submittal and Resubmittal. Incomplete Submittals and Shop Drawings which do not comply with these requirements will be returned for correction, revision and resubmittal. See General Conditions for format, quantity, etc.
- B. Submit in a three ring binder with hardboard covers. Submittals shall show:
1. Indicate listing by UL or other approved testing agency.
  2. Highlight with yellow or blue marker adequate information to demonstrate materials being submitted fully comply with Contract Documents.
  3. Review and check all material prior to submittal and stamp "Reviewed and Approved".
- C. Shop Drawings shall show:
1. Ratings of items and systems.
  2. How the components of an item or system are assembled, interconnected, function together and how they will be installed on the Project.
  3. System layout floor plans with complete device layout, point-to-point wiring connection between all components of the system, wire sizes and color coding.
  4. Coordinate with other division Shop Drawings and Submittals. Identify interface points and indicate method of connection.
- D. The Contractor agrees:
1. Submittals and Shop Drawings processed by the Architect are not change orders.
  2. The purpose of Submittals and Shop Drawings by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept.
  3. Submittals demonstrate equipment and material Contractor intends to furnish and install and indicate detailing fabrication and installation methods Contractor intends to use.
  4. To accept all responsibility for assuring that all materials furnished under this Division of the Specifications meet, in full, all requirements of the Contract Documents.
  5. To pay for Engineers review cost of submittal review beyond one Resubmittal.

## SECTION 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

- E. The Engineer's review is only for general conformance with the design concept of the Project and general compliance with the information given in the Contract Documents. Corrections or comments made during this review do not relieve Contractor from compliance with the requirements of the Drawings and Specifications. Contractor is responsible for dimensions which shall be confirmed and correlated at the Job site; fabrication process and techniques of construction; coordination of his work with that of all other trades; performing his work in a safe and satisfactory manner.
- F. Submittals and Shop Drawings are required per the submittals schedule at the end of this Section.

### 1.10 PROJECT CLOSE-OUT

- A. Coordinate with close-out provisions in Division 01 - General Requirements.
- B. Request For Final Punchlist
  1. To request a final electrical punch list, forward a letter to Sparling, Inc. stating; "The Electrical Work on this project is complete, all punch list items to date are complete, items a. - n. in the Punchlist Procure paragraph in Section 280500 - Common Work Results For Electronic Safety and Security are complete and the project is ready for final punch list observation."
  2. Project Punchlist Procedure: Perform the following procedures for project closeout of electrical portions of Work.
    - a. Provide engraved nameplates on electrical equipment.
    - b. Refinish electrical equipment finishes which are damaged.
    - c. Obtain final electrical permit inspection. Include copies in O & M manual.
    - d. Provide written warranty in O & M per the General Conditions of the Contract.
    - e. Furnish Record Drawings per this section. Obtain signature on Job Completion Form.
    - f. Furnish O & M Manuals per this section. Obtain signature on Job Completion Form.
    - g. Give instruction periods to owner's personnel per this Section. Obtain signature on Job Completion Form.
    - h. To request final acceptance of Project, fill out Job Completion Form in this Section and forward to Sparling. Note: If Inspectors have not signed form, a copy of signed-off permits will suffice.
    - i. Include with Job Completion Form, a copy of the final punch list with the word "DONE", and the date and Contractor's initials after each item on the list.

### 1.11 ELECTRICAL EQUIPMENT OPERATION AND MAINTENANCE (O&M) MANUALS

- A. Provide O&M manuals required in Division 01 - General Requirements plus one manual for Sparling for all equipment furnished under Division 28 - Electronic Safety and Security Specifications. Submit a preliminary copy, complete except for the bound cover, 60 days prior to completion of the Project for checking and review. Deliver final bound corrected copies as noted in Division 1 - General Requirements plus a copy to Sparling 20 days prior to scheduled instruction periods. Obtain a receipt for the manuals and forward a copy of the receipt to the Engineer with the Job Completion Form.
- B. The information included must be the exact equipment installed. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets.

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- C. These O&M manuals shall contain all the information needed to operate and maintain all systems and equipment provided in the Project. Present and arrange information in a logical manner for efficient use by the Owner's operating personnel. The information provided shall include but not be limited to the following:
1. Equipment Manufacturer, make, model number, size, nameplate data, etc.
  2. Description of system configuration and operation including component identification and interrelations. A master control schematic Drawings(s) may be required for this purpose.
  3. Dimensional and performance data for specific unit provided as appropriate.
  4. Manufacturer's recommended operation instructions.
  5. Manufacturer's recommended lubrication and servicing data including frequency.
  6. Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriate). Parts lists shall give full ordering information assigned by the original parts Manufacturer. Relabeled and/or renumbered parts information as reassigned by Equipment Supplier not acceptable.
  7. Shop Drawings.
  8. Wiring Diagrams.
  9. Signal equipment Submittals shall contain step-by-step circuit description information designed to acquaint maintenance personnel with equipment operation in each mode of operation.
  10. A complete list of local (nearest) Manufacturer representative and distributor contacts for each type of equipment and Manufacturer. Include name, company, address, phone, fax, e-mail address, and web site.
- D. Furnish complete wiring diagrams for each system for the specific system installed under the Contract. "Typical" line diagrams will not be acceptable unless revised to indicate the exact field installation.
- E. Group the information contained in the manuals in an orderly arrangement by Specification Index. Provide a typewritten index and divider sheets between categories with identifying tabs. Bind the completed manuals with hard board covers not exceeding 5" thick. (Provide two or more volumes if required.) Signal and communication systems shall be in separate volumes. Imprint the covers with the name of the Job, Owner, Architect, Electrical Engineer, Contractor and year of completion. Imprint the back edge with the name of the Job, Owner and year of completion. Hard board covers and literature contained may be held together with screw post binding.

### 1.12 INSTRUCTION PERIODS

- A. After substantial completion of the work and 20 days after the O&M manuals have been delivered to the owner and after all tests and final inspection of the Work by the Authority(s) Having Jurisdiction; demonstrate the electrical systems and instruct the Owner's designated Operating and Maintenance Personnel in the operation and maintenance of the various electrical systems. The Contractor shall arrange scheduled instruction periods with the Owner. The Contractor's Representatives shall be Superintendents or Foremen knowledgeable in each system and Suppliers Representatives when so specified. When more than one training session is specified, the second session shall be 30 to 90 days after the first as agreed to by the Owner.
- B. Include in each instruction session an overview of the system, presentation of information in maintenance manuals with appropriate references to Drawings. Conduct tours of the building areas with explanations of maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures and adjustment locations.

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- C. Include the following scheduled instruction periods: 

1 <sup>st</sup> Session
1. Fire Detection and Alarm
2 hours
- D. Factory trained suppliers representatives shall provide instruction for each of the sessions listed above.
- E. Provide one professionally produced digitally recorded or video tape of each training session in DVD format. Furnish two (2) copies to the owner.

1.13 RECORD DRAWINGS

- A. Continually record the actual electrical system(s) installation on a set of prints kept readily available at the project during construction. These prints shall be used for this purpose alone.
  - 1. Mark record prints with red erasable pencil. Mark the set to show the actual installation where the installation varies substantially from the work as originally shown.
  - 2. Accurately locate with exact dimensions all underground and underslab raceways and stub-outs.
  - 3. Note changes of directions and locations, by dimensions and elevations, as utilities are actually installed.
  - 4. Include addenda items and revisions made during construction.
  - 5. Erase conditions not constructed or "X-out" and annotate "not constructed" to clearly convey the actual "as constructed" condition.
  - 6. Organize record drawings sheets in manageable sets, bind and print suitable titles, dates and other identification on the cover of each set.
- B. Transmit the Record Drawing set to the Architect at the completion of the Work. Final payment to the Contractor will not be authorized until these prints have been submitted to and accepted by the Architect.
- C. Transfer the changes marked up on the record prints into AutoCAD 2002 (or higher) at the completion of the Work. Provide two (2) sets of prints, one set of fixed line reproducible Drawings and one set of AutoCAD drawing files on 3-1/2" floppy disks, CD Rom or Zip disk. Transmit Drawings, CAD files and the Record Drawing Mark-ups to the Architect. Final payment to the Contractor will not be authorized until these documents have been submitted to and accepted by the Architect.

1.14 FINAL ACCEPTANCE REQUEST

- A. Submit to the Architect, with a copy to the Sparling Engineer, a Sparling Job Completion Form (form attached in this Section) properly filled out prior to the time final acceptance of the electrical Work is requested.

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1.15 ABBREVIATIONS AND DEFINITIONS

- A. When the following abbreviations and definitions are used in relation to the Work for Division 28 they shall have the following meanings:

<u>Item</u>	<u>Meaning</u>
AHJ	Authority Having Jurisdiction.
Boxes	Outlet, Junction or Pull Boxes.
Code	All applicable Codes currently enforced at Project location.
Compression	Compressed using a leverage powered (hydraulic or equivalent) crimping tool.
Connection	All materials and labor required for equipment to be fully operational.
Exterior Location	Outside of or penetrating the outer surfaces of the building weather protective membrane.
Fully Operational	Tested, approved, and operating to the satisfaction of the AHJ, Manufacturer and Contract Documents.
Furnish	Deliver to the jobsite
Install	To enter permanently into the Project and make fully operational.
Kcml	Thousand circular mils (formerly MCM).
Mfr.	Manufacturer.
NEC	National Electrical Code, National Fire Protection Association, Publication #70.
Noted	Shown or specified in the Contract Documents.
Provide	Furnish and install.
Required	As required by code, AHJ, Contract Documents, or Manufacturer for the particular installation to be fully operational.
Shown	As indicated on the Drawings or details.
Wiring	Raceway, conductors and connections.

PART 2 PRODUCTS

2.1 GENERAL

- A. All materials and equipment installed shall have been tested and listed by Underwriters Laboratories or other approved testing organization and shall be so labeled unless otherwise permitted by the Authority Having Jurisdiction (Inspector).
- B. All materials to be new, free from defects and not less than quality herein specified. Materials shall be designated to insure satisfactory operation and operational life in the environmental conditions which will prevail where they are being installed.
- C. Each type of materials furnished shall be of the same make, be standard products of Manufacturers regularly engaged in production of such materials and be the Manufacturer's latest standard design.
- D. All materials, equipment and systems furnished that include provisions for storing, displaying, reporting, interfacing, inputting, or functioning using date specific information shall perform properly in all respects regardless of the century. Any interface to other new or existing materials, equipment or systems shall function properly and shall be century compliant, both in regards to information sent and received.

2.2 SUBSTITUTION OF MATERIALS

- A. No Substitute:  
Where a specified product is indicated "no substitute", it is the intent of this Specification to require new materials to be compatible with the existing installation or as specifically requested by the Owner. To this end certain materials and systems no substitution will be allowed.

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- B. Prior to Bid Opening:  
Acceptance of products other than those specified will be issued by Addendum to the Bid Documents only after the following requirements are met and the proposed listed material is determined to meet or exceed the requirements:
1. Requests for listing to be original material, clearly indicating the product fully complies with Contract Documents and be neatly marked with yellow felt tip marker to clearly define and describe the product for which listing is requested.
  2. Include certified laboratory test report for lighting fixtures.
  3. Samples shall be submitted if requested.
  4. Requests shall be received 10 days prior to Bid opening.
  5. Requests containing insufficient information to confirm compliance with Contract Documents will not be considered.
- C. After Award of Contract:  
Substitution of products will be considered after award of Contract only under the following conditions:
1. The Contractor shall have placed orders for specified materials promptly after Contract is awarded and the specified products can not be delivered to the project to meet the Owner's construction schedule.
  2. The reason for the unavailability is beyond the Contractor's control, i.e., due to strikes, bankruptcy, discontinuance of Manufacturer, acts of God.
  3. The specified product is no longer manufactured.
  4. There is compelling economic advantage to the Owner.
- D. In all cases, should a substituted material result in requiring electrical system or building modifications; the Contractor alone shall pay all costs to provide these modifications including all costs to the Engineer and Architect for redesign, and updating of Record Drawings required to accommodate the required modifications.

### 2.3 NAMEPLATES

- A. Provide nameplates per Section 26 05 53 - Identification for Electrical Systems.

## PART 3 EXECUTION

### 3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle products according to the Manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft. Handle all equipment carefully to prevent damage, breakage, denting, and scoring of finishes. Do not install damaged equipment.
- B. Store products subject to damage by the elements above ground, undercover in a weather tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by Manufacturer's instruction.

### 3.2 CUTTING BUILDING CONSTRUCTION

- A. Obtain permission from the Architect and coordinate with other trades prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills or concrete saws except where space limitations prevent the use of such tools.
- B. All construction materials damaged or cut into during the installation of this work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that particular building trade.

### 3.3 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire rated floor and wall assemblies to maintain fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 section "Firestopping".

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3.4 PAINTING

- A. Items furnished under this Division that are scratched or marred in shipment or installation shall be refinished with touchup paint selected to match installed equipment finish.

3.5 EQUIPMENT CONNECTION

- A. For equipment furnished under this or other Divisions of the Specifications, or by Owner, provide complete all electrical connections necessary to serve such equipment and provide required control connections to all equipment so that the equipment is fully operational upon completion of the project. Provide disconnect switch as required by Code whenever an equipment connection is shown on the Drawings.
- B. Investigate existing equipment to be relocated and provide new connections as required.

3.6 CLEAN UP

- A. Contractor shall continually remove debris, cuttings, crates, cartons, etc., created by his work. Such clean up shall be done daily and at sufficient frequency to eliminate hazard to the public, other workmen, the building or the Owner's employees. Before acceptance of the installation, Contractor shall carefully clean cabinets, panels, lighting fixtures, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.
  - 1. Wipe surfaces of electrical equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

3.7 TESTING AND DEMONSTRATION

- A. Demonstrate that all electrical equipment operates as specified and in accordance with Manufacturer's instructions. Perform tests in the presence of the Architect, Owner or Engineer. Provide all instruments, Manufacturer's operating instructions and personnel required to conduct the tests. Repair or replace any electrical equipment that fails to operate as specified and or in accordance with Manufacturer's requirements.

SPARLING ELECTRICAL JOB COMPLETION FORM

PROJECT NAME: MMC ED/CC Expansion  
 PROJECT LOCATION: \_\_\_\_\_  
 DATE: \_\_\_\_\_

A. Electrical Inspectors Final Acceptance (Copy of certificate attached.)

Name	Agency	Date
------	--------	------

B. Fire Marshal's Final Acceptance of Fire Alarm System (Copy of certificate attached.)

Name	Agency	Date
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C. The following system has been demonstrated to Owner's representative.

1. Fire Detection and Alarm

Owner's Rep	Date
-------------	------

D. Record Drawings  
 Attached Transmitted previously to \_\_\_\_\_  
 Date \_\_\_\_\_

E. O & M Manuals  
 Attached Transmitted previously to \_\_\_\_\_

F. Test Reports  
 Attached Transmitted previously to \_\_\_\_\_  
 Date \_\_\_\_\_

G. The work is complete in accordance with Contract Documents and authorized changes except for

\_\_\_\_\_ and the Architect/Engineer's representative is requested to meet with

\_\_\_\_\_ at \_\_\_\_\_ on \_\_\_\_\_  
 Supervisor of Electrical Work Time Date

\_\_\_\_\_  
 Contractors Rep. Signature Date

**Sparling Schedule of Values for MMC ED/CC Expansion**

Description of Work	Amount
Device Rough-in (boxes and raceways) - Labor and Materials	
Circuit Conductors - Labor and Materials	
Fire Detection and Alarm - Labor and Materials	
Testing, Demonstration (AHJ approvals)	
Training	
Close Out (Record Drawings, O&M, etc.) - Materials & Labor	
<b>TOTAL DIVISION 28</b>	

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**SPARLING SUBMITTAL LIST MMC ED/CC EXPANSION**

SECTION	DESCRIPTION	SUBMIT RECEIVE DATE	STATUS
280513	CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY		
283100	FIRE DETECTION AND ALARM		

END OF SECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Coaxial cabling.
  - 2. Fire alarm wire and cable.
  - 3. Identification products.

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.
- D. EMI: Electromagnetic interference.
- E. IDC: Insulation displacement connector.
- F. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- G. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- H. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- I. RCDD: Registered Communications Distribution Designer.
- J. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.
- K. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.
- L. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. For coaxial cable, include the following installation data for each type used:
    - a. Nominal OD.
    - b. Minimum bending radius.
    - c. Maximum pulling tension.
- B. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
  - 1. Vertical and horizontal offsets and transitions.
  - 2. Clearances for access above and to side of cable trays.
  - 3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
  - 4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- D. Source quality-control reports.
- E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: [25 or less.
  - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
  - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
  - 2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
  - 3. Test each pair of UTP cable for open and short circuits.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 PRODUCTS

2.1 PATHWAYS

- A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
  - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
  - 2. Lacing bars, spools, J-hooks, and D-rings.
  - 3. Straps and other devices.
- B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems".
  - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

2.3 FIRE ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Comtran Corp.
  - 2. Draka USA.
  - 3. Genesis Cable Products; Honeywell International, Inc.
  - 4. Rockbestos-Suprenant Cable Corporation.

5. West Penn Wire/CDT; a division of Cable Design Technologies.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair.
  1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
  1. Low-Voltage Circuits: No. 16 AWG, minimum.
  2. Line-Voltage Circuits: No. 12 AWG, minimum.

#### 2.4 IDENTIFICATION PRODUCTS

- A. Manufacturers:
  1. Brady Corporation
  2. HellermannTyton.
  3. Kroy LLC.
  4. Panduit Corp.
- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 260553 Identification for Electrical Systems.

#### 2.5 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### PART 3 EXECUTION

#### 3.1 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.
- D. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- E. Pathway Installation in Equipment Rooms:
  1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
  2. Install cable trays to route cables if conduits cannot be located in these positions.
  3. Secure conduits to backboard when entering room from overhead.
  4. Extend conduits 3 inches (75 mm)] above finished floor.
  5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- F. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

## 3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Install 110-style IDC termination hardware unless otherwise indicated.
  - 4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. Separation from EMI Sources:
  - 1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
  - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
  - 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
  - 5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

### 3.3 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to Section 260533 Raceway and Boxes for Electrical Systems.
  1. Install plenum cable in environmental air spaces, including plenum ceilings.
  2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
  1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
  2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is not permitted.
  3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

### 3.4 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
  1. Class 1 remote-control and signal circuits, No. 14 AWG.
  2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
  3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

### 3.5 CONNECTIONS

- A. Comply with requirements in Division 28 Section "Fire Detection and Alarm" for connecting, terminating, and identifying wires and cables.

### 3.6 FIRESTOPPING

- A. Comply with requirements in Division 07 Penetration Firestopping.
- B. Comply with TIA/EIA-569-A, Firestopping Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7 GROUNDING

- A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 Identification for Electrical Systems.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

## SECTION 28 31 00 FIRE DETECTION AND ALARM

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes fire alarm systems with manual stations, detectors, signal equipment, controls, and devices.
- B. Related Sections
  - 1. Section 08 70 00 - Hardware for door closures/holders, electric door locks, and release devices that interface with fire alarm system.
  - 2. Division 21 - Fire Suppression for waterflow, valve tamper switches and post indicator valves that interface with fire alarm system.
  - 3. Division 25 - Integrated Automation for interface between mechanical HVAC control system and fire alarm system.
- C. Substitutions: Substitute products will be considered only under the terms and conditions of Section 28 05 00 - Common Work Results For Electronic Safety and Security.

#### 1.3 REFERENCES

- A. American National Standards Institute (ANSI)
- B. National Electrical Manufacturers Association (NEMA)
- C. Underwriter's Laboratories, Inc. (UL)
- D. National Fire Protection Association (NFPA)

#### 1.4 APPLICABLE CODES AND STANDARDS

- A. Provide the system in compliance with the following:
  - 1. NFPA Codes, Standards and Manuals (latest issue enforced)
    - a. 70 - National Electrical Code
    - b. 72 - National Fire Alarm Code
    - c. 90A- Standard for the Installation of Air Conditioning and Ventilating Systems
  - 2. Uniform Fire Code (UFC)
  - 3. Washington Administrative Codes (WAC)
    - a. WAC 296-46 Safety Standards - Installing Electric Wires and Equipment
    - b. WAC 51-40-1101 Chapter 11, Accessibility
    - c. WAC 51-44 State Building Code Adoption of the Uniform Fire Code
  - 4. Other Codes
    - a. Local Fire Code, Building Code, Mechanical Code, Electrical Code, rules and interpretations required by the Authority Having Jurisdiction.

#### 1.5 QUALITY ASSURANCE

- A. Each and all items of the Fire Alarm System shall be listed as a product of a Fire Alarm System Manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL) and Factory Mutual (FM), and shall bear the UL and FM labels. All control equipment shall be listed under UL Category UOJZ as a single control unit. Partial listing is NOT acceptable.
- B. In addition to UL-UOJZ requirement mentioned above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760.
- C. All control equipment shall have transient protection devices to comply with UL 864 requirements.

## SECTION 28 31 00 FIRE DETECTION AND ALARM

### 1.6 CONTRACTOR DESIGN

- A. The Contract Drawings indicate the general nature of the fire alarm system, but do not necessarily show all components required. The Drawings are intended to aid the Contractor and/or Subcontractor and/or Supplier in providing the complete fire alarm system required. Raceways, routing and wiring are not shown on the Drawings and it shall be the responsibility of the Fire Alarm System Supplier to design raceway routing and wiring and to show the same on Shop Drawings.
- B. Evacuation alarm sound level: The number of fire alarm notification devices shall be increased if required by the AHJ.

### 1.7 SUBMITTALS

- A. General: Make submittals in accordance with Section 28 05 00 - Common Work Results For Electronic Safety and Security.
- B. Product Data: Submittals shall include a compilation of Manufacturer's catalog or Specification sheets of all system components. Items being provided shall be clearly indicated. Any variations of the Submittal from the Specifications shall be clearly indicated. Include the following additional information:
  - 1. Point Schedule
  - 2. Complete schedule of customized English message formats of alarms and troubles for system.
  - 3. Battery systems and standby battery load calculations.
  - 4. Fire Alarm zone and address schedule including alphanumeric description for each monitor and control point.
  - 5. Actual Graphic Drawings.
  - 6. Outputs zone schedule for off-premise UL Central Station Monitoring.
  - 7. Complete sequence of operations for all fire alarm system functions.
  - 8. Unit Pricing
- C. Shop Drawings
  - 1. Riser Diagrams. Fire Alarm Supplier and/or Subcontractor shall develop CAD based original fire alarm riser diagram to show main geographical fire alarm zones and point to point wiring requirements.
  - 2. Floor Plans. CADD based floor plans shall be drafted to show conduit routing, device locations, end of line resistors, wire count and color coded wiring between device locations on each plan. Show room names and numbers for each room where a fire alarm device is located.
  - 3. Release of CADD files for Shop Drawings. Contractor may request to utilize the project CAD drawing files in producing Shop Drawings. Request shall be made by signing Sparling's "Agreement for Release of CADD Files" letter.
  - 4. Ownership. All original Shop Drawings shall become the property of the Owner at the completion of the Project.
- D. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals specified in Division 1 Section "Submittals", make an identical submission to authorities having jurisdiction. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.
- E. Installer Certificates: Signed by Manufacturer certifying that installers comply with requirements.
- F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Comply with NFPA 72.
- G. Certificate of Completion: Comply with NFPA 72.
- H. Operation and Maintenance Manual: Per Section 28 05 00 - Common Work Results For Electronic Safety and Security. Include Record Drawings, Certificate of Completion, and Test Results.

## SECTION 28 31 00 FIRE DETECTION AND ALARM

### 1.8 TO QUALIFY AS AN ACCEPTABLE SUPPLIER AND/OR SUBCONTRACTOR

- A. Have the ability to provide the fire alarm system indicated in the Contract Documents from the criteria contained in the Specification and the information shown on the Drawings.
- B. Provide AHJ approved Shop Drawings which show complete system plan views indicating equipment layout, device layout, raceway routing and sizing, point to point wiring, termination and connection diagrams and wire numbers for all conductors and terminations.
- C. Prior to bid determine the complete system components required to conform to local Code and AHJ requirements. Include the cost of all components to all contractors in Bid price.
- D. To have been in the business of installing and maintaining the specific type of system equipment under the present firm name for at least five years.
- E. To have distributing and/or installing the specific brand and model line of system equipment for at least three years prior to the date on the Contract Documents.
- F. To have the capability of dispatching a maintenance or repair truck with a qualified repairman to the job site within four (4) hours of a request for service on the equipment.

### 1.9 ADDITIONAL REQUIREMENTS

- A. Fire Alarm System Supplier and/or Subcontractor Requirements:
  - 1. Coordinate the installation of the fire alarm system including the preparation of Shop Drawings in conformance with Section 28 05 00 - Common Work Results For Electronic Safety and Security.
  - 2. Furnish and load all software required to implement a complete monitoring and control system.
- B. Contractor Requirements:
  - 1. Submit Shop Drawings to the "Authority Having Jurisdiction" (AHJ) as defined in NFPA 72. The AHJ for this project is the local Fire Marshal and the Washington State Fire Marshal. One copy of the above Shop Drawings with this approval evidenced shall be included with the submittal required by Section 28 05 00 - Common Work Results For Electronic Safety and Security.
  - 2. Provide raceway, back boxes, wiring, and power circuits for the fire alarm system, and install the devices ready for final termination at the Fire Alarm Panel by the Fire Alarm System Subcontractor. Contact the Fire Alarm System Subcontractor prior to bidding to determine exact requirements and include all costs in the Bid price.
  - 3. Provide all 120V power circuits to fire alarm control equipment and remote power supplies. Remote power supplies are not shown. Contact the Fire Alarm System Subcontractor prior to bidding to determine exact 120V power requirements and include all costs in the Bid price.
  - 4. In addition, the Contractor shall schedule periodic inspections by the AHJ during the course of the installation and shall make any minor corrections, deletions, relocations or additions to the system as required for acceptance of the completed system by the AHJ. Contractor shall obtain and pay for all required permits.
  - 5. Coordinate the interface requirements between mechanical control systems and the fire alarm system.
  - 6. Performance Test: Final approval of the fire alarm system is contingent upon a successful performance test, accomplished by the installer and witnessed by the Fire Marshal.

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### 1.10 DESCRIPTION

- A. General: Non-coded, addressable-analog fire alarm system with manual and automatic alarm initiation; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only. Provide a complete and fully operational fire detection and alarm system which fully complies with the local Fire Code currently enforced at the Project location. If any conflict occurs between government adopted Code rules and these Contract Documents, the Codes are to govern.

### 1.11 GENERAL OPERATION

- A. The system shall be solid state, microprocessor based, using a true digital format between the Central Processing Unit (CPU) and each addressable device. Systems which do not transmit digital data between CPU and devices over a one (1) pair cable are not acceptable. System shall be able to communicate with a minimum of 100 addressable devices per pair of wires.
- B. Adding points within the system, up to its maximum point capacity shall not require memory additions.
- C. The control panel shall be initially configured to monitor a minimum of 380 addressable points. Control panels, transponders and remote power supplies shall be sized to accommodate 20% future growth beyond the scope of the initial project. All secondary power supply batteries shall be sized for future system growth. Spare battery capacity required by NFPA 72 and local codes shall be in addition to future system growth capacity.
- D. Under normal condition the fire alarm control panel shall display a "SYSTEM NORMAL" message and the current time and date.
- E. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory, or Trouble) shall flash. The panel audible signal shall pulse for alarm conditions and sound steadily for trouble and supervisory conditions.
- F. The panel shall display the following information relative to the abnormal condition of a point in the system. These three characteristics relative to an abnormal condition of a point shall be displayed simultaneously:
  - 1. Custom location label (80 characters minimum)
  - 2. Type of device (i.e. smoke, manual station, waterflow)
  - 3. Point status (i.e. alarm, trouble)
- G. All information displayed by the fire alarm control panel shall also be capable of being transmitted and displayed on any system CRT and printer or graphic terminal.
- H. Provide live and pre-recorded voice annunciation in the occupied areas of the building. Provide combination horn/strobe system in mechanical areas and garages.
- I. Subordinate Control Panel on floors indicated, to interface with the Master Control Panel, and to provide power and monitoring of initiating devices, indicating devices, fireman's handsets, and control devices. Master Control Panel shall continuously poll the subordinate control panel(s) to receive and send alarm, supervisory and control data.

### 1.12 OPERATION OF FIRE ALARM SYSTEM

- A. Operation of any initiation device shall immediately cause all of the following:
  - 1. All fire alarm speakers to sound a three pulse temporal tone pattern (per ANSI S3.41) followed by a voice message chime tone and pre-recorded voice message throughout the facility until silenced by a switch at the Fire Alarm Control Panel (FACP) or until the system is reset. Visual alarm lights throughout shall flash repetitively until the system is reset.
  - 2. Auxiliary controlled devices shall operate until the alarm condition is corrected and the system reset.

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3. Full English language annunciation of the alarm condition, type and location at the FACP display. An audible signal shall sound and the alarm condition shall flash on the FACP display and CRT until acknowledged. Emergency instructions shall be displayed in English for the operator.
  4. Printout in full English language of the alarm condition, type and location plus time and date. All fire alarm initiated event commands shall be recorded automatically.
  5. Upon receipt of the signal the Mechanical Control System will automatically initiate fan control sequence. Coordinate all fan control requirements with mechanical.
  6. Initiate the starting of the Elevator Shaft and Stairwell Pressurization Fans.
- B. Air handling equipment to be automatically shutdown only when activated by the smoke detector located in the supply air duct downstream of the filters. Both the supply fan and its related exhaust fan shall be shut down by the same sensor.
- C. History Logging: The system shall log and store 300 events in an alarm log and 300 events in a trouble log. These events shall be stored in random access memory with battery protection. Each event shall include the time and date of the events occurrence.
- D. A drill switch is to be provided at the Fire Alarm Control Panel to sound an evacuation alarm signal but not send an alarm to the Fire Department.
- E. The system, including annunciation, and remote annunciation shall be completely supervised to sound an audible and visual trouble signal upon the occurrence of any open or grounded circuits except that auxiliary control circuits (door holders, and fan shutdown) and smoke detector remote indicator lights need not be supervised. An open or grounded zone circuit or annunciator circuit shall illuminate the trouble lamp and sound the trouble alarm at the control panel.
- F. Sprinkler System Monitoring
- Coordinate the Fire Alarm System with the Sprinkler System to provide circuits for detection and annunciation as required by the AHJ to supervise PIV, OSY and gate valve positions. Provide circuits for detection and annunciation of water flow. Each water flow device and it's associated valve position switch shall have their own address.
- Activation of any tamper switch shall activate the system supervisory trouble light. Differentiation between valve tamper switch and open/or grounds in the initiation circuit wiring shall be provided.
- G. Elevator Capture. Provide circuitry to the elevator controllers to indicate when an alarm has been initiated by the associated elevator lobby smoke detectors to initiate recall. Coordinate exact circuitry required with elevator subcontractor. Provide circuits from FACP to corresponding elevator controller.
- H. Bypass Switches: Provide the following bypass switches for testing purposes:
1. Elevator Bypass - to prevent recalling the elevators.
  2. Door Release Bypass - to prevent releasing the smoke doors.
  3. Fan Control Bypass - to prevent shutdown of fans or starting of elevator and stairwell pressurization fans.
  4. Remote Alarm Bypass - to prevent the transmission of a fire alarm to the remote monitoring agency.
- I. Fire Pump. Connect the fire pump zone to a fire pump running dry contact on the fire pump annunciator. Connect the trouble for the fire pump zone to a fire pump trouble dry contact on the fire pump annunciator. Provide interface relays as required.
- J. Provide live and prerecorded voice evacuation announcement in all occupied areas of the building.
1. The automatic responses of the system shall be augmented by the manual activation of the communications system(s).

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2. An operator at the voice command station shall have the ability to use the microphone to transmit live emergency voice paging messages.
3. Voice system microphone shall be in location approved by the AHJ.

### 1.13 DEFINITIONS

- A. FACP: Fire Alarm Control Panel.
- B. LED: Light-emitting diode.
- C. Definitions in NFPA apply to fire alarm terms used in this section.

### 1.14 SEQUENCING AND SCHEDULING

- A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove existing fire alarm equipment and restore damaged surfaces.
  1. In coordination with the Architect, these materials shall be made available for his inspection and decision as to whether the Owner will retain possession. Items selected for retention shall be turned over to the Owner. These items shall be delivered to a location on the premises selected by the Owner. Take reasonable care to avoid damage to this material. If the Contractor fails to conform to this requirement, he shall purchase and turn over to the Owner replacement material of like kind and quantity.
  2. All material not selected for retention by the Owner and debris shall be removed from site and legally disposed of by the Contractor.

### 1.15 INTERFACE REQUIREMENTS

The Contractor is responsible for coordinating the system with owner furnished and other Contractor furnished systems and equipment. The Work consists of but is not limited to the following:

- A. Mechanical Control Panels. Division 25 automatically controls all smoke dampers. Provide a dry contact with wiring to mechanical control panels to signal a fire emergency mode.
- B. Duct Smoke Detectors. Duct smoke detectors and associated sampling tubes installed by Division 25 contractor. Provide final connections and testing of duct smoke detectors.
- C. Elevators:
  1. Fire Emergency. Control module dry contact with wiring to the elevator controllers to signal a fire emergency mode for automatic elevator recall.
  2. Elevator Lobby Smoke Detectors. To signal smoke in an elevator lobby to the FACP.
  3. Elevator power shut down control circuit shall be monitored for presence of operating voltage. Loss of voltage shall cause a supervisory signal at the control panel and remote annunciators
  4. Fire Signal Speakers. Provide speakers for all elevators. Coordinate installation with Division 14.

### 1.16 SPARE COMPONENTS

- A. Furnish the Owner with the following spare components:
  1. Quantity        Item
  2.        2                Manual stations.
  3.        4                Smoke Detectors of each type on Project.
  4.        2                Heat Detectors of each type on Project.
  5.        6                Smoke/heat detector bases.
  6.        4                Fire Alarm Speakers
  7.        4                Visual Alarm Lights

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### 1.17 RECORD DRAWINGS

- A. Provide per Section 28 05 00 - Common Work Results For Electronic Safety and Security. Record Drawings shall clearly indicate:
1. Actual routing of all raceways and location of all junction boxes.
  2. Actual cable types, numbers and routing.
  3. Actual system wiring diagrams, connection diagrams and interface of all components in the system.

### 1.18 UNIT PRICES

- A. Provide unit prices to add/delete the following:

Manual Pull Station

Smoke Detector

Duct Smoke Detector

Heat Detector

Fire Alarm Chime

Fire Alarm Speaker

Visual Alarm Light

Monitoring Module

Control Module (control relay)

Remote Indicating Light

Unit prices shall include Shop Drawings, engineering, and any system programming required for each device.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. All equipment shall be the product of a single Manufacturer except that certain individual components which are regularly used as part of the system may be the product of a different Manufacturer. Approved Manufacturers:

1. Simplex Time Recorder Company

### 2.2 PRINTOUT OF EVENTS

- A. On receipt of the signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble), and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including the same information for device, location, date, and time. Commands initiate the printout of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

### 2.3 FACP ALPHANUMERIC DISPLAY

- A. Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.

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### 2.4 AUTOMATIC REPORTING

- A. Provide for connection via telephone line to an approved monitoring agency. System shall report both alarm and trouble signals for each major geographic zone. Conform with applicable requirements of NFPA 72 National Fire Alarm Code. Owner will pay initial charges and contract with the monitoring agency for interface device(s) and monthly charges subsequent to completion of the Project.

### 2.5 CENTRAL FACP

- A. Cabinet: Lockable steel enclosure. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.
  - 1. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1/2 inch high. Identify individual components and modules within cabinets with permanent labels.
  - 2. Mounting: Flush.
  - 3. Mounting: Surface.
- B. Alarm and Supervisory Systems: Separate and independent in the FACP. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.
- C. Control Modules: Include types and capacities required to perform all functions of fire alarm systems.
- D. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Provide each type of audible alarm with a different sound.
- E. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.
- F. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components, including annunciation, supervision, and control.
  - 1. Display: A minimum of 80 characters; alarm, supervisory, and component status messages; and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
  - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- G. Voice Alarm: An emergency communication system, includes central voice alarm system components complete with microphones, preamplifiers, amplifiers, and tone generators. Features include the following:
  - 1. Three alarm channels to permit simultaneous transmission of different announcements to different zones or floors automatically and by using the central control microphone. All announcements are made over dedicated, supervised communication lines.
  - 2. Status annunciator indicates the status of various voice alarm speaker zones and the status of firefighters' two-way telephone communication zones.

### 2.6 SUBORDINATE CONTROL PANELS

- A. Provide microprocessor-based subordinate control panels, located on floors indicated. To provide direct interface, supervision, and termination points for initiating and indicating circuits, control circuits, firemen's communications circuits, and digital communications with the Main Control Panel. Provides DC power for field devices, and audio power amplification and switching for loudspeaker circuits.
- B. In the event of communications loss with the FACP, the subordinate control panel must be capable of reacting to all its connected input devices and applying its own stand-alone local mode programming instruction to determine the status of all its connected outputs.

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- C. Integral firemen's handset and paging microphone.
  - D. Provide sufficient cabinet space, power supply capacity, etc., to increase the number of field devices and zone circuits by at least 20 percent.
  - E. Power amplifiers shall be sized for at least 20 percent spare capacity, based on a minimum tap power of 2 watts per speaker, and assuming a minimum load of 50 speakers per floor.
  - F. Provide sufficient strobe outputs to provide 20 percent spare capacity, based on the rated current of the strobes.
  - G. Provide termination, power and control for firemen's handsets of the floors served by the panels, and communications with the other floors via the Master Control Panel.
  - H. Each subordinate control panel shall be provided with a maintenance free battery backup system sized for the hours specified herein.
- 2.7 EXISTING FIRE ALARM SYSTEM
- A. Provide all necessary equipment enclosures, power supplies, batteries, signal, relay and zone modules, drivers, interfaces and amplifiers of types and capacities to perform all functions of the fire alarm system.
  - B. Provide secondary (standby) power capacity meeting the requirements of NFPA 72.
- 2.8 REMOTE LCD ANNUNCIATOR
- A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledge, silence, reset, and test.
    - 1. Mounting: Flush cabinet, NEMA 250, Class 1.
    - 2. Mounting: Surface cabinet, NEMA 250, Class 1.
  - B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LED's to permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.
- 2.9 TRANSIENT PROTECTION DEVICES
- A. All control equipment shall have transient protection devices to comply with UL 864 requirements:
    - 1. Provide an Isolated Loop Circuit Protector (ILCP) device on all fire alarm initiating circuits, alarm indicating appliance circuits, signaling line circuits which extend beyond the main building by either aerial, underground or other methods, walkways, bridges or other above ground connectors.
    - 2. The ILCP shall be located as close as practicable to the point at which the circuits leave or enter the building.
    - 3. The ILCP grounding conductor is to be a No. 12 AWG wire having a maximum length of 28 feet to be run in as straight a line as practicable and connected to a building ground electrode system (unified ground) per Article 800 of the National Electrical Code.
    - 4. The ILCP is to have a line to line response time of less than one (1) nanosecond capable of accepting greater than 2000 amps (9 joules each line) to earth. Shield to earth current is to be 5000 amps maximum.
    - 5. The ILCP shall be protected by a high dielectric insulating material and of small enough size to mount in a standard 4" square 2 -1/8" deep electrical box.
    - 6. Spark gap devices or devices incorporated in or installed within the fire alarm control panel in lieu of the specified ILCP are not acceptable.
    - 7. All ILCP's shall comply with UL 497B requirements.
- 2.10 SECONDARY POWER SUPPLY
- A. General: Components include gel cell sealed batteries, charger, and an automatic transfer switch.
    - 1. Battery Nominal Life Expectancy: 2 years, minimum.

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- B. Battery Capacity: Comply with NFPA 72.
- C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger shall recharge them completely within four hours. Supervise charger output as part of system power supply supervision.
- D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

### 2.11 ONE-WAY VOICE COMMUNICATION

- A. The system shall incorporate one-way voice communication and tone generation.
- B. A central audio control module shall be provided for the necessary alarm message/tone generation, main and remote microphone connections and mixer/pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure should a problem occur (e.g. main microphone trouble, tone trouble, etc). Audio outputs shall have individual gain control.
- C. A hand held, push to talk microphone shall be provided, recessed within a protective panel-mount enclosure. The microphone shall be a noise-canceling communication type with a frequency range of 200 Hz to 4000 Hz and shall be equipped with a self-winding five foot long coiled cable. An LED indicator shall be provided to indicate the microphone push-to-talk button has been pressed and speaker circuits are ready for transmission. The microphone shall be supervised for disconnection. This function shall also be provided at the voice command center with a key lock.
- D. An audio control switch module shall be furnished to provide manual access to audio operations for authorized personnel. The module shall include an "ALL Circuits" switch, "Aux Tone 1" switch and "Audio Trouble Reset" switch. These switches and associated LED indicators shall be supervised for disarrangement or failure.
- E. Audio power amplifiers shall be furnished with a self-contained filtered 24VDC power supply, transformer, and amplifier monitor circuits. The amplifiers shall provide a 70V RMS output with a frequency response of 120 Hz to 12,000 Hz. Provide sufficient amplification to operate all system speakers simultaneously plus twenty (20) percent spare capacity. No one amplifier shall provide audio power for more than 15 percent of the speaker load for the building.
- F. Provide at least one back-up amplifier capable of replacing any failed amplifier at each amplifier bank or node with audio amplifiers.
- G. The speaker circuits shall be capable of supplying 25V RMS audio power from the system amplifiers. Supervision for open, short, or ground fault conditions shall be provided. Individual and distinct trouble indications shall be provided for each fault.
- H. Digitized tones for alarm three pulse temporal and auxiliary requirements (wail, horn, chime, etc.) shall be provided.
- I. Manual voice paging sequence
  1. The system shall be configured to allow selective voice paging. Upon activation of any speaker manual control switch, two (2) attention getting beeps shall sound over the speakers indicating an impending voice message will occur.
  2. If any speaker manual control switches are activated, the control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers. This shall be accomplished by means of an "ALL Circuit" switch. The system shall allow zoning such that each building or individual floors can be paged.

### 2.12 MANUAL PULL STATIONS

- A. Description: Fabricated of metal or plastic, and finished in white with molded, raised-letter operating instructions of contrasting color.
  1. Double-action mechanism requiring two actions, such as a push and a pull, to initiate an alarm.

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2. Break glass type with 10% (six minimum) spare glass elements.
3. Station Reset: Key or wrench operated, rated for the voltage and current at which it operates.
4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false alarm operation.
5. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

### 2.13 SMOKE DETECTORS

- A. General: Include the following features:
  1. Operating Voltage: 24-V dc, nominal.
  2. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation except resetting the control panel.
  3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
  4. Integral Visual-Indicating Light: LED type to indicate when detector has operated.
  5. Sensitivity: Can be tested and adjusted in-place after installation.
  6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
  7. Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
  8. All smoke detectors located adjacent to roll down smoke doors or motorized smoke doors shall be provided with a relay base.
- B. Photoelectric Smoke Detectors: Include the following features:
  1. Sensor: LED or infrared light source with matching silicon-cell receiver.
  2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
- C. Duct Smoke Detector: Photoelectric type.
  1. Sampling Tube: Design and dimensions as recommended by the Manufacturer for the specific duct size, air velocity, and installation conditions where applied.
  2. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

### 2.14 OTHER DETECTORS

- A. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
  1. Mounting: Plug-in base, interchangeable with smoke detector bases.
  2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

### 2.15 NOTIFICATION APPLIANCES

- A. Description: Equip for mounting as indicated and have screw terminals for system connections.
  1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly and enclosure.
  2. Provide Randl Industries 5" square, 2-7/8" deep outlet box with plaster ring.
- B. Bells: Electric-vibrating, 24-V dc, under-dome type; with provision for housing the operating mechanism behind the bell. When operating, bells provide a sound-pressure level of 94 dB, measured 10 feet from the bell. 10-inch size, unless otherwise indicated. Bells are weatherproof where indicated.

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- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns produce a sound-pressure level of 96 dB, measured 10 feet from the horn.
  - D. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear lens. The word "FIRE" is engraved in minimum 1-inch-high letters. Flash rate shall not exceed two flashes per second nor be less than one flash per second. Maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40 percent. Shall be suitable for installation in a single gang outlet box. Color of housing shall be white in all areas.
    - 1. Strobe Leads: Factory connected to screw terminals.
    - 2. Combination visual/audible notification devices allowed only where shown.
  - E. Voice/Tone Speakers:
    - 1. High-Range Units: Rated 2 to 15 W.
    - 2. Low-Range Units: Rated 1/4 to 2 W.
    - 3. Mounting: Flush, semirecessed, surface, or surface-mounted; bidirectional as indicated.
    - 4. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
    - 5. Speakers shall be UL listed for emergency alarm systems.
- 2.16 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES
- A. Description: LED indicating light near each smoke detector that may not be readily visible when standing in the room. Light is connected to flash when the associated device is in an alarm or trouble mode. The lamp is flush mounted in a single gang plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector.
- 2.17 MONITOR MODULE
- A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts and for heat detectors located in high ambient temperature areas.
- 2.18 CONTROL RELAY MODULE
- A. Description: Microelectronic control module listed for use in controlling smoke/fire dampers, door release service and other control functions.
- 2.19 REMOTE MICROPHONE
- A. Description: Supervised microphone control at a remote location for manual paging. With "Ready to Talk" LED and keyed switch for controlled access.
- 2.20 FIRE ALARM TERMINAL CABINETS
- A. NEMA Type 1 enclosure, hinged door front with flush hinge, latch and lock. Provide terminal blocks in all cabinets with 25% spare capacity. Box and front shall be steel, painted red with label "Fire Alarm". Flush mounted.
- 2.21 GUARDS FOR PHYSICAL PROTECTION
- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, notification appliance, or other device requiring protection.
    - 1. Factory fabricated and furnished by the Manufacturer of the device.
    - 2. Finish: Paint of color to match the protected device.
- 2.22 WIRE
- A. Non-Power-Limited Circuits: Conductors shall be 600-V rated, 75 deg C, color-coded insulation.
    - 1. Low-Voltage Circuits: No. 16 AWG, minimum, stranded copper (maximum of seven strands).
    - 2. Line-Voltage Circuits: No. 12 AWG, minimum, solid or stranded copper.

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- B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

### 2.23 RACEWAYS, OUTLETS AND JUNCTION BOXES

- A. Shall conform to specification sections "Raceways" and "Outlet and Junction Boxes".
- B. Provide 5" square by 2-2/7" deep outlet boxes with plaster ring for all flush mounted notification appliances.

### 2.24 SURVIVABLE CIRCUITS

- A. Where required by applicable codes and standards provide survivable circuits using one or more of the following methods:
  1. Fire Alarm Circuit Integrity (CI) Cable, 2-hour fire rated per UL 1724.
  2. Electrical Circuit Protective Systems (FHIT) - System No. 17 of the UL Building Materials Directory.
  3. Installation in a 2-hour rated shaft or enclosure.
  4. Installation in a 2-hour rated stairwell in a building fully sprinklered in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

## PART 3 EXECUTION

### 3.1 SYSTEM SUPPLIER AND/OR SUBCONTRACTOR REQUIREMENTS

- A. Determine the complete system raceway, wiring and outlet box requirements.
- B. Provide and/or supervise all wiring, wiring terminations and connections.
- C. Provide and/or supervise all equipment installation.
- D. Perform and/or supervise all testing during and after installation.
- E. Certify in writing to the Architect at completion stating that system has been inspected, tested and is complete and fully operational in accordance with Contract Documents.
- F. Instruct and/or assist the contractor in instructing Owner's personnel in the operation and maintenance of the system.

### 3.2 EQUIPMENT INSTALLATION

- A. Manual Pull Stations: Mount semiflush in recessed back boxes.
- B. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.
- C. Ceiling-Mounted Smoke Detectors: Not less than 4 inches from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 feet apart in any direction.
- D. Wall-Mounted Smoke Detectors: At least 4 inches, but not more than 12 inches, below the ceiling.
- E. Smoke Detectors near Air Registers: Install no closer than 3 feet.
- F. Duct Smoke Detectors: Comply with Manufacturer's written instructions. Duct smoke detector and sampling tubes installation by Division 15 Contractor.
  1. Duct smoke detector shall be listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
  2. Sampling tubes shall extend the full width of the duct.
  3. Coordinate installation with Division 15 sheetmetal installer.
  4. Provide a remote indicator light when the detector is above a suspended ceiling or in an area which is not readily accessible.
- G. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed.

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- I. Visible Alarm-Indicating Devices: Install wall mounted devices such that the lens is not less than 80 inches and not greater than 96 inches above the finished floor. Ceiling mount devices allowed where shown and shall be approved for ceiling application. More than two visible notification devices in the same room or adjacent space within the field of view shall flash in synchronization. Synchronization of devices not in the same field of view is allowed. In corridors where there are more than two devices in any field of view, they shall be spaced a minimum of 55' apart or they shall flash in synchronization.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor when the device is not visible when standing in the room.
- K. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- L. Annunciator: Install with the top of the panel not more than 72 inches (1830 mm) above the finished floor.

### 3.3 WIRING INSTALLATION

- A. Provide all wiring complete per system requirements. Wiring shall be contained in steel raceways and red color junction boxes. Seal raceways to prevent air passage at each smoke detector. Permanent wire markers shall be affixed to all conductors at terminations and splices. Numbering system shall be consistent with shop drawings. All terminations shall be T&B "Sta-Kon" (or equivalent) self insulated, flanged or forked tongue lugs where connected at screw type terminals.
- B. Wiring within Enclosures: Wiring in main control cabinet shall be neatly arranged and bundled with tie wraps. Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- E. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signal from other floors or zones.
- F. Provide 1/2", 3 #12 from control panel to 20 amp C.B.s with lock-on device in a 120 volt panelboard. Panelboard on emergency distribution system when applicable.
- G. Survivable Circuits:
  - 1. A single notification appliance circuit shall not serve more than one notification zone.
  - 2. Failure of equipment or a fault on one or more insulation wiring conductors of one notification appliance circuit shall not result in functional loss of any other notification appliance circuit.
  - 3. Notification appliance circuits and any other circuits necessary for the operation of the notification appliance circuits shall be protected from the point at which they exit the control unit until the point that they enter the notification zone that they serve using one or more of the following methods:
    - a. A 2-hour rated cable assembly
    - b. A 2-hour rated shaft or enclosure

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- c. A 2-hour rated stairwell in a building fully sprinklered in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems

### 3.4 IDENTIFICATION

- A. Paint power-supply disconnect switch red and label "FIRE ALARM." When the fire alarm system primary power is served from a branch circuit panelboard the panel cover shall be labeled "FIRE ALARM PRIMARY SOURCE" and the branch circuit breakers serving the fire alarm system provided with "lock-on" devices.

### 3.5 GROUNDING

- A. Ground cable shields and equipment according to system Manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.
- C. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Section 260526 - Grounding and Bonding For Electrical Systems.
- D. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

### 3.6 ACCESS DOORS

- A. Provide where required for access to system components. Access doors are not shown on the Drawings.
- B. Provide door, mounting frame and trim for access openings in ceiling. Door shall have fire rating equivalent to that of the ceiling it is installed in. Nominal door opening shall be 24" x 24" with hinge fully concealed. Latches shall be flush screwdriver operated type. In latched position, door shall seat firmly against frame at all points and there shall be no warps, sags or open gaps.

### 3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.
- B. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the compliance of the system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
- C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of witnesses to preliminary tests.
- D. Final Test Notice: Provide a minimum of 10 days' notice in writing when the system is ready for final acceptance testing.
- E. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
  - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
  - 2. Test all conductors for short circuits using an insulation-testing device.
  - 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.

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4. Verify that the control unit is in the normal condition as detailed in the Manufacturer's operation and maintenance manual.
  5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
  6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
  7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
  8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of tests.
- H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.
- ### 3.8 CLEANING AND ADJUSTING
- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.
- ### 3.9 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours' training.
  2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
  3. Schedule training with Owner, through Architect, with at least seven days' advance notice.
- ### 3.10 ON-SITE ASSISTANCE
- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.
- ### 3.11 OPERATION AND MAINTENANCE MANUALS
1. Provide all information as required by Section 28 05 00 - Common Work Results For Electronic Safety and Security.
  2. Include Record Drawings, letter of certification and Record Drawings.

SECTION 28 31 00 FIRE DETECTION AND ALARM

END OF SECTION



## SECTION 28 31 10 SMOKE DAMPER CONTROL

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION

- A. General: Provide 120 volt power, fire alarm control connections, control module (CMX), wiring and relays to control smoke/fire dampers specified under Division 23.
- B. Contractor Design: Raceways, routing, and wiring are not shown on the drawings. Contractor shall be responsible for design of conduit routing and wiring and to show the same on shop drawings. System shall be in steel raceways.

#### 1.3 OPERATION

- A. Provide control modules on each floor for each of the fan systems (supply, exhaust, return) serving the floor. Derive 20 amp, 120 volt power from the nearest panel serving the floor on which dampers are located. Provide emergency circuit if fan serving the area is on emergency power. Derive control circuits from fire alarm transponder(s). Monitor the fan running status via the fire alarm system. Program the control modules to close when the fan is running and open when the fan is stopped.

#### 1.4 SUBMITTALS

- A. Assemble product data in submittal brochure as specified in Section 260500.
- B. Shop Drawings:
  - 1. Floor Plans: Submit CAD based shop drawings to show device locations, raceway routing, and color coded wiring between devices. Show panelboard and circuit numbers serving each damper. Show room names and numbers for each room where a fire/smoke damper is located.
  - 2. Detail Plans: Prepare original Auto CAD based drawings showing termination and connection diagrams at control modules and relays.
  - 3. Release of CAD Files: Contractor may request to utilize Sparling CAD files for assistance in producing shop drawings. Request shall be made by signing Sparling's "Agreement for Release of CAD Files" letter.

### PART 2 PRODUCTS

#### 2.1 SMOKE DAMPERS

- A. Electrically operated, single phase, 120 volt, two position. Dampers close upon de-energization. Damper and electric activator are specified under Division 23.

#### 2.2 CONTROL RELAYS

- A. Heavy duty plug-in relay, 10 amp rated contacts. IDEC RHIB-U-AC120 with SHIB-05 socket.

#### 2.3 ENCLOSURE

- A. NEMA 1 with hinged cover, 8"h x 12"w x 4"d. Provide nameplate per section 16010 with 1/2" lettering on each cover "SMOKE DAMPER RELAYS".

#### 2.4 NAMEPLATES

- A. Provide nameplate per Section 260500 with 1/8" lettering on each relay to identify which fan it is associated with. (i.e. "Supply Fan SF-1")

### PART 3 EXECUTION

#### 3.1 CONTROL SEQUENCE

- A. Signal from fire alarm system is sent to control module (CMX) to close smoke/fire dampers. Smoke dampers to open immediately when control module (CMX) is reset.

## SECTION 28 31 10 SMOKE DAMPER CONTROL

### 3.2 ENCLOSURE

- A. Install in the electrical room serving the project area.

### 3.3 SMOKE DAMPERS

- A. Provide 120 volt connections from the control module/relay(s) to all smoke dampers in the project area. Separate circuits/controls are required for each supply, exhaust and return fan.

### 3.4 RECORD DRAWINGS

- A. Provide per 260500. Record drawings shall clearly indicate:
  1. Actual routing of all raceways, and location of all junction boxes.
  2. Actual cable type, numbers and routing.
  3. Actual system wiring diagrams, connection diagrams and interface of all components in the system.

### 3.5 TESTING

- A. With the fan stopped, visually inspect each smoke damper to insure that it is closed. With the fan running, visually inspect each smoke damper to insure that it has opened. Submit test report to engineer.

END OF SECTION