

Northern Kentucky Water District  
2835 Crescent Springs Road  
Erlanger, KY 41018

PROJECT MANUAL VOL. 2

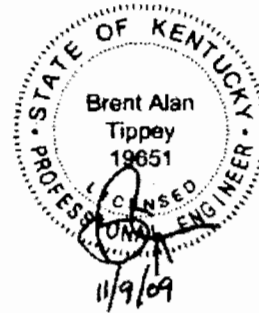
TECHNICAL SPECIFICATIONS OF THE CONTRACT (DIVISION 00-07)

for the construction of the  
Fort Thomas Treatment Plant and Memorial Parkway Treatment Plant Advanced Treatment  
Contract No. \_\_\_\_\_



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**END OF SECTION**



**SECTION 07 07 25  
FALL ARREST ANCHORS**

**PART 1 GENERAL**

**1.01 QUALITY ASSURANCE**

- A. Installation and Design Responsibility: Work of this Section to be executed by a firm thoroughly conversant with the applicable laws, by-laws and regulations which govern the Work, and are capable of workmanship of best modern shop and field practice known to recognized manufacturers specializing in this type of work.
- B. Have the Work of this Section engineered by a professional engineer licensed in Kentucky. The Work of the engineer shall comply with the OSHA requirements for fall arrest anchor systems. The Contractor shall be responsible for:
  - 1. Layouts and quantities, to the requirements of the Authorities Having Jurisdiction,
  - 2. Co-ordination and ensure compatibility with building structure.
  - 3. Obtain all necessary permits and approvals.
  - 4. Installer Qualifications: Trained and approved by the manufacturer and having a minimum three years experience in the installation of the Work described in this Section and can show evidence of satisfactory completion of projects of similar size, scope and type. If requested, the Contractor shall provide letter of certification from the manufacturer stating that the installer is a certified applicator of its Products, and is familiar with proper procedures and installation requirements required by the manufacturer.
  - 5. Maintenance Seminars: Engage a factory authorized service representative to train the Owner's maintenance personnel on proper procedures and schedules for adjusting, operating, troubleshooting, servicing, and maintaining the Work.
  - 6. Pre-Installation Meeting: Ten (10) Working Days prior to commencing any roofing Work, arrange for the manufacturer's technical representative to visit the Site and review the preparatory and installation procedures to be followed, conditions under which the Work will be done, and inspect the surfaces to receive the Work of this Section. Advise the Owner of the date and time of the meeting.

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7. Manufacturer's Site Inspection: Have the manufacturer's technical representative inspect the Work at suitable intervals during application and at conclusion of the Work of this Section, to ensure that the Work is correctly installed. Submit the manufacturer's inspection reports and verification that the Work of this Section is correctly installed.
8. Source Limitations: Obtain each type of Product from a single manufacturer.

### 1.02 SUBMITTALS

- A. Shop Drawings: Bearing the professional seal and signature of a professional engineer, registered in Kentucky, responsible for the engineering design of Work of this Section. Show anchor profile, layout, materials, construction, and securement method to building structure.
- B. Samples: Duplicate full size samples of each anchor type.
- C. Maintenance Manuals: Include complete written and illustrated instruction manuals relative to the care, adjustment and operation of all parts of the equipment, a complete description and listing of components, with recommended frequency of service and maintenance to ensure maximum efficiency, reliability and long life of the equipment.
- D. Fall Arrest Anchor Reports: Include an approved roof layout plan, anchor details, test reports, special liability insurance certificate, warranty certificate.

### 1.03 PROTECTION

- A. Protect the structure and its finishes from damage due to installation, testing and operation of the Work of this Section.
- B. Make good components or surfaces soiled or otherwise damaged in connection with the Work of this section.

### 1.04 MAINTENANCE INSPECTIONS

- A. Provide three (3) years of anchor maintenance inspections as part of the Contract, from the date of Substantial Performance, at no additional cost to the Owner. Maintenance inspections shall include, but not be limited to, pull tests, flashing inspection and weld inspections.

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### 1.05 CERTIFICATION OF COMPETENCY

- A. The Contractor shall provide, as part of the required anchor report, a currently dated and duly authorized certificate, indicating that the Subcontractor performing the Work of this Section is competent to undertake the fabrication and installation of the Work of this Section.

### 1.06 WARRANTY

- A. Provide a written and signed warranty in the name of the Owner, that the anchor system shall be free of defects in materials, workmanship and installation for a period of three (3) years from the date of Substantial Performance of the Work.
- B. Defects shall include, but not be limited to:
  - 1. Flashing failure.
  - 2. Weld failure.
  - 3. Excessive deformation of anchors or part of anchors while under imposed loading.
  - 4. Metal fatigue.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE PRODUCTS

- A. Fall Arrest Roof Anchors: Urethane insulated, hollow galvanized steel post with base plate, stainless steel flashing sleeve, and stainless steel U-bolt assembly, by Thaler Metal Products or an equivalent acceptable to the Engineer.
  - 1. Through Bolted Type: FARA -16USS.
  - 2. Through Bolted Type: FARA-13 (metal deck)
  - 3. Through Bolted Type: FARA-11 (concrete roof slab)

### 2.02 MATERIALS

- A. Stainless Steel Plates, Round Bars and Flat Bars: Structural quality with  $F_y = 50,000$  psi.
- B. Stainless Steel Sheet: 18 gauge AISI type 304 stainless steel with "No.4 finish".
- C. Stainless Steel Plates: New stock (not weathered or rusted), Hot-dip galvanize steel plates after fabrication to ASTM A123.



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- D. Galvanized Steel Sheet: Commercial quality, stretcher leveled, 0.24" thick to ASTM A446 with minimized spangle zinc coating Z275 to ASTM A526.
- E. Stainless Steel Welding Materials: To AWS D1.1. Use electrodes compatible with and of the same properties as the stainless steel.
- F. Bituminous Paint: Bituminous solvent type to ASTM D1187.
- G. Stainless Steel Lock Washers and Hex Nuts: High strength AISI 300 or 400 Series austenitic grade stainless steel types.

### **PART 3 EXECUTION**

#### 3.01 PREPARATION

- A. Examine the Work of other Sections where such Work influences the Work of this Section and report unsuitable conditions to the Engineer.
- B. Supply anchors, inserts, rough-in dimensions and templates required to be built-in by other Sections, in adequate time so as not to delay the Work.
- C. Have a senior, qualified manufacturer's representative on Site to direct and supervise the installation of materials which are installed by Subcontractors and Other Contractors.

#### 3.02 INSTALLATION - EQUIPMENT

- A. Install Work by the manufacturer or its authorized representative.
- B. Isolate dissimilar metals with two coats of bituminous paint.
- C. Perform pull test on one out four fasteners, in accordance with the requirements of the OSHA and the Local Authorities Having Jurisdiction.
- D. Replace defective equipment at no cost to the Owner.
- E. Adjust operating parts to ensure smooth, efficient operation.

#### 3.03 INSTALLATION – ROOF WORK PLANS

- A. Securely install copies of roof Work plans in clear acrylic covers and at all roof access locations, in accordance with the requirements of the OSHA and Local Authorities Having Jurisdiction.

**END OF SECTION**

**SECTION 07 14 00  
FLUID-APPLIED WATERPROOFING**

**PART 1 GENERAL**

**1.01 SUBMITTALS**

**A. Action Submittals:**

1. Shop Drawings: Copies of manufacturer's literature for products proposed.
2. Samples:
  - a. Cured membrane and coating system applied to 12-inch square by 1/4-inch thick plywood or similar rigid base.
  - b. Sample of each color and coating to be used on Project.

**B. Informational Submittals:**

1. Certification: Compliance with product requirements specified.
2. Sample copy of guarantee to be provided. Upon completion and acceptance of the Work required by this section, submit an executed copy of the guarantee.
3. Applicator approval letter from membrane manufacturer.

**1.02 QUALITY ASSURANCE**

- A. Applicator:** Approved and licensed by fluid applied waterproofing manufacturer.

**1.03 DELIVERY, STORAGE, AND HANDLING**

- A.** Deliver materials to Project Site in sealed, undamaged containers. Identify each container with material name, date of manufacture, and lot number.
- B.** Store material in dry area out of direct sunlight. Storage area temperature shall not exceed 90 degrees F.

**1.04 ENVIRONMENTAL REQUIREMENTS**

- A.** Perform work only when existing and forecasted weather conditions are within limits established by manufacturer of materials and products used.
- B.** Proceed with installation only when substrate construction and preparation work is complete and in condition to receive waterproofing.

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## 1.05 SPECIAL GUARANTEE

- A. Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction or, at the option of Owner, removal and replacement of Work specified in this Specification section found defective during a period of 3 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

## PART 2 PRODUCTS

### 2.01 MEMBRANE

- A. Polyurethane elastomer-based fluid applied waterproofing membrane.
- B. Manufacturers and Product:
  - 1. 3M Co., St. Paul, MN; Scotch-Clad Brand Deck Coating.
  - 2. The Neogard Corp., Dallas, TX; Perma-Gard III.
  - 3. Gaco Western, Seattle, WA.
  - 4. Carlisle Coatings and Waterproofing, Sapulpa, OK; CCW-525.
  - 5. Sonneborn, Shakopee, MN; HLM 5000.
  - 6. W.R. Grace & Co., Cambridge, MA; Procor 20.
  - 7. Pecora Corp., Harleyville, PA; Duramem V500.

### 2.02 COATING

- A. One-component moisture curing polyurethane elastomer.
- B. Color: Gray.
- C. Manufacturers and Products:
  - 1. 3M Co., St. Paul, MN; Scotch-Clad Waterproof Coating.
  - 2. Gaco Western, Seattle, WA; Gacoflex P-50.
- D. Waterproofing for filtered water channels to be NSF-61 compliant.

### 2.03 RELATED MATERIALS

- A. As follows, compatible with components produced by membrane manufacturer:

1. Primers: As recommended by membrane manufacturer for type of substrate involved.
2. Sealants: Low modulus, unmodified polyurethane or as recommended by membrane manufacturer.
3. Backer Rod: Expanded polyethylene rod as manufactured by Dow Chemical,
4. Flashing Reinforcement: Woven, uncoated fiberglass mesh on 0.050-inch thick precured neoprene.
5. Protection Board: Approved by membrane manufacturer.

### **PART 3 EXECUTION**

#### **3.01 CONDITIONS OF SURFACES**

- A. Verify curing methods used for concrete are compatible with membrane system.

#### **3.02 PREPARATION**

- A. Cleaning:
  1. Thoroughly clean surfaces to receive membrane following membrane manufacturer's recommendations.
  2. Treat as necessary to remove laitance, loose material on surface, grease, oil, and other contaminants that will affect bond of the membrane.
  3. Vacuum clean or clear water wash surfaces and allow to dry completely.
- B. Fill voids and control joints with sealant and overcoat with nonflow membrane material. Fill or coat visible shrinkage cracks to minimum 2 inches either side of crack.
- C. Use drop cloths or masking as required for protection of adjacent surfaces.

#### **3.03 FLASHINGS-FLUID APPLIED**

- A. Unless Drawings establish more restrictive requirements, the following minimum requirements apply:
  1. Fill construction joint voids at intersections of vertical and horizontal walls with backer rod and sealant in accordance with requirements of membrane manufacturer.
  2. Nonreinforced Flashing:
    - a. Install nonreinforced flashing at construction joints not subject to movement, at all intersecting surfaces that are structurally and rigidly connected, and at all piping or other penetrations through membraned surface that do not require reinforced flashing.

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- b. Apply 50-mil minimum dry film thickness of membrane for 4 inches minimum onto adjacent surfaces.
  - c. At intersections of membrane with vertical walls, piping penetrations, and at projections through horizontal membrane, extend flashing coat to a height not greater than finished horizontal surface, with due allowance for installation of sealant work. Trowel a 1-inch high, 45-degree cant at meeting angle using nonflowing membrane material.
  - d. At projections through a vertical membrane, extend flashing coat 4 inches minimum onto penetrating element.
3. Reinforced Flashing:
- a. Apply flashing reinforcement over cracks, expansion and control joints, and at changes of plane where adjacent surfaces are not structurally and rigidly connected and also at penetrations through a membrane surface.
  - b. Apply 50-mil dry film thickness embedment coat of membrane to surfaces to be flashed. Extend 6 inches minimum out onto adjacent deck surface.
  - c. Embed reinforcement in wet coating. Embedment coating should extend 2 inches beyond reinforcement.
  - d. At intersections of membrane with vertical walls, extend embedment coat and reinforcement to a height not greater than finished horizontal surface with due allowance for installation of sealant work. Trowel a 1-inch high, 45-degree cant at meeting angle using nonflowing coating material.

### 3.04 MEMBRANE

- A. Install, following safety and weather conditions required by manufacturer or as modified by applicable rules and regulations of federal, state, and local authorities having jurisdiction.
- B. Following manufacturer's instructions, apply membrane material with a calibrated notched squeegee, trowel, or approved spray equipment to produce a 50-mil minimum dry thickness.
- C. Extend membrane over previously flashed areas.
- D. Use self-leveling membrane material up to a 5 percent slope.
- E. Use nonflow membrane material for vertical surfaces and surfaces over a 5 percent slope.
- F. Allow membrane to cure overnight. At temperatures less than 75 degrees F and relative humidities less than 50 percent, extend curing time.

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### 3.05 PROTECTION

- A. Protect cured vertical membranes exposed to backfilling operations with protection board.
- B. Butt all boards; do not overlap.
- C. Adhere or bond protection boards to membrane as recommended by membrane manufacturer.

### 3.06 COATING

- A. Apply 20-mil (0.020-inch) thick base coat of self-leveling (up to 5 percent pitch) or nonflow (over 5 percent pitch) coating to surfaces as shown. Overcoat previously detailed areas. Allow to cure overnight.
- B. Apply a second 20-mil (0.020-inch) thick topcoat of self-leveling (up to 5 percent pitch) or nonflow (over 5 percent pitch) coating to surfaces previously base coated.

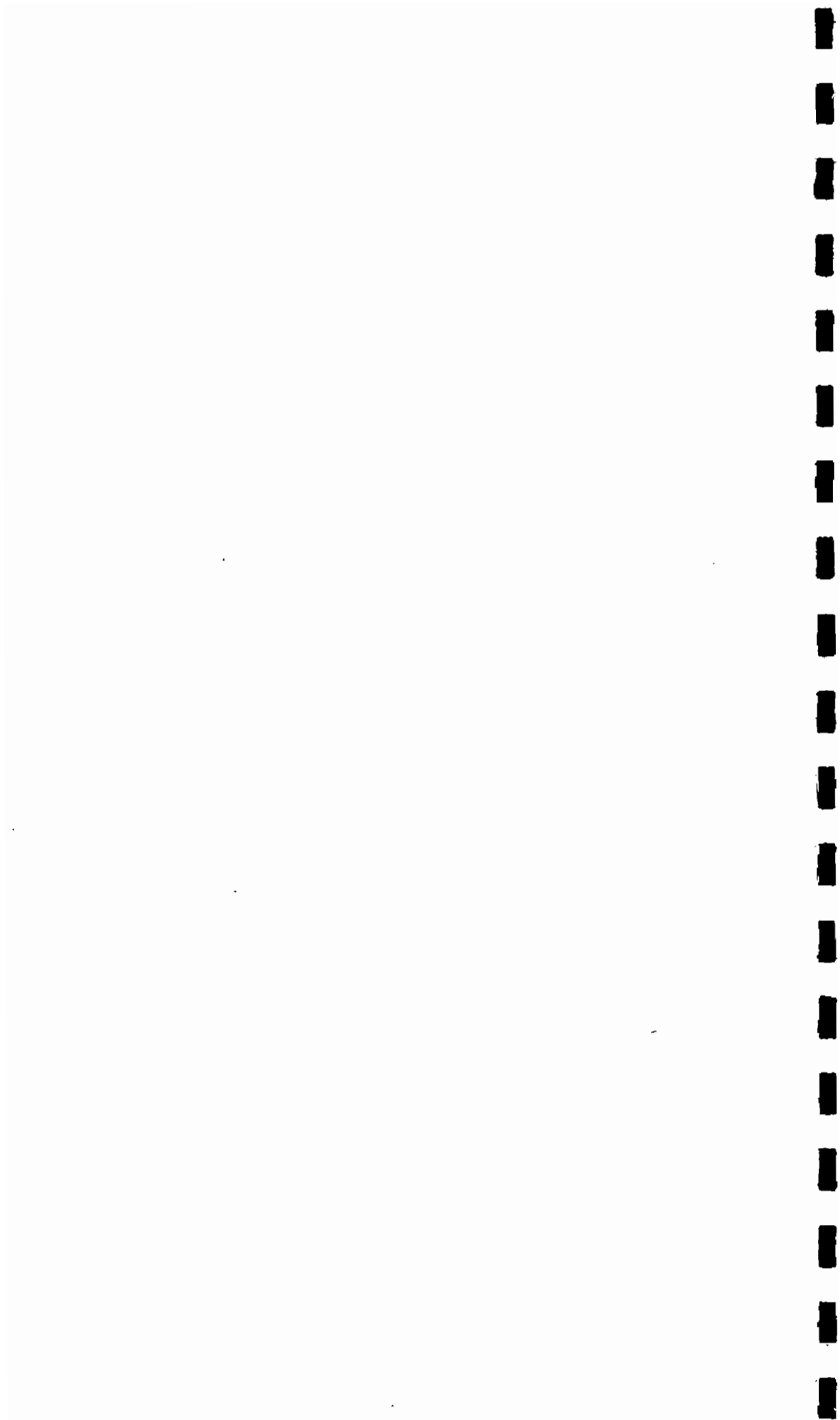
### 3.07 CLEANING

- A. Clean stains from adjacent surfaces with toluene, 1-1-1, trichloroethane, xylene, commercial tar remover, or as recommended by the membrane manufacturer.
- B. Remove foreign matter from finished membrane surface.

### 3.08 APPLICATION SCHEDULE

- A. Membrane:
  - 1. Apply waterproofing membrane and protection board to exterior surfaces of cast-in-place concrete structures below finish ground level that enclose spaces that may be occupied, such as stairways, galleries, pump rooms, mechanical and electrical equipment rooms, and other areas shown.
  - 2. Apply membrane from top of footings to 6 inches below finished grade.
- B. Coating: Apply waterproof coating to interior surfaces of walls and slabs of hydraulic channels, conduits, wet wells, trenches, tanks, and basins that are common with habitable spaces including stairways, galleries, pump rooms, mechanical and electrical equipment spaces, and other areas as shown.

**END OF SECTION**



**SECTION 07 18 00  
TRAFFIC COATINGS**

**PART 1 GENERAL**

1.01 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
  - a. Complete manufacturer's literature and technical data for the coating system proposed.
  - b. Project-specific details of roof penetrations and perimeter conditions.
2. Samples:
  - a. Coating system applied to 12-inch by 12-inch by 1/4-inch plywood or similar rigid base.
  - b. One Sample of each color and coating type to be used on Project.

B. Informational Submittals:

1. "Licensed Applicator Certificate" issued by the coating system materials manufacturer.
2. Maintenance Manual: Upon completion of the coating system, submit one maintenance manual, identified with project name, location, and date; type of coating applied; and surface to which system was applied, including sketches where necessary. Include recommendations for periodic inspections, care, and maintenance. Identify common causes of damage with instructions for temporary patching until repair can be made.
3. Special guarantee.

1.02 QUALITY ASSURANCE

A. Applicator: Approved and licensed by the coating system materials manufacturer.

B. Preapplication Conference:

1. Conduct a preapplication conference with the Engineer, applicator, coating system materials manufacturer, and all Subcontractors likely to be on the deck, present.
2. Questions regarding the acceptability of the substrate, the coating system and related materials, and the mechanical related items should be discussed and finalized during this conference.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in sealed, undamaged containers. Identify containers with material name, date of manufacture, and lot number.

### 1.04 ENVIRONMENTAL REQUIREMENTS

- A. Weather Conditions: Do not install coating materials if rain is anticipated or predicted within 8 hours of application.
- B. Temperature: Substrate surface above 40 degrees F. and less than 110 degrees F.
- C. Do not allow open fires or spark-producing equipment in application area until after vapors have dissipated.

### 1.05 SPECIAL GUARANTEE

- A. Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of 3 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

## **PART 2 PRODUCTS**

### 2.01 MANUFACTURERS

- A. Scotch-Clad Deck Coating, System P and System V (as applicable) as manufactured by 3M Co., St. Paul, MN.
- B. Peda-Gard II and Auto-Gard II (as applicable) as manufactured by Neogard Corp., Dallas, TX.
- C. Gacoflex GW-13-U and GW-15-U (as applicable) as manufactured by Gates Engineering Co., Inc.

### 2.02 MATERIALS

- A. General: Materials used in the coating system shall be the end products of one manufacturer or approved by the manufacturer whose coating system specification is selected for use.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Traffic Coating: Polyurethane elastomer based and capable of producing a seamless, waterproof coating system.
  - 1. Color of Topcoating and Aggregate gray for both pedestrian and vehicular coating types.
- C. Primer: As recommended by the deck coating system materials manufacturer for the type of substrate involved.
- D. Backer Rod: Expanded polyethylene rod equal to Ethafoam by Dow Chemical.
- E. Sealant: Polyurethane or polysulfide based, as recommended by coating system materials manufacturer.
- F. Flashing Reinforcement: Woven, uncoated fiberglass mesh.
- G. Aggregate:
  - 1. Pedestrian: Silicon carbide, 20 to 24 mesh.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Thoroughly clean surfaces to receive coating system in strict accordance with manufacturer's instructions and recommendations.
  - 1. Remove laitance, loose material on the surface, grease, oil, and other contaminants which will affect bond of the coating system. Leave surfaces broom-clean.
  - 2. Prepare all concrete surfaces by brushoff blasting followed by vacuum cleaning or by etching with a 10 to 15 percent solution of muriatic acid.
  - 3. Flush all acid with clean water and allow to dry.
- B. Condition of Surfaces:
  - 1. Concrete Surfaces: Visibly dry and pass a 4-hour rubber mat test (no condensation) prior to application of coating system. Mat shall be taped to substrate on all edges.
  - 2. Metal Surfaces: Dry and free from rust, corrosion, and coatings which would affect bond of coating system, and without sharp edges or offset at joints.
- C. Rout or saw cut all cracks exceeding 1/16 inch in width and fill with sealant.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Use sealant to fill expansion, control, and construction joints to be overcoated by traffic coating system. Provide 1/4-inch by 1/4-inch saw cut where coating system to be terminated within a horizontal plane.
- E. Protect adjacent surfaces with drop cloths or masking as required.

### 3.02 FLUID APPLIED FLASHINGS

- A. Provide fluid applied flashings at locations where a horizontal surface abuts a vertical surface and at all deck penetrations.
- B. Unless detailed or specified otherwise, at projections through coating system such as posts, vents, pipes, stanchions, railings, and similar locations of potential slight movement, reinforce coating with one layer of flashing reinforcement.

### 3.03 PRIMER AND DETAIL WORK

- A. Prime concrete, masonry, and metal surfaces. Apply primer at manufacturer's recommended rate. Allow prime coat to completely dry but do not apply more than 8 hours preceding application of coating. Metal prime coat may be applied up to 9 days prior to application of coating.
- B. Apply 20-mil dry film thickness of nonflowing type coating over flashings. Extend coating 2 inches beyond flashing out onto adjacent substrate surface. Unless otherwise indicated on Drawings or where limited by height of base, extend coating a minimum of 1 inch above the top of the flashing and terminate in a neat straight line. Use masking tape for such purposes.
- C. Apply 20-mil dry film thickness of nonflowing type coating for a distance of 1-1/2 inches on each side of all cracks.
- D. Apply 20-mil dry film thickness of nonflowing type coating or nonadhering tape for a distance of 2 inches on each side of expansion joints, control joints, and construction joints to be coated.

### 3.04 APPLICATION

- A. Base Coat:
  - 1. Apply coating material at a minimum dry film thickness of 25 mils. Extend coating over fluid applied flashings and detail coatings.
  - 2. Allow to cure for 16 hours minimum. At temperatures less than 75 degrees F and relative humidities less than 50 percent, extend curing time.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### B. Topcoat:

1. Apply topcoating material at a minimum dry film thickness of 15 mils to all areas which have been previously coated.
2. While coating is still fluid, uniformly broadcast aggregate over surface at the rate of 5 pounds per 100 square feet. Immediately roll to evenly distribute and completely coat the aggregate.
3. Allow topcoat to cure for 24 hours minimum (pedestrian) and 48 hours minimum (vehicular) before permitting traffic on surfaces. At temperatures less than 75 degrees F and relative humidities less than 50 percent, extend curing time.

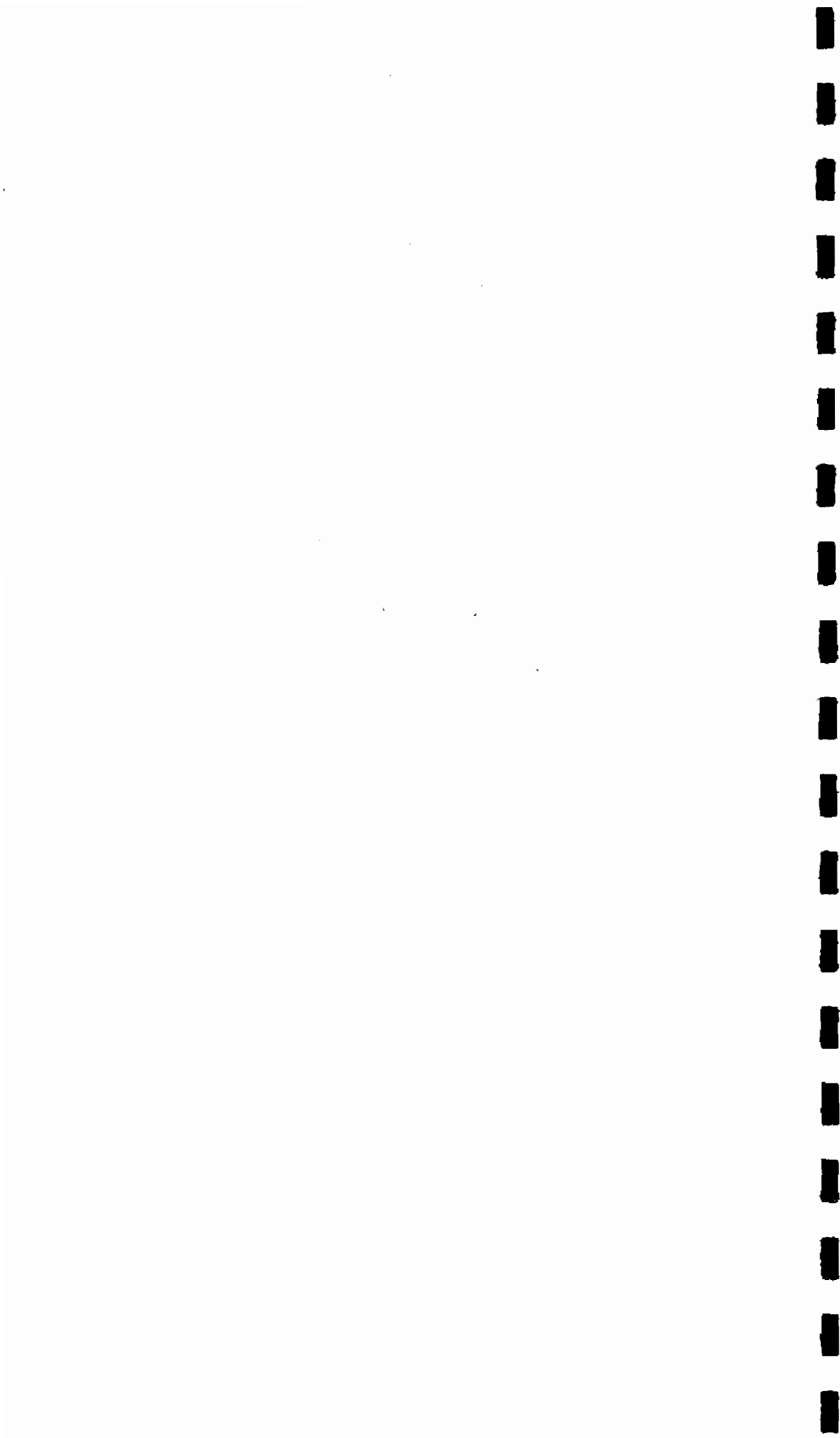
### 3.05 CLEANING

- A. Clean stains from adjacent surfaces with toluene, 1,1,1, trichloroethane, xylene, commercial tar remover, or as recommended by coating manufacturer.
- B. Remove foreign matter from finished coating surfaces.

### 3.06 APPLICATION SCHEDULE

- A. As shown on Drawings

**END OF SECTION**



**SECTION 07 19 00  
WATER REPELLENTS**

**PART 1 GENERAL**

**1.01 SUBMITTALS**

**A. Action Submittals:**

1. Manufacturer's product data for water repellent.

**B. Informational Submittals:**

1. Manufacturer's current application instructions for water repellent.
2. Evidence of applicator certification by product manufacturer.
3. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
4. Manufacturer's Certificate of Compliance in accordance with Section 01 33 00, Submittal Procedures.

**1.02 QUALITY ASSURANCE**

**A. Qualifications: Applicator certified by product manufacturer.**

**B. Mockup:**

1. Apply water repellent following manufacturer's application instructions to not less than 20 square feet of substrate material that matches actual job conditions. Determine the optimum coverage rate required for application.
2. After sample treatment has cured (approximately 12 to 24 hours), water test to verify that substrate is coated with sufficient water repellent to effectively repel moisture from the surface.
3. Verify that application of water repellent materials will produce no surface stains or discoloration, and obtain Engineer's acceptance.
4. Maintenance: Maintain mockup during construction for workmanship comparison; remove and legally dispose of mockup when no longer required.
5. Incorporation: Mockup may be incorporated into final construction upon Owner's approval.

**1.03 DELIVERY, STORAGE, AND HANDLING**

**A. Delivery: Deliver materials in manufacturer's original sealed containers.**

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
  - 1. Lids must be kept tightly sealed. Do not allow moisture to enter containers.
  - 2. Store containers in a dry place, upright and airtight at temperatures of 45 degrees F (7 degrees C) and not exceeding 100 degrees F (38 degrees C).

### 1.04 PROJECT CONDITIONS

- A. Surface, air, and material temperatures shall not be lower than 40 degrees F or higher than 95 degrees F during application unless otherwise permitted by manufacturer's instructions. Do not apply when temperature is expected to fall below 40 degrees F within 12 hours following application.
- B. Weather: Clear with no precipitation during application or expected for 4 hours following application.
- C. Provide positive ventilation throughout the application.

### 1.05 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of 10 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.
- B. Conditions: Applied product will retain its water repellent effects during the Special Guarantee period.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Harris Specialty Chemicals; Hydrozo, Enviroseal 40.
- B. Huls America, Inc.; Chem-Trete BSM 40.
- C. Chemprobe Technologies, Inc.; Prime A Pell.
- D. Textured Coatings of America; Tex-Cote Rainstopper Series 140.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.02 WATER REPELLENT

- A. Active Alkylalkoxysilane Content: By weight, 40 percent.
- B. Not alter appearance of masonry or change the surface texture.
- C. No fillers, stearates, or paraffins.
- D. Clear color.
- E. VOC content: Less than 350 grams per liter using EPA Method 24.

### **PART 3 EXECUTION**

#### 3.01 EXAMINATION AND PREPARATION

- A. Verify that surfaces are solid, dry, and free of dirt, efflorescence, oil, wax, frozen matter, loose particles, cracks, pits, laitance, curing compounds, and other foreign matter that would block absorption of water repellent.
- B. Verify that curing of sealants is complete.
- C. Clean masonry surfaces to make them acceptable for application.
- D. Protect and mask adjacent surfaces during application.

#### 3.02 APPLICATION

- A. Follow product manufacturer's instructions and recommendations, including application apparatus and techniques, and coverage rates.
- B. Provide uniform coverage over entire surface of face brick on exterior and interior of buildings.

#### 3.03 FIELD QUALITY CONTROL

- A. Notify Engineer 48 hours prior to application.
- B. After water repellent has dried (24 hours, low humidity, medium temperature (70 to 90 degrees F) and 48 hours, high humidity, low temperature (50 to 69 degrees F), test surfaces with a water spray. Recoat areas that indicate water absorption.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.04 CLEANING

- A. At completion, remove from the jobsite excess material, debris, and waste. Dispose of water repellent containers according to state and local environmental regulations.
- B. Upon completion of Work, clean window glass and other splattered surfaces.

### 3.05 PROTECTION

- A. Protect adjacent shrubs, metal, wood trim, glass, asphalt, and other building hardware from overspray. Do not permit spray mist or liquid to drift onto surrounding properties or parking lots. Avoid contact with automobile paint and windshields. Clean up immediately after application using cleaners approved by product manufacturer.
- B. Protect installed product's finish surfaces from damage during construction.

**END OF SECTION**

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## SECTION 07 21 00 THERMAL INSULATION

### PART 1 GENERAL

#### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
  - a. C272, Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
  - b. C303, Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
  - c. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
  - d. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
  - e. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
  - f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - g. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

#### 1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
  - a. Manufacturer's product literature identifying products proposed for use.

#### 1.03 DELIVERY, STORAGE, AND HANDLING

- A. On packaging clearly identify manufacturer, contents, brand name, applicable standard, and R-value.
- B. Store materials off ground and keep them dry. Protect against weather, condensation, and damage.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## PART 2 PRODUCTS

### 2.01 BATT INSULATION AND FASTENERS

- A. Fiberglass or Mineral Wool Batts:
  - 1. ASTM C665, Type I, with no vapor retarder with R-values as indicated on Drawings.
  - 2. Manufacturers:
    - a. CertainTeed Corp.
    - b. Owens-Corning Insulating Systems.
    - c. Johns Manville.
- B. Fasteners: As recommended by insulation manufacturer. Tape: As recommended by insulation manufacturer.
- C. Ventilation Baffles: As recommended by insulation manufacturer for installation between trusses.

### 2.02 VAPOR RETARDER

- A. Plastic Sheeting: ASTM D4397, minimum thickness of 6 mils.
- B. Sealant and Tape: As recommended by vapor retarder manufacturer.

### 2.03 AIR BARRIER, AIR SEAL AND DAMPPROOF FALSHING

- A. Rubberized Asphalt Composite Wall membrane:
  - 1. meeting requirements of ASTM E96, Method B.
  - 2. Rubberized asphalt integrally bonded to a film of high density cross laminated polyethylene.
  - 3. Thickness: Minimum 40 mils.
  - 4. Primer : As recommended by membrane manufacturer.
  - 5. Manufacturer and Product: W.R.Grace Construction Products; Perm-A-Barrier.

### 2.04 CAVITY WALL INSULATION

- A. Material; semi-rigid boards of inorganic glass fiber.
- B. Conformance: ASTM C612
- C. Flame Spread: Less than 25 when tested with ASTM E84
- D. Thickness or R-value: As shown on drawings.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- E. Manufacturer's and products:
  - 1. Owens Corning: AF 530.
  - 2. Jons Manville, Insul-Shield 300.

### 2.05 RIGID INSULATION

- A. Extruded Polystyrene Foam:
  - 1. ASTM C578, Type IV.
  - 2. Flame Spread: Less than 25 when tested in accordance with ASTM E84.
  - 3. R-value: As shown.
  - 4. Manufacturers and Products:
    - a. Dow Chemical Co.; Styrofoam Square Edge.
    - b. UC Industries; Foamular.
- B. Adhesives and Fasteners: As recommended by insulation manufacturer.

## PART 3 EXECUTION

### 3.01 BATT INSULATION

- A. Install in accordance with manufacturer's instructions and as specified below:
  - 1. Install in widths required by framing spacing.
  - 2. Fit tightly to ensure continuous seal.
  - 3. Where electrical outlets, ducts, pipes, vents, or other utility items occur, place insulation on cold weather side of obstruction.
  - 4. Protect installed insulation from tears and other damage until covered with finish material.
  - 5. Remove and replace damaged material.
  - 6. Install ventilation baffles between trusses as recommended by manufacturer.

### 3.02 VAPOR RETARDER

- A. Install in accordance with the following:
  - 1. Apply to substrate in sheets as large as possible.
  - 2. Lap joints 6 inches.
  - 3. Seal joints with sealant and tape as recommended by vapor retarder manufacturer.
  - 4. Fit tightly and seal around penetrations to ensure vapor-tight installation.
  - 5. Repair minor tears or holes with tape.
  - 6. Fasteners: As recommended by plastic sheet manufacturer.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

7. Replace sheets with tears or holes, which require more than 6-inch length of tape to repair.

3.03 CAVITY WALL INSULATION

- A. Install as specified in Section 04 21 13.13, Masonry Veneer.

3.04 RIGID INSULATION

- A. Install in accordance with the following:
  1. Install boards in location and in thickness as shown.
  2. Cut insulation with saw, knife, or other sharp tool to fit tightly around obstructions.
  3. Butt insulation boards together tightly at joints.
  4. Where thickness required exceeds 1-1/2 inches, install two layers of boards.
  5. Apply to masonry or concrete with adhesive recommended by insulation manufacturer:
    - a. Adhere first layer to substratum, then adhere second layer to first, staggering joints.
    - b. Follow manufacturer's recommendations for preparing surfaces and applying adhesive

3.05 AIR BARRIER, AIR SEAL AND DAMPPROOF FLASHING

- A. Install as specified in Section 04 21 13.13, Masonry Veneer.

**END OF SECTION**

**SECTION 07 24 13**  
**POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
    - a. C150, Standard Specification for Portland Cement.
    - b. C578, Standard Specification for Preformed, Cellular Polystyrene Thermal Insulation.
    - c. C954, Standard Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Base to Steel Studs from 0.033 inches to 0.112 inches in Thickness.
    - d. C1002, Standard Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases.
    - e. D578, Standard Specification for Glass Fiber Strands.
    - f. D1682, Standard Test Methods for Breaking Load and Elongation of Textile Fabrics.

1.02 DEFINITIONS

- A. Exterior insulation and finish systems refer to exterior assemblies composed of an inner layer of board insulation and an outer layer composed of a glass fiber mesh reinforced base coat applied directly to board insulation and a textured protective finish coat. These assemblies are applied to supporting surfaces of construction.
- B. EIMA: Exterior Insulation Manufacturers Association.
- C. System Manufacturer: Manufacturer of exterior insulation and finish systems.

1.03 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
    - a. Shop Drawings showing fabrication and installation of system including plans, elevations, sections, details of components, joint locations and configurations within and between system including construction penetrating, and attachments to construction behind system.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. Product data for each component of exterior insulation and finish systems.
  2. Samples: 2-foot square panels for each finish, color, and texture.

### B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Certificates:
  - a. Manufacturer's Certificate of Proper Installation.
  - b. Manufacturer's certificate, certifying installer to do the Work.

## 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer certified in writing by system manufacturer.
- B. Mockups: Prior to installation of system, erect mockups for each form of wall construction and finish to demonstrate esthetics effects. Build mockups to comply with the following using same materials for final Work:
  1. Locate mockups on Project Site in location and of as directed by Engineer.
  2. Demonstrate the proposed range of color and texture to be expected in completed Work.
  3. Obtain Engineer's acceptance of mockups before start of final Work.
  4. Retain and maintain mockups during construction for judging completed Work.
  5. Demolish mockups and remove from Project Site as directed by Engineer.
  6. Accepted mockups in undisturbed condition at time of Substantial Completion may become part of completed Work.

## 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in a cool dry place out of direct sunlight, protected from the elements and from damage. Store at a temperature of not less than 40 degrees F.

## 1.06 ENVIRONMENTAL REQUIREMENTS

- A. Ambient temperatures above 40 degrees F for application of the system. Provide supplementary heat installation in temperatures less than 40 degrees F. Maintain a minimum ambient temperature of 40 degrees F for at least 24 hours after system installation.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.07 SEQUENCING AND SCHEDULING

- A. Sequence installation of system with related Work to ensure that wall assemblies including flashing, trim, and joint sealers, are protected against damage from weather, aging, corrosion, and other such causes.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Provide EIMA Class PB system product from one of the following manufacturers:

1. Bonsal; W.R. Bonsal Co.
2. Dryvit Systems, Inc.
3. ISPO USA, Inc.
4. Pleko Products, Inc.
5. Senergy Inc.
6. Simplex Div., Anthony Industries, Inc.
7. STO Industries, Inc.
8. TEC Inc., an H.B. Fuller Co.
9. Thoro System Products.
10. Vitricon Div., Polymer Plastics Corp.

### 2.02 MATERIALS

- A. Compatibility: Furnish adhesive, board insulation, reinforcing fabrics, base and finish coat materials, sealants, and accessories that are compatible with one another and are approved for use by system manufacturer.
- B. Surface Sealer: System manufacturer's standard adhesion intermediary designed to improve bond between substrate and adhesive for application of insulation.
- C. Adhesive for Application of Insulation: Adhesive compatible, both in bond strength and chemical structure with the insulation and the substrate to which it is adhered, and in compliance with the following requirements:
  1. Job-mixed formulation of portland cement conforming to ASTM C150, Type 1, and polymer-based adhesive required for base coat
  2. Factory-mixed formulation designed for adhesive attachment of insulation to substrates, as approved by system manufacturer
  3. Either job-mixed or ready-mixed formulation indicated above.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Molded Polystyrene Insulation Board: Rigid expanded polystyrene conforming to ASTM C578 for Type I and approved by system manufacturer for material qualities including corner squareness, dimensional tolerances, and the following:
1. Age insulation in block form prior to cutting and shipping by air drying for not less than 6 weeks or by another method approved by system manufacturer that produces equivalent results.
  2. Furnish insulation in boards not less than 2 feet by 4 feet and in thickness as shown on Drawings.
- E. Fiberglass Reinforcing Fabric: Balanced, alkali-resistant open weave glass fiber fabric twisted multiend strands, specifically treated for compatibility with all components of system. Tensile strength of multiend strands not less than 145 pounds and 150 pounds in warp and fill directions in accordance with ASTM D1682. Minimum weight for the following items in accordance with ASTM D578:
1. Standard Reinforcing Fabric: 6 ounces per square yard.
  2. Impact-Resistant Reinforcing Fabric: 20.5F ounces per square yard.
- F. Base Coat Materials: System manufacturer's standard, job-mixed formulation of portland cement conforming to ASTM C150, Type I, white or natural color; and system manufacturer's standard polymer-based adhesive designed for this application.
- G. Finish Coat Materials: System manufacturer's standard mixture complying with the following requirements for material composition and method of combining materials:
- H. Plastic Veneer Base: Hard and breathing type bonding layer of an especially prepared mastic type material applied in a thickness sufficient to completely embed the reinforced fabric. Strength of the shear bond on surface of the insulation board, sufficient to develop the full tensile strength of the reinforcing fabric
- I. Plastic Veneer Finish: Hardening and air cured mastic type material capable of forming a breathing type coating fully bonded and compatible with the plastic veneer base to which is applied. Plastic veneer finish, color, factory mixed and integral. Color and texture; to later selection from manufacturer's full range of colors. Water: Clear, clean, and potable without any foreign matter in solution that might affect the color or setting qualities of the cement, adhesive, or finish coat.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- J. Mechanical Fastener Assemblies: System manufacturer's standard corrosion-resistant fastener assemblies consisting of thermal cap, standard washer and shaft attachments. Selected for properties of pullout, tensile, and shear strength required to resist design loads of application, capable of pulling fastener head below surface of insulation board, and of the following description:
  - 1. For attachment to masonry and concrete substrates, furnish sheathing dowel in the form of plastic wing-tipped fastener with thermal cap, sized to fit insulation thickness and penetrate substrate to depth required to secure anchorage.
- K. Elastomeric Sealants: Chemically curing, elastomeric sealant that is compatible with joint fillers, substrate joints, and other related materials complying with system manufacturer's requirements.

### 2.03 MIXING

- A. Comply with system manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as approved by system manufacturer. Mix materials in clean containers. Use materials within time period required by system manufacturer or discard.

### 2.04 ACCESSORIES

- A. Furnish plastic or noncorrosive metal beads, drips, grounds, and other accessories.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Substrate Preparation: Prepare and clean substrate surfaces to comply with system manufacturer's requirements to obtain optimum bond between substrate and adhesive for insulation.
- B. Apply surface sealer over substrate surfaces where required by system manufacturer for improving adhesion.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 3.02 INSTALLATION

- A. Comply with system manufacturer's current published instructions for installation of system to each type of substrate shown on Drawings.
  - 1. Apply adhesive to insulation by notched trowel method in manner that results in adhesive coating entire surface of gypsum sheathing once insulation is adhered to sheathing, unless system manufacturer instructions specify use of surface sealer in combination with ribbon and dab method.
  - 2. Allow adhered insulation to remain undisturbed for period prescribed by system manufacturer but not less than 24 hours, prior to beginning rasping and sanding insulation or application of base coat and reinforcing fabric.
  - 3. Apply insulation boards over dry substrates in courses with long edges oriented horizontally; begin first course from a level baseline and work upwards.
  - 4. Stagger vertical joints in successive courses to produce running bond pattern.
  - 5. Interlock ends at internal and external corners.
  - 6. Abut boards tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between insulation boards. If gaps occur, fill with insulation cut to fit gaps exactly, insert without use of adhesive.
  - 7. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/32 inch from surface of insulation and yellowed areas due to sun exposure. Do not create depressions deeper than 1/16 inch.
  - 8. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes conforming to details shown on Drawings.
  - 9. Interrupt insulation where expansion joints are shown on Drawings in substrates behind exterior insulation and finish systems.
  - 10. Form joints for sealant application between adjoining insulation edges, including insulation edges and dissimilar adjoining surfaces as shown on Drawings.
  - 11. Treat exposed edges of insulation board, except those forming substrate of sealed joints within system or between system and other Work, by encapsulating with base coat, reinforcing fabric, and finish coat.
  - 12. Coordinate installation of flashing and insulation to produce a wall system that does not allow water to penetrate behind protective coating.
- B. Apply base coat to exposed surfaces of insulation in minimum thickness recommended by system manufacturer.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Fully embed reinforcing fabric in wet base coat to produce wrinkle-free installation with fabric continuous at corners and lapped or otherwise treated at joints in accordance with system manufacturer's instructions.
  - 1. Standard reinforcing fabric.
  - 2. Impact-resistant reinforcing fabric.
- D. Double Layer Application: Apply a second base coat and second layer of reinforcing fabric of weight indicated below, in same manner as first application. Do not apply until first base coat has cured.
  - 1. Impact-resistant reinforcing fabric.
- E. Apply finish coat over dry base coat in thickness required by system manufacturer to produce a uniform finish of texture and color selected.

### 3.03 APPLICATION

- A. Insulation Board:
  - 1. Begin the application of insulation board to vertical surfaces at the base from firm, permanent, or temporary support. Apply board horizontally in a running bond. Precut insulation board to fit openings and projections. Stagger vertical joints and corners. Apply a bead of mixed adhesive 2 inches wide by 3/8 inch thick on entire perimeter of board. Apply dabs of adhesive 3/8 inch thick by 4 inches in diameter approximately 8 inches on center to the interior area. Minimum of 25 percent adhesive area must result.
  - 2. Method of Application for Masonry Substrates: Using a 3/8-inch notched trowel, apply mixed adhesive to entire surface of insulation board. The "notched trowel" method must be used on all gypsum substrates. It can also be used as an alternate method on flat substrates. Apply pressure over entire surface of board to ensure uniform contact and high initial grab. Abut all joints tightly and ensure an overall flush level surface. Rasp flush all irregularity of insulation board greater than 1/16 inch. All accessory items and expansion joints completely bedded in with adhesive.
- B. Plastic Veneer Base and Reinforcing Fabric: Using a stainless steel trowel apply mixed plastic veneer base to entire surface of insulation board to a uniform thickness of approximately 1/16 inch. Immediately place the reinforcing fabric against the wet plastic veneer base coating by troweling from the center to the edges, embed the fabric into the coating. Reinforcing fabric continuous at corners and lapped not less than 2-1/2 inches at fabric

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edges. Avoid wrinkles in embedding the reinforcing fabric. Apply additional layers of plastic veneer base and reinforcing fabric at all wall openings and outside corners.

### C. Plastic Veneer Finish:

1. Using a clean stainless steel trowel, apply a tight coat of the plastic veneer finish material directly to the reinforced plastic veneer base coating. During the same operation apply and level to the minimum attainable thickness consistent with uniform coverage. Continually apply and texture plastic veneer finish over wall surfaces. Work to corners or joints and do not allow the material to set up within a distinct wall area.
2. Achieve final texture after the plastic veneer finish has gelled so that it does not stick to the trowel. Apply the final texture by allowing the trowel to roll on the round aggregate using a variety of motions and trowels or floats to create the desired sand-float texture to match sample.
3. Final Texture: Sandblast sprayed.
4. Final Thickness: No greater than the diameter of the largest aggregate of the plastic veneer finish material.
5. Following manufacturer's directions, apply plastic veneer finish to concrete in locations shown on Drawings.

### 3.04 PROTECTION

- A. Protect surrounding areas and surfaces to preclude damage during application of the system. Protect finished Work when stopping for the day and when completing an area to prevent water from penetrating behind the system.

**END OF SECTION**

**SECTION 07 26 00  
VAPOR RETARDERS**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI): 302, Guide for Concrete Floor and Slab Construction.
  2. ASTM International (ASTM):
    - a. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
    - b. D1709, Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
    - c. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
    - d. D4479, Standard Specification for Asphalt Roof Coatings – Asbestos-Free.
    - e. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
    - f. E1745, Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
    - g. F1249, Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

**1.02 SUBMITTALS**

- A. Action Submittals: Manufacturer's materials' specifications.
- B. Informational Submittals:
1. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
  2. Manufacturer's written instructions for preparation, installation/application, repair, protection and maintenance.
  3. Manufacturer's Certification of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

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## 1.03 DELIVERY, STORAGE, AND HANDLING

- A. Store fluid-applied materials in area where temperatures are not less than 50 degrees F or over 85 degrees F, unless otherwise authorized in writing by manufacturer.

## **PART 2 PRODUCTS**

### 2.01 UNDERSLAB VAPOR RETARDER

- A. Meet or exceed ASTM E1745, Class A, with the following properties:
  - 1. Water Vapor Permeance: 0.03 perms maximum when tested in accordance with ASTM E96/E96M or ASTM F1249.
  - 2. Tensile Strength: 45-foot-pounds per inch minimum, when tested in accordance with ASTM D882.
  - 3. Puncture Resistance: 2,200 grams minimum, when tested in accordance with ASTM D1709.
  - 4. Thickness: 10 mils minimum, in accordance with ACI 302.
- B. Manufacturers and Products:
  - 1. Fortifiber Building Systems Group; Moistop Ultra 10.
  - 2. Reef Industries, Inc.; Griffolyn 10 mil Green.
  - 3. Stego Industries, LLC; Stego Wrap Class A Vapor Retarder.

### 2.02 FLUID APPLIED VAPOR RETARDER

- A. Two-Component Butyl Rubber Elastomer:
  - 1. Brush or spray consistency.
  - 2. Manufacturer and Product: Futura Coatings, Inc.; Elasto-Bond 801.
- B. Asphalt Compound:
  - 1. Brush or spray consistency meeting ASTM D4479, Type 1.
  - 2. Manufacturers and Products:
    - a. W.R. Meadows, Inc.; Sealtight Sealmastic.
    - b. Texmastic International, Inc.; Tex-Mastic No. 720.

### 2.03 PLASTIC SHEET VAPOR RETARDER

- A. ASTM D4397.
- B. Minimum Thickness: 6 mils.

2.04 ANCILLARY MATERIALS

- A. Fasteners, Tape, Adhesive, or Sealant: As recommended by vapor retarder manufacturer.
- B. Pipe Boots: Underslab vapor retarder manufacturer's prefabricated or field fabricated item.

**PART 3 EXECUTION**

3.01 UNDERSLAB VAPOR RETARDER

- A. Installation: Apply vapor retarder in accordance with manufacturer's instructions, and as follows:
  - 1. After base for slab has been leveled and tamped, apply vapor retarder with roll width parallel to direction of concrete pour.
  - 2. Lap vapor retarder over footings and seal to foundation walls.
  - 3. Overlap joints 6 inches and seal with tape.
  - 4. Seal penetrations with pipe boots.
  - 5. Repair damaged areas with patches of vapor retarder, overlapping damaged area by 6 inches and sealing sides of patch with tape.

3.02 FLUID APPLIED VAPOR RETARDER

- A. Examination: Verify appropriate substrate and environmental conditions exist prior to starting Work.
- B. Preparation:
  - 1. Clean surfaces, in accordance with manufacturer's written instructions, of dust, dirt, oil, wax, and other foreign materials.
  - 2. Remove efflorescence by scrubbing surface with muriatic acid and thoroughly rinsing with water.
  - 3. Fill cracks, voids, and honeycombs with mortar to provide sound surface.
  - 4. Allow 72 hours' surface drying time before applying vapor retarder.
- C. Application:
  - 1. Do not apply when ambient temperature is less than 50 degrees F, or when temperatures below 40 degrees F are predicted within 24 hours after application.
  - 2. Do not apply in rainy conditions or within 72 hours after surfaces become wet from rainfall or other moisture.



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3. Use brush or approved low-pressure airless spray equipment with coarse nozzle.
4. Rate: In accordance with manufacturer's written recommendations.
5. Commence application at top of wall and work down surface, keeping a wet edge at all times, forming a continuous unbroken film, free from pinholes and other surface breaks.
6. Film Thickness: As required to provide perm rating not greater than 0.1.
7. Protect surfaces from heat and direct sunlight until dried.

### D. Testing:

1. After vapor retarder has dried, spray surfaces with water.
2. Recoat surfaces that show water absorption.

### 3.03 PLASTIC SHEET VAPOR RETARDER

- A. Place on frame construction with sheet size as large as possible.
- B. Fasteners: As recommended by plastic sheet manufacturer.
- C. Joints: Apply joint tape or adhesive as recommended by plastic sheet manufacturer.
- D. Seal edges with tape or manufacturer's recommended sealant.
- E. Seal around penetrations such as outlets or piping to ensure complete vapor-tight installation.

### 3.04 CLEANING

- A. Upon completion of vapor retarder installation, remove waste materials and debris resulting from this operation and dispose offsite.
- B. Clean fluid applied spillage and overspray from adjacent surfaces as recommended by manufacturer.

**END OF SECTION**

**SECTION 07 41 13  
STANDING SEAM ROOF PANELS**

**PART 1 GENERAL**

1.01 SCOPE OF WORK

- A. Work described in this Section includes pre-formed metal roofing system complete with clips, perimeter and penetration flashing and closures.

1.02 RELATED SECTIONS

- A. Drawings and General Provisions of the Contract, including General Supplementary Conditions and Division 1 Specification Sections apply to this Section.
- B. Related Work:
  - 1. Preparation for Roofing.
  - 2. Steel Joists.
  - 3. Metal Roof Decks.
  - 4. Structural Steel.
  - 5. Rough Carpentry.
  - 6. Roof and Deck Insulation.
  - 7. Flashing and Sheet Metal.
  - 8. Vapor Barrier.
  - 9. Roof Specialty and Accessory Items.

1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Architectural Manufacturer Association (AAMA):  
AAMA 501.1, Standard Test Method for Metal Curtain Walls for Water Penetration Using Dynamic Pressure.
  - 2. American Iron and Steel Institute (AISI): 1996 Ed., Specification for the Design of Cold-Formed Steel Structural Members.
  - 3. American Society of Civil Engineers (ASCE): ASCE 7-02, Minimum Design Loads for Buildings and Other Structures.
  - 4. ASTM International (ASTM):
    - a. A653-96, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
    - b. A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

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- c. A875-99, Standard Specification for Steel Sheet, Zinc-5% Aluminum Alloy-Coated by the Hop Dip Process.
  - d. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  - e. D1056-91, Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
  - f. D3575-84, Standard Specification for Test Methods for Flexible Cellular Materials made from Olefin Polymers.
  - g. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
  - h. E331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
  - i. E1592-95, Standard Specification for Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
  - j. E1646-95, Standard Specification for Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
  - k. E1680, Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): Architectural Sheet Metal Manual, 5<sup>th</sup> Ed.
  6. Underwriters Laboratories Inc. (UL): 580, Standard for Tests for Uplift Resistance of Roof Assemblies.

### 1.04 SUBMITTALS

- A. Any material submitted as equal to the specified material must be accompanied by a copy of the manufacturer's standard specification section. That specification section shall be signed and sealed by a professional engineer licensed in the state/province in which the installation is to take place. Substitution requests containing specifications without licensed engineer certification shall be rejected for non-conformance.
- B. Shop Drawings:
  1. Show roofing system with flashings and accessories in plan, sections and details. Include metal thickness' and finishes, panel lengths, joining details, anchorage details, flashings and special fabrication provisions for termination and penetrations; thermal expansion provisions and special supports.
  2. Indicate relationships with adjacent and interfacing work. Indicate fastener types and spacing; and provide fastener pullout values.

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3. Shop drawings must be completed by the metal panel manufacturer's engineering department.
- C. Product Data: Include manufacturer's detailed material and system description, sealant and closure installation instructions, engineering performance data and finish specifications. Indicate fastener types and spacing; and required fastener pullout values.
- D. Design Loads: Submit copy of manufacturer's minimum design load calculations according to ASCE 7-02, Method 2 for Components and Cladding. In no case shall the design loads be taken to be less than those detailed in Article 1.9 of this Specification.
- E. Design Test Reports: Provide certified test reports from an independent testing laboratory that bear the seal of a registered professional engineer to show compliance with the performance criteria specified in Article 1.9. Each of the following test reports must be submitted:
1. ASTM E283-93 and E331-86: Test results must clearly demonstrate compliance with the performance requirements specified in Article 1.9.
  2. ASTM E1646-95 and E1680-95: Test results must clearly demonstrate compliance with the performance requirements specified in Article 1.9. Results are not applicable for systems that are thinner, wider, lower grade, or different material/profile than the system which was tested. The differential test pressures must be equal to those specified in Article 1.9.
  3. UL 790: The proposed roof panel shall be listed as a non-combustible roof covering material and be approved for use in a UL classification assembly.
  4. UL 263: The proposed roof panel shall be listed for use in a UL fire rated construction assembly.
- F. Samples: Provide full scale samples of the following materials and system components. Samples shall be of identical material type, thickness, panel width, and material grade/alloy/temper as the system specified for this project. Except for Item 2, samples may be of any of the manufacturer's standard colors.
1. Submit a twelve (12) inch long by actual width sample of panel showing seam profile and stiffening mesas across the flat pan of the panel. Also include separate snap-on cap with factory applied hot melt sealant beads.
  2. Provide a six by six (6 x 6) inch sample of the color selected for this project. The sample shall be the actual specified coating system on a metal substrate.

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3. Provide samples of actual system components, including: each type of anchor/clip required, head closure assembly, roll goods (if specified), bearing plates and/or frame (if specified).

### 1.05 ALTERNATE MANUFACTURERS

- A. Alternate Manufacturers: The following manufacturer criteria must be submitted. Alternate systems will not be considered for approval unless each of these items has been submitted for review at least 10 business days prior to bid opening:
  1. Submit each item listed in Article 1.4 (A through E) for evaluation of the proposed system.
  2. Tests shall have been made for identical systems within the ranges of specified performance criteria.
  3. Empirical calculations for roof performance shall only be acceptable for positive loads.
  4. A list of a minimum of five (5) jobs where the proposed alternate material was used under similar conditions. The reference list shall include date of project, size of project, project address, and telephone number of architect/Owner contact.
  5. A financial statement demonstrating a minimum of a 3:1 ratio of assets to liabilities.
  6. A written statement from the manufacturer stating that they will provide the building owner with a daily site inspection for a minimum of one (1) hour per day by an experienced, full time employee of the company.
  7. A written statement from the manufacturer stating that they will provide the Engineer of record with a daily site inspection by an experienced full time employee of the company.
  8. A written statement from a corporate officer of the manufacturing company stating that he or she has reviewed the specifications and confirms that the proposed system meets or exceeds all performance requirements listed as well as meets the panel size, gauge, weight, clip design, sealant design, uplift pressures and height of the vertical seam.
  9. A copy of manufacturer's 30 year warranty. Warranty must include coverage for all trim, flashing, and penetrations associated with this roof.
  10. Proof that the manufacturer has been in business for a minimum number of years equal to the warranty period required for this project.
- B. Proof that the manufacturer has been in business for a minimum number of years equal to the warranty period required for this project.

1.06 QUALITY ASSURANCE

A. Applicator's Qualifications: Approved and trained by materials manufacturer.

B. Mockups:

1. Before Work of this section begins, fabricate, for acceptance, (4' wide) Sample roofing panel including fascia and soffit using materials and methods identical to those to be used on Project.
2. Sample panel shall include typical seam, fasteners, curbs, ridges, eaves, gutters, soffit, downspouts, and valleys.
3. Locate mockup where directed by the Engineer.
4. Accepted mockup constitutes minimum Project standards and shall be maintained for comparison with finished Work.
5. Dispose of mockup when directed by the Engineer.

C. Preliminary Roofing Conference:

1. Before starting roof deck construction, conduct onsite conference with Engineer, roofing applicator, roofing system materials manufacturer, testing and inspecting agency and Subcontractors likely to be on roof.
2. Agenda: Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to avoid delays. Discuss and resolve questions regarding acceptability of the deck, roofing system and materials, flashing details, roof insulation, roof-mounted mechanical equipment, and roofing. Document all discussions.

D. Preinstallation Conference:

1. Before starting metal roof installation, conduct a conference with Engineer, roofing applicator, roofing system materials manufacturer, testing and inspecting agency. Subcontractors likely to be on roof, and installers whose work affects metal roof installation.
2. Items to be reviewed and discussed include, but are not limited to, the following items:
  - a. Examine roof deck or substrate conditions for compliance with requirements for flatness and tolerance of structural members.
  - b. Review structural loading limitations of roof deck or purlins and rafters during roofing installation.
  - c. Review flashing details, roof drainage, roof insulation, roof penetrations, roof-mounted mechanical equipment, and other construction and conditions that might affect metal roof panel installation.

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- d. Review governing regulations and requirements for insurance, certificates, and testing and inspecting as applicable.
- e. Review temporary protection requirements for metal roof panels during and after installation.

### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver components and metal roof panels so as not to be damaged or deformed. Package for protection during transportation and handling.
- B. Storage and Handling:
  - 1. Protect against damage and discoloration.
  - 2. Handle panels with nonmarring slings.
  - 3. Do not bend panels.
  - 4. Store panels aboveground on pallets or platforms, with one end elevated for drainage.
  - 5. Protect strippable protective covering from exposure to sunlight except as necessary for metal roof installation.
  - 6. Stack panels to prevent twisting, bending, or abrasion, and to provide ventilation.
  - 7. Protect panels against standing water and condensation between adjacent surfaces.
  - 8. If panels become wet, immediately separate sheets, wipe dry with clean cloth, and separate sheets for air-drying.
  - 9. During storage prevent contact with materials that may cause discoloration or staining.

### 1.08 COORDINATION

- A. Coordinate installation of roof curbs, equipment support, and other roof accessories as specified in Section 07 70 01, Roof Specialties and Accessories.
- B. Coordinate metal roof installation with flashing and trim as specified in Section 07 62 00, Sheet Metal Flashing and Trim.
- C. Coordinate work with construction of decks, parapets, walls, and other adjoining work.

### 1.09 SPECIAL GUARANTEE

- A. Product: Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction or, at the option of the Owner, removal and

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replacement of roofing panels, flashing, finish, and accessories found defective during a specified period after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified the General Conditions.

1. Manufacturer's 30 years watertight warranty, including coverage for all trim, flashings, and penetrations associated with standing seam roof area.
  2. 20 year coverage on finish including checking, crazing, peeling, chalking, fading and /or adhesion.
  3. installer shall provide 2 year warranty covering roofing system installation and watertightness.
  4. One manufacturer shall provide a single warranty for standing seam roof areas, and modified bithumen roof area, and transition between two material types.
- B. Conditions:
1. Roofing Panels: No rupture, structural failure, or perforation.
  2. Finish: No cracking, blistering, flaking, chipping, checking, chalking, peeling, or fading.
  3. Components: Watertight and weathertight with normal usage.

### **PART 2 PRODUCTS**

#### **2.01 ROOFING , FLASHING AND FASCIA PANELS**

- A. Material: Steel, galvanized, ASTM A653/A653M, coating designation G90, 24-gauge minimum metal thickness.
- B. Surface: Smooth finish.
- C. Finish:
  1. Two coats coil applied, backed on full strength( 70% resin) fluorocarbon coating system( polyvinylidene fluoride, PVF-2), applied be manufacturer's approved applicator.
  2. ting system to provide nominal 1.0mil dry film thickness, consisting of primer and color coat
  3. Color: To match Garland Dark Bronze.
  4. Unexposed surfaces for coated panels to have backed-on polyester coating with .20-.30 DFT



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### D. Standing Seam, Snap-Joint:

1. Factory-formed metal roof panels with vertical ribs at panel edges and flat pan between vertical ribs; designed for sequential field installation by mechanically attaching panels to supports using concealed clips located under one side of panel and engaging opposite edge of adjacent panels and snapping together.
2. Panel Coverage: 18 inches.
3. Panel Height: 1.75inches.
4. Manufacturers and Products:
  - a. Garland Company ,R-MER Span System.
  - b. Acceptable manufacturers:
  - c. AEP-SPAN.
  - d. Berridge.
  - e. Petersen Aluminum Corp.

## 2.02 METAL SOFFIT PANELS

- A. General: Provide factory-formed metal soffit panels designed to be field-assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fastening and factory-applied sealant in side laps; included accessories for a complete, weathertight installation.
- B. Match finish, color, material, and profile of metal roof panels.
- C. Flush Profile: Perforated panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges with flush joint between panels.
  1. Material; Aluminum sheet 0.032-inch minimum metal thickness.
  2. Finish: Fluoropolymer.
  3. Color: As selected from manufacturer's standard color range.
  4. Panel Coverage: 12 inches.
  5. Panel Height: 1 inch(es).
  6. Manufacturers and Products:
    - a. AEP Span.
    - b. CENTRIA Architectural Systems.
    - c. Garland Company.
- D. Accessories.
  1. Gable anchor clips:
    - a. Standing Seem style
    - b. Galvalume steel, type AZ-55, minimum thickness 16 gauge

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### 2.03 ACCESSORY PRODUCTS

- A. Underlayment: ASTM D226, Type II or ASTM D2178, Type III asphalt roofing felt.
- B. Ice and Water Shield: Cold applied, self-adhering, polyethylene-faced sheet, consisting of slip-resisting polyethylene-film reinforcing top surface laminated to SBS-modified asphalt adhesive with release-paper backing, 40-mil minimum thickness meeting ASTM D1970.
- C. Slip Sheet: Coated-glass fiber fire-resistant slip sheet as recommended by sheet metal roofing manufacturer.
- D. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal by means of factory-applied coating.
  - 1. Concealed fasteners; Corrosion resistant steel( stainless steel) designed to meet structural loading requirements.
  - 2. Type 410 stainless steel.
  - 3. Fasteners for Flashing and Trim: Self-drilling screws with hex washer head or blind fastener rivets of high-strength aluminum or stainless steel.
- E. Holddown Clips: System manufacturer's ASTM A792/A792M standard shape steel.
- F. Closures: Manufacturer's standard neoprene blocks shaped to fit roof metal profile.
- G. Sealant:
  - 1. Joint Sealant: Type 5 as specified in Section 07 92 00, Joint Sealants.
  - 2. Silicone Sealant: Type 1 as specified in Section 07 92 00, Joint Sealants.
  - 3. Tape Sealant: Type 13 as specified in Section 07 92 00, Joint Sealants.
  - 4. Butyl Sealant: Butyl-rubber based, solvent-release sealant per ASTM C1311.
- H. Isolation Paint: ASTM D1187, asphalt.

### 2.04 FABRICATION

- A. Fabricate and finish metal roof panels and accessories at factory to the greatest extent possible.

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- B. Provide panel profile, including major ribs and any intermediate stiffening ribs for full panel length.
- C. Panel Length: Roof panels shall be full length from eave to ridge, unless otherwise indicated or limited by shipping limitations.
- D. Where indicated, fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact.
- E. Form and fabricate sheets, battens, strips, cleats, valleys, ridges, edge treatments, integral flashings, gutters, downspouts, and other components of specified metal roofing panels to profiles, patterns, and drainage arrangement shown, and as required for permanent leakproof construction, and as recommended by SMACNA's "Architectural Sheet Metal Manual."
- F. Provide for thermal expansion and contraction of Work.
- G. Conceal fasteners and methods of expansion where possible. Do not use exposed fasteners on faces of accessories where exposed to view.
- H. Finishes:
  - 1. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
  - 2. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half the range of approved sample. Noticeable variations within same piece are not acceptable. Variations in other component appearances are acceptable if within range of approved samples and are assembled or installed to minimize contrast.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION.**

- A. Examine substrates and conditions for compliance with alignment tolerances required by metal roof panel manufacturer.
- B. Prior to beginning installation, examine rough-in location for items penetrating metal roof panels and coordinate with seam locations.

#### **3.02 PREPARATION**

- A. Deck: Firm, dry, free of foreign materials, and smooth. Report immediately to Engineer cracks, breaks, holes, or other unusual irregularities in surface.

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### B. Layout Pattern:

1. Lay out to place seams equidistant from corners and aligned with seams on other side of hip or ridge.
2. Coordinate Work of this section with flashing, trim, and other construction to provide a permanently leakproof, secure, and noncorroding installation.

### 3.03 INSTALLATION

#### A. General:

1. Apply roofing only in dry weather and where weather conditions permit.
2. Install in accordance with manufacturer's written instructions and warranty requirements.
3. Comply with recommendations of the SMACNA "Architectural Sheet Metal Manual."
4. Install metal roofing fascia and soffit system consisting of nonstructural sheet metal panels held to substrate with concealed fasteners.
5. Conceal expansion joint provisions wherever possible in exposed Work; locate so as to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
6. Closures and Trim:
  - a. Provide ridges, hips, valleys, eaves, rakes, fascia and soffit, coping, gutters, downspouts, and other exposed trim and flashing for a weather-tight roofing system.
  - b. Provide metal closures at peaks: rake edges: rake wall: and each side of ridge and hip caps.
  - c. Flash and seal metal roof panels with weather closures at eaves, rakes, and at perimeter of openings. Fasten with self-tapping screws.
7. Install ridge and hip caps as the metal roof panel work proceeds.
8. Dissimilar Metals:
  - a. Separate from each other where electrolysis might occur.
  - b. Separate metal panels where contact with corrosive substrates may occur.
  - c. Separation is satisfactorily accomplished by coating metals with isolation Paint.
  - d. Comply with various metals producers' recommendations for other forms of protection against contamination from corrosive materials or agents.
9. Locate panel splices, if occur, over structural supports. Do not fasten. Stagger panel splices and end laps to avoid a four-panel lap splice condition. At cross seams, form with 3/4-inch fold under on lower end

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and 2-inch fold over on upper end. Slit folds in cross-seams at each corner 1 inch in from seam to form tab. Use holddown cleats at cross seams. Hook fold on lower end of panel into fold on upper end of underlaying panel. Use two cleats per panel width.

10. Lap metal flashing over metal roof panels to allow moisture to run over and off the material.
  11. Cutting and Fitting: Neat, square, and true. Saw cut panels, deburr, and use touchup paint immediately as recommended by roofing panel manufacturer. Torch cutting is prohibited.
  12. Gutters, Downspouts, and Flashings:
    - a. Straight, weather-tight, exposed surfaces free of dents, scratches, abrasions, stains, and other visible defects.
    - b. Extend gutter lining under metal roofing 6 inches minimum and terminate in 3/4-inch folded edge secured by cleats
- B. Ice and water shield:
1. Install ice and water shield membrane on metal deck, in accordance with manufacturer's recommendation.
  2. Install no more than can be covered by metal roofing or other approved protection, in same day.
- C. Standing-Seam and Batten-Seam Metal Roof:
1. Install as recommended by metal roof panel manufacturer's installation instructions and recommendations.
  2. Begin at eaves. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction.
  3. Install clips in panel side joints at location, spacing, and with fasteners as recommended by manufacturer for type of substrate and wind loading specified.
- D. Metal Soffit Panels: Provide full width of soffit. Install perpendicular to support framing. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of openings and joints.
- E. Fascia Panels: Align bottom edge for a straight true line. Flash and seal panels with weather closures where metal fascia panels meet walls, along lower panel edges, and at perimeter of all openings and joints.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.04 CLEANING AND PROTECTION

#### A. Cleaning:

1. At the end of each day sweep metal clean of foreign materials, especially metal particles and scrap.
2. Peel off strippable film.
3. Where needed, clean metals in conformance with metals industry recommendations or use Basic H organic metal cleaner, Shaklee Products, Hayward, CA.

#### B. Protection:

1. Protect material from exposure to chlorides, hydrochloric-based and muriatic acids. If contaminated, wash affected areas immediately with 5 percent soda and water solution and rinse with clear water.
2. Avoid walking on roof after completion.

#### C. Final Cleanup:

1. Remove debris, metal clips, nails, and other materials that could prevent adequate drainage or produce corrosion products through electrolysis.
2. Repair and touch up damage.
3. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair.

**END OF SECTION**



**SECTION 07 52 16**  
**SBS-MODIFIED BITUMINOUS MEMBRANE ROOFING**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards that may be referenced in this section:
1. American Wood Preservers' Association (AWPA): C2, Lumber, Timbers, Bridge Ties, and Mine Ties-Preservative Treatment by Pressure Processes.
  2. ASTM International (ASTM):
    - a. C552, Standard Specification for Cellular Glass Thermal Insulation.
    - b. C578, Standard Specification for Preformed, Cellular Polystyrene Thermal Insulation.
    - c. C726, Standard Specification for Mineral Fiber Roof Insulation Board.
    - d. C728, Standard Specification for Perlite Thermal Insulation Board.
    - e. C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
    - f. D41, Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
    - g. D312, Standard Specification for Asphalt Used in Roofing.
    - h. D1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
    - i. D4586, Standard Specification for Asphalt Roof Cement, Asbestos Free.
    - j. D4601, Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing.
    - k. D6162, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements.
    - l. D6164, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.
  3. Factory Mutual (FM): Loss Prevention Data.
    - a. I-28, Insulated Steel Deck.
    - b. I-28S, Wind Uplift Pressure on Roofs.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

4. Federal Specifications (FS):
  - a. HH-1/GEN, (Basic; Am 1; Notice 1) Insulation Board, Thermal, Faced, Polyurethane or Polyisocyanurate.
  - b. HH-1/2, (Basic; Am 1) Insulation Board, Thermal, Polyurethane or Polyisocyanurate Faced with Asphalt/Organic Felt, Asphalt/Asbestos Felt or Asphalt/Glass Fiber Felt on Both Sides of the Foam.
5. National Roofing Contractors Association (NRCA): Handbook of Accepted Roofing Knowledge (HARK).

### 1.02 SUBMITTALS

#### A. Action Submittals:

1. Project-specific details of roof edges and penetrations.
2. Mechanical fastening diagram for rigid insulation, where applicable.
3. Layout drawings for tapered insulation, showing slopes and thicknesses.
4. List of materials proposed for use including roofing materials, insulation, composition flashing, and fasteners.
5. Roofing materials manufacturer's specifications selected for use.
6. Description of complete system, from deck up, proposed for use.

#### B. Informational Submittals:

1. Manufacturer's installation instructions.
2. A letter from roofing materials manufacturer stating roofer is approved by manufacturer to apply roof.
3. Sample copy of special guarantee to be provided.
4. Manufacturer's Certification of Compliance.
5. Test reports, in triplicate, of field test cuts of roofing system.
6. Written notice when roofing installation is ready for final inspection.
7. Record of Preroofing Conference.
8. Record drawings for tapered insulation.

### 1.03 QUALITY ASSURANCE

- A. Materials, including insulation, used in a roofing system shall be furnished by, or approved by, manufacturer whose roofing system is selected for use.
- B. Roofer Qualifications: Approved by roofing materials manufacturer to apply roof.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### C. Preroofing Conference:

1. Attendees: Conduct preroofing conference with Engineer, roof deck installer, inspecting agency, roofing system materials manufacturer's representative, roof insulation manufacturer's representative, roofer, mechanical equipment installer and other subcontractors likely to be on roof.
2. Agenda: Follow outline in NRCA, HARK including acceptability of deck, roofing system materials manufacturer's specification selected, flashing details, roof guarantee, and protection of finished roofing system.
3. Record: Discussions and agreements and furnish copy to each participant and entity invited.

### 1.04 APPROVED MANUFACTURERS

- A. This system is based on Soprema's products. Equivalent by Garland Company are accepted provided that they meet the specified requirements.

### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened containers and rolls with labels intact and legible. Labels on bitumen shall show composition, softening point (SP) range, minimum flashpoint (FP), minimum finished blowing temperature (BT), and equiviscous temperature (EVT) range.
- B. Handle roll goods so as to prevent damage to edge or ends. Store roll goods on end.
- C. Store rigid roof insulation materials on clean, raised platforms.
- D. Protect materials against direct sunlight, wetting, moisture absorption, mud, dust, sand, oil, grease, dirt, and construction traffic.

### 1.06 ENVIRONMENTAL REQUIREMENTS

- A. Temperature:
  1. Apply roofing only in dry weather and when ambient temperature is above 40 degrees F.
  2. When temperature is below 45 degrees F, application must be approved by, and under supervision of, roofing materials manufacturer.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.07 SPECIAL GUARANTEE

- A. Product: Furnish manufacturer's extended guarantee, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction or, at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of 30 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.
- B. Coverage and Conditions:
  - 1. All costs for repairs required to maintain roofing system, composition flashing, and expansion joint covers in watertight condition.
  - 2. Natural deterioration of roofing system due to ordinary wear and tear by the elements; and
  - 3. Defects due to faulty materials or workmanship during application.

## 1.08 SCOPE OF WORK

- A. Work of this section includes installing 2-ply Modified Bitumen membrane roofing over a concrete deck, including but not limited to the following:
  - 1. Self-adhesive Vapor Retarder
  - 2. Adhered tapered insulation
  - 3. Adhered Polyisocyanurate rigid insulation.
  - 4. Adhered Insulation Overlay Board
  - 5. Torch-on Base Sheet
  - 6. Self-adhesive Base Sheet Flashing
  - 7. Torch-on Cap and Cap Sheet Flashing
  - 8. Walkways Protection Mat
  - 9. Concrete pavers on pedestals

## PART 2 PRODUCTS

### 2.01 PRIMER

- A. Description: A stabilized bituminous emulsion primer used to enhance adhesion of membranes.
- B. Specified product: ELASTOCOL STICK by SOPREMA (for self adhesive membranes)
- C. Specified product: ELASTOCOL 500 by SOPREMA (for torched or hot mopped membranes)

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.02 VAPOR RETARDER

- A. Description: Self-adhesive vapor barrier membranes composed of bitumen modified with thermoplastic polymers and high-density polyethylene film. Width of the membrane to be 45 inches. The self-adhesive under face is covered with a silicone release sheet. Water vapor permeability: 0.016 Perm.
- B. Specified product: SOPRAVAP'R by SOPREMA.

### 2.03 ROOF INSULATION

- A. Average Aged R-Value for Total Thickness of Rigid Roof Insulation: Minimum R=20.
- B. At Contractor's option, any one of the following insulation materials may be used on this Project provided roofing materials manufacturer approves insulation used and will guarantee roofing system.
  - 1. Fibrous Glass Board: ASTM C726, minimum size 3 feet by 4 feet, covered on one side with a factory-applied base sheet, as manufactured by Johns Manville.
  - 2. Cellular Glass: ASTM C552, minimum size 18 inches by 24 inches, as manufactured by Pittsburgh Corning, Foamglas.
  - 3. Expanded Perlite Board: ASTM C728, minimum size 2 feet by 4 feet, as manufactured by:
    - a. Celotex; Celo--Therm.
    - b. GAF; Permalite.
    - c. Johns Manville; Fesco Board.
  - 4. Polyisocyanurate Foam Board: ASTM C1289, Type II, with Factory Mutual Class I approval, minimum size 2 feet by 4 feet, as manufactured by:
    - a. Atlas Roofing Corp.; AC Foam II.
    - b. Celotex; Hy-Therm AP.
    - c. GAF; GAFTEMP Isotherm.
    - d. Johns Manville; E'NRG'Y 2.
  - 5. Composite Board: Of polyisocyanurate or polyurethane foam core bonded to 1/2-inch perlite fiberboard minimum size 3 feet by 4 feet, as manufactured by:
    - a. Atlas Roofing Corp.; AC Foam II.
    - b. Apache Products Co.; Millox.
    - c. Celotex; Hy-Therm COMPOSITE.
    - d. Johns Manville; ISO-1.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

6. Tapered Board System:
  - a. Factory precut or field tapered insulation board, minimum 1-inch thick, with top surface cut to a uniform, continuous slope of 1/4 inch per foot.
  - b. Fabricate miters and edges to match abutting blocks.
  - c. Manufacturers and Products:
    - 1) As specified for composite board.
    - 2) Apache Products Co.; Tapered Millox.
    - 3) Johns Manville; Tapered E'NRG'Y 2 Plus.
    - 4) Pittsburgh Corning Corp., Pittsburgh, PA 15239; Tapered Foamglas "PC Plusystem 1".

### 2.04 TAPERED EDGE, CRICKETS, AND CANT STRIPS

- A. Use Preformed Shapes:
  1. Bitumen-coated on all sides, expanded perlite.
  2. Wood treated in accordance with AWPA C2 for waterborne salts and dried to 19 percent moisture content or less after treatment.

### 2.05 INSULATION OVERLAY BOARDS

- A. Description: Multi-ply, semi-rigid asphaltic roofing substrate board composed of a mineral fortified asphaltic core formed between two asphaltic saturated fiberglass liners. Length 4 feet-0 inches by width 5 feet-0 inches by 1/8 inches.
- B. Specified product: SOPRABOARD by SOPREMA or approved equivalent.
- C. At parapets and curbs use 1/4 inch thick SOPRABOARD.

### 2.06 ADHESIVES

- A. For Temperatures Above 40 Degrees F (5 Degrees C):
  1. Description: Solvent-based polyurethane bitumen adhesive that can be applied by ribbons or spots
  2. Specified product: COLTACK by SOPREMA or approved equivalent
- B. For Temperatures Below 40 Degrees F (5 Degrees C):
  1. Description: Low-rise two-part urethane adhesive with no solvents. Allows a complete cure in few minutes, with no temperature restrictions.
  2. Specified product: DUOTACK INSULATION ADHESIVE by SOPREMA or approved equivalent

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.07 MEMBRANES

#### A. Roof Membrane Base Sheet:

1. Description: Roofing membrane with glass & polyester reinforcement and elastomeric bitumen. Both sides covered with a thermofusible plastic film. The top face must be marked with three (3) distinctive blue chalk lines to ensure proper roll alignment.
2. Specified product: SOPRAPLY BASE-520 by SOPREMA

#### B. Roof Membrane Base Sheet Flashing:

1. Roofing membrane with glass mat reinforcement and SBS modified bitumen. The top face is covered with a thermofusible plastic film, the under side is self-adhesive. The top face must be marked with three (3) distinctive blue chalk lines to ensure proper roll alignment.
2. Specified product: SOPRAFLASH FLAM STICK by SOPREMA.

#### C. Roofing Membrane Cap Sheet and Cap Sheet Flashing:

1. Roofing membrane with fiberglass & polyester reinforcement and elastomeric bitumen. The top face is covered protected by coloured granules, the under face is covered with a thermofusible plastic film.
2. Specified products: SOPRAPLY TRAFFIC CAP 560 by SOPREMA.

### 2.08 WALKWAYS PROTECTION MAT

- A. Description: 3/4 inch thick recycled rubber mat for protecting waterproofing membranes from foot traffic. The top face of the SOPRAMAT is embossed with a hexagon-shaped design. Underneath the SOPRAMAT there are longitudinal grooves spaced at 1 inch. The grooves are 1/4 inches wide by 1/8 inches deep.
- B. Specified product: SOPRAMAT by Soprema Inc.

### 2.09 CONCRETE PAVERS

- A. 24 inches by 24 inches by 2 inches precast concrete paver by Brooklin Concrete Products or approved equivalent

### 2.10 WATERPROOFING MASTICS

- A. Waterproofing products: Mastic made of synthetic rubbers, plasticized with bitumen and solvents.
- B. Specified product: SOPRAMASTIC by SOPREMA.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Specified product: SOPRAMASTIC ALU by SOPREMA. (for exposed areas).

### **PART 3 EXECUTION**

#### 3.01 SURFACE EXAMINATION AND PREPARATION

- A. Surface examination and preparation must be completed in conformance with recommendations in the SOPREMA Manual, particularly for fire safety precautions.
- B. Do not begin any work before surfaces are smooth, dry, and exempt of ice and debris. Use of calcium or salt is forbidden for ice or snow removal.
- C. No materials will be installed during rain or snowfall.

#### 3.02 METHOD OF INSTALLATION

- A. Prepare surfaces and complete waterproofing work in conformance with SOPREMA'S requirements, and the "Material Installation Guide"
- B. Install roofing elements on clean and dry surfaces, in conformance with manufacturer's instructions and recommendations.
- C. Roofing work must be completed in a continuous fashion as surfaces are readied and weather conditions permit.
- D. Ensure watertight conditions for roofs at all times, including protection during installation work by other trades and progressive protection as work is completed (e.g. vents, drains, etc.).

#### 3.03 EQUIPMENT FOR WORK EXECUTION

- A. Maintain all roofing equipment and tools in good working order.
- B. Use torches recommended by SOPREMA.

#### 3.04 APPLICATION OF ASPHALT PRIMER

- A. Roofing substrates of wood, metal, concrete, masonry or gypsum board surfaces will receive a coat of asphalt primer at a rate of 100 to 150 square feet per gallon (none required for factory-painted metals). All surfaces to be primed must be free of rust, dust or any residue that may hinder adherence. Cover primed surfaces with roofing membrane as soon as possible. Application temperature limit 14 degrees F (-10 degrees C).

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.05 INSTALLATION OF VAPOR RETARDER

- A. Beginning at the bottom of the slope, without adhering the membrane, unroll onto the substrate for alignment. Do not immediately remove the silicone release sheet.
- B. Align the roll parallel to the corrugations of the steel deck. Make sure the membrane overlaps are supported along their entire length.
- C. Peel back one end of the silicone release sheet and adhere this part of the membrane to the substrate. Peel back the remaining release sheet at a 45° angle to avoid wrinkles in the membrane.
- D. If the membrane is not properly aligned, do not try to adjust it. Instead, cut the roll and start again, making sure that it is properly aligned and that it overlaps the end of the misaligned piece by 6 inches.
- E. Overlap adjacent membranes by 3 inches. Overlap end laps by 6 inches. Stagger end laps by at least 12 inches.

### 3.06 INSULATION INSTALLATION

- A. Apply insulation to vapour retarder with adhesive in conformance with manufacturer's written recommendations.
- B. Install only as much insulation as can be covered in the same day.
- C. Around the drains lower insulation by 1" to create a sump 4' X 4' in area. Bevel the edge of the 3" insulation on a 45° angle.

### 3.07 INSTALLATION OF INSULATION OVERLAY

- A. Apply insulation overlay to insulation with adhesive in conformance with manufacturer's written recommendations.
- B. Firmly set the insulation boards, long joints continuous and short joints staggered. All boards must be evenly and tightly butted together.
- C. All vertical joints between boards and insulation will be staggered.
- D. Apply only as many boards as can be covered with base sheet in the same day.
- E. At parapets and curbs mechanically fasten overlay board to substrate before installation of self-adhesive base flashings. Use 1/4 inch overlay boards at these locations.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.08 INSTALLATION OF MEMBRANES

- A. Install membrane in strict conformance with SOPREMA installation instructions. See master specifications in the SOPREMA Manual, as well as the last edition of the Material Installation Guide.

### 3.09 INSTALLATION OF TORCH-APPLIED BASE SHEET

- A. Unroll base sheet flashing at drain level with first side lap lined up with drain centre (parallel to roof edge)
- B. Torch base sheet entirely onto prepared substrate. Overlap side laps by 3 inches along lines provided to this end, and overlap end laps by 150 mm. Stagger end joints by a minimum of 12 inches.
- C. Torch sufficiently and continuously to avoid wrinkles, air pockets or fishmouths. In cold weather, adjust welding time to obtain homogenous seam (it may be necessary to slow down in certain cases.)

### 3.10 BASE-SHEET FLASHING INSTALLATION

- A. Apply primer to the substrate at a rate of 1 gal. per 100 square feet. Primer should be dry before installation of Base Sheet
- B. Install base sheet flashing in one 3 feet widths to cover roofing substrate over 4 inches. Overlap side laps by 3 inches. Stagger side laps by at least 4 inches from base sheet overlaps on roof to avoid excessive layering.
- C. Apply base sheet flashing directly onto substrate by removing siliconed paper cover sheet. Proceed from top to bottom. Once in place, apply pressure manually in a uniform fashion to obtain homogenous adherence over entire surface. Preferably seal seams with rubber roller. Nail outside edge at 300 mm o/c. Burn off plastic film of base sheet before adhering base sheet flashing over it.
- D. Avoid forming wrinkles, air pockets or fishmouths.
- E. Always seal overlaps at the end of the workday.

### 3.11 ROOFING CAP SHEET INSTALLATION

- A. Once base sheet is applied and no defects are apparent, proceed with cap sheet installation.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Begin with double-selvage starter roll. If starter roll is not used, side laps covered in granules must be degranulated by embedding side laps in torch-heated bitumen over a 3-4 inches width.
- C. Unroll cap sheet at drain. Carefully align first side lap (parallel to roof edge).
- D. Weld cap sheet onto base sheet with torch recommended by membrane manufacturer. During application, simultaneously melt both designated contact surfaces so a bead of bitumen is apparent as cap sheet unrolls.
- E. Avoid Overheating.
- F. Make sure joints between the two layers are staggered by at least 300 mm.
- G. Overlap cap sheet side laps by 3-4 inches and end laps by 6 inches. Cut off corners at end laps to be covered by next roll. All overlap surfaces must be degranulated.
- H. Complete perfect welds between two membranes. Leave no zone unwelded. In cold weather, adjust welding time to obtain homogenous seam (it may be necessary to slow down in certain cases.)
- I. Once cap sheet is installed, carefully check all overlapped joints.
- J. During installation, take care to avoid excessive bitumen bleed-out at joints

### 3.12 CAP SHEET FLASHING INSTALLATION

- A. This cap sheet must be installed in one-metre-wide strips. The side joints must overlap by 3-4 inches and must be staggered by at least 4 inches with respect to the joints of the cap sheet on the field surface to avoid areas of excessive membrane thickness. The overlaps on the field surface must be 2 inches wider than those of the base sheet membrane on the upstands and parapets. At end laps, angle-cut the corners that will be covered by the following roll.
- B. Use a chalk line to draw a straight line on the field surface 6 inches from the upstands and parapets.
- C. Use a propane torch and round-nose trowel to embed the surface granules in the layer of hot bitumen [starting from the chalk line on the field surface to the bottom edge of the upstand or parapet as well as] on the granulated vertical surfaces that are to be overlapped.
- D. This cap sheet will be heat-welded directly to the base sheet membrane, proceeding from bottom to top. This technique softens both membranes in order to obtain even, continuous weld

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- E. During installation, be careful not to overheat the membrane or to create excessive bitumen bleeding at the joints.

### 3.13 WATERPROOFING OF PLANTERS

- A. Torch-apply one layer of Base Sheet inside the concrete planters as indicated on drawings.
- B. Follow Base Sheet installation instructions.

### 3.14 WATERPROOFING AT ROOF DRAINS

- A. Mechanical drains:
  - 1. Install mechanical drains in conformance with SOPREMA detail SOP12.
- B. Drains:
  - 1. Install drains in conformance with SOPREMA detail SOP13.
- C. Drains with compressible connectors:
  - 1. Install base sheet centered on drain. Cut opening of same diameter as downpipe for required water drainage.
  - 2. Install drain on base sheet in a layer of adhesive. Mechanically fastened to support.
  - 3. Torch weld reinforcement band (4 feet by 4 feet) in a diagonal position to base sheet and previously primed drain flange. Apply manual pressure at drain connectors.
  - 4. Install cap sheet to edge of opening.
  - 5. Fasten dome to drain.

### 3.15 WATERPROOFING FOR VARIOUS DETAILS

- A. Install waterproofing membranes in conformance with various roofing details illustrated in the SOPREMA Manual.

### 3.16 WALKWAYS PROTECTION MAT INSTALLATION

- A. Cold-bond the rubber panels, grooved surface down, using a coat of adhesive over the entire surface. Leave at least 1/2 inch. between each panel to allow for expansion of the panels.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.17 CONCRETE PAVERS INSTALLATION

- A. Install concrete pavers where indicated on drawings.
- B. Cut and shape pavers to fit neatly at all points of termination and roof openings.

### 3.18 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturer's Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance and training of Owner's personnel for maintaining specified system.

### 3.19 CLEANING

- A. Upon completion of the roofing installation:
  - 1. Clean up waste material and debris resulting from roofing operation.
  - 2. Dispose of waste material off the Site.
  - 3. Remove spots and smears of asphalt or other material from flashing, gravel stops, and other surfaces not intended to be coated with such material.
  - 4. During removal, ensure that no damage will be done to the surfaces.
  - 5. Use solvents, if necessary, to satisfactorily clean the materials.

**END OF SECTION**



**SECTION 07 62 00**  
**SHEET METAL FLASHING AND TRIM**

**PART 1 GENERAL**

**1.01 REFERENCES**

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
  - a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - c. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, and Flat Bar.
  - d. A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
  - e. B32, Standard Specification for Solder Metal.
  - f. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  - g. B370, Standard Specification for Copper Sheet and Strip for Building Construction.
  - h. C920, Standard Specification for Elastomeric Joint Sealants.
  - i. C1311, Standard Specification for Solvent Release Sealants.
  - j. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
  - k. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
2. Federal Specifications (FS): QQ-L-201F(2), Lead Sheet.
3. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Architectural Sheet Metal Manual, 5th Edition.

**1.02 PERFORMANCE REQUIREMENTS**

- A. General: Sheet metal flashing and trim shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Fabricate and install roof edge flashing capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Wind Zone 1: For velocity pressures of: 21 to 30 foot pounds per square foot, 60 foot pounds per square foot perimeter uplift force, 90 foot pounds per square foot corner uplift force, and 30 foot pounds per square foot outward force.
- D. Thermal Movements:
  - 1. Provide sheet metal flashing and trim that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.
  - 2. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
  - 3. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 4. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.
- E. Water Infiltration: Provide sheet metal flashing and trim that does not allow water infiltration to building interior.

### 1.03 QUALITY ASSURANCE

- A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown, unless more stringent requirements are indicated.

### 1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. Show joints, types and location of fasteners, and special shapes.
    - b. Catalog data for stock manufactured items.
  - 2. Samples: Color Samples for items to be factory finished.

### 1.05 DELIVERY, HANDLING, AND STORAGE

- A. Inspect for damage, dampness, and wet storage stains upon delivery to Work Site.
- B. Remove and replace damaged or permanently stained materials that cannot be restored to like-new condition.
- C. Carefully handle to avoid damage to surfaces, edges, and ends.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Do not open packages until ready for use.
- E. Store materials in dry, weathertight, ventilated areas until immediately before installation.

### 1.06 SPECIAL GUARANTEE

- A. Product: Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction or, at the option of the Owner, removal and replacement of factory-applied fluoropolymer coating, finish, and accessories found defective during a period of 20 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.
- B. Conditions:
  - 1. Finish: No cracking, blistering, flaking, chipping, checking, chalking, peeling, or fading.
  - 2. All Components: Watertight and weathertight with normal usage.

## PART 2 PRODUCTS

### 2.01 METAL

- A. Prefinished Aluminum Sheet: ASTM B209, alloy and temper as required for application and finish: 0.032-inch thick; precoated with fluoropolymer coating (Kynar polyvinylidene fluoride resin) coating; color as selected from manufacturer's standard color range.

### 2.02 REGLETS AND COUNTERFLASHING

- A. For Concrete:
  - 1. Stainless steel, 0.015 inch.
  - 2. Manufacturers and Products:
    - a. Fry Reglet Corp.; Fry Springlok Type CO and Springlok Flashing.
    - b. Cheney Flashing Co.; Type A reglet and Snap Lock Cap Flashing.
- B. For Masonry:
  - 1. Stainless steel, 0.015 inch
  - 2. Manufacturers and Products:
    - a. Fry Reglet Corp.; Fry Springlok Type MA and Springlok Flashing.
    - b. Cheney Flashing Co.; Type B reglet and Snap Lock Cap Flashing.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### C. Surface Mounted:

1. Stainless steel, 0.015 inch.
2. Manufacturers and Products:
  - a. Fry Reglet Corp.; Fry Springlok Type SM and Springlok Flashing.
  - b. Cheney Flashing Co.; Type D reglet and Snap Lock Cap Flashing.

## 2.03 PREFABRICATED METAL SYSTEMS

### A. Coping System:

1. Snap-on system, stucco embossed pattern aluminum, 0.050-inch minimum thickness.
2. Include ancillary items, such as mitered and welded corners, and end caps, where shown and as required for complete system.
3. Manufacturers and Products:
  - a. W.P. Hickman Co.; Permasnap Coping or equal.
  - b. MM Systems Corp.; Snap-Lok Coping or equal.

### B. Finish: Factory finished with full strength fluoropolymer coating (Kynar polyvinylidene fluoride resin). Color to later selection.

## 2.04 DOWNSPOUTS, GUTTERS, SCUPPERS, AND CONDUCTOR HEADS

### A. Same metal and thickness as aluminum flashing.

## 2.05 ANCILLARY MATERIALS

- A. Solder: ASTM B32, alloy composition Sn 50 and Sn 60 for stainless steel.
- B. Soldering Flux: ASTM B32, Type RA.
- C. Burning Rod for Lead: Same composition as lead sheet.
- D. Sealing Tape: Polyisobutylene sealing tape specifically manufactured for setting flanges on bituminous roofing.
- E. Isolation Paint: ASTM D1187, asphalt.
- F. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil thick minimum polyester.
- G. Plastic Roof Cement: ASTM D4586, Type II.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- H. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
- J. Fasteners:
  - 1. For Galvanized Steelwork: Steel, galvanized per ASTM A153/A153M or stainless steel fasteners.
  - 2. For Zinc or Aluminum Work: Stainless steel or aluminum; reglet fasteners may be galvanized or cadmium-plated steel.
  - 3. For Stainless Steelwork: Stainless steel.
  - 4. Nails: Roofing nailhead, 10-gauge spiral or ring shank, lengths as required to penetrate wood at least 3/4 inch or as required in Article Performance Requirements.

### 2.06 FABRICATION OF FLASHING

- A. Field measure prior to fabrication.
- B. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual that apply to design, dimensions, metal, and other characteristics of item indicated.
- C. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
- D. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
  - 1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- E. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- F. Reinforcements and Supports: Provide same material as flashing, unless other material is shown. Steel, where shown or required, shall be galvanized or stainless.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- G. Rigid Joints and Seams: Make mechanically strong. Solder galvanized and stainless steel metal joints. Do not use solder to transmit stress.
- H. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
- I. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1-inch deep, filled with butyl sealant concealed within joints.
- J. Fabricate sheet metal in 10-foot maximum lengths, unless otherwise indicated.
- K. At exposed ends of counterflashing furnish watertight closures.
- L. Fabricate corners in one-piece with legs extending 30 inches each way to field joint. Lap, rivet, or solder corner seams watertight. Apply sealant if necessary.
- M. Neutralize soldering flux.
- N. Solvent clean sheet metal. Surfaces to be in contact with roofing or otherwise concealed shall be coated with isolation paint.
- O. Pipe Penetrations through Roof: As shown on Drawings and details.
- P. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
- Q. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
  - 1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" and FMG Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

### 2.07 FABRICATION OF DOWNSPOUTS, GUTTERS, SCUPPERS, AND CONDUCTOR HEADS

- A. Form downspouts and gutters in maximum lengths as practicable to sizes and shapes indicated on Drawings:
  - 1. Telescope end joints 1-1/2 inches and lock longitudinal joints of downspouts.
  - 2. Furnish elbows at bottom where downspouts empty onto splash blocks.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Fit downspouts into cast iron boots or drainpipes where indicated on Drawings; neatly caulk or cement joints.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, and cant strips and reglets in place.
- B. Verify nailing strips and blocking are properly located.
- C. Verify membrane termination and base flashings are in place, sealed, and secure.

#### 3.02 INSTALLATION

- A. Flashing:
  1. General: Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.
  2. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
    - a. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 16-inch centers.
  3. Isolate metal from wood and concrete and from dissimilar metal with isolation tape or two coats of isolation paint.
  4. Use only stainless steel fasteners to connect isolated dissimilar metals.
  5. Joints: 10-foot maximum spacing and 2-1/2 feet from corners, butted with 3/16-inch space centered over matching 8-inch-long backing plate with sealing tape in laps.
  6. Set flanges of flashings and roof accessories on continuous sealer tape or in plastic roof cement on top of envelope ply of roofing. Nail flanges through sealing tape and at 3-inch maximum spacing. Touch up isolation paint on flanges.
  7. Joints, Fastenings, Reinforcements, and Supports: Sized and located as required to preclude distortion or displacement due to thermal expansion and contraction.
  8. Provide continuous holddown clips at counterflashing and gravel stops.
  9. Conceal fastenings wherever possible.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

10. Set flashing and sheet metal to straight, true lines with exposed faces aligned in proper plane without bulges or waves.
11. At vents through roof turn down lead flashing minimum 2 inches inside vent pipe.

### B. Prefabricated Metal Systems:

1. Follow system manufacturer's printed instructions.
2. Place color variations in pieces so no extremes are next to each other.

### C. Downspouts, Gutters, Scuppers, and Conductor Heads: Anchor downspouts to wall with straps of same material as downspouts. Install gutters, scuppers, and conductor heads as indicated on Drawings.

## 3.03 FINISH

- ### A. Exposed Surfaces of Flashing and Sheet Metalwork: Free of dents, scratches, abrasions, or other visible defects, and clean and ready for painting where applicable.

## 3.04 CLEANING AND PROTECTION

- ### A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- ### B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- ### C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- ### D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

**END OF SECTION**

**SECTION 07 70 01  
ROOF SPECIALTIES AND ACCESSORIES**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Air Movement and Control Association International (AMCA).
  2. American Architectural Manufacturers Association (AAMA).
  3. ASTM International (ASTM):
    - a. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
    - b. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
  4. FM (Factory Mutual) Global (FM).
  5. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings of each item specified showing materials, details, flashing, anchorage, and relation to adjacent structure.
  2. Catalog cuts of each item specified item.

1.03 SEQUENCING AND SCHEDULING

- A. Coordination: Schedule and coordinate work of this section with work of Section 07 52 16, SBS-Modified Bituminous Membrane Roofing 22 40 00, Plumbing Fixtures: 23 77 00, Air Handling Units= 07 41 13 Metal roof panels and Section 07 62 00, Sheet Metal Flashing and Trim.

**PART 2 PRODUCTS**

2.01 ROOF CURBS

- A. Prefabricated Galvanized Steel: Minimum 12-inch-high curb with treated wood nailer liner panel, and factory installed insulation as required for conditions shown on Drawings.
- B. Metal Gauge and Reinforcement: To suit imposed loads of equipment to be supported.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Fabricate curbs to fit roof slope.
- D. Manufacturers and Products:
  - 1. Pate Co.; PC-2.
  - 2. ThyCurb; Model TC-3.
  - 3. RPS Corporation; RC-2A.

### 2.02 METAL BUILDING ROOF CURBS

- A. Prefabricated Galvanized Steel: Minimum 8-inch-high curb with: liner panel integral water deflecting cricket, loose cell caps, and factory-installed insulation as required for conditions shown on Drawings.
- B. Metal Gauge and Reinforcement: To suit imposed loads of equipment to be supported.
- C. Fabricate curbs with level tops, with flanges surface mounted over metal building roof panels.
- D. Fabricate cell caps to conform to profile of standing seam of approved metal building roof panels.
- E. Manufacturers and Products:
  - 1. Pate Co.; Model PC-2MB-3.
  - 2. ThyCurb; Model TC-3 MBD.
  - 3. RPS Corporation; RC-7.

### 2.03 EQUIPMENT SUPPORT CURBS

- A. Prefabricated Galvanized Steel: Minimum 12-inch-high curb with counterflashing, factory installed insulation, and treated wood nailer as required for conditions shown on Drawings.
- B. Metal Gauge and Reinforcement: To suit imposed loads of equipment to be supported.
- C. Fabricate curbs to fit roof slope.
- D. Manufacturers and Products:
  - 1. Pate Co.; ES-2.
  - 2. ThyCurb; Model TEMS-3.
  - 3. RPS Corporation; ER-2A.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.04 PIPE CURB ASSEMBLY

- A. Prefabricated Galvanized Steel: Minimum 12-inch-high curb for pipe penetrations of roof, complete with cover, liner panel, factory installed insulation and accessories as required for conditions shown on Drawings.
- B. Fabricate to fit roof slope and furnish covers to suit pipe penetrations indicated on Drawings.
- C. Manufacturers and Products:
  - 1. Pate Co.; PCA-2, with cover.
  - 2. ThyCurb; Model TC-3, with cover.
  - 3. RPS Corporation; Pipe Portal System.

### 2.05 EXPANSION AND WALL CURBS

- A. Prefabricated Galvanized Steel: Minimum 12-inch-high curb with treated wood nailer, liner panel, factory-installed insulation, inside and outside corners, sloping end sections, spreader clips, and connector clips, as required for conditions shown on Drawings.
- B. Fabricate curbs to fit roof slope.
- C. Manufacturers and Products:
  - 1. Pate Co.; EJ-2.
  - 2. ThyCurb; Model TJX-3.
  - 3. RPS Corporation; EC-2A.

### 2.06 PIPE SEALS

- A. Prefabricated one-piece aluminum flanged base with stepped, graduated EPDM cap and adjustable stainless steel clamps.
- B. Manufacturers and Products:
  - 1. Pate Co.; Pipe Seal.
  - 2. Portals Plus, Inc.; Alumi-Flash.

### 2.07 FLEXIBLE BASE PIPE SEALS

- A. Prefabricated one-piece aluminum flanged base with stepped, graduated EPDM cap and adjustable stainless steel clamps. Aluminum base shall be capable of bending to match profile of sheet metal roofing panels.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Manufacturers and Products:
  - 1. Pate Co.; Dektite.
  - 2. Portals Plus, Inc.; Deck-Mate.

### 2.08 ROOF HATCHES

- A. Material: Aluminum, 11-gauge with factory-insulated curb and cover.
- B. Manufacturers and Products:
  - 1. Size: 3 feet by 2.5 feet:
    - a. Bilco; S-50.
    - b. Babcock-Davis; B-RHA Series.
    - c. JL Industries; RHA-1.

### 2.09 EXPANSION JOINT COVER

- A. Flexible Bellows: 0.018-inch stainless steel flanges with factory formed joints, intersections, transitions, and fasteners as indicated or required.
- B. Manufacturers and Products:
  - 1. Building Materials Corp. of America; Metalastic.
  - 2. Johns Manville; Expand-O-Flash.

### 2.10 ROOF VENTS

- A. Manufacturers and Products:
  - 1. Johns Manville; FP-10, one-way roof vent.
  - 2. Portals Plus, Inc.; Plasti-Vent, plastic.

### 2.11 ANCILLARY MATERIALS

- A. Sealer Tape: Polyisobutylene sealer tape specifically manufactured for setting flanges on bituminous roofing.
- B. Isolation Paint: ASTM D1187, asphalt.
- C. Coat aluminum surfaces in contact with concrete or dissimilar metals as specified in Section 09 90 00, Painting and Coating.
- D. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil-thick minimum polyester.
- E. Plastic Roof Cement: ASTM D4586, Type II.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- F. Fasteners: Stainless steel of type required.

### **PART 3 EXECUTION**

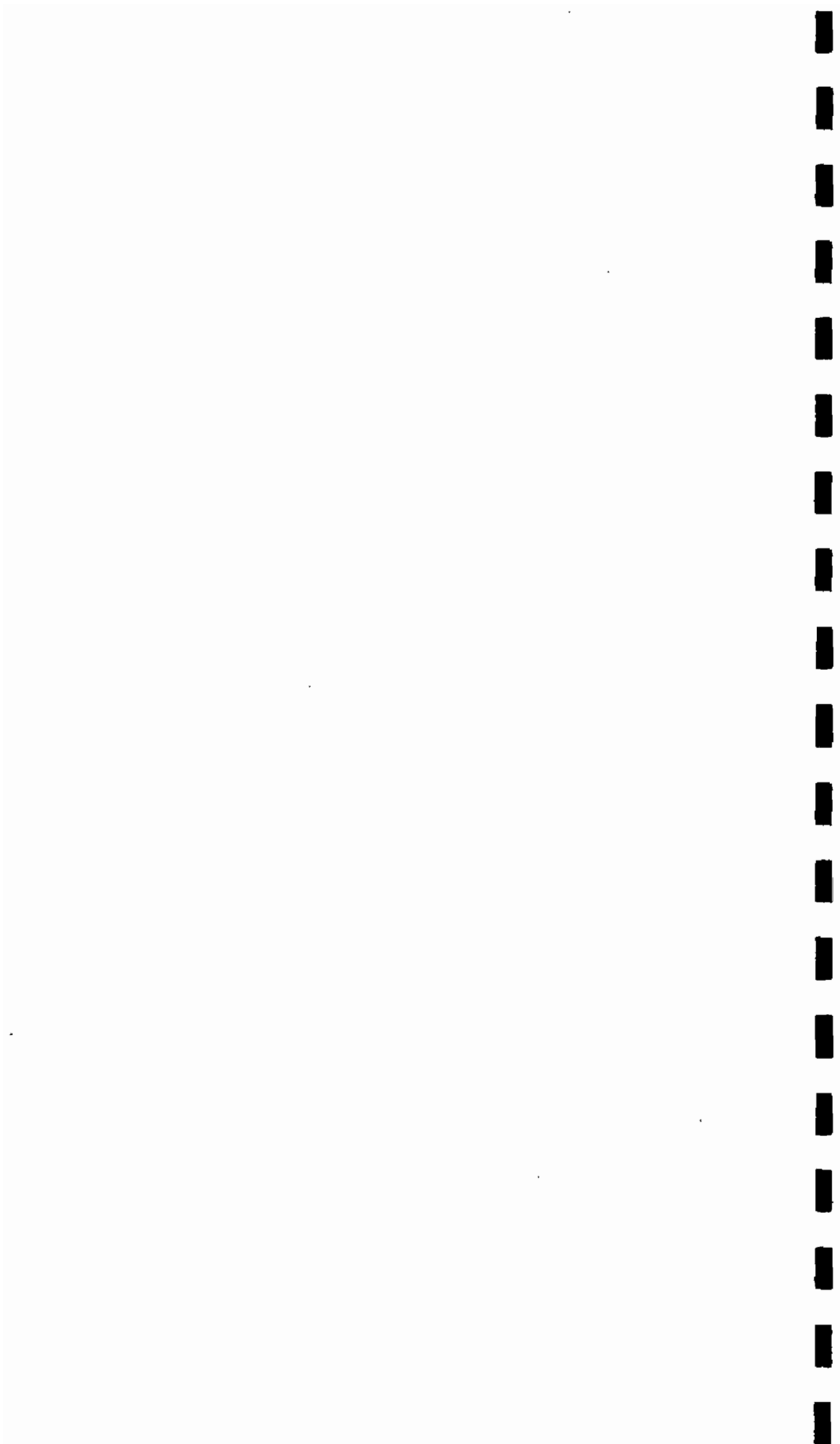
#### 3.01 PREPARATION

- A. Examine surfaces and structures to receive the Work of this section.
- B. Take measurements at Site and fabricate work to suit. No changes shall be made in supporting structure to accommodate this Work.

#### 3.02 INSTALLATION

- A. General:
  - 1. Install roof specialties and accessories as detailed in approved shop drawings and in conformance with manufacturer's instructions, recommendations, and standards.
  - 2. Use appropriate pipe curb assembly, pipe seal, flexible base pipe seal, or vent pipe flashing where pipe, conduit, or cable, etc., penetrate roofing membrane.
  - 3. Factory Finished Units: Place color variations in pieces so no extremes are next to each other.
  - 4. Make Work weathertight and free of expansion and contraction noise.
  - 5. Maintain separation between aluminum surfaces and concrete or dissimilar metals with isolation paint.
- B. Roof Hatches and Smoke Vents: Install to operate freely and not rattle when closed or open.
- C. Roof Vents: Install in accordance with roofing system manufacturer's instructions, but in no case less than one per 1,000 square feet of roof area.

**END OF SECTION**



**SECTION 07 84 00  
FIRESTOPPING**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards that may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. E814, Test Method for Fire Tests of Through-Penetration Firestops.
  - 2. Underwriters Laboratory, Inc. (UL):
    - a. 1479, Fire Tests of Through-Penetration Firestops.
    - b. 2079, Tests for Fire Resistance of Building Joint Systems.

**1.02 SYSTEM DESCRIPTION**

- A. Provide systems of material or combination of materials used to fill openings around penetrating items to prevent the spread of fire and retain integrity of fire rated construction by maintaining an effective barrier against spread of flame, smoke, water, and hot gases through penetrations in fire rated wall and floor assemblies.
- B. Provide Fire Safing:
  - 1. At slot gaps between edge of floor slabs and exterior walls.
  - 2. Gaps between top of walls and structure above.
  - 3. Expansion joints in walls, floors, and ceilings.
- C. Performance Requirements: Provide firestop systems with materials that have been manufactured and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
- D. Regulatory Requirements:
  - 1. Firestop Systems: Meet requirements of ASTM E814, UL 1479, or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.
  - 2. Proposed Firestop Materials and Methods: Conform to applicable governing codes having local jurisdiction.
  - 3. Meet F and T ratings of ASTM E814 for a period equal to construction penetrated.
  - 4. Underwriters Laboratories classified as fill, void, or cavity materials under UL 1479.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.03 SUBMITTALS

### A. Action Submittals:

1. Shop Drawings: Show layout, profiles, and product components; include UL Systems Number on Shop Drawings and diagram of UL approved assembly.
2. Product Data: Include manufacturer's SPEC-DATA® product sheet for products selected for use.

### B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
3. Certificates:
  - a. Product certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical requirements.
  - b. Certificate indicating installer qualifications.
  - c. Certificate of Proper Installation.
4. Special Guarantee documents specified below.

## 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Experienced in performing Work of this section and specialized in the installation of work similar to that required for this Project.
- B. Preinstallation Meetings: Conduct preinstallation meeting to identify where seals are required and verify Project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

## 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at Project Site.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification and UL listing mark intact.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- D. Follow recommended procedures, precautions, or remedies described in Material Safety Data Sheets as applicable.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.06 SEQUENCING AND SCHEDULING

- A. Firestopping requirements may be created by mechanical and electrical portions of the Work:
  - 1. Identify locations requiring firestopping.
  - 2. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

## 1.07 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this section found defective during a period of 2 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

## **PART 2 PRODUCTS**

### 2.01 GENERAL

- A. Furnish firestop system products from a single manufacturer.

### 2.02 MANUFACTURERS

- A. 3M Corp.; Firestopping Products.
- B. Hilti Construction Chemicals; High Performance Firestop Systems.
- C. International Protective Coatings Corp. (IPC); Flamesafe Firestop Products.
- D. Isolatek International (Cafco); TPS.
- E. Specified Technologies; Inc. (STI).
- F. United States Gypsum Co. (USG); Firestop Systems and Thermafiber Safing Insulation.

### 2.03 MIXES

- A. For those products requiring mixing prior to application, follow firestopping manufacturer's directions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

containers, mixing time, and other procedures needed to produce firestopping products of uniform quality with optimum performance characteristics for application indicated.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. With manufacturer's representative, examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### **3.02 PREPARATION**

- A. **Surface Cleaning:** Clean openings and joints immediately prior to installing firestopping in accordance with firestop manufacturer recommendations and the following requirements:
  - 1. Remove foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
  - 2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form release agents from concrete.
- B. **Priming:** Prime substrates where recommended by firestopping manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. **Masking Tape:** Use masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed upon completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestopping materials. Remove tape as soon as it is possible to do so without disturbing firestopping seal with substrates.

#### **3.03 INSTALLATION**

- A. **Manufacturer's Instructions:** Follow manufacturer's instructions for installation of through-penetration systems selected for use.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

1. Seal holes or voids made by penetrations for pipes, conduits and ducts through fire-rated floors, walls, and roofs and to ensure air and water resistant seals.
  2. Receive Engineer's approval prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
- B. Fire Safing: Install, following manufacturer's instructions, to completely fill gaps between tops of fire-rated walls and floor or roof deck above, between edge of floors and walls, and other locations indicated on Drawings.
- C. Meet Underwriters Laboratories and Factory Mutual requirements.

### 3.04 FIELD QUALITY CONTROL

- A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of Work accessible until inspection by applicable code authorities.
- C. Perform patching and repairing of firestopping caused by cutting or penetrating existing firestop systems.

### 3.05 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, and training of installer's personnel in proper installation procedures.

### 3.06 PROTECTION

- A. Protect installed product from contact with contaminating substances and from damage during construction.

**END OF SECTION**





MEMORIAL PARKWAY WTP ADVANCED TREATMENT

**SECTION 07 92 00  
JOINT SEALANTS**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. C661, Standard Test Method for Indentation Hardness of Elastomeric Type Sealants by Means of a Durometer.
    - b. C834, Standard Specification for Latex Sealants.
    - c. C920, Standard Specification for Elastomeric Joint Sealants.
    - d. C1193, Standard Guide for Use of Joint Sealants.

1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings: Surface preparation instructions. Indicate where each product is proposed to be used.
  - 2. Samples: Material proposed for use showing color range available.
- B. Informational Submittals:
  - 1. Installation instructions.
  - 2. Documentation showing applicator qualifications.
  - 3. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
  - 4. Special guarantee.

1.03 QUALITY ASSURANCE

- A. Applicator Qualifications: Minimum of 5 years' experience installing sealants in projects of similar scope.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Ambient Temperature: Between 40 degrees F and 80 degrees F (4 degrees C and 27 degrees C) when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.05 SPECIAL GUARANTEE

- A. Product: Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction or, at the option of the Owner, removal and replacement of Work specified in this section found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.
- B. Conditions: No adhesive or cohesive failure of sealant.
- C. Sealed Joints: Watertight and weathertight with normal usage.

## PART 2 PRODUCTS

### 2.01 SEALANT MATERIALS

- A. Characteristics:
  - 1. Uniform, homogeneous.
  - 2. Free from lumps, skins, and coarse particles when mixed.
  - 3. Nonstaining, nonbleeding.
  - 4. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
  - 5. Immersible may be substituted for nonimmersible.
- B. Color: Unless specifically noted, match color of the material adjoining area of application.
- C. Type 1—Silicone, Nonsag, Nonimmersible:
  - 1. Silicone base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
  - 2. Capable of withstanding movement up to 50 percent of joint width.
  - 3. Manufacturers and Products:
    - a. Dow Corning Corp.; No. 790.
    - b. General Electric; Silpruf.
    - c. BASF; Sonneborn, Omniseal-50.
- D. Type 2—Multipart Polyurethane, Self-leveling, Immersible:
  - 1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade P, Class 25.
  - 2. Capable of being continuously immersed in water.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Manufacturers and Products:
  - a. BASF; Sonneborn, SL-2.
  - b. Pecora Corp.; Urexspan NR-200.
  - c. Tremco; THC-900/901.
  - d. Sika Chemical Corp.; Sikaflex 2c SL.
  
- E. Type 3—Multipart Polyurethane, Nonsag, Immersible:
  1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
  2. Capable of being continuously immersed in water.
  3. Manufacturers and Products:
    - a. Pecora; DynaTrol II.
    - b. Tremco; Dymeric 240.
    - c. BASF; Sonneborn NP-2.
    - d. Sika Chemical Corp.; Sikaflex 2c NS.
  
- F. Type 4—Multipart Polyurethane, Nonsag, Nonimmersible:
  1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
  2. Manufacturers and Products:
    - a. BASF; Sonneborn NP-2.
    - b. Pecora Corp.; Dynatrol II.
    - c. Tremco; Dymeric 240.
    - d. Sika Chemical Corp.; Sikaflex 2c NS.
  
- G. Type 5—One-part Polyurethane, Immersible:
  1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
  2. Capable of being continuously immersed in water.
  3. Manufacturers and Products for Nonsag:
    - a. Sika Chemical Corp.; Sikaflex-1a.
    - b. Tremco; Vulkem 116.
  4. Manufacturers and Products for Self-leveling:
    - a. BASF; Sonneborn, SL-1.
    - b. Tremco; Vulkem 45.
    - c. Sika Chemical Corp.; Sikaflex 1c SL.
  
- H. Type 6—One-Part Polyurethane, Nonimmersible:
  1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Manufacturers and Products:
  - a. Pecora Corp.; Dynatrol 1 XL.
  - b. Tremco; Dymonic.
  - c. BASF; Sonneborn, NP-1.
- I. Type 7—Multipart Polysulfide, Immersible:
  1. Polysulfide base, two-component, chemical curing; ASTM C920, Type M, Grade P or NS, Class 25.
  2. Capable of being continuously immersed in water.
  3. Manufacturers and Products:
    - a. W. R. Meadows; Deck-O-Seal Gun Grade, two-part.
    - b. BASF; Sonolastic, two-part Polysulfide.
- J. Type 8—One-Part Polysulfide, Nonsag, Nonimmersible:
  1. Polysulfide base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 12 1/2.
  2. Capable of withstanding movement up to 20 percent of joint width.
  3. Manufacturer and Product: W. R. Meadows; Deck-O-Seal, one-part.
- K. Type 9—One-Part Acrylic Terpolymer, Nonsag, Nonimmersible:
  1. Acrylic base, single-component, solvent curing; ASTM C834 nonsag.
  2. Capable of withstanding movement up to 7.5 percent of joint width; Shore "A" hardness of 55 maximum.
  3. Manufacturer and Product: Tremco; Mono 555.
- L. Type 10—Sanitary Sealant:
  1. Silicone sealant similar to Type 1, above, formulated to resist mold growth and repeated exposure to high humidity while retaining adhesion, flexibility, and color.
  2. Manufacturers and Products:
    - a. Dow Corning; 786.
    - b. General Electric; Sanitary Sealant SCS1700.
- M. Type 11—Fire Penetration Seal:
  1. Manufacturers and Products:
    - a. 3M Corp.; Fire Barrier Caulk CP25 and Putty 303.
    - b. General Electric; Pensil Sealant or Foam.
    - c. Unifrax Corporation; Fyre Putty.
    - d. Hilti USA; CP 604.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- N. Type 12—One-Part Polycarbonate, Immersible:
  - 1. Polycarbonate base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
  - 2. Capable of being continuously immersed in water.
  - 3. Manufacturer and Product: Pro-Seal Products, Inc.; Pro-Seal 34.
- O. Type 13—Tape Sealant:
  - 1. Compressible polyurethane foam impregnated with polybutylene or polymer-modified asphalt.
  - 2. Color: Black.
  - 3. Size: 3/4 inch wide by length required by expanded thickness recommended by manufacturer for particular application.
  - 4. Manufacturers and Products:
    - a. Emseal Joint Systems, Ltd.; AST—High Acrylic.
    - b. Dayton Superior; Polytite Standard.
    - c. PARR Technologies; PARR Sealant EP-7212-T.

### 2.02 BACKUP MATERIAL

- A. Nongassing, extruded, closed-cell round polyurethane foam or polyethylene foam rod, compatible with sealant used, and as recommended by sealant manufacturer.
- B. Size: As shown or as recommended by sealant material manufacturer. Provide for joints greater than 3/16 inch wide.
- C. Manufacturers and Products:
  - 1. Sonneborn; Sonolastic Closed-cell Backing Rod.
  - 2. Tremco; Closed-cell Backing Rod.
  - 3. Pecora Corporation; Green Rod.

### 2.03 ANCILLARY MATERIALS

- A. Bond Breaker: Pressure sensitive tape as recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Primer: Nonstaining type recommended by sealant manufacturer to suit application.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.04 PREFORMED SEALS

### A. Preformed Compressible Joint Seals:

1. Widths Up to 5 Inches:
  - a. BASF, Watson Bowman Acme Div.; Wabo Weatherseal II.
  - b. Emseal Joint Systems Limited; Colorseal.
  - c. LymTal International; Iso-flex Joint System.
2. Other Widths: Series or model recommended by seal manufacturer.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Use of more than one material for the same joint is not allowed unless approved by sealant manufacturer.
- B. Install joint sealants in accordance with ASTM C1193.
- C. Horizontal and Sloping Joints up to 1 Percent Maximum Slope: Use self-leveling (Grade P) joint sealant.
- D. Steeper Sloped Joints, Vertical Joints, and Overhead Joints: Use nonsag (Grade NS) joint sealant.
- E. Use joint sealant as required for the applicable application and as follows:

<u>Joint Size</u>	<u>Sealant Type</u>
Less than 1"	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 12
Less than 2"	1, 2, 3, 4, or 7
Over 2"	Follow manufacturer's recommendation

### 3.02 PREPARATION

- A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.
- B. Surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials.
  1. Mask adjacent surfaces where necessary to maintain neat edge.
  2. Starting of work will be construed as acceptance of subsurfaces.
  3. Apply primer to dry surfaces as recommended by sealant manufacturer.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Verify joint shaping materials and release tapes are compatible with sealant.
- D. Examine joint dimensions and size materials to achieve required width/depth ratios.
- E. Follow manufacturer's instructions for mixing multi-component products.

### 3.03 INSTALLATION

- A. Use joint filler to achieve required joint depths, to allow sealants to perform intended function.
  - 1. Install backup material as recommended by sealant manufacturer.
  - 2. Where possible, provide full length sections without splices; minimize number of splices.
  - 3. Tape sealant may be used as joint filler if approved by sealant manufacturer.
- B. Use bond breaker where recommended by sealant manufacturer.
- C. Seal joints around window, door and louver frames, expansion joints, control joints, and elsewhere as indicated.
- D. Joint Sealant Materials: Follow manufacturer's recommendation and instructions, filling joint completely from back to top, without voids.
- E. Joints: Tool slightly concave after sealant is installed.
  - 1. When tooling white or light color sealant, use a water wet tool.
  - 2. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.
- F. Tape Sealant: Compress to 50 percent of expanded thickness and install in accordance with manufacturer's instructions.

### 3.04 PREFORMED SEALS

- A. Prepare joint surfaces clean and dry, free from oil, rust, laitance, and other foreign material.
- B. Construct joints straight and parallel to each other and at proper width and depth.
- C. Apply joint sealant manufacturer's approved primer and adhesive in accordance with manufacturer's instructions.



MEMORIAL PARKWAY WTP ADVANCED TREATMENT

D. Install seal in accordance with manufacturer's instructions.

3.05 CLEANING

A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.

B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

3.06 JOINT SEALANT SCHEDULE

A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of Project.

Joint Locations	Sealant Type(s)
<b>Expansion/Contraction and Control Joints At:</b>	
Concrete Walls (except water-holding and below grade portions of structures)	1, 3, 4, 5, 6, 7, 12
Concrete Floor Slabs (except for water-holding Structures)	2, 5
Slabs Subject to Vehicle and Pedestrian Traffic	2, 5
Masonry Walls	1, 3, 4, 5, 6, 7, 12, 13
Exterior Insulation and Finish System	4
Ceramic Tile Floors	1, 2, 5, 10
Ceramic Tile Walls	1, 3, 5, 10
<b>Material Joints At:</b>	
Metal Door, Window, and Louver Frames (Exterior)	1, 5, 6, 8, 12
Metal Door, Window, and Louver Frames (Interior)	1, 5, 6, 8, 9
Wall Penetrations (Exterior)	1, 5, 6, 8, 12
Wall Penetrations (Interior)	1, 5, 6, 8
Floor Penetrations	5, 6, 7
Ceiling Penetrations	1, 3, 4, 5, 6, 7
Roof Penetrations	5

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

Joint Locations	Sealant Type(s)
Sheet Metal Flashings	5, 13
Sheet Metal Roofing and Siding	5, 13
Precast/Prestressed Floor Panels (Interior)	2, 7
Precast/Prestressed Floor and Roof Panels (Exterior)	3, 7
<b>Other Joints:</b>	
Threshold Sealant Bed	5
Between Counter Tops and Backsplashes	10
Around Plumbing Fixtures	10
Openings Around Pipes, Conduits, and Ducts Through Fire-Rated Construction	11
Concrete Form Snap-Tie Holes	1, 4, 5

END OF SECTION



**SECTION 08 11 00  
METAL DOORS AND FRAMES**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI):
    - a. A250.6, Hardware on Standard Steel Doors (Reinforcement - Application).
    - b. A250.8, Recommended Specification for Standard Steel Doors and Frames.
    - c. A250.11, Recommended Erection Instructions for Steel Frames.
  2. ASTM International (ASTM):
    - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    - b. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
    - c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    - d. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
    - e. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
  3. Builders Hardware Manufacturers Association (BHMA): A156.115, Hardware Preparations in Standard Steel Doors and Frames.
  4. National Fire Protection Association (NFPA): 80, Standard for Fire Doors and Other Opening Protectives.
  5. Underwriters Laboratories, Inc. (UL): Building Materials Directory.

**1.02 SUBMITTALS**

- A. Action Submittals: Applicable information for each type of door and frame, including:
1. Frame conditions and complete anchorage details, supplemented by suitable schedules covering doors and frames.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Glass and louver opening sizes and locations in doors.
3. Connections of door frames to structural steel framing concealed in frames.
4. Location and field splice joints for frames too large to ship in one piece; indicate complete instructions for making field splices.
5. Joints required to accommodate expansion joint movement.
6. Relate to door numbers used in Contract Drawings.

### 1.03 DELIVERY, STORAGE, AND HANDLING

- A. Properly identify each item with number used in Contract Drawings.
- B. Store doors upright, in protected dry area, at least 1 inch off ground or floor and at least 1/4 inch between individual pieces.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
  1. Curries Manufacturing.
  2. The Ceco Corp.
  3. Fenestra Division, Marmon Group.
  4. Mesker Industries, Inc.
  5. Monarch Steelcraft, Ltd.
  6. Overly Manufacturing Co.
  7. Pioneer Industries.
  8. Precision Metals, Inc.
  9. Republic Steel Corp.
  10. Steelcraft Manufacturing Co.
  11. Trussbilt, Inc.
  12. Williamsburg Steel Products Co.
  13. Stiles Custom Metal, Inc.

### 2.02 MATERIALS

- A. Basic Metal Material:
  1. ASTM A1008/A1008M; sheet steel, cold-rolled, stretcher level.
  2. ASTM A167, Type 316 stainless steel.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Hollow Metal Frames:
1. Products of hollow metal door manufacturer.
  2. ANSI 250.8, except as modified herein.
  3. Frames for Doors and Windows 16 gauge for interior and 14 gauge with thermal break, for exterior, welded type, of cross-section shown.
  4. Prepare floor and wall anchors, reinforcement, and cutouts for hardware to meet requirements of BHMA A156.115 and ANSI A250.6.
  5. Finished size, shape, and profile of frame members as shown.
  6. Concealed fasteners or welding are preferred to through-the-face fasteners.
  7. Identification: Stamp opening number, as shown on Drawings, on center hinge reinforcement of each frame.
- C. Hollow Metal Doors: ANSI A250.8, except as modified herein. BHMA A156.115 and ANSI A250.6 to receive hardware specified in Door and Hardware Schedule.
1. Interior:
    - a. Flush Panel Doors: 18 gauge, Level 2, Model 1.
    - b. Flush end closure at top of doors.
  2. Exterior:
    - a. Flush Panel Doors: 16 gauge, Level 3, Model 1.
    - b. Double Doors: Overlapping astragals for active leaf, except as noted or detailed otherwise.
    - c. Flush end closure at top of doors.
- D. Labeled Fire Doors and Frames:
1. Conform to listing requirements of Underwriters Laboratories, Inc. (UL).
  2. Label each door and frame for class of rating required.
  3. Overlapping astragal on active leaf of double doors.
  4. Label requirements, dimensions, and type of door are indicated in Door and Hardware Schedule on Drawings.
    - a. Modify drawing details if required to secure label.
    - b. Clearly identify modifications on Shop Drawings.
    - c. Maximum temperature rise of 450 degrees F for stairway enclosures.
- E. Glazing:
1. Doors: Furnish with formed flush-type glazing strips with butt corner joints to permit selection of secure side in field.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Glazing Arrangements: Accommodate glass of type and thickness indicated and as specified in Section 08 80 00, Glazing.

### 2.03 MISCELLANEOUS ITEMS

- A. Filler or Transom Panels: Furnish of same construction and finish as door to include fire-resistive label and sound-retardant construction.
- B. Furnish manufacturer's standard core filler, anchors, fasteners, and other ancillary items.

### 2.04 FACTORY FINISHING REQUIREMENTS

- A. Galvanized with A60 zinc coating in accordance with ASTM A653/A653M (Wipe Coat galvanized coating is not acceptable).
- B. Fabricate cut-outs and concealed reinforcement in door and frame as required for installation of security system. Weld standard electrical junction box frame, centered over cut outs.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Frames:
  1. Follow ANSI A250.11 and manufacturer's instructions.
    - a. Maintain scheduled dimensions, hold head level, and maintain jambs plumb and square.
    - b. Secure anchorages and connections to adjacent construction.
    - c. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb and anchors are securely attached.
- B. Doors:
  1. Hollow Metal Doors: ANSI A250.8.
  2. Hardware: In accordance with manufacturer's templates and instructions.
    - a. Adjust operable parts for correct function.
    - b. Remove hardware, with exception of prime coated items, tag, box, and reinstall after finish paint work is completed.
  3. Labeled Doors: NFPA Pamphlet No. 80.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.02 FIELD PAINTING

- A. Where prime coat has been damaged, sand smooth and touch up with same primer as applied at shop.
  - 1. Remove rust before painting.
  - 2. Touch Up: Not obvious.
  - 3. Perform immediately after door and frame installation.

### 3.03 PROTECTION

- A. Protect installed doors and frames against damage from other construction work.

### 3.04 SCHEDULES

- A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see Door and Hardware Schedule on Drawings.

**END OF SECTION**





**SECTION 08 33 23  
OVERHEAD COILING DOORS**

**PART 1 GENERAL**

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): A36/A36M, Standard Specification for Carbon Structural Steel.
2. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
3. National Fire Protection Association (NFPA): 70, National Electrical Code.

1.02 SUBMITTALS

A. Action Submittals:

1. Construction and installation details and electrical characteristics and control diagrams for motor operators.

B. Informational Submittals:

1. Installer's factory authorization.

1.03 QUALITY ASSURANCE

A. Qualifications: Experienced, factory authorized installer.

**PART 2 PRODUCTS**

2.01 OVERHEAD COILING (ROLLUP) DOORS

A. Manufacturers:

1. Alpine Overhead Doors, Inc.
2. Apton Rolling Doors.
3. Cornell Iron Works, Inc.
4. Kinnear, Division of Wayne-Dalton Corp.
5. Mahon Door Corp.
6. North American, Division of Wayne-Dalton Corp.
7. Overhead Door Corp.
8. Pacific Rolling Door Co.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

9. The Cookson Co.
  10. CECO/Windsor Door.
- B. Design Requirement: Complete assembly, each component and anchorage to building to withstand a wind load of 30 pounds per square foot.
- C. Insulated Curtain: Interlocking insulated flat slats of 16-gauge (B & S) minimum ASTM B209, 5052-H32 aluminum alloy with maximum U-value of 0.40 and backing of PVC thermally separated from face slat.
- D. Hood: Match curtain material and finish.
- E. Slide Guides: ASTM B308/B308M, 6061-T6 aluminum alloy, shapes as appropriate for conditions.
- F. Brackets, Gears, and Barrel: Manufacturer's standard items.
- G. Features:
1. Bottom Bar: Steel bottom bar with flexible weatherstripping astragal on all exterior doors. Provide limit switch and AUTOMATIC stop and reversing feature in astragal.
  2. End Locks and Wind Locks: End locks at ends of each slat, of material compatible with curtain. Provide wind locks at ends of every other slat minimum on exterior doors.
  3. Weather Seals:
    - a. Rubber, neoprene, or vinyl water seal at hood to prevent airflow around coil on exterior doors.
    - b. Weather seal sealing strip on guide to close space between guide and curtain on exterior doors.
  4. Finish:
    - a. Curtain Slats: PPG Duranar 2 coat system, color to later selection
    - b. Bottom Bar, and Hood: Galvanized and prime painted.
    - c. Other Steel Surfaces: Corrosion-inhibiting prime paint, compatible with finish paint specified in Section 09 90 00, Painting and Coating.
- H. Security System provisions; On doors scheduled for Security Control System, coordinate with security system supplier. Provide interface relays for interlocking with Plant security system.
- I. Operator: Motor, 480 volts, three-phase, with three pushbuttons in NEMA 250, Type 1 enclosure and endless chain or crankshaft for emergency operation.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- J. Door Operation:
  - 1. Open/Close from outside by remote control.
  - 2. Provide 2 remote control units per each door.
  - 3. Open/Close/Hold Open button inside. 1 per door

### **PART 3 EXECUTION**

#### 3.01 INSTALLATION

- A. Follow manufacturer's instructions for installation of components of assembly.

#### 3.02 ADJUSTING AND CLEANING

- A. On completion, adjust and lubricate doors, check and adjust controls, verify that equipment and mechanisms are operating smoothly. When directed demonstrate operation, control and safety fixtures of each door
- B. Clean and make good surfaces soiled or otherwise damaged in connection with the work of this section.

**END OF SECTION**



**SECTION 08 41 13**  
**ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS**

**PART 1 GENERAL**

**1.01 REFERENCES**

A. The following is a list of standards which may be referenced in this section:

1. The Aluminum Association, Incorporated (AA): Designation System for Aluminum Finishes.
2. American Architectural Manufacturers Association (AAMA): 800, Voluntary Specification and Test Method for Sealants.
3. ASTM International (ASTM):
  - a. C509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
  - b. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
  - c. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen.
  - d. E330, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
  - e. E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

**1.02 SYSTEM DESCRIPTION**

A. Design Requirements:

1. Provide a thermally isolated aluminum framing system that utilizes straight-in glazing without projecting stops. Position glass near exterior of frame and provide operable vents where shown.
2. System shall have interior flashing to provide continuous flashing to exterior through pressure relieved horizontal weep holes.
3. Face Clip Design:
  - a. Engaged by pushing straight into the clip.
  - b. Easily removed for deglazing.
  - c. Reusable for reglazing.
4. Entrances and glass framing shall be compatible in appearance.

B. Performance Requirements: Meet requirements of Article Performance Tests.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.03 SUBMITTALS

### A. Action Submittals:

1. Shop Drawings:
  - a. Details of doors, framing, and anchorage to structure.
  - b. Manufacturer's brochures or catalogs, specifications, recommendations, and standard details illustrating and specifying products proposed for use on this Project.
  - c. Show field measurements.
2. Samples: At least 3-inch long Samples of anodized extruded aluminum, showing probable range of variation in color.

### B. Informational Submittals:

1. Evidence of installer's qualifications.
2. Certified test reports showing compliance with specified performance tests.
3. Manufacturer's Certificate of Compliance: In accordance with Section 01 33 00, Submittal Procedures.

## 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Entity specializing in the installation of aluminum glazing systems, with a minimum of 3 years' experience and approved by the system manufacturer.
- B. Preinstallation Meeting: Conduct to discuss and verify project requirements, substrate conditions, and manufacturer's installation instructions and warranty requirements.

## 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Store materials as recommended by manufacturer, in inside designated areas, free of dust and corrosive fumes, as close as possible to point of installation.
- C. Prevent contaminants from contacting aluminum.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Framing systems, entrance doors, and ventilators shall be the products of a single manufacturer.
- B. Materials and products specified in this section shall be products of:
  - 1. Kawneer Co.
  - 2. United States Aluminum Corp.
  - 3. Tublite, Inc.

### 2.02 BASIC MATERIALS

- A. Basic Aluminum Extrusions: 6063-T5 aluminum not less than 0.094 inch thick; door extrusions not less than 0.125 inch thick.
- B. Framing Members: 4-1/2 inches in: with thermal break and face width of 2 inches.
- C. Swing Entrance Doors:
  - 1. Thickness: 1-3/4 inches.
  - 2. Stile and Rail Construction:
    - a. Wide (over 4-inch) stiles and top rails, and: 6-inch. 10-inch bottom rail.
    - b. Mechanically fastened and welded.
    - c. Hook-in type glazing stops.
    - d. Configuration indicated.
- D. Glazing Gaskets: Framing manufacturer's standard elastomeric extrusion, conforming to ASTM C509.
- E. Glass and Glazing: As specified in Section 08 80 00, Glazing.
- F. Concealed Fastening Devices, Reinforcements, and Other Internal Components: Of aluminum alloy, stainless steel, or corrosion-resistant plated.
- G. Screws: Stainless steel, factory finished color to match aluminum finish.
- H. As specified in Section 08 71 00, Door Hardware.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- I. Sealants:
  1. AAMA 800, to seal metal to metal, nonworking joints.
  2. Color to be compatible with adjacent materials.
- J. Isolation Tape:
  1. Manufacturers and Products:
    - a. Tremco; 440.
    - b. 3M; EC1202.
    - c. Presstite; 579.6.
- K. Mineral Fiber Insulation: Curtain wall insulation/CW225 by Owens Corning Inc. or Roxul RXL40 by Roxul Inc.
- L. Isolation Paint: Bituminous coating conforming to ASTM D1187.

### 2.03 FINISH

- A. Exposed Framing Members: Free of scratches and other serious surface blemishes.
- B. Treatment and Color:
  1. Apply finish to aluminum components after fabrication or forming
  2. Fluoropolymer enamel: PPG Duranar XL 3 coat system 40 microns dry film thickness. Color to later selection.

### 2.04 FABRICATION

- A. Methods of Fabrication and Assembly: Manufacturer's discretion, unless otherwise specified.
- B. Reinforcement for Surface Hardware: Manufacturer's standard.
- C. Wind Load: Reinforce mullions as necessary to limit deflection to 1/175 of span when wind load on wall is 30 psf in addition to dead loads.
- D. Prepare all doors and frames for Security Control System.
- E. Include aluminum cover plates, trim components, bent plates, closure trims, drips, flashings and other components required to complete installation.
- F. Assembly: As far as practicable, do fitting and assembly work in shop.

**PART 3 EXECUTION**

**3.01 PREPARATION**

- A. Substrate Conditions: Verify acceptability for product installation in accordance with manufacturer's instructions.
- B. Field Measurements: Verify actual opening sizes prior to fabrication.

**3.02 INSTALLATION**

- A. In accordance with manufacturer's installation instructions.
- B. Set items straight, level, square, plumb, and at proper elevations and in alignment with other work.
- C. Securely anchor units to surrounding structure to resist wind loads and to withstand the normal loads imposed by the operation of the doors.
- D. Fasten framing members in place using screws and backing, anchor plugs, or straps.
  - 1. Accurately cut and fit framing and moldings to result in tightly closed flush, hairline weathertight joints.
  - 2. No visible unfinished aluminum.
  - 3. Provide concealed attachments and fasteners.
- E. Door Operation:
  - 1. Swing freely, and without rattle when closed.
  - 2. Swing Type Doors: Head and jamb clearance of 3/32 inch, plus or minus 1/32 inch.
- F. Coat aluminum surfaces in contact with concrete, cement plaster, or stucco with isolation paint, sealant, or isolation tape cut to neat line.
- G. Seal all joints.
- H. Glazing: As specified in Section 08 80 00, Glazing.

**3.03 PERFORMANCE TESTS**

- A. Air Leakage Through Assembly: Maximum 0.06 cfm per minute per square foot of wall area at 6.24 psf, as measured in accordance with ASTM E283.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Resistance to Water Infiltration: No leaks in the complete system when tested in accordance with ASTM E331 at test pressure of 8 psf.
- C. Performance Under Uniform Loading:
  - 1. Test in accordance with ASTM E330 for a wind load of 30 psf.
  - 2. Maximum Deflection: Not to exceed 1/175 of member span.
  - 3. When Load is Removed: No permanent deformation or damage.

### 3.04 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services for preinstallation meeting, installation assistance, inspection and certification of proper installation, and performance testing of specified equipment.

### 3.05 CLEANING

- A. After erection, protect exposed portions from damage by machines, plaster, lime, paint, acid, cement, or other harmful compounds.
- B. Remove protective materials and clean with plain water, water with soap, or household detergent.

### 3.06 PROTECTION

- A. Protect adjacent areas and finish surfaces from damage during product installation.

### 3.07 SCHEDULES

- A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see Door and Hardware Schedules on Drawings.

**END OF SECTION**

**SECTION 08 51 13  
ALUMINUM WINDOWS**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. The Aluminum Association, Incorporated (AA): Designation System for Aluminum Finishes.
  2. American Architectural Manufacturers Association (AAMA):
    - a. 101, Voluntary Specifications for Aluminum and Poly(Vinyl Chloride) (PVC) Prime Windows and Glass Doors.
    - b. 605.2, Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
    - c. 606.1, Voluntary Guide Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.
    - d. 701, Combined Voluntary Specification for Pile Weather Strip.
    - e. 800, Voluntary Specification and Test Methods for Sealants.
  3. ASTM International (ASTM):
    - a. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    - b. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
    - c. B456, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
    - d. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
    - e. C509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
    - f. C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
    - g. C1036, Standard Specification for Flat Glass.
    - h. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
    - i. D3656, Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns.
    - j. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
    - k. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

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- l. E330, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
  - m. E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
  - n. E774, Standard Specification for Sealed Insulating Glass Units.
  - o. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
4. Glass Association of North America (GANA): Glazing Manual.

### 1.02 SUBMITTALS

#### A. Action Submittals:

- 1. Shop Drawings:
  - a. Large scale details and layout of windows, operators, anchorages, and adjoining construction with all materials indicated accurately to scale.
  - b. Manufacturer's literature including brochures or catalogs, specifications, instructions, and standard details illustrating products proposed for use and other window products available.
- 2. Samples: Finish on aluminum in sets of two, indicating light and dark extremes, to be used in evaluating products furnished.

#### B. Informational Submittals:

- 1. Manufacturer's Certification of Compliance.
- 2. Reports of factory quality control tests.

### 1.03 QUALITY ASSURANCE

- A. All Units: Meet construction and testing requirements of AAMA 101 and carry the quality certified label of AAMA.

### 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store window units in vertical upright position and off the ground on dunnage, preferably inside a building.
- B. Protect units from weather, abuse, defacement, and damage.
- C. Store units inside in areas free of dust and corrosive fumes, as close as possible to point of installation.
- D. Prevent contaminants from contacting aluminum.

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- E. Keep water away from stored units and assemblies.
- F. Handle units according to recommendations of AAMA.

### 1.05 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this Specification section found defective during period of 2 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Aluminum: Proper alloy and temper to meet specified requirements.
- B. Hardware: Corrosion-resistant and compatible with aluminum; suitable for intended use and the same as used on the tested units.
- C. Anchors and Fasteners:
  - 1. Exposed: Aluminum, Type 304 stainless steel, or ASTM B456 nickel-plated brass.
  - 2. Concealed: Aluminum, cadmium-plated steel, ASTM B633 or ASTM A123 zinc-plated steel, or Type 304 stainless steel.
  - 3. Concealed anchors may be of carbon steel, painted after fabrication with zinc chromate primer.
  - 4. Other Fasteners and Components: Carbon steel or ASTM B456 Nickel plus Chromium plated.
- D. Sealants:
  - 1. AAMA 800 to seal metal to metal, nonworking joints.
  - 2. Color to be compatible with adjacent materials.
- E. Weatherstripping: High quality materials capable of meeting environmental exposure and performance requirements.
  - 1. Pile Weatherstrip: AAMA 701.
  - 2. Closed Cell Elastomer: ASTM C509.
  - 3. Dense Elastomer: ASTM C864.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

F. Glass and Glazing: As Specified in Section 08 80 00, Glazing.

### 2.02 FABRICATION

- A. Fabricate and assemble frame, sash, and ventilator members into windows and window systems in accordance with reviewed Shop Drawings, and as required by AAMA 101.
- B. Mechanical fasteners, welded components, and hardware items shall not bridge thermal barriers unless the window units tested also have thermal bridges.
- C. Sealing Insulating Glass Units: Designed so that water entering space around unit will drain and not remain in contact with edge seal of the glass.
- D. Glazing Beads:
  - 1. Square and coped to uniformly tight hairline joints at corners.
  - 2. Material may be prefinished.

### 2.03 FINISH

- A. Finish components after fabrication, except those that may be prefinished as specified.
- B. Exposed framing members shall be free of scratches and other surface blemishes.
- C. Fluoropolymer Enamel: PPG Duranar three coats system 40 microns DFT.

### 2.04 ANCILLARY MATERIALS

- A. Isolation Tape:
  - 1. Manufacturers and Products:
    - a. Tremco; 440.
    - b. 3M; EC1202.
    - c. Presstite; 579.6
- B. Isolation Paint: Bituminous coating conforming to ASTM D1187.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### C. Screens:

1. Furnish rigid metal frame screens to match window frames for operating vents and sash.
2. ASTM D3656, Class 1, 18 by 16 mesh.

## 2.05 PROJECTED AND FIXED WINDOWS

### A. Meet requirements of AAMA 101 Designation P-C20 or F-C20, P-R15 or F-R15.

### B. Provide polyvinyl chloride thermal break separator between inside and outside for all frames.

### C. Ventilators:

1. Project-out type with crank operators and hook or cam type latch.
2. Anderberg stainless steel, adjustable friction, four-arm mechanisms for ventilators operated directly or by pole.
3. Provide pole operator where ventilators are more than 6 feet above floor.

## 2.06 WINDOW WALL

### A. Materials:

1. Extrusions of 6063-T5 alloy and temper; ASTM B221, alloy GS 10A-T5.
2. All sections to be free from defects impairing appearance, strength or durability.
3. Thermal Barrier: Two-part, chemically curing, high density polyurethane.
4. Exposed Fasteners: Aluminum or stainless steel, or zinc-plated steel in conformance with ASTM F593.
5. Perimeter Anchors: Aluminum or stainless steel, provided steel is properly insulated from aluminum.
6. Use elastomeric gaskets to provide fully resilient glass setting on both sides of the glass.

### B. Construction of Framing Members:

1. Two-part construction incorporating thermal barrier that eliminates direct contact between interior and exterior aluminum sections.
2. Use high density polyurethane to provide positive, mechanical interlocking of interior and exterior aluminum sections and final bonding.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Provide for flush glazing on all sides with no projecting stops.
4. Exterior face members shall be seamless.
5. Vertical and Horizontal Members:
  - a. Nominal face dimension of 2 inches.
  - b. Provide a glass pocket depth of not less than  $\frac{3}{4}$  inch.
6. Overall Depth: 4 1/2 inches with centered glazing.

### 2.07 SOURCE QUALITY CONTROL

#### A. Tests:

1. Resistance to Air Infiltration: No greater than 0.06 cfm per square foot of fixed area, as tested in accordance with ASTM E283.
2. Resistance to Water Infiltration: No leakage in frame at test pressure difference of 8 psf, as tested in accordance with ASTM E331.
3. Resistance to Uniform Loading: When tested under load of 20 psf, in accordance with ASTM E330:
  - a. Maximum Deflection: No greater than 1/175 times span for any member.
  - b. When load is removed, no evidence of permanent deformation or damage.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Verify dimensions by taking measurements at the Site.
- B. Verify that openings are within allowable dimensional tolerances, are plumb, level, clean, and provide a solid anchoring surface.
- C. Verify conformance with Shop Drawings and that dimensions and conditions are correct before installing windows.

### 3.02 INSTALLATION

#### A. Window and Window Components:

1. Plumb and align window faces in a single plane for each wall plane.
2. Erect windows and materials square and true and in proper alignment with other work, anchored to maintain position when subjected to normal thermal and building movement and specified 30 pounds per square foot wind loads.
3. Install in accordance with manufacturer's instructions.
4. Installation shall be weathertight as specified under Article Source Quality Control.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Coat aluminum surfaces in contact with concrete, cement plaster, or stucco with isolation paint, sealant, or isolation tape cut to neat line.

### 3.03 GLAZING

- A. Glass may be factory or field installed.
- B. Install in accordance with Section 08 80 00, Glazing and glass manufacturer's instructions.

### 3.04 ADJUSTING AND CLEANING

- A. Remove protective materials and clean windows with potable water, or water with household soap or detergent.
- B. Inspect and readjust glazed ventilators as necessary for free operation at completion.
- C. Adjust windows for proper operation after installing.
- D. Lubricate hardware and movable units.
- E. Leave windows in closed position after adjusting and cleaning.

### 3.05 PROTECTION

- A. Protect installed window units from materials that could cause damage, such as lime, mortar, runoff from concrete and copper, careless handling of tools, weld splatter, acids, roofing asphalt, solvents, and abrasive cleaners.

### 3.06 SCHEDULE

- A. For window types, sizes, glass, and other requirements, see drawings.

**END OF SECTION**



**SECTION 08 71 00  
DOOR HARDWARE**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. Builders Hardware Manufacturer's Association (BHMA):
    - a. A156.1, Butts and Hinges.
    - b. A156.2, Bored and Preassembled Locks and Latches.
    - c. A156.3, Exit Devices.
    - d. A156.4, Door Controls - Closers.
    - e. A156.13, Mortise Locks & Latches.
    - f. A156.16, Auxiliary Hardware.
    - g. A156.18, Materials and Finishes.
  2. International Code Council (ICC): A117.1, Accessible and Usable Buildings and Facilities.
  3. Underwriters Laboratories, Inc. (UL): Fire Protection Equipment List.

**1.02 SUBMITTALS**

- A. Action Submittals:
1. Shop Drawings:
    - a. Product Data: Manufacturer's literature for each item of finish hardware required herein, clearly marked.
    - b. Finish Hardware Schedule: Furnish complete and detailed schedule, show product items, numbers, and finishes for hardware for each separate opening.
    - c. Special Tools: Provide listing and description of usage.
- B. Informational Submittals:
1. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
  2. Manufacturer's Field Service Report.
  3. Certification of Hardware Consultant.
  4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Services.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.03 QUALITY ASSURANCE

- A. Qualifications of Supplier: Recognized supplier of architectural finish hardware, with warehousing facilities, who has been furnishing hardware in vicinity of Project for not less than 5 years, and who is, or who employs, architectural hardware consultant.
- B. Qualifications of Architectural Hardware Consultant (AHC): Certified by Door and Hardware Institute.

## 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Before delivery, clearly identify and tag each item of hardware with respect to specified description and location of installation.
- B. Provide secure storage for finish hardware until installation is made.

## 1.05 EXTRA MATERIALS

- A. Special Tools: Two sets for installation and maintenance of hardware.

## **PART 2 PRODUCTS**

### 2.01 MATERIALS

- A. Provide end products of one manufacturer for each product in order to achieve standardization for appearance, maintenance, and replacement.
- B. Finishes: BHMA A156.18.
- C. Some products listed below may not be used on this Project.

### 2.02 FASTENERS

- A. Stainless steel.

### 2.03 BUTT HINGES

- A. BHMA A156.1.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

B. Quantity per Door Leaf (Minimum):

<u>Door Height</u>	<u>Hinges</u>
Up to 5'-0"	1 pair
5'-1" to 7'-7"	1-1/2 pair
7'-8" to 10'-0"	2 pairs
10'-1" to 12'-6"	2-1/2 pairs

C. Hinge Height (Minimum):

<u>Door Width</u>	<u>Hinge Height</u>
Up to 3'-0"	4-1/2"
3'-1" to 4'-0"	5"
Over 4'-0"	6"

D. Width: Minimum for clearance of trim and 180-degree swing.

E. Exterior Hinges: Nonremoveable pin.

F. Joint Tolerance: 0.012 inch maximum, gauged in CLOSED position.

G. Finish: Satin stainless steel No. 630.

H. Types and Manufacturers:

No.	Type Description	Stanley	Mc-Kinney	Lawrence	BHMA
H1	Regular weight, two ball-races, full mortise, [stainless steel	FBB191-32D	TB2314	BB4101-32D	A5112

2.04 LOCKS AND LATCH SETS

A. Mortise Locks: BHMA A156.13, Series 1000, Grade 1.

1. Materials: Brass or stainless steel.
2. Trim: Wrought or forged lever handles and roses.
3. Core Cylinders: Interchangeable, removable; minimum of six pins.
4. Bolt Throw: 5/8 inch minimum.
5. Lever Backset: 2-3/4 inches.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- 6. Manufacturers and Products:
  - a. Sargent; LNJ.
  - b. Schlage; 03.
  - c. Best; 3H Fairbanks.

B. Finish:

- 1. Satin stainless steel No. 630.

C. Types and Manufacturers:

No.	Type Description	Best	Sargent	Schlage	BHMA
L1	Mortise entrance lock with lever handle	45H7TA3H	8245-LNJ	L9456P-03	F12, F13
L3	Mortise latch with lever handle	45H0N3H	8215-LNJ	L9010-03	F01
L5	Mortise utility room lock with lever handle	45H7D3H	8204-LNJ	L9080-03	F07
L8	Mortise privacy lock with lever handle	45H7L3H	8265-LNJ	L9040-03	F19, F22
L16	Lock by exit device manufacturer; furnish cylinders for keying to other locks as required				

D. Keying:

- 1. Lock Cylinders: Operate by grand master key system that allows for future expansion.
- 2. Keylocks: Key new locks into existing master key system: As directed by Owner.
- 3. Keys: Two per lock; tag with schedule information.
- 4. Master Keys: Four; send by registered mail to Owner.
- 5. Furnish lock manufacturer's removable core maximum security keying system

2.05 CONSTRUCTION KEY SYSTEM

- A. Removable construction core system for locks.
- B. See Article Manufacturer's Services under Part 3, Execution.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2.06 CONSTRUCTION KEY SYSTEM

- A. Assemble permanent cylinders with construction inserts and ship with all lock sets.
- B. Change Keys: Pack in separately identified envelopes and ship.
- C. Construction Keys: Pack in cartons marked "packing list" and ship.
- D. Construction Insert Extractor Keys, Master Keys, and Grand Master Keys: Ship by registered mail to: Owner.
- E. On completion of job, deliver construction keys to Owner.

2.07 EXIT DEVICES

- A. BHMA A156.3.
- B. Furnish fire exit devices and mullions at fire-rated doors.
- C. Trim:
  - 1. Levers: Sargent ETJ; Von Duprin 03.
- D. Finish:
  - 1. Exit Device: Satin chromium-plated No. 626.
  - 2. Removable Mullion: Steel with prime coat.
- E. Types and Manufacturers:

No.	Type Description	Sargent	VonDuprin	BHMA
X1	Rim type, key locks/unlocks lever	8813ETJ	99L	08
X2	Rim type, lever always active	8815ETJ	99L-BE	Type 1
X4	Concealed vertical rod type for pairs, key locks/unlocks lever	8613ETJ	9947L	Type 8 08
X5	Concealed vertical rod type, lever always active	8615ETJ	9947L-BE	Type 8



MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2.08 CLOSERS

- A. BHMA A156.4.
- B. Size closers in accordance with manufacturer's standards. Mount regular arm closers on pull side of doors. Mount parallel arm closers on push side of doors.
- C. Finish: Satin chromium-plated No. 626.
- D. Types and Manufacturers:

No.	Type/Description	LCN	Sargent	BHMA
C4	Parallel arm with integral stop	4110 Cush-N-Stop Series	351-PS Series	C02021
C6	Parallel arm with integral stop and hold-open	4110H Cush-N-Stop Series	351-PSH Series	C02061

2.09 PUSH-PULLS

- A. Solid metal, not plated.
- B. Finish: Satin stainless steel No. 630, unless indicated otherwise.
- C. Plates: Beveled four edges, square corners.
- D. Pulls: Bolted through door.
- E. Push Plates: Countersink pull-through bolts and cover with push plate.
- F. Types and Manufacturers:

No.	Type Description	BBW	Baldwin
P1	8" x 3/4" Pull handle on plate: 0.050" x 4" x 16", and push plate: 0.050" x 8" x 16"	1017-3B and 47-G	2367 and 2125

2.10 STOPS AND HOLDERS

- A. BHMA A156.16.
- B. Machine Screws: In threaded anchors at concrete or masonry.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Self-Tapping Screws: At stud partitions, wood, or metal mountings.
- D. Metal Risers: For mounting at carpet floors.
- E. Finish: Satin chromium-plated No. 626.
- F. Types and Manufacturers for Each Leaf:

No.	Type Description	BBW or GJ	Baldwin	BHMA
S1	Spring and chain stop	Ives 115	4485	

2.11 BOLTS

- A. BHMA A156.16.
- B. Finish: Bright nickel No. 645.
- C. Types and Manufacturers:

No.	Type/Description	Stanley	Lawrence	BHMA
B1	<u>Top:</u> 8" bolt w/48" chain	1055	T146	
	<u>Bottom:</u> 8" foot-bolt or surface bolt	1056 4060	T145 283	

2.12 KICKPLATES

- A. Solid metal, not plated Bevel four edges.
- B. Width of door leaf less than 1-1/2 inches at single leaf and less than 1 inch at pairs.
- C. Finish: Satin stainless steel No. 630.
- D. Types and Manufacturers: Builders Brass Works, Baldwin, or Cipeco as follows:
  - 1. K1 10 inches high by 0.05 inch thick.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.13 THRESHOLDS

- A. Thresholds: One-piece full width of opening; extend beyond jamb where indicated.
- B. Provide with stainless steel machine screws in threaded expansion anchors at concrete.
- C. Finish: Dark bronze anodized aluminum, unless indicated otherwise.
- D. Types and Manufacturers:

No.	Type Description	Pemko	Reese
T1	Saddle (smooth, 4" x 1/2")	175D	S104D
T2	Half Saddle (serrated, 4" x 1/4")	227A	3284A
T3	Thermal break (6-1/8")	253XDFG	S473D

## 2.14 ELECTRIC STRIKE

- A. Model Von Duprin Series 6000; Model 310-3-1 by Folger Adams Co; stainless steel finish 6 12024 V AC factory wrapped electrical connections in heat shrink tubing, LBM switch..
- B. Faceplate: 620 stainless steel.

## 2.15 AUTOMATIC DOOR BOTTOM

- A. Automatic door bottom (A1): CT-50 by K.N.Crowder Mfg. Ltd; heavy duty anodized extruded aluminum with closed cell sponge neoprene seal.

## 2.16 WEATHERSTRIP

- A. Finish: Dark bronze anodized aluminum, unless indicated otherwise.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

B. Seal Types and Manufacturers:

No.	Type Description	Pemko	Reese
W1	Rubber or vinyl bulb at jambs and head, and at meeting stiles of pairs	S88D	797B
	Door shoe	222DV	DB596DF
	Rain drip	346D	R201D
W5	Weatherstripping furnished by door manufacturer		

2.17 MISCELLANEOUS ITEMS

A. Provide as indicated in Door and Hardware Schedule:

M1	Nameplate as specified in Section 10 14 00, Signage, in text noted in Door and Hardware Schedule		
	Brass pulls	411	100-B
M7	Coordinator:		
		GJ	Ives
	Model	COR-65	469

2.18 SILENCERS

- A. Ives, Glynn-Johnson.
- B. At metal frame of each hinged door that does not have seals scheduled.
- C. Three at single leaves and two at pairs.

2.19 TEMPLATES

- A. Fabricate to template hardware applied to metal doors and frames.
- B. Ensure that required templates are furnished to various manufacturers for fabrication purposes.
- C. Templates: Make available not more than 10 days after receipt of approved Hardware Schedule.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.20 EXIT AND FIRE DOORS

- A. Exit Doors: Always openable from inside by simple turn of lever handle or push on panic bar without use of key or any special knowledge or effort, to include each leaf of door pairs.
- B. Hardware for Fire Doors: Underwriters Laboratories Inc., Fire Protection Equipment List.

## **PART 3 EXECUTION**

### 3.01 INSTALLATION

- A. In accordance with manufacturer's written instructions.
- B. Make Work neat and secure, develop full strength of components, and provide proper function.
- C. Prevent marring, scratching, or otherwise damaging adjacent finishes during hardware installation.
- D. Latchbolts:
  - 1. Install to engage in strikes automatically, whether activated by closers or manually.
  - 2. In no case shall additional manual pressure be required to engage latchbolt in strike.
- E. Stops and Holders: Set to allow doors to open as far as possible.
- F. Wall Mounted Hardware: Install over solid structural backing or solid blocking in hollow walls.
- G. Thresholds:
  - 1. Cope ends neatly to profile of jamb.
  - 2. Set in sealant and seal ends to jambs.
- H. Hardware: Adjust for easy, noise-free operation.
- I. Replace damaged hardware items.

### 3.02 MOUNTING DIMENSIONS

- A. Standard Door Hardware Locations: As recommended and published by Door and Hardware Institute, except as noted or detailed otherwise.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Door Silencers: Install 3 inches from top and bottom of jamb and 1 inch above strike at single doors, and 3 inches from edges of doors in head for pairs of doors.
- C. Nameplates: Attach to doors or walls adjacent to doors 5 feet 6 inches above floor using removable adhesive.

### 3.03 MANUFACTURER'S SERVICES

- A. Deliver permanent lock cores to Site.
- B. Remove temporary construction cores and insert permanent cores.
- C. Inspect each lock set to ensure permanent cores are operating satisfactorily.
- D. Deliver to Owner change and control keys for permanent system.
- E. Return temporary construction cores to manufacturer.
- F. Furnish manufacturer's representative for the following services at Site or classroom as designated by Owner for minimum person-days listed below, travel time excluded:
  - 1. One person-days for installation assistance, inspection, and Manufacturer's Certificate of Proper Installation.
  - 2. One person-days for functional: and: performance testing.

### 3.04 PROTECTION

- A. Cover and protect exposed surfaces of hardware during installation and until Substantial Completion.
- B. Fit, dismantle, and reinstall finish hardware as required for finish painting work.
- C. Protect and prevent staining of hardware during construction in accordance with manufacturer's recommendations.
- D. Remove protective measures and permanent lock cylinders installed prior to final cleaning.

### 3.05 DOOR AND HARDWARE SCHEDULE

- A. Door and Hardware Schedule on Drawings, is guide to functional requirements of each opening.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Provide finish hardware as scheduled. Sizes omitted shall be as recommended by manufacturer.
- C. Provide rain drip on all exterior doors.

**END OF SECTION**

**SECTION 08 80 00  
GLAZING**

**PART 1 GENERAL**

**1.01 REFERENCES**

A. The following is a list of standards which may be referenced in this section:

1. American Architectural Manufacturers Association (AAMA): 800, Voluntary Specifications and Test Methods for Sealants.
2. American National Standards Institute (ANSI): Z97.1, Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test.
3. ASTM International (ASTM):
  - a. C542, Standard Specification for Lock-Strip Gaskets.
  - b. C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
  - c. C920, Standard Specification for Elastomeric Joint Sealants.
  - d. C1036, Standard Specification for Flat Glass.
  - e. C1048, Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.
  - f. C1172, Standard Specification for Laminated Architectural Flat Glass.
  - g. E774, Standard Specification for the Classification of the Durability of Sealed Insulating Glass Units.
4. Code of Federal Regulations (CFR): 16 CFR 1201, Safety Standard for Architectural Glazing Materials.
5. Glass Association of North America (GANA):
  - a. Glazing Manual.
  - b. Sealant Manual.
6. Insulating Glass Certification Council (IGCC).
7. Insulating Glass Manufacturer's Alliance (IGMA).
8. Underwriters Laboratories Inc. (UL):
  - a. 752, Standard for Bullet-Resisting Equipment.
  - b. Automotive Burglary Protection and Mechanical Equipment Directory (ABPMED).

**1.02 SUBMITTALS**

A. Action Submittals:

1. Shop Drawings:
  - a. Complete schedule of glass and glazing material to be used for each purpose.



## MEMORIAL PARWAKWAY WTP ADVANCED TREATMENT

- b. Catalog cuts of glazing materials with inclusion of glass edge cutting procedures.
2. Samples:
  - a. Two of each different type of glass at least 12 inches by 12 inches properly labeled.
  - b. Two of each different type of glazing materials.

### B. Informational Submittals:

1. Manufacturer's Certificate of Compliance for each type of glazing, in accordance with Section 01 43 33, Manufacturers' Field Services.
2. Details and methods of glazing for each type of glazing condition; include manufacturer's recommendations for setting, sealing materials, and installing each type of glazing.
3. Documentation declaring compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants and other glazing materials.
4. Documentation of glazer's previous experience and manufacturer's approval.

## 1.03 QUALITY ASSURANCE

### A. Glazier:

1. Have previous experience with installation of equal size and requirements that can be inspected by Owner.
2. Have approval of glass and framing manufacturer(s).

### B. Factory Label Glass: Nonlabeled glass will be rejected.

### C. Mock-Ups:

1. Incorporate glazing assembly mock-up materials in building exterior wall mock-up.
2. Locate where directed by Engineer.

### D. Single Source Fabrication Responsibility: Fabrication processes, including Low-E and reflective coatings, insulating, laminating, silkscreen, and tempering, shall be fabricated by a single fabricator.

## 1.04 DELIVERY, STORAGE, AND HANDLING

### A. Storage:

1. Support cases on both sides when stored vertically.

## MEMORIAL PARWAKWAY WTP ADVANCED TREATMENT

2. After unpacking, place interleaving protection between lites.
3. Keep glass and interleaving dry by storing inside where temperatures are above dewpoint, or if outside storage is necessary, cover the glass interleaving with opaque tarpaulins or plastic and inspect periodically. Wet interleaving can stain glass.
4. Avoid exposing stored glass to direct sunlight.

### B. Handling:

1. Stack individual lites on edge and lean them against sturdy uprights at a slope of 5 degrees to 7 degrees from vertical.
2. Cushion bottom edges with soft, firm pads free of dirt, grit, glass chips, or other foreign material.
3. Do not rotate or cartwheel insulating glass units over their corners. Use turning device such as a rolling block if units must be rotated.

### 1.05 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of years for coated glass 5 years for laminated glass 10 years for vertical application insulating glass 5 years for ceramic frit glass 5 years for spandrel glass after the date of Substantial Completion. Guarantee to cover deterioration due to normal conditions of use and not due to handling installing and cleaning practices performed contrary to glass manufacturer's published instructions. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Products of the following manufacturers, that meet these Specifications, may be used on this Project:
  1. Flat Glass:
    - a. AFG Industries, Inc.
    - b. Pilkington Libbey-Owens-Ford Glass Co.
    - c. PPG Industries, Inc.
    - d. Guardian Industries, Corp.
    - e. Monsanto Co.
    - f. Viracon, Inc.

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2. Laminated Safety Glass, Bullet-resistant Glass, Insulated Glass, Tempered and Heat-strengthened Glass, and Spandrel Glass:
  - a. AFG Industries, Inc.
  - b. Arch Aluminum & Glass Co.
  - c. Cardinal LG.
  - d. Interpane Glass Company.
  - e. TPG Technical Glass Products.
3. Fire-Rated and Safety-Rated Glass: TPG Technical Glass Products.
4. Plastic and Polycarbonate Sheet:
  - a. Du Pont.
  - b. Rohm and Haas Co.
  - c. General Electric Co.
  - d. CYRO Industries.
5. Sealant, Gasket, Tape, and Compound:
  - a. Dow Corning.
  - b. General Electric Silicones.
  - c. Pecora Corporation.
  - d. Tremco.
  - e. F. H. Maloney Co.
  - f. Standard Products Co.

### 2.02 GLAZING MATERIALS

- A. Float Glass (F.G.): ASTM C1036, Type I, Class 1 clear Class 2 Glazing Quality q3, 1/4 inch, (6 minimum thickness.)
- B. Tempered Float Glass (T.G.): ASTM C1048,; Class 2 (tinted, heat absorbing, and light-reducing), Glazing Quality q3; meeting ANSI Z97.1 and 16 CFR 1201, as applicable; 1/4 inch (6 minimum thickness.
- C. Tinted Float Glass (T.): ASTM C1036, Type I, Class 3, Glazing Quality q3, 52 percent visible daylight transmittance, bronze color.
- D. Wire Glass (W.G.): ASTM C1036, Type II, Class 1, Form 1, glazing quality, clear float, UL listed, meeting ANSI Z97.1, with 0.020-inch diameter welded wire in square mesh pattern embedded in 6 mm thickness.
- E. Tinted Insulating Glass (T.I.G.): Insulating glass units with 1/2-inch air space, specified tinted tempered glass outboard and clear tempered glass inboard, each sheet 6 mm minimum thickness meeting ASTM E774, Class C, warranted by manufacturer against failure of edge sealing for minimum 5 years from date of manufacture.

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- F. Tinted Insulating Glass (I.G.-T.): Insulating glass units with 1/2-inch air space, specified tinted glass outboard and clear glass inboard, each sheet 6 mm minimum thickness meeting ASTM E774, Class C, warranted by manufacturer against failure of edge sealing for minimum 5 years from date of manufacture.
- G. Tinted Insulating Glass (I.G.-T2.): Insulating glass units with 1/2-inch air space, specified tinted glass outboard and tinted CL Sm68/3 glass inboard, each sheet 6 mm minimum thickness meeting ASTM E774, Class C, warranted by manufacturer against failure of edge sealing for minimum 5 years from date of manufacture.
- H. Spandrel Glass (S.P.): Insulating glass units with 1/2-inch air space, specified tinted glass outboard and tinted float glass, 6 mm thick with ceramic frit fused to one side.( 6mm harmony Bronze OPACICOAT). ASTM C1048, Kind HS, Condition B, Type I, Class 2, Glazing Quality q3, Style B. Units warranted by manufacturer against failure of edge sealing for minimum 5 years from date of manufacture.

### 2.03 ANCILLARY MATERIALS

- A. Setting Blocks: ASTM C864 Option neoprene EPDM, 70 Shore A durometer hardness, chemically compatible with sealant used.
- B. Glazing Tape: Preformed, semisolid, polymeric-based material of proper size and compressibility. Use only where glazing rabbet is designed for tape and tape is recommended by glass or sealant manufacturer.
- C. Glazing Channels: Resilient EPDM or vinyl gaskets, as recommended by glass manufacturer, as provided with aluminum frames to be glazed.
- D. Metal Sash Glazing Compounds: AAMA 800, nonskinning type butyl.
- E. Glazing Sealant: One-component nonsag silicone elastomeric sealant ASTM C920, Type S, Grade NS, Class 25, Use G, or AAMA 800.
- F. Compression Gaskets: Preformed dense elastomeric compression glazing gaskets, ozone resistant, meeting ASTM C864, Option 1, Shore A durometer between 65 and 75, of profile required to maintain weathertight seal.
- G. Mineral Fiber Insulation: Curtain wall insulation/CW225 by Owens Corning Inc. or Roxul RXL40 by Roxul Inc.

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## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Do not perform glazing work in damp, foggy, or rainy weather, or when temperatures are not within range recommended by GANA "Glazing Manual".
- B. Surfaces: Smooth, even, sound, dry, and clean.
- C. Priming: Complete and cured.
- D. Measure size of frames to receive glass and compute actual glass size allowing for edge clearances.
- E. Use wire glass in all glazed openings in labeled fire doors and tempered glass in all other doors, transoms, and sidelights.
- F. Verify functioning weep system is present.
- G. Do not proceed with glazing until unsatisfactory conditions have been corrected.

### 3.02 GLAZING INSTALLATION

- A. General: Follow recommendations of glass manufacturer GANA "Sealant Manual, GANA "Glazing Manual" and the following:
  - 1. Cutting:
    - a. Make concealed edges clean, straight cut, and free from chips and fissures.
    - b. Shop cut all glass. Nipping glass on job not allowed.
    - c. Allow for maximum grip on all edges.
  - 2. Positioning Glass:
    - a. Set glass with equal bearing on entire width of pane.
    - b. Position sheets of glass with setting blocks of hardness, chemically compatible with sealants used, and sizes recommended by glass and sealant manufacturers.
    - c. Set tong marks of tempered glass at bottom of installed sheet.
    - d. Orient pattern and draw of glass pieces in same direction.
    - e. Place glass waves parallel or horizontal to floor.
    - f. Set glass with one translucent surface, with smooth surface, on weather side.
  - 3. Glass shall not move or rattle.

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### B. Stop Glazing:

1. Set glass on glazing tape.
2. Fill all voids around perimeter and between exterior glass and stop with glazing compound to provide completely watertight installation.
3. Trim tape and compound flush with sight line.

### C. Putty Glazing:

1. Glaze steel sash with galvanized metal glazing clips and glazing compound.
2. Cut putty off neatly and evenly to sight line of sash with sharply mitered corners.
3. Installed putty shall present a smooth surface of uniform width.

### D. Channel Glazing:

1. Set glass in glazing channel in accordance with manufacturer's installation instructions.
2. Do not stretch channel.

### E. Sealant Glazing:

1. Place setting blocks at quarter points of sill rabbet.
2. Install spacers in channel.
3. Install filler rod in channel.
4. Apply sealant to back and bottom of rabbet.
5. Bed glass in position, centered vertically and horizontally, with glazing points or clips.
6. Apply sealant to face with sufficient force to eliminate voids.
7. Trim sealant to form watershed sloping away from glass.

### F. Tape Glazing:

1. Cut glazing tape to length and set against permanent stops, horizontal strips first, extending over width of opening, then vertical strips.
2. Place setting blocks at quarter points.
3. Remove paper backing from tape.
4. Position glass on setting blocks and press against tape for full contact.
5. Place glazing tape on free perimeter of glass.
6. Seal butt joints of tape with joint sealant.
7. Install removable stop, avoiding displacement of tape, and exert pressure on tape for full continuous contact.

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### G. Gasket Glazing:

1. Cut compression gasket with mitered corners to length of channel without stretching and install as recommended by gasket and frame manufacturer.
2. Apply gasket to outside fixed edge of rabbet perimeter.
3. Place setting blocks at quarter points of sill rabbet.
4. Place glass on setting blocks and center horizontally.
5. Apply gasket to inside stop, mitering corners.

### 3.03 HOSE TEST

- A. Use 3/4-inch minimum hose without nozzle. With full stream, flood glazing from bottom to top.
- B. Correct any leaks disclosed by hose test by reglazing and retesting until eliminated.

### 3.04 CLEANING

- A. Leave glass and glazing in undamaged condition and ready for final cleaning.
- B. Remove excess glazing compound from installed glass.
- C. Remove labels from glass surface at time of final cleaning.
- D. Wash and polish both faces of glass.

### 3.05 SCHEDULE OF APPLICATION:

- A. Interior fire rated doors, transoms, windows and, sidelights: WG( Wire Glass)
- B. Interior Windows (Not fire rated assemblies): FG(Float Glass)
- C. Exterior windows and screens ( GAC area) : Tinted Insulated Glazing IG-T2
- D. Exterior windows and screens: Tinted Insulated Glazing IG-T
- E. Exterior doors, Tinted tempered insulated glazing: (TIG)
- F. Spandrel Panel: Spandrel Glass (SP)

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### 3.06 PROTECTION OF COMPLETED WORK

#### A. Protection:

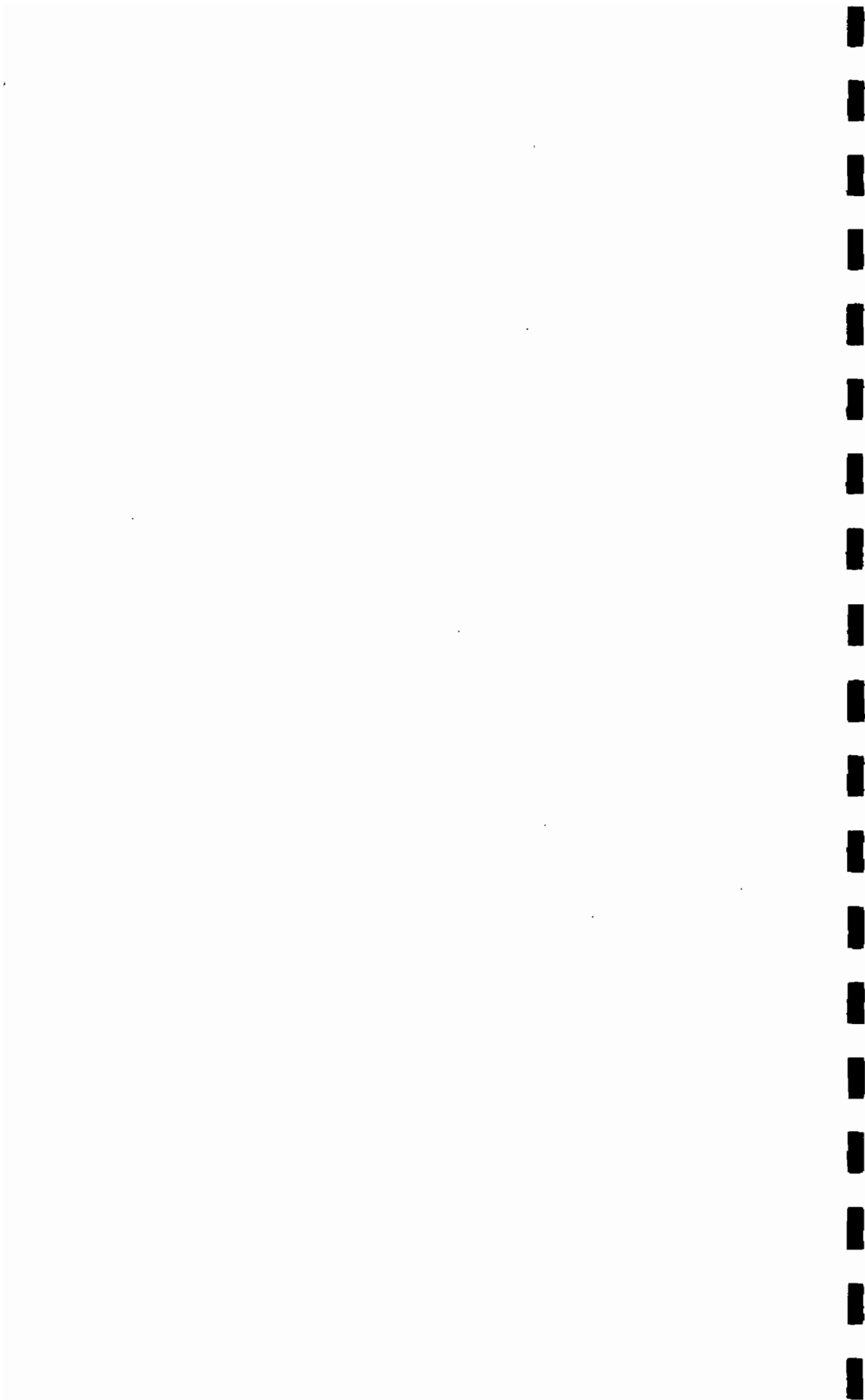
1. Keep glass free from contamination by materials capable of staining glass.
2. Install tape across lights secured to frames or structure.
3. No tape or marking allowed on glass.

#### B. Replacements and Repairs:

1. Prior to Substantial Completion, replace broken, defective, or scratched glass and repair damaged compounds.

**END OF SECTION**





**SECTION 08 90 00  
LOUVERS AND VENTS**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. Air Movement and Control Association (AMCA): 500-L, Laboratory Methods of Testing Louvers for Rating.
  2. The Aluminum Association, Incorporated (AA): Designation System for Aluminum Finishes.
  3. ASTM International (ASTM):
    - a. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
    - b. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
    - c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  4. Underwriters Laboratories, Inc. (UL): Building Materials Directory.

**1.02 DESIGN REQUIREMENTS**

- A. Installed Louvers:
1. Capable of resisting: wind load of 30 pounds per square foot

**1.03 SUBMITTALS**

- A. Action Submittals:
1. Shop Drawings: Large scale details of louvers, anchorage, and relationship to adjoining construction.
    - a. Manufacturer's Literature:
      - 1) Descriptive and performance data of louvers, including standard drawings and louver-free area.
  2. Samples: Manufacturer's standard finishes and colors.
- B. Informational Submittals:
1. Factory test data.
  2. Certificates of AMCA ratings.
  3. Installation instructions.

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4. Parts list, if applicable.
5. Maintenance procedures.
6. Special Guarantee.

## 1.04 SPECIAL GUARANTEE

- A. Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction, or at option of Owner, removal and replacement of special fluorocarbon or baked-on finish found defective during a period of 20 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Nonacoustical louver sizes are based on 50 percent free area and 800 fpm maximum velocity through free area. If louvers furnished do not meet these parameters, Contractor is responsible for resizing louvers and wall openings, and for making other adjustments to allow for larger openings.
- B. Water Penetration Rate: No greater than 0.02 ounce per square foot.
- C. Louvers: Rated and tested in accordance with AMCA 500-L.
- D. Furnish louvers with interior duct collars.

### 2.02 FIXED STORMPROOF LOUVERS

- A. Frame: Extruded aluminum channel, 0.081 inch thick, 4 inches deep, with concealed mullions.
- B. Blades: Extruded aluminum, 0.081 inch thick, Z-shaped, 35-degree to 45-degree pitch angle, spaced 3 inches to 4.25 inches on center.
- C. Pressure Loss: AMCA certified rating of no greater than 0.10-inch WC.
- D. Sizes: As shown on Drawings.
- E. Screen: Inside mounted, painted aluminum, 1/2-inch mesh.
- F. Finish: Kynar 500 fluorocarbon coating.

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### G. Manufacturers and Products:

1. Construction Specialties; Model 4110.
2. Dowco; Series LEB-4.
3. Ruskin; Model ELF-375DXH.

### 2.03 BRICK AND BLOCK VENTS (TYPE BV)

- A. Frame: Extruded aluminum, minimum 0.125 inch thick, 4 inches deep, with mortar ribs, continuous top and bottom drips, bottom weep, and rear water stop.
- B. Blades: Extruded aluminum, minimum 0.125 inch thick, permanently attached to frame at 45-degree angle.
- C. Sizes: As shown on Drawings.
- D. Screen: Inside mounted, aluminum insect screen.
- E. Finish: Kynar 500 fluorocarbon coating.
- F. Manufacturers and Products:
  1. Construction Specialties; Brick and Block Vents.
  2. Industrial Louvers; Model BV.

### 2.04 ACCESSORIES

- A. Anchors and Fasteners: Stainless steel.
- B. Flashings: Match louver frame.
- C. Isolation Tape: Tremco 440, 3M EC1202, or Presstite 579.6.
- D. Isolation Paint: ASTM D1187, bituminous coating.
- E. Insulated Blank-Off Panels:
  1. Panels: Urethane core faced on both sides with 0.032-inch stucco embossed 5005-H134 aluminum sheet in finish and color to match louvers.
  2. Frames: 6063-T52 extruded aluminum sections 0.080 inch thick, with mitered corners.
  3. Perimeter Gaskets: Closed-cell PVC, to ensure tight fit of panel to louver.
  4. Thickness: 2 inches.

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## 2.05 SOURCE QUALITY CONTROL

- A. Factory Performance Tests:
  - 1. Airflow versus pressure loss.
  - 2. Rain penetration data.
  - 3. Air infiltration leakage through closed operating louvers.

## **PART 3 EXECUTION**

### 3.01 EXAMINATION

- A. Check openings to ensure dimensions conform to Drawings.
- B. Ensure openings are free of irregularities that would interfere with installation.
- C. Do not install louvers until defects have been corrected.

### 3.02 INSTALLATION

- A. Install louvers as shown on reviewed Shop Drawings. Coordinate with heating or ventilation ductwork to be connected.
- B. Follow procedures in manufacturer's recommended installation instructions.
- C. Install insulated blank-off panels where indicated, completely closing space between ducts and louver frames.
- D. Separate aluminum from other metals with isolation tape or paint.

### 3.03 CLEANING

- A. After erection, protect exposed portions from damage by machines, paint, lime, acid, cement, or other harmful compounds.
- B. Remove protective materials and clean with plain water, water with soap, or household detergents.

**END OF SECTION**

**SECTION 09 30 00  
TILING**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI):
    - a. A108.1A, Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar.
    - b. A108.1B, Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar.
    - c. A108.1C, Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar - or - Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar.
    - d. A108.4, Ceramic Tile installed with Organic Adhesives or Epoxy Adhesives and Water Cleanable Tile-Setting Epoxy Adhesive.
    - e. A108.5, Ceramic Tile Installed with Dry-Set or Latex Portland Cement Mortar.
    - f. A108.6, Ceramic Tile Installed with Chemical Epoxy Mortar and Grout.
    - g. A108.8, Ceramic Tile Installed with Chemical-Resistant Furan Resin Mortar and Grout.
    - h. A108.9, Ceramic Tile Installed with Modified Epoxy Emulsion Mortar/Grout.
    - i. A108.10, Installation of Grout in Tilework.
    - j. A108.11, Interior Installation of Cementitious Backer Units.
    - k. A118.1, Dry-Set Portland Cement Mortar.
    - l. A118.3, Chemical Resistant, Water-Cleanable Tile Setting Mortar and Grouting Epoxy, and Water-Cleanable Tile Setting Epoxy Adhesive.
    - m. A118.4, Latex-Portland Cement Mortar.
    - n. A118.5, Chemical Resistant Furan Mortars and Grouts.
    - o. A118.6, Standard Ceramic Tile Grouts for Tile Installation.
    - p. A136.1, Organic Adhesives for Installation of Ceramic Tile.
    - q. A137.1, Specifications for Ceramic Tile.
  2. ASTM International (ASTM):
    - a. A497, Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
    - b. C144, Standard Specification for Aggregate for Masonry Mortar.

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- c. C150, Standard Specification for Portland Cement.
  - d. C206, Standard Specification for Finishing Hydrated Lime.
  - e. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
  - f. C267, Standard Test Method for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing.
  - g. C395, Standard Specification for Chemical-Resistant Resin Mortars.
  - h. C847, Standard Specification for Metal Lath.
  - i. C920, Standard Specification for Elastomeric Joint Sealants.
  - j. D226, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
3. Tile Council of North America (TCA):
    - a. Handbook for Ceramic Tile Installation.
    - b. Handbook for Limitations.

### 1.02 SUBMITTALS

#### A. Action Submittals:

##### 1. Samples:

- a. Two for each color, pattern, and type of tile specified.
- b. Size: Approximately 12 inches square.
- c. Mark Samples clearly to indicate color or shade, location in which to be used, and manufacturer's name.

#### B. Informational Submittals:

1. Certification of Compliance: For tile, mortar, grouts, and adhesives.
2. Manufacturer's Instructions: For storage, mixing, application, cleanup, and use of proposed mortars, grouts, and adhesives.
3. Tile Manufacturer's Maintenance Guidelines: For Owner's use in maintaining ceramic tilework specified herein.

### 1.03 ENVIRONMENTAL REQUIREMENTS

- A. Set and grout tile in portland cement mortar when ambient temperature is at least 50 degrees F and rising. Follow ANSI A108.1A.
- B. Comply with minimum temperature recommendations of manufacturers for bonding and grouting materials other than portland cement mortar.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 1.04 EXTRA MATERIALS

- A. Tile: Furnish extra 2 percent of each tile used in clean, marked cartons for Owner's future use.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Materials and products specified in this section shall be products of:
  - 1. American Olean Tile Co.
  - 2. Dallas Ceramic Co.
  - 3. Summitville Tiles, Inc.
  - 4. United States Ceramic Tile Co.

### 2.02 MATERIALS

- A. Tile: Standard grade, ANSI A137.1.
- B. Unglazed Ceramic Floor and Wall Tile: ANSI A137.1, Section 5.1, porcelain type\smooth cushion edge, nominal face size 12 inches by 12 inches, three colors, in pattern selected.
- C. Trim Shapes and Bases: color, and finish to match tiles.
- D. Epoxy Grout:
  - 1. For Quarry Tile and Pavers: ANSI A118.3, as manufactured by Upco U-Poxy/AAR-II or Atlas Rezklad.
  - 2. For Glazed Wall Tile: TCA Formula UG-II.

### 2.03 ANCILLARY MATERIALS

- A. Expansion Joints:
  - 1. Sealant: Silicone rubber type, meeting ASTM C920, Type S, Grade P, Class 25, Use T, color to match grout, with Shore A hardness of minimum 25 for joints in horizontal surfaces and minimum 35 in traffic areas.
  - 2. Backup Material: Flexible and compressible type, nonstaining and compatible with sealants used.
- B. Edge Strips: Stainless steel, Alloy 316 flat bar, 1/8 inch by depth of tile and mortar.



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- C. Sealer: Hillyard Chemical Co., Cemseal II or Thompson's Water Seal 101.
- D. Tile Cleaner: Neutral tile cleaner solution acceptable to tile manufacturer.
- E. Construction Paper: Heavy-duty, nonstaining kraft paper.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Examine surfaces to receive ceramic tile, setting beds, or accessories prior to tile installation.
- B. Correct defects or adverse conditions affecting quality and execution of tile installation.
- C. Tolerances for Surfaces to Receive Tile:
  - 1. Portland Cement, Dry-Set, Epoxy, and Furan Mortar Methods:
    - a. Maximum Variation in Subfloor Surface: 1/4 inch in 10 feet.
    - b. Maximum Variation in Vertical and Ceiling Surfaces: 1/4 inch in 8 feet.
  - 2. Organic Adhesive Method:
    - a. Maximum Variation in Subfloor Surface: 1/16 inch in 3 feet.
    - b. Maximum Height of Abrupt Irregularities: 1/32 inch.
    - c. Maximum Variation in Vertical and Ceiling Surfaces: 1/8 inch in 8 feet.
- D. Grounds, anchors, plugs, hangers, bucks, electrical and mechanical work, in or behind tile, to be installed prior to proceeding with tilework.
- E. Protection: Protect adjoining work surfaces before tilework begins.
- F. Make substrate firm, dry, clean, and free of oily or waxy films.

#### **3.02 INSTALLATION**

- A. Prepare surfaces, fit, set, or bond tile, grout and clean tile in accordance with applicable requirements of ANSI Standards for setting method specified, except as otherwise noted.
- B. Trim: Provide bases, caps, stops, returns, trimmers, and other shapes to finish installation.

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- C. Setting Wall Tile (Thin-Set Application):
  - 1. On Concrete or Masonry: Meet TCA Method W202.
- D. Setting Floor Tile (Thin-Set Application):
  - 1. On Concrete: Meet TCA Method F131 with epoxy mortar and grout.
- E. Edge Strips:
  - 1. At openings without thresholds and similar discontinuous edges of thin-set tile floors.
  - 2. Where ceramic tile floors are adjacent to other flooring material at same level.
  - 3. Where ceramic tile cove base is combined with other types of flooring.

### 3.03 CLEANING AND SEALING

- A. Clean tile surfaces thoroughly on completion of grouting.
- B. Remove grout haze, observing tile manufacturer's recommendations as to use of acid and chemical cleaners.
- C. Rinse tilework thoroughly with clean water before and after using chemical cleaners.
- D. Polish surface of glazed tilework with soft cloth.
- E. After grout has cured for 10 days, clean and seal nonglazed tiles following sealer manufacturer's instructions and recommendations.

### 3.04 PROTECTION

- A. From Construction Dirt:
  - 1. Apply protective coat of neutral cleaner solution, 1 part cleaner to 1 part water, to clean completed tile walls and floors.
  - 2. Cover tile floors with heavy-duty, nonstaining construction paper, masked in-place.
  - 3. Just before substantial completion, remove paper and rinse protective coat of neutral cleaner from tile surfaces.
- B. From Traffic:
  - 1. Prohibit foot and wheel traffic from using newly tiled floors for at least 7 days.

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2. Place large, flat boards in walkways and wheelways for 7 days where use of newly tiled floor with cement type grout is unavoidable.

**END OF SECTION**

**SECTION 09 51 23**  
**ACOUSTICAL TILE CEILINGS**

**PART 1 GENERAL**

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):
  - a. A641, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
  - b. C635, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
  - c. C636, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
  - d. E1264, Standard Classification for Acoustical Ceiling Products.
2. Underwriters Laboratories Inc. (UL): Fire Resistance.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
  - a. Detailed layout of grid indicating hanger spacing, fastening and splicing details, change in level details, and access location.
  - b. Manufacturer's recommendation for installation of system.
2. Samples:
  - a. One 12-inch square of each acoustical unit material to illustrate range of appearance.
  - b. One full-size Sample of each suspension system member and molding.
  - c. Mark with the name of the manufacturer and specific design and technical data.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials with manufacturer's labels indicating brand name, pattern, size, thickness, and fire rating.
- B. Store materials in original protective packaging to prevent soiling, physical damage, or wetting.

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## 1.04 ENVIRONMENTAL REQUIREMENTS

- A. Maintain humidity of 65 percent to 75 percent in area where acoustical materials are to be installed for 25 hours before, during, and 25 hours after installation.
- B. Maintain a uniform temperature of 55 degrees F to 70 degrees F during installation of materials.

## 1.05 EXTRA MATERIAL

- A. Provide additional acoustical units from the same production run as installed equal to 1 percent of area.

## PART 2 PRODUCTS

### 2.01 SUSPENSION SYSTEMS

- A. Components, Materials, and Accessories: Product of a single manufacturer.
- B. ASTM C635, Intermediate Duty:
  - 1. Exposed Tee Grid: Fire-rated spaced to fit lay-in panels.
    - a. Manufacturers and Products:
      - 1) Chicago Metallic Corp.; Fire Front 1230 System.
      - 2) Donn Corp.; Donn DXL fire-rated grid.
  - 2. Main and Cross Members:
    - a. Single web design, cold-rolled steel, minimum thickness of 0.020 inch, electrozinc-coated and factory-painted low-sheen satin white finish.
    - b. Exposed flange width of 15/16 inch.
  - 3. Edge Molding:
    - a. Minimum 0.020-inch steel, channel- or angle-shaped.
    - b. Minimum flange width of 15/16 inch.
    - c. Finish to match main members.
  - 4. Hanger Wire: ASTM A641, minimum 12-gauge, galvanized, soft-annealed, mild steel wire.
  - 5. Wire Ties: ASTM A641, 18-gauge, galvanized, annealed steel wire.
  - 6. Furnish manufacturer's hold down clips and accessories required for a complete system in high seismic zones.

### 2.02 ACOUSTICAL UNITS

- A. Flat Lay-In Panels:
  - 1. Material: Fire-resistive mineral fiber, Class A.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Reference Specification: ASTM E1264, Type III, Form 2.
3. Pattern: Random fissured.
4. Noise Reduction Coefficient (NRC): 0.55 to 0.65.
5. Ceiling Attenuation Class (CAC): 35 minimum.
6. Light Reflectance: LR 0.75 or over.
7. Nominal Size: 24 inches by 48 inches by 5/8 inch thick.
8. Edges: Square.
9. Finish and Color: Painted white, unless scheduled otherwise.
10. Manufacturers and Products:
  - a. Armstrong; Item 895, Minaboard, Cortega.
  - b. Celotex; Item PBT-197, Hytone, Baroque.
  - c. U.S.G.; Item 56705, Auratone, Natural Fissured II.

### 2.03 FIRE RATING

## **PART 3 EXECUTION**

### 3.01 SEQUENCING

- A. Lay out grid.
- B. Coordinate with mechanical and electrical equipment in framing and cutting material around ceiling penetrations.
- C. Install suspension systems after mechanical work above is complete.
- D. Install acoustical units.

### 3.02 INSTALLATION OF SUSPENDED GRID SYSTEM

- A. Hang level and in straight alignment directly from structure following ASTM C636 and the manufacturer's current printed instructions for type of installation required for this Project.
- B. Hanger Wires:
  1. Space maximum 4 feet on center each direction and securely attach to structure above.
  2. Install additional hangers at ends of each suspension member and at light fixtures, 6 inches from vertical surfaces.
  3. Do not splay wires more than 5 inches in a 4-foot vertical drop.
  4. Provide four-way wire splays at 45 degrees from main runner to support structure for every 144 square feet of ceiling area.
  5. Wrap wire minimum three times horizontally, turning ends upward.

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6. Where hanger wires cannot be hung vertically from structure above because of ducts, pipes, cable trays, or other interferences, provide trapezes of steel channels (minimum 2-inch deep, 16-gauge cold-rolled carrying channels) hung on steel rods or 8-gauge wire from structural members above. Hang ceiling wires from these trapezes or similar members supporting ducts or pipes. Do not hang directly from ducts or pipes.
  7. Follow suspension system manufacturer's instructions for modified installation required in Seismic Zone A.
- C. Edge Molding:
1. Install at intersection of suspended ceiling and vertical surfaces.
  2. Miter corners where moldings intersect or install corner caps.
  3. Attach to vertical surface with mechanical fasteners.
- D. Provide additional channels, hangers, and trapezes as required to support edges of ceiling around and under mechanical and electrical work.

### 3.03 INSTALLATION OF ACOUSTICAL UNITS

- A. Install with pattern running in one direction after completion of suspended grid system and other concealed work.
- B. Place material to bear all around on suspension members.

### 3.04 CLEANING

- A. Clean soiled or discolored unit surfaces after installation.
- B. Touch up scratches, abrasions, voids, and other defects in painted surfaces.

### 3.05 SCHEDULE OF CEILING TYPES

- A. Areas to Receive Acoustical Ceilings: Indicated on Interior Finish Schedule.

**END OF SECTION**

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## SECTION 09 90 00 PAINTING AND COATING

### PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA):
    - a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
    - b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
    - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
    - d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
  2. Environmental Protection Agency (EPA).
  3. NACE International (NACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
  4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
  5. Occupational Safety and Health Act (OSHA).
  6. The Society for Protective Coatings (SSPC):
    - a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
    - b. PA 3, Guide to Safety in Paint Applications.
    - c. SP 1, Solvent Cleaning.
    - d. SP 2, Hand Tool Cleaning.
    - e. SP 3, Power Tool Cleaning.
    - f. SP 5, White Metal Blast Cleaning.
    - g. SP 6, Commercial Blast Cleaning.
    - h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
    - i. SP 10, Near-White Blast Cleaning.
    - j. SP 11, Power Tool Cleaning to Bare Metal.
    - k. SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
    - l. SP 13, Surface Preparation of Concrete.
    - m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.



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## 1.02 DEFINITIONS

### A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PDS: Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. SP: Surface Preparation.

## 1.03 SUBMITTALS

### A. Action Submittals:

1. Shop Drawings:
  - a. Data Sheets:
    - 1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
    - 2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
    - 3) Technical and performance information that demonstrates compliance with Specification.
    - 4) Furnish copies of paint system submittals to the coating applicator.
    - 5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
  - b. Detailed chemical and gradation analysis for each proposed abrasive material.
2. Samples:
  - a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. Reference Panel:
  - 1) Surface Preparation:
    - a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
    - b) Provide panel representative of the steel used; prevent deterioration of surface quality.
    - c) Panel to be reference source for inspection upon approval by Engineer.
  - 2) Paint:
    - a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
    - b) Furnish additional samples as required until colors, finishes, and textures are approved.
    - c) Approved samples to be the quality standard for final finishes.

### B. Informational Submittals:

- 1. Applicator's Qualification: List of references substantiating experience.
- 2. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
- 3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
- 4. Manufacturer's written verification that submitted material is suitable for the intended use.
- 5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
- 6. Manufacturer's written instructions and special details for applying each type of paint.

### 1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.
- B. Regulatory Requirements:
  - 1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Perform surface preparation and painting in accordance with recommendations of the following:
  - a. Paint manufacturer's instructions.
  - b. SSPC PA 3, Guide to Safety in Paint Applications.
  - c. Federal, state, and local agencies having jurisdiction.

### C. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

## 1.05 DELIVERY, STORAGE, AND HANDLING

### A. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

### B. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

## 1.06 PROJECT CONDITIONS

### A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

**PART 2 PRODUCTS**

2.01 MANUFACTURERS

- A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.
- B. Minimum of 5 years' verifiable experience in manufacture of specified product.
- C. Each of the following manufacturers is capable of supplying most of the products specified herein:
  - 1. Sherwin Williams, Cleveland OH.
  - 2. ICI Devoe Coating, Louisville KY.
  - 3. Carboline, St. Louisville MO.

2.02 ABRASIVE MATERIALS

- A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

- A. General:
  - 1. Manufacturer's highest quality products suitable for intended service.
  - 2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
  - 3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd

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Product	Definition
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Alkyd Wood Primer	Flat alkyd
Bituminous Paint	Single-component, coal-tar pitch based
Block Filler	Primer-sealer designed for rough masonry surfaces, 100% acrylic emulsion
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Primer— Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy Primer— Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation., Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat

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Product	Definition
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading
Sanding Sealer	Co-polymer oil, clear, dull luster
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Stain, Concrete	Acrylic, water repellent, penetrating stain
Stain, Wood	Satin luster, linseed oil, solid or transparent as required
Varnish	Nonpigmented vehicle based on a variety of resins (alkyd, phenolic, urethane) in gloss, semigloss, or flat finishes, as required
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.

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5. Mix only components specified and furnished by paint manufacturer.
  6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
- B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

### 2.05 SHOP FINISHES

- A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.
- B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.
- C. Shop Coating Requirements:
1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
  2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.
- D. Pipe:
1. Ductile Iron Pipe:
    - a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
    - b. The surface preparation and application of the primer shall be performed by pipe manufacturer.
    - c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
    - d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.

**PART 3 EXECUTION**

**3.01 GENERAL**

- A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.
- B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.
- C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

**3.02 EXAMINATION**

- A. Factory Finished Items:
  - 1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to Site.
  - 2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.
- B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

**3.03 PROTECTION OF ITEMS NOT TO BE PAINTED**

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering.
- E. Protect surfaces adjacent to or downwind of Work area from overspray.



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 3.04 SURFACE PREPARATION

### A. Field Abrasive Blasting:

1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.

### B. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 500 square feet.
2. Surface with chloride levels exceeding 3  $\mu\text{g}/\text{square centimeter}$  for submerged surfaces and 5  $\mu\text{g}/\text{square centimeter}$  for exposed surfaces shall be treated with a liquid soluble salt remover equivalent to CHLOR\*RID (CHLOR\*RID International, Chandler, AZ).
3. Follow manufacturer's recommendations and procedures for the use of this product to remove the surface contamination.

### C. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
  - a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
  - b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
  - c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
  - d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
  - e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
  - g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
  - h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
  - i. SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high-pressure and ultrahigh-pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ-1 through WJ-4 for visual surface preparation definitions and SC-1 through SC-3 for nonvisual surface preparation definitions.
- 2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
  - 3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.
  - 4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
  - 5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
  - 6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
  - 7. Welds and Adjacent Areas:
    - a. Prepare such that there is:
      - 1) No undercutting or reverse ridges on weld bead.
      - 2) No weld spatter on or adjacent to weld or any area to be painted.
      - 3) No sharp peaks or ridges along weld bead.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
  8. Preblast Cleaning Requirements:
    - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
    - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
    - c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
  9. Blast Cleaning Requirements:
    - a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
    - b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
    - c. Use only dry blast cleaning methods.
    - d. Do not reuse abrasive, except for designed recyclable systems.
    - e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
  10. Post-Blast Cleaning and Other Cleaning Requirements:
    - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
    - b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.
- D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:
  1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
  2. Remove oil and grease by wiping or scrubbing surface with suitable solvent, rag, and brush. Use clean solvent and clean rag for final wiping to avoid contaminating surface.
  3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### E. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

### F. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

### G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
  - a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
  - b. Brush-off blasting.
  - c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### H. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Engineer prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:
  - a. Synthetic-based wood putty approved by paint manufacturer for paint system.
  - b. For natural finishes, color of wood putty shall match color of finished wood.
  - c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
  - d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.
  - e. Use cellulose type putty for stained wood surfaces.
5. Ensure surfaces are clean and dry prior to painting.

### I. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.

1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

### J. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. For ductile iron pipe with asphaltic varnish finish not specified to be abrasive blasted, apply coat of tar stop prior to application of cosmetic finish coat.
8. Application of Cosmetic Coat:
  - a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. Check compatibility by application to a small area prior to starting painting.
  - c. If lifting or other problems occur, request disposition from Engineer.
9. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

### 3.05 SURFACE CLEANING

#### A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

#### B. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
  - a. Rate: Approximately 2 gallons per 100 square feet.
  - b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
  - c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
  - d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
  - e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
  - f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
3. Ensure surface is completely dry before application of coating.
4. Apply acid etching to obtain a "grit sandpaper" surface profile. If not, repeat treatment.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### C. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

## 3.06 APPLICATION

### A. General:

1. The intention of these Specifications is for existing and new, interior and exterior wood, masonry, concrete and metal, and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

1. Use on the following items or areas:
  - a. Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather

E. System No. 5 Exposed Metal—Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer— Ferrous Metal	1 coat, 2.5 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
  - 1) Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as pipe galleries and similar areas.

F. System No. 6 Exposed Metal—Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust-Inhibitive Primer	1 coat, 2 MDFT
	Alkyd Enamel	2 coats, 4 MDFT

1. Use on the following items or areas:
  - a. Exposed metal surfaces new and existing located inside or outside of structures or exposed to weather, including metal doors and frames, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim and the following specific surfaces:
    - 1) Inside duct stack heads behind diffusers, registers, and grilles with flat black.
    - 2) Instrumentation and control systems exposed enclosures for process.
  - b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.



MEMORIAL PARKWAY WTP ADVANCED TREATMENT

G. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Coal-Tar Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
  - a. Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles; and the following specific surfaces:

H. System No. 8 Buried Metal—General:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Standard Hot Coal-Tar Enamel	AWWA C203
	-OR- Coal-Tar Epoxy	2 coats, 16 MDFT
	For Highly Abrasive Soil, Brackish Water: Tape Coat System	AWWA C214 with Double Outer Wrap

1. For steel pipe and fittings, follow AWWA C209 and AWWA C214
2. Use on the following items or areas:

I. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer  Remaining coats as required for exposure

1. Use on the following items or areas:
  - 1) Galvanized surfaces requiring painting
  - b. After application of System No. 10, apply finish coats as required for exposure.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

J. System No. 13 Skid-Resistant—Aluminum and FRP:

Surface Prep.	Paint Material	Min. Coats, Cover
Aluminum: In accordance with Article Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation -OR- FRP: In accordance with Article Plastic and FRP Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 16 MDFT

1. Use on the following items or areas:
  - a. All aluminum and FRP horizontal surfaces subject to foot traffic.

K. System No. 15 Heat-Resistant—425 Degrees F Maximum:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Inorganic Zinc Primer	1 coat, 2.5 MDFT
	Silicone Acrylic (limited colors)	2 coats, 2 MDFT

1. Use on the following items or areas:
  - a. All items subject to elevated temperatures.

L. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:
  - a. All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

M. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

1. Use on the following items or areas:
  - a. Use on aluminum surfaces embedded or in contact with concrete.

3.08 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.
- B. As shown in Finish Schedule on Drawings: Additional requirements are included in the Piping Schedule.
- C. System No. 102 Wood, Semigloss (Interior or Exterior):

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Wood-Surface Preparation	Alkyd Wood Primer	1 coat, 400 SFPG
	Alkyd (Semigloss)	1 coat, 400 SFPG

1. Use on the following items or areas:
  - a. Miscellaneous exposed wood surfaces.

D. System No. 106 Metal Trim and Structural Steel:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust-Inhibitive Primer	1 coat, 2 MDFT
	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

1. Use on the following items or areas:
  - a. All exposed structural steel surfaces.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

E. System No. 107 Galvanized Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Manufacturer's Recommended Primer	1 coat, as recommended by manufacturer
	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

1. Use on the following items or areas:
  - a. Hollow metal frames and doors.
  - b. All exposed galvanized surfaces

F. System No. 109 Masonry, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Masonry Surface Preparation	Block Filler	1 coat, 75 SFPG
	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
  - a. As scheduled in Interior Finish Schedule

G. System No. 111 Concrete and Masonry, Stain and Seal(CS Colored Sealer):

Surface Prep.	Paint Material	Min. Coats, Cover
Concrete: In accordance with Paragraph Concrete Surface Preparation  -OR-  Masonry: In accordance with Paragraph Masonry Surface Preparation	Stain, Concrete	2 coats, 250 SFPGPC
	Permeable Acrylic Sealer	2 coats, 100 SFPGPC

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- 1. Use on the following items or areas:
  - a. As scheduled in interior Finish Schedule.

H. System No. 112 Concrete, Flat:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Acrylic Latex (Flat)	2 coats, 240 SFPGPC

- 1. Use on the following items or areas:
  - a. As scheduled in interior Finish Schedule

I. System No. 113 Concrete, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Article Concrete Surface Preparation	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

- 1. Use on the following items or areas:
  - a. As scheduled in interior Finish Schedule.

J. System No. 114 Gypsum Board and Plaster, Flat:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Gypsum Board Surface preparation	Latex Primer Sealer	1 coat, 350 SFPG
	Acrylic Latex (Flat)	2 coats, 240 SFPGPC

- 1. Use on the following items or areas:
  - a. As scheduled in interior Finish Schedule.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

K. System No. 115 Gypsum Board and Plaster, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Gypsum Board Surface Preparation	Latex Primer/Sealer	1 coat, 350 SFPG
	Acrylic Latex (Semigloss) or Alkyd (Semigloss)	2 coats, 400 SFPGPC

1. Use on the following items or areas:
  - a. As scheduled in interior Finish Schedule.

3.09 COLORS

- A. Provide as shown in interior Finish schedule and as shown in Piping Schedule.
- B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.
- C. Equipment Colors:
  1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
  2. Paint equipment and piping one color as selected.
  3. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
    - a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
    - b. Fire Protection Equipment and Apparatus: OSHA Red.
    - c. Radiation Hazards: OSHA Purple.
    - d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.
- D. Pipe Identification Painting:
  1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
  2. Pipe Color Coding: As shown in table below.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
4. Pipe Supports: Painted light gray, as approved by Engineer.

### E. Pipe System Color Code:

1. All banding to be 2 inches wide and four feet on center.
2. Sample, drain, vent, metering, blowoff, decant, and hot lines shall be painted the same color combination as the piping system from which the line originates unless specified otherwise above. The additional pertinent text shall be applied to the pipe.
3. Insulated pipe, jacketed with canvas, shall be painted with color combination specified above.
4. Insulated pipe, jacketed with aluminum and/or stainless steel shall have the jacket unpainted. When valves and fittings for such lines are not insulated, the valves and fittings shall be color coded.
5. Building service lines such as plumbing lines, HVAC lines, and electrical conduit, shall not be color coded but shall be painted the same color as the background construction.
6. The following pipes shall be dark blue: Filter Effluent, GAC Effluent, UV Effluent, Filter to Waste, GAC to Waste, and Sample.
7. The following pipes shall be medium blue: Slurry water.
8. The following pipes shall be light gray: Backwash supply.
9. The following pipes shall be black: GAC slurry and drain.
10. The following pipes shall be light brown: Filter Backwash Waste and GAC Backwash Waste.
11. The following pipes shall be dark green: Compressed air.
12. All potable water not otherwise specified above shall be painted medium blue and stenciled as directed by the Engineer.
13. All electrical conduits and junction boxes not otherwise specified above shall be painted orange and stenciled as directed by the Engineer.
14. All natural gas lines not otherwise specified above shall be painted red and stenciled as directed by the Engineer.
15. All sewer lines not otherwise specified above shall be painted brown and stenciled as directed by the Engineer.
16. FRP panels, stainless steel panels, valves, tanks and instruments shall not be painted.
17. All hydrofluosmic acid lines shall be painted light blue with red bands and stenciled as directed by the Engineer.
18. All ferric sulfate lines shall be painted orange with black bands and stenciled as directed by the Engineer.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

19. All corrosion inhibitor (K-5) lines shall be painted light green with red bands and stenciled as directed by the Engineer.
20. All caustic lines shall be painted yellow with green bands and stenciled as directed by the Engineer.
21. All PACL lines shall be painted orange with green bands and stenciled as directed by the Engineer.
22. All sodium hypochlorite lines shall be painted yellow with red bands and stenciled as directed by the Engineer.
23. All copper and/or copper sulfate lines shall be painted black with blue bands and stenciled as directed by the Engineer.
24. All chemical piping shall be painted, chemicals missing shall be painted yellow and stenciled as directed by the Engineer.
25. All lettering shall be done in capital letters of approved size and type.
26. Legend symbols shall be applied on piping on every run and spaced not greater than 8 feet apart.
27. Text shall be applied on piping in the middle of pipe runs for runs under 50 feet or in one room, whichever is the least distance. On runs greater than 50 feet, text shall be applied at third points in the run and no more than 35 feet apart.
28. Pumps and other items of equipment to be painted shall be painted a color corresponding to their service, in accordance with the above schedule.

### 3.10 FIELD QUALITY CONTROL

#### A. Testing Equipment:

1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Razor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Testing:
1. Thickness and Continuity Testing:
    - a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
    - b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.
    - c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.
    - d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.
- C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.
- D. Unsatisfactory Application:
1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
  2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
  3. Repair defects in accordance with written recommendations of coating manufacturer.
- E. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repair in accordance with recommendations of paint manufacturer.
  2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
  3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

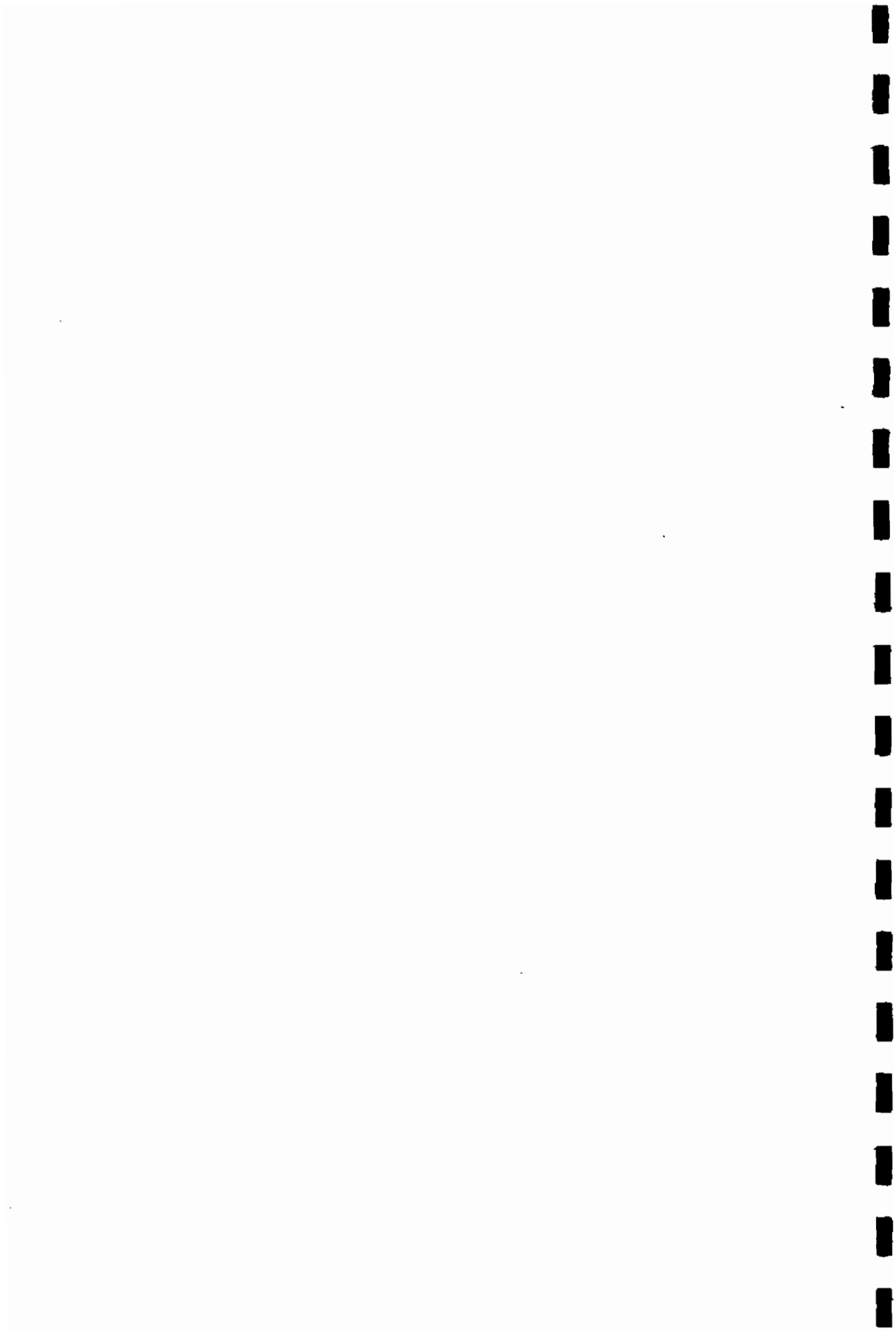
### 3.11 MANUFACTURER'S SERVICES

- A. In accordance with Section 01 43 33, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:
  - 1. On first day of application of any coating system.
  - 2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
  - 3. As required to resolve field problems attributable to or associated with manufacturer's product.
  - 4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

### 3.12 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.
- B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

**END OF SECTION**



**SECTION 10 14 00  
SIGNAGE**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards that may be referenced in this section:
1. American National Standards Institute (ANSI): A117.1, American Standard for Building and Facilities Providing Accessibility and Usability for Physically Handicapped People.
  2. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
  3. ASTM International (ASTM):
    - a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
    - b. D709, Standard Specification for Laminated Thermosetting Materials.
  4. The Chlorine Institute, Inc.: WC-1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.
  5. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
  6. National Fire Protection Association (NFPA):
    - a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
    - b. HAZ-01, Fire Protection Guide to Hazardous Materials.
  7. Occupational Safety and Health Act (OSHA).
  8. U.S. Department of Transportation, Federal Highway Administration: Manual on Uniform Traffic Control Devices for Streets and Highways.

**1.02 SUBMITTALS**

- A. Action Submittals:
1. Shop Drawings:
    - a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
    - b. Manufacturer's literature showing letter sizes and styles, sign materials, and standard mounting details.
  2. Samples: One full size for each type of nameplate, sign, and label specified.
- B. Informational Submittals: Manufacturer's installation instructions.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## PART 2 PRODUCTS

### 2.01 DOOR NAMEPLATES

- A. Material: Plastic with square corners.
- B. Thickness: 1/8 inch.
- C. Height: 2 inches.
- D. Finish: Nondirectional matte.
- E. Background: Black.
- F. Letters: Engraved.
  - 1. Size: 1 inch high.
  - 2. Color: White.
  - 3. Style: Helvetica medium upper case.
  - 4. Message Text: As shown on Door and Hardware Schedule.
- G. Manufacturers and Products:
  - 1. Best Manufacturing Co., Kansas City, MO; System A-101.
  - 2. Andco Industries Corp., Greensboro, NC; 1400 series.

### 2.02 PICTORIAL SYMBOLS

- A. Material: Plastic with square corners, match door nameplates.
- B. Conform to ANSI A117.1, Section 4.30.
- C. Manufacturers and Products:
  - 1. Best Manufacturing Co., Kansas City, MO; System A-101.
  - 2. Andco Industries Corp., Greensboro, NC; 1400 series.

### 2.03 SIGNS

- A. Plastic Signs (Type A):
  - 1. Exterior: Laminated plastic subsurface image type, 3/16 inch thick with high-gloss finish.
  - 2. Interior: Plastic, 1/8 inch thick with nondirectional matte finish and engraved letters.
  - 3. Rounded corners.

## MEMORIAL PARKWAY, WTP ADVANCED TREATMENT

5. Furnish 1-inch margin with holes at each end of label, for mounting. On fiberglass labels, furnish grommets at each hole.
6. Size:
  - a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
  - b. Furnish same size base dimensions for all labels.
7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
8. Manufacturers:
  - a. Brady Signmark.
  - b. Seton Identification Products.

### 2.05 ANCILLARY MATERIALS

- A. Fasteners: Stainless steel screws or bolts of appropriate sizes.
- B. Wood Posts: Preservative treated 4 by 4 wood as specified in Section 06 10 00, Rough Carpentry.
- C. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53, Type S, Grade B.
- D. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.
- E. Manufacturer's standard brackets for wall mounting of two-sided exit signs.

## PART 3 EXECUTION

### 3.01 INSTALLATION—GENERAL

- A. In accordance with manufacturer's recommendations.
- B. Mount securely, plumb, and level.

### 3.02 DOOR NAMEPLATES AND PICTORIAL SYMBOLS

- A. Attach to doors walls adjacent to doors with removable adhesive. See Door and Hardware Schedule for locations and messages.
- B. Mount with bottom of nameplate at 5 feet 6 inches above floor.

### 3.03 SIGNS

- A. Fasten to walls or posts or hang as scheduled. Anchor in place for easy removal and reinstallation with ordinary hand tools.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

B. Information, Exit, and Safety Signs:

1. Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.
2. Install where scheduled.
3. Removable with ordinary hand tools without leaving scars on structure or equipment.

C. Hazardous Material Signals:

1. Install where required by NFPA No. 704 and IFC, Chapter 27.
2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled and on sides of stationary tanks.
3. Specific Materials:

Hazardous Materials					
Mark	Material	Health Hazard (Blue)	Flammability Hazard (Red)	Instability Hazard (Yellow)	Special Hazard (White)
H-1	Aluminum Sulfate (48.5% solution)	2	0	0	
H-2	Aqueous Ammonia (28-50% solution)	3	0	0	
H-3	Calcium Hydroxide (95% + solid)	3	0	0	COR
H-4	Chlorine (100% gas)	3	0	0	COR, OXY
H-5	Diesel Fuel, No. 2	2	2	0	
H-6	Ferric Chloride (35-40% solution)	3	0	0	
H-7	Hydrofluosilicic Acid (30% solution)	3	0	0	COR
H-8	Hydrogen Peroxide (30-35% solution)	3	0	0	COR, OXY
H-9	Liquid Oxygen (99+% gas)	3	0	0	OXY

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Hazardous Materials					
Mark	Material	Health Hazard (Blue)	Flammability Hazard (Red)	Instability Hazard (Yellow)	Special Hazard (White)
H-10	Ozone (100% gas)	4	0	0	COR, OXY
H-11	Potassium Permanganate (100% solid)	3	0	0	COR, OXY
H-12	Soda Ash (100% solid)	2	0	0	
H-13	Sodium Bisulfite (25-38% solution)	2	0	0	
H-14	Sodium Hydroxide (10-30% solution)	3	0	0	COR
H-15	Sodium Hypochlorite (3-5% solution)	2	0	0	
H-16	Sodium Hypochlorite (12-15% solution)	3	0	0	COR
H-17	Sulfuric Acid (4-12.6% solution)	3	0	0	COR
H-18	Sulfuric Acid (12.7-50% solution)	3	0	1	COR, W
H-19	Sulfuric Acid (92-98% solution)	3	0	2	COR, W
H-20	Zinc Orthophosphate (31% solution)	2	0	0	

3.04 IDENTIFICATION LABELS

A. Pipe Labels:

1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.
5. Application: To pipe only after painting in vicinity is complete or as approved by Engineer.
6. Installation: In accordance with manufacturer's instructions.

### B. Equipment Labels:

1. Locate and install on equipment or concrete equipment base as shown on Drawings.
2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

## 3.05 SPECIFIC SIGN MESSAGES

### A. Polymer Fill Station Format and Message:

1. Polymer Fill Station: This station allows for unloading concentrated polymer from trucks. When operating, wear safety goggles and face shield, rubber gloves, rubber boots, rubber apron, cotton or polyester long-sleeved shirt or rubber jacket, and plastic hard hat.
2. Operating Procedure:
  - a. Notify plant personnel prior to unloading. Ask for assistance if needed.
  - b. Place corrosion-resistant bucket under bleed valve in fill station.
  - c. Remove cap from polymer fill line adapter and make connection between truck hose adapter and polymer fill line adapter.
    - 1) Open valve on fill line.
    - 2) Open valve on truck hose.
  - d. Unload polymer from truck. Observe level in polymer storage tank at all times by using local level indicator.
  - e. When level in storage tank indicates TANK FULL, discontinue unloading of polymer.
    - 1) Close valve on fill line.
    - 2) Close valve on truck hose.
  - f. Open bleed valve to drain polymer between fill line valve and truck hose valve into bucket.
  - g. Close bleed valve.
  - h. Use caution to break connection between truck hose adapter and polymer fill line adapter.
  - i. Replace cap on polymer fill line adapter.

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- j. Remove bucket and pour waste polymer either back into delivery truck or into a water-holding basin at a location selected by plant operating personnel. Thoroughly rinse bucket by submerging bucket in water basin.
3. In Case of Emergency: Immediately flush contaminated skin or eyes with water at the safety shower and eyewash. Notify plant personnel. Follow procedures outlined in the polymer Material Safety Data Sheet.

### 3.06 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification.
  1. Sign Schedule: A tabulation of characteristics and mounting information for each sign on the Project. Provide items as scheduled. Meet requirements of Occupational Safety and Health Act (OSHA).

**END OF SECTION**



## SIGN SCHEDULE

SIGN SCHEDULE													
Sign									Lettering				
No. <sup>1</sup>	Type <sup>2</sup>	Format <sup>3</sup>	Size			Mounting			Height to Top	Height	Style	Color	Message
			Width	Height	Color	Location	Method						
C-1	C	1014-002	20"	14"	Yellow	Hanging	Chain	5'-6"	1" min.	Helvetica	Black	CAUTION Equipment Start Automatically	
C-2	C	1014-002	20"	14"	Yellow	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	CAUTION Ear Protection Required	
D-1	C	1014-001	20"	14"	White	Door	Screws or Bolts	5'-6"	1" min.	Helvetica	Black	DANGER High Voltage	
D-2	C	1014-001	20"	14"	White	Door	Screws	5'-6"	1" min.	Helvetica	Black	DANGER Hazardous Air NO SMOKING Possible Toxic F and Lack of Ox	
D-3	B	1014-001	20"	14"	White	Pipe Post	Bolts	3'-6"	1" min.	Helvetica	Black	DANGER Hazardous Air Possible Toxic F and Lack of Ox	
D-4	C	1014-001	20"	14"	White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	DANGER No Smoking	
D-5	B	1014-001	20"	14"	White	Pipe Post	Bolts	3'-6"	1" min.	Helvetica	Black	DANGER No Smoking	
D-6	C	1014-001	20"	14"	White	Wall	Bolts	3'-6"	1" min.	Helvetica	Black	DANGER Nonpotable W Not for Drinki	

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MEMORIAL PARKWAY WTP ADVANCED TREATMENT

SIGN SCHEDULE													
Sign									Lettering				
No. <sup>1</sup>	Type <sup>2</sup>	Format <sup>3</sup>	Size			Mounting			Height to Top	Height	Style	Color	Message
			Width	Height	Color	Location	Method						
D-7	B	1014-001	20"	14"	White	Pipe Post	Bolts	3'-6"	1" min.	Helvetica	Black	DANGER Nonpotable Water Not for Drinking	
D-8	C	1014-001	20"	14"	White	Door	Screws	5'-6"	1" min.	Helvetica	Black	DANGER CHLORINE	
D-9	F	N/A	As required		White	Tank Side	Painted	5'-0"	3" min.	Block	Red	*DANGER COMBUSTIBLE LIQUIDS	
D-10	B	1014-001	14"	10"	White	Fence	Bolts	5'-6"	1" min.	Helvetica	Black	DANGER HIGH VOLTAGE	
D-11 <sup>4</sup>	C	1014-001	10"	7"	White	Door	Screws	5'-6"	1" min.	Helvetica	Black	DANGER CONFINED SPACE AUTHORIZED PERSONNEL EMPLOYEES ONLY	
H-*	H	1014-006	10" min.	10" min.	*	Wall	Screws	5'-6"	4"	Block	Black	*	
I-1	A	N/A	As required		White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	Sodium Bisulfite Fill Station	
I-2	A	N/A	As required		White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	*Polymer Fill Station	

SIGNAGE  
10 14 00 SUPPLEMENT - 2

## SIGN SCHEDULE

SIGN SCHEDULE													
Sign									Lettering				
No. <sup>1</sup>	Type <sup>2</sup>	Format <sup>3</sup>	Size			Mounting			Height to Top	Height	Style	Color	Message
			Width	Height	Color	Location	Method						
I-3	A	1014-008	20"	14"	White	Wall	Screws	5'-6"	1" min.	Helvetica	Black	NOTICE Authorized Person Only	
I-4	A	1014-008	20"	14"	White	Wall	Screws	5'-6"	1" min.	Helvetica	Black	NOTICE This elevator is freight only Not for Passengers	
S-1	B	1014-009	10"	7"	White	Door	Screws	5'-6"	1" min.	Helvetica	Red	FIRE DOOR DO NOT OBSTRUCT	
S-2	A	1014-007	6"	7"	White	Wall	Screws	5'-0"	3/8" min.	Helvetica	Black	In case of fire use stairway Do not use elevator	
S-3	B	1014-011	7"	10"	White	Door/Wall	Screws/ Bolts	5'-6"	2-1/2"	Block	Black	NOT AN EXIT	
T-1	D	STD	30"	30"	Red	Wood	Bolts	7'-6" min.	7" min.	Block	White	STOP	
T-2	D	STD	24"	30"	White	Wood Post	Bolts	3'-6"	7" min.	Helvetica	Black	SPEED LIMIT 25	
T-3 <sup>4</sup>	D	1014-004	12"	18"	Blue	Pipe Post	Bolts	5'-6"	1" min.	Block	White	*HANDICAPPED PARKING STATE PERMITS REQUIRED	

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MEMORIAL PARKWAY WTP ADVANCED TREATMENT

SIGN SCHEDULE													
Sign									Lettering				
No. <sup>1</sup>	Type <sup>2</sup>	Format <sup>3</sup>	Size			Mounting			Height to Top	Height	Style	Color	Message
			Width	Height	Color	Location	Method						
W-1	C	1014-003	20"	14"	Orange	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	WARNING Corrosive Mater Wear Require Protection	
W-2	C	1014-003	20"	14"	Orange	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	WARNING Eye Protection Required in this	
X-1	G	1014-005	10"	14"	White	Wall	Bolts	6'-0"	6"	Block	Red	EXIT	
X-2	G	1014-010	10"	14"	White	Wall	Flag	6'-0"	6"	Block	Red	← EXIT	
X-3	G	1014-010	10"	14"	White	Wall	Bolts	6'-0"	6"	Block	Red	EXIT →	
X-4	G	1014-010	10"	14"	White	Wall	Bracket	7'-6" min.	6"	Block	Red	← EXIT/EXIT	

<sup>1</sup>Numbers refer to a particular sign type with a particular message.

<sup>2</sup>Letters refer to sign types specified in this section.

<sup>3</sup>Numbers refer to Design Details that show sign layout.

<sup>4</sup>Verify requirements for this sign with Laws and Regulations in state where Project is located.

SIGNAGE

10 14 00 SUPPLEMENT - 4

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**SECTION 10 44 00**  
**PORTABLE FIRE AND SAFETY EQUIPMENT**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Factory Mutual (FM).
  2. Mine Safety and Health Administration (MSHA): Standard Nos. TC-13F-80, TC-13F-115.
  3. National Fire Protection Association (NFPA):
    - a. No. 10, Standard for Portable Fire Extinguishers.
    - b. No. 30, Flammable and Combustible Liquids Code.
  4. National Institute of Safety and Health (NIOSH): Certification Program.
  5. Occupational Safety and Health Act (OSHA).
  6. Superintendent of Documents: "A Guide to Industrial Respiratory Protection", GPO 017-033-00153-7.
  7. Underwriters Laboratories Inc. (UL): Fire Protection Equipment List.

1.02 SUBMITTALS

- A. Action Submittals: Manufacturer's product data for each item including sizes, ratings, UL listings, or other certifications, and mounting information.

**PART 2 PRODUCTS**

2.01 PORTABLE FIRE EXTINGUISHERS

- A. General:
1. Conform to NFPA 10 for fire extinguishers.
  2. Furnish fire extinguishers and cabinets from one manufacturer.
  3. All Extinguishers: UL listed, charged and ready for service.
- B. Multipurpose Hand Extinguisher (F. Ext-1):
1. Tri-class dry chemical extinguishing agent.
  2. Pressurized, red enameled steel shell cylinder.
  3. Activated by top squeeze handle.
  4. Agent propelled through hose or opening at top of unit.
  5. For use on A, B, and C class fires.
  6. Minimum UL Rating: 4A-60B:C, 10-pound capacity.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Carbon Dioxide Hand Extinguisher (F. Ext-2):
  - 1. Carbon dioxide.
  - 2. Pressurized, red enameled steel shell cylinder.
  - 3. Activated by top squeeze handle.
  - 4. Agent propelled through hose and spreader nozzle.
  - 5. For use on B and C class fires.
  - 6. Minimum UL Rating: 10B:C, 15-pound capacity.

### 2.02 FIRST-AID CABINETS AND SUPPLIES

- A. Manufacturers:
  - 1. Afassco, Inc.
  - 2. Johnson & Johnson.
  - 3. Zee Medical Products Co., Inc.
- B. Cases:
  - 1. Enameled metal or break-resistant plastic.
  - 2. Carrying handles.
  - 3. Made to hang on wall.
- C. Supplies: Quantities to serve 10 people.

### 2.03 ACCESSORIES

- A. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.
  - 1. Metal expansion shields for machine screws at concrete and masonry.
  - 2. Interior: Rust-resistant.
  - 3. Exterior: Stainless steel.
- B. Brackets: For all hand extinguishers not located in cabinets, furnish heavy-duty brackets with clip-together strap for wall mounting.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install where indicated or directed and following manufacturer's recommendations.
- B. Plumb and level equipment.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Rigidly attach cabinets and brackets to structure.
- D. Provide adequate backing for mounting surfaces.

### 3.02 PORTABLE FIRE EXTINGUISHERS AND CABINETS

- A. Provide at locations shown or as directed by Engineer.
- B. Mount hangers securely in position, following manufacturer's recommendations.
- C. Top of Extinguisher: No more than 54 inches above floor.

### 3.03 FIRST-AID CABINETS AND SUPPLIES

- A. Provide (1) one cabinet at location as directed by Engineer.

**END OF SECTION**



**SECTION 10 80 00  
MISCELLANEOUS SPECIALTIES**

**PART 1 GENERAL**

1.01 SUMMARY

- A. Section includes:
1. Flagpole.
  2. Floor mats and frames.
  3. Dock bumpers.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International:
    - a. A591, Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight [Mass] Applications.
    - b. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  2. Underwriters Laboratories Inc. (UL): Fire Protection Equipment List.

1.03 SUBMITTALS

- A. Action Submittals:
1. Manufacturers' descriptions, installation data, color charts, and cleaning and service instructions for all items proposed for use. Clearly identify each item.

**PART 2 PRODUCTS**

2.01 FLAGPOLE

- A. Materials: Aluminum 6063-T6 tubing; round cast aluminum base collar; corrugated galvanized steel tube foundation sleeve.
- B. Composition: Cone tapered, seamless aluminum tubing designed to withstand 100 mph winds.
- C. Finish and Color: Anodized, dark bronze.
- D. Size: Height of 30 feet 0 inch aboveground.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- E. Accessories: Standard fittings of ball, revolving nonfouling enclosed sheaves, halyards, cleats, centering wedges, ground spike, support plate, and baseplate.
- F. Manufacturers:
  - 1. Concord Industries, Inc.
  - 2. Pole-Tech Co., Inc.

### 2.02 FLOOR MATS AND FRAMES

- A. Mat Frame:
  - 1. Materials: Extruded aluminum 6063 T-5 frame.
  - 2. Composition: Recess mat frame prefabricated at the factory to ensure fit of mat, furnished complete with corner pins of aluminum and anchor pins of strap steel.
  - 3. Finish: Mill.
  - 4. Manufacturers and Products:
    - a. American Floor Products Company, Inc., Gaithersburg, MD; No. MF-153.
    - b. R. C. Musson Rubber Co., Akron, OH; No. RF-14.
    - c. Pawling Corporation, Wassaic, NY; No. MRF-1002.
  - 5. Sizes: As shown on Drawings.

### 2.03 DOCK BUMPERS

- A. Materials: Fabric-reinforced rubber truck tires; 3/4-inch diameter galvanized steel rods; minimum 1/4-inch thick galvanized structural steel angles.
- B. Composition: Fabricated from multiple plies cut from rubber truck tires to a uniform thickness of 4-1/2 inches. Laminated under pressure on steel supporting rods that are welded and bolted to structural steel angle closures with predrilled anchor holes. Size angles to provide not less than 1 inch of tread plies extending beyond the face of the closure angles.
- C. Manufacturers and Products:
  - 1. Horizontal Units:
    - a. Durable Corporation; Dura-Dock, Model B4510-36.
    - b. Pawling Corporation; Model H-1038.

**PART 3 EXECUTION**

**3.01 INSTALLATION OF SPECIALTIES**

- A. Follow manufacturer's recommendations and printed instructions. Consult with Engineer so that minor adjustments in the locations can be decided if necessary.
  - 1. Install materials plumb or level as applicable and attach securely to adjacent materials with suitable fasteners.
  - 2. Prevent scratching or damaging adjacent materials during installation.
- B. Flagpole:
  - 1. Paint portions of flagpole belowgrade with heavy coat of bituminous paint.
  - 2. Install flagpole, base assembly, and fittings in accordance with approved Shop Drawings and manufacturer's instructions. Provide positive lightning ground.
  - 3. Check and adjust installed fittings for smooth operation of halyards.
- C. Floor Mats and Frames:
  - 1. Assemble frame to suit mat thickness and securely anchor in-place following manufacturer's instructions. Place cement grout base below the floor level, screeded into the interior frame area, using the edge of frame as a guide.
  - 2. Install mat in frame recess as recommended by manufacturer, flat and without curls or humps.
- D. Dock Bumpers: Securely anchor in-place following manufacturer's instructions and recommendations.

**END OF SECTION**



**SECTION 22 07 00  
PLUMBING PIPING INSULATION**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy-Efficient Design of New Buildings except Low-Rise Residential Buildings.
  2. ASTM International (ASTM):
    - a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    - b. C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
    - c. C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    - d. C547, Standard Specification for Mineral Fiber Pipe Insulation.
  3. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
  4. Underwriters Laboratories, Inc. (UL).

**1.02 SUBMITTALS**

- A. Action Submittals: Product description, include list of materials, thickness for each service scheduled, and locations.
- B. Informational Submittals:
1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
  2. Manufacturer's installation instructions.

**1.03 QUALITY ASSURANCE**

- A. Materials furnished under this Specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.
- B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

### 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Stamp or Label:
  - 1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Site shall have manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
  - 2. Insulation packages and containers shall be marked "asbestos-free."

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.
- B. Insulation shall conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.
- C. Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.
- D. Fire Resistance:
  - 1. Insulation, adhesives, vapor barrier materials and other accessories, except as specified herein, shall be noncombustible.
  - 2. Use no fugitive or corrosive treatments to impart flame resistance.
  - 3. Flame proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.
  - 4. Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with NFPA 255 methods.
  - 5. Materials exempt from fire-resistant rating:
    - a. Nylon anchors.
    - b. Treated wood inserts.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

6. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
  - a. Polyurethane insulation.
  - b. PVC casing.
  - c. Fiberglass-reinforced plastic casing.

### 2.02 PIPE INSULATION

- A. Type P1 – Fiberglass (ASTM C547, Type 1 (Minus 20 Degrees F to 500 Degrees F);
  1. Fiberglass, UL-rated, preformed, sectional rigid, minimum 4 pounds per cubic foot (PCF) density, K factor 0.23 maximum at 75 degrees F mean, with factory-applied all-service jacket (ASJ) composed of reinforced kraft paper and aluminum foil laminate. Jacket shall have self-sealing lap to facilitate closing longitudinal and end joints.
  2. Manufacturers and Products:
    - a. CertainTeed; Preformed Pipe Insulation.
    - b. Johns Manville; Micro-Lok AP-T.
    - c. Owens/Corning Fiberglass Pipe Insulation.
    - d. Knauf Pipe Insulation; Crown Pipe Insulation.
- B. Type P2—Calcium Silicate (ASTM C533, 1,200 Degrees F, Maximum):
  1. Calcium silicate, minimum 12 PCF density, K factor 0.46 maximum at 300 degrees F mean, without factory-applied jacket.
  2. Manufacturers and Products:
    - a. Owens/Corning Fiberglass; Kaylo 10.
    - b. Johns Manville; Thermo-12 Gold.
    - c. Calsilite; 1,200-degree thermal insulation.
- C. Type P3—Elastomeric (ASTM C534, Minus 40 Degrees F to 220 Degrees F):
  1. Flexible, closed cell elastomeric.
  2. Nominal 6 PCF density, K factor 0.27 maximum at 75 degrees F mean.
  3. Water Vapor Transmission: 0.1 perm-inch, or less.
  4. Manufacturers and Products:
    - a. Armacell; AP Armaflex.
    - b. Nomaco; K-Flex LS.
    - c. Rubatex; R-180-FS.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.03 INSULATION FINISH SYSTEMS

### A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, white, for straight run piping and fitting locations, temperatures to 159 degrees F.
2. Manufacturers and Products:
  - a. Johns Manville; Zeston.
  - b. Ceel-Co; 550.

### B. Type F2—Paint:

1. Acrylic latex paint, white, and suitable for outdoor use.
2. Manufacturers and Products:
  - a. Armstrong; WB Armaflex finish.
  - b. Rubatex; 374, white finish.

## **PART 3 EXECUTION**

### 3.01 INSTALLATION OF INSULATION

- A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices.
- B. Apply insulation over clean, finish painted, and dry surfaces.
- C. Install insulation after piping system has been pressure tested and leaks corrected.
- D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
- E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.
- F. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- G. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.
- H. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

pipe run. Install factory molded, precut or job-fabricated units. Finish hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

- I. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.
- J. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.
- K. Insulation on piping that is to be heat traced shall be installed after installation of heat tape.
- L. Insulate valve bodies, flanges, and pipe couplings.
- M. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
- N. Do not insulate flexible pipe couplings and expansion joints.
- O. Do not allow insulation to cover nameplates or code inspection stamps.
- P. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
- Q. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.
- R. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.
- S. Placement:
  - 1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
  - 2. Insulate valves and fittings with sleeved or cut pieces of same material.
  - 3. Seal and tape joints.
- T. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.
- U. Roof Drains: Insulate vertical drops from roof drain to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.
- V. Roof and Overflow Drain Sumps: Insulate underside.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### W. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

### 3.02 INSTALLATION OF INSULATION FINISH SYSTEMS

- A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.
- B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
- C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
- D. Do not use screws or rivets to fasten the fitting covers.
- E. Install removable prefabricated aluminum covers on exterior flanges and unions.
- F. Caulk and seal exterior joints to make watertight.

### 3.03 INSULATION APPLICATIONS

- A. Potable Cold Water (In Slab or Walls):
  1. Type P3, elastomeric.
  2. 1-inch thickness for all pipe sizes.
- B. Potable Hot Water:
  1. Type P1, fiberglass.
  2. 1-inch thickness for all pipe sizes.
- C. Roof Drain and Overflow Drain Sump:
  1. Type P1, fiberglass.
  2. 1-inch thickness.
- D. Pipe Hangers:

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

1. Type P1, Fiberglass: UL-rated, preformed rigid pipe insulation inserts of thickness equal to adjoining insulation, 10 inches in length, with factory-applied, vinyl-coated and embossed vapor barrier jacket with self-sealing lap.
2. Type P3, Elastomeric: Rigid insulation section with 9-inch-long, 16-gauge galvanized steel saddle.

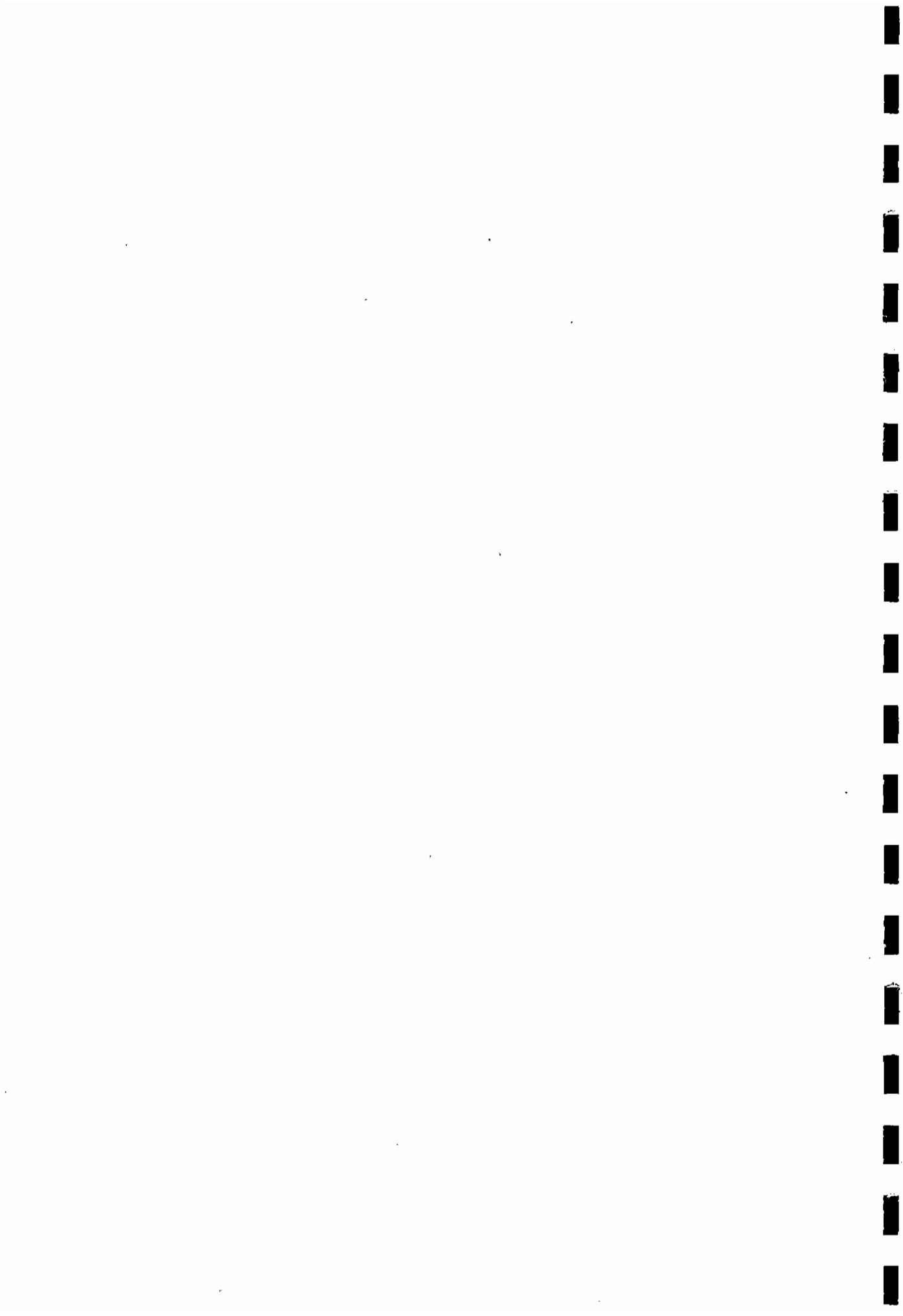
### 3.04 INSULATION FINISH APPLICATIONS

- A. Piping Insulation (Concealed Areas): Factory finish.
- B. Piping Insulation (Exposed to View, Indoors):
  1. Type F1, PVC.
- C. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

### 3.05 FIELD QUALITY CONTROL

- A. Test factory-applied materials assembled. Field-applied materials may be tested individually.

**END OF SECTION**



**SECTION 22 10 01.01  
PLUMBING PIPING SCHEDULE**

Legend	Service	Size(s) (in.)	Exposure	Piping Material	Specification Section	Operating Pressure (psig)	Test Type	Test Pressure (psig)	P Colo La
CD	Condensate Drain, HVAC	All	EXP/BUR	COP	40 27 00.13	NA	H	5	
D	Sanitary Drain	All	EXP/BUR	CISP	22 10 01.03	NA	H	5	
HW, RHW	Hot Water, Potable	All	EXP/BUR	COP	40 27 00.13		H		
RL, RS	Refrigerant	All	EXP/BUR	COP-ACR	23 23 00	Note 1	Note 1	Note 1	
RW	Rain Water	All	EXP/BUR	CISP	22 10 01.03	NA	H	5	
TP	Trap Primer	1/2 - 3/4	EXP/BUR	COP	40 27 00.13	NA	H		
TW	Tempered Water, Potable	All	EXP/BUR	COP	40 27 00.13		H		
V, VTR	Sanitary Vent	All	EXP	PVC-DWV	22 10 01.02	NA	H	5	
V, VTR	Sanitary Vent	All	EXP	CISP	22 10 01.03	NA	H	5	
W1	Cold Water, Potable	All	EXP/BUR	CPVC PVC	40 27 00.11 40 27 00.10		H		
W1	Cold Water, Potable	All	EXP/BUR	COP	40 27 00.13		H		

## Notes:

1. Refer to Section 23 23 00, Refrigerant Piping, for testing requirements.
2. Finish all FS piping exposed to view, color to be OSHA red, in accordance with Section 09 90 00, Painting and Coating, Paint System No. 5.
3. Heat trace as specified in Section 40 05 33, Pipe Heat Tracing.
4. Insulate as specified in Section 22 07 00 Building Mechanical Thermal Insulation.



MEMORIAL PARKWAY WTP ADVANCED TREATMENT

Legend					
Exposure		Pressure Test		Material	
BUR	Buried	H	Hydrostatic	ACR	Air-Conditioning and Refrigeration
EXP	Exposed	I	In Service	CISP	Cast Iron Soil Pipe
SUB	Submerged	P	Pneumatic	CISTP	Cast Iron Storm Pipe
ENC	Concrete Encased	NA	Not Applicable	CLDI	Cement-Lined Ductile Iron
				CMP	Corrugated Metal Pipe
				COP	Copper
				CPVC	Chlorinated PVC
				DI	Ductile Iron
				DWV	Drain Waste and Vent
				FRPX	Fiberglass Reinforced Plastic
				GLDI	Glass-Lined Ductile Iron
				GSP	Galvanized Steel Pipe
				HDPE	High Density Polyethylene
				PP	Polypropylene Pipe
				PSTL	PVDF-Lined Steel
				PVC	Polyvinyl Chloride
				PVDF	Polyvinylidene Fluoride
				RCP	Reinforced Concrete Pipe
				RSTL	Rubber-Lined Steel
				SST	Stainless Steel
				STL	Steel
				VC	Vitrified Clay Pipe

END OF SECTION

PLUMBING PIPING SCHEDULE  
22 10 01.01 SUPPLEMENT - 2

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22 10 01.03

**SANITARY DRAIN WASTE, VENT, SEWER AND ROOF DRAINAGE SYSTEM**

**PART 1 GENERAL**

1.01 ABOVE GRADE

- A. Sanitary, drain, waste, vent, sewer and roof drainage lines shall be of cast iron soil pipe and fittings and shall conform to the requirements of CISPI Standard 301, ASTM A888, or ASTM A74. Pipe and fittings shall be marked with a collective trademark of the Cast Iron Soil Pipe Institute or receive prior approve of the Engineer.

1.02 BELOW GRADE

- A. Sanitary drain, waste, vent, sewer, and roof drainage lines shall be of cast iron soil pipe and fittings, and shall conform to the requirements of CISPI Standard 301, ASTM A888, or ASTM A74. Pipe and fittings shall be marked with a collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the Engineer.
- B. Building of house sewers shall be of cast iron soil pipe and fittings from the building drain to point of connection with city sewer or private disposal plant. All pipe and fittings shall conform to the requirements of CISPI Standard 301, ASTM A888, or ASTM A74. Pipe and fittings shall be marked with a collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the Engineer.

1.03 JOINTS

- A. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions, the CISPI Standard 310 and local code requirements. Hubless coupling gaskets shall conform to ASTM Standard C564.
- B. Joints for hub-and-spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM Standard C564 and ASTM Standard C1563 or shall be installed with lead and oakum.



**SECTION 22 10 01  
PLUMBING PIPING AND ACCESSORIES**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this Section:
1. American National Standards Institute (ANSI).
  2. American Society of Sanitary Engineering (ASSE):
    - a. 1010, Performance Requirements for Water Hammer Arresters.
    - b. 1050, Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems.
  3. ASTM International (ASTM):
    - a. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
    - b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
    - c. A536, Standard Specification for Ductile Iron Castings.
    - d. A888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
    - e. B75, Standard Specification for Seamless Copper Tube.
    - f. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
    - g. C1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
    - h. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40.
  4. American Water Works Association (AWWA):
    - a. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In (100 mm Through 3,600 mm).
    - b. C606, Grooved and Shouldered Joints.
    - c. C651, Disinfecting Water Mains.
  5. Cast Iron Soil Pipe Institute (CISPI): 301, Standard Specification for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
  6. Plumbing and Drainage Institute (PDI): WH 201, Water Hammer Arrester Standard.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.02 DESIGN REQUIREMENTS

- A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:
  - 1. Building Service Piping: ASME B31.9, as applicable.
  - 2. Sanitary Building Drainage and Vent Systems: Kentucky Plumbing Code.

## 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Product data sheets.
  - 2. Shop Drawings:
    - a. Showing changes in location of fixtures or equipment that are advisable in the opinion of Contractor.
  - 3. Isometric riser diagrams.
- B. Informational Submittals:
  - 1. Changes in location of equipment or piping that affect connecting or adjacent work, before proceeding with the work.
  - 2. Complete list of products proposed for installation.
  - 3. Test records produced during testing.

## **PART 2 PRODUCTS**

### 2.01 PIPING

- A. Piping Schedule: Refer to Section 40 27 00, Process Piping—General.
- B. Piping Material: Refer to Section 40 27 00, Process Piping—General.

### 2.02 HOSE VALVES AND HYDRANTS

- A. Refer to Plumbing Fixture Schedule (MP-P-601).

### 2.03 PIPE HANGERS AND SUPPORTS

- A. Refer to Section 40 05 15, Piping Support Systems.

### 2.04 INSULATION

- A. As specified in Section 22 07 00, Plumbing Piping Insulation.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.05 VALVES

#### A. General:

1. Furnish complete with necessary operating hand wheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, and wrenches.
2. Renewable Parts Including Discs, Packing, and Seats: Types as recommended by valve manufacturer for intended service.
3. Units shall have name of manufacturer and size of valve cast on body or bonnet or shown on a permanently attached plate in raised letters.

#### B. Design Features:

1. Brass and bronze components, including appurtenances in contact with water.
2. Alloys containing less than 16 percent zinc and 2 percent aluminum.
3. Alloys are of the following ASTM designations:
  - a. B61, B62, B98/B98M (Alloy A, B, or D), B139 (Alloy A), B164, B194, and B127.
  - b. Stainless steel Alloy 18-8 may be substituted for bronze as an option with approval of Engineer.
4. Gland Bolts on Iron Body Valves: Bronze, fitted with brass nuts.

#### C. Valve Operators:

1. Open by turning counterclockwise.
2. Worm and Gear Operators On Manually Operated Valves: Totally enclosed design, proportioned as to permit operation of valve under full operating head with maximum pull of 40 pounds on handwheel or crank.
3. Self-locking type to prevent the disc or plug from creeping.
4. Self-Locking Worm Gears:
  - a. One-piece design of gear bronze material, accurately machine cut.
  - b. Worm: Hardened alloy steel, with thread ground and polished.
  - c. Reduction gearing shall run in a proper lubricant.
5. Galvanize handwheels.

#### D. Gate Valves:

1. 3 Inches and Smaller for Water and Air Services:
  - a. All-bronze with screwed bonnet, single solid wedge gate with nonrising stem, and handwheel operator.
  - b. Rated 125-pound SWP, 200-pound WOG.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- c. Manufacturers and Products for Threaded Ends:
    - 1) Crane; No. 438.
    - 2) Nibco; Model No. T-113.
  - d. Manufacturers and Products for Soldered Ends:
    - 1) Crane; No. 1701S.
    - 2) Nibco; Model No. S-113.
  - 2. 4 Inches and Larger for Water and Air Services:
    - a. Iron body, bronze mounted, with flanged ends, solid wedge gate with nonrising stem, and handwheel operator.
    - b. Rated 125-pound SWP, 200-pound WOG.
    - c. Manufacturers and Products:
      - 1) Crane; No. 461.
      - 2) Nibco; Model No. F-619.
- E. Ball Valves:
- 1. 2 Inches and Smaller for General Water and Air Service:
    - a. Three-piece body type, bronze body and end pieces, hard-chrome plated bronze or brass ball, full bore port, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip.
    - b. Rated 6-pound WOG, 150-psi SWP.
    - c. Manufacturers and Products:
      - 1) Threaded Ends:
        - a) Milwaukee; BA-300.
        - b) Nibco; T-595-Y.
        - c) Conbraco Apollo; 82-100.
      - 2) Soldered Ends:
        - a) Milwaukee; BA-350.
        - b) Nibco; S-595-Y.
        - c) Conbraco Apollo; 82-200.
- F. Globe Valves:
- 1. 3 Inches and Smaller:
    - a. Bronze body, replaceable composition disc, screwed ends, union bonnet, inside screw rising stem, and TFE disc.
    - b. Rated 150-pound SWP, 300-pound WOG.
    - c. Manufacturers and Products:
      - 1) Crane; No. 7TF.
      - 2) Nibco; No. T-235-Y.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- G. Angle Valves 3 Inches and Smaller:
  - 1. Bronze body, threaded ends, union bonnet, and rising stem.
  - 2. Rated 150-pound SWP and 300-pound WOG.
  - 3. Manufacturers and Products for Threaded End:
    - a. Crane; No. 17TF.
    - b. Nibco; No. T-335-Y.
  
- H. Check Valves 3 Inches and Smaller:
  - 1. Bronze body, wye pattern, threaded ends and cap, regrinding seat, and swing type disc.
  - 2. Rated 125-pound SWP, 200-pound WOG.
  - 3. Manufacturers and Products:
    - a. Crane; No. 37.
    - b. Walworth Co.; Figure 406.
  
- I. Water Pressure Reducing Valves 3 inches:
  - 1. Spring controlled, with a neoprene diaphragm.
  - 2. Sizes and Ratings:
    - a. PRV-1: 3-inch IPS, outlet pressure 80 psig.
  - 3. Manufacturers and Products:
    - a. Fisher; Type 75.
    - b. Watts; No. 223.
  
- J. Gauge Cock Valves 1/8 Inch to 3/8 Inch:
  - 1. Bronze body, hexagon male and female ends, and tee head.
  - 2. Rated for 125-pound SWP.
  - 3. Manufacturers and Products:
    - a. Ernst Gage Co.
    - b. Lunkenheimer.
  
- K. Manual Air Vent Valves:
  - 1. With coin-operated air vent.
  - 2. Manufacturers and Products:
    - a. Bell & Gossett; No. 4V.
    - b. Dole; No. 9.
  
- L. Thermostatic Mixing Valve Assembly:
  - 1. Function: Provide tempered water at 3 to 50 gpm.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Components:
  - a. High flow mixing valve for 15 to 50 gpm.
  - b. Low flow mixing valve for 3 to 7 gpm.
  - c. Pressure reducing valve.
  - d. Pressure gauge.
  - e. Isolation valve.
  - f. Thermometer.
  - g. Pipe fittings.
  - h. Heavy-gauge steel cabinet with access door and manufacturer's standard baked enamel finish.
3. Inlets: One each, 3/4-inch NPT, cold and hot water.
4. Outlets: 1 inch NPT.
5. Self-contained; no electrical requirements.
6. Performance: With 140 degrees F hot inlet and 60 degrees F cold inlet, deliver 100 degrees F at inlet pressures between 30 and 100 psig. Set outlet at 95 degrees F.
7. Manufacturers and Products:
  - a. Powers Process Controls; Series 430/420 Hydroguard.
  - b. Leonard; Model TM 650.

### 2.06 MISCELLANEOUS PIPING SPECIALTIES

#### A. Strainers for Water Service:

1. Iron body, Y-pattern, 125-pound rated, with screwed bronze or bolted iron cap.
2. Screen: Heavy-gauge stainless steel or monel, 30 mesh.
3. Manufacturers and Products:
  - a. Crane; No. 988-1/2.
  - b. Mueller; No. 751.

#### B. Vacuum Breakers 2 Inches and Smaller:

1. Angle type, as required.
2. Manufacturers:
  - a. Febco.
  - b. Watts.

#### C. Water Hammer Arresters:

1. Materials: ASSE 1010 certified, Type L copper tube, HHPP piston with two lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Manufacturers and Products:
  - a. Sioux Chief Mfg. Co., Inc.; Series 650 and 660.
  - b. Precision Plumbing Products, Inc.

### D. Water Hose:

1. Furnish 50-foot length(s) of 1-1/2-inch, EPDM black cover and EPDM tube, reinforced with two textile braids. Furnish each length with brass male and female NST hose thread couplings to fit hose nozzle(s) and hose valve(s) specified.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
  - a. Goodyear.
  - b. Boston.

### E. Hose Nozzles:

1. Furnish 1-1/2-inch cast brass satin finish nozzle(s) with adjustable fog, straight-stream, and shut-off features and rubber bumper. Provide nozzle(s) with female NST hose thread.
2. Manufacturers:
  - a. Croker.
  - b. Elkhart.

### F. Sleeves:

1. Manufacturers and Products:
  - a. J. R. Smith; Figure 1720.
  - b. Josam; No. 26400.

### G. Flashing Sleeves for Roof Penetrations:

1. Built-Up Bituminous Roofing: Fabricate of lead as specified in Section 07 62 00, Sheet Metal Flashing and Trim.
2. Single-Ply Membrane Roofing: Pipe seals as specified in Section 07 70 01, Roof Specialties and Accessories.

### H. Insulating Dielectric Unions and Flanges:

1. Galvanically compatible with piping to which attached and pressure ratings suitable for system working pressures.
2. Unions 2 Inches and Smaller: Screwed or solder-joint type.
3. Unions 2-1/2 Inches and Larger: Flanged type, complete with bolt insulators, dielectric gasket, bolts, and nuts.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

4. Manufacturers:
  - a. Epco Sales, Inc., Cleveland, OH.
  - b. Capitol Insulation Unions.
- I. Joint Solder: 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
- J. Pipe Joint Sealer: Compound insoluble in water or Teflon tape; approved by NFS for use in potable water.
- K. Rubber Gaskets: ASTM C564.

### 2.07 MEASURING DEVICES

- A. Thermometers:
  1. Adjustable angle, red reading mercury type with 9-inch case and scale range in degrees F, as shown.
  2. Furnish with 3-1/2-inch stem length and separable NPT brass thermowell.
  3. Manufacturers:
    - a. Trerice Co.; Model A005.
    - b. Weksler.
- B. Pressure Gauges:
  1. Construction: 3-1/2-inch gauge size, 0 to 690 kPa, 0 to 160 psi range, steel case, glass crystal, brass movement, and 1/4-inch NPT lower connection.
  2. Furnish with 1/4-inch brass gauge cock.
  3. Manufacturers and Products:
    - a. Ashcroft; Type 1008.
    - b. Marsh; J80.
    - c. Marshalltown.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Install plumbing systems to meet the applicable plumbing code.
- B. Field Obstructions:
  1. Drawings do not attempt to show exact details of piping. Provide offsets around obstructions.
  2. Do not modify structural components, unless approved by Engineer.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Sleeves:
  - 1. Pipe sizes shown are nominal sizes, unless shown or specified otherwise.
  - 2. Provide piping passing through walls, floors, or ceilings with standard-weight pipe sleeves.
  - 3. Provide pipes passing through finished walls with chrome-plated canopy flanges.
  - 4. Dry pack sleeves in existing work in-place and provide finished appearance.
  - 5. Pack holes left by removal of existing piping with grout and finish to match adjacent surface.
- D. Provide unions in piping systems at connections to equipment.
- E. Provide insulating dielectric unions and flanges between ferrous and nonferrous piping and where otherwise required for electrically insulated connection.
- F. Pipe air release valves, water-lubricated bearings, and other appurtenances having water effluent with copper tubing to nearest drain.
- G. Trench Excavation and Backfill: As specified in Section 31 23 16, Excavation.

### 3.02 INSTALLATION

- A. Copper Tubing:
  - 1. Cut tubing square and remove burrs.
  - 2. Clean both inside of fittings and outside of tubing with steel wool and hydrochloric acid before soldering.
  - 3. Prevent annealing of fittings and hard-drawn tubing when making connections.
  - 4. Do not use mitered joints for elbows or notching of straight runs of pipe for tees.
- B. Water System Balancing: Provide a qualified registered engineer or firm specializing in testing and balancing to adjust domestic water system. Balance system for required water flows at each plumbing fixture, terminal device, and recirculating hot water loop.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Water Hammer Arresters:
  - 1. Install in piping systems where shown on Drawings and adjacent to pieces of equipment where quick closing valves are installed.
  - 2. Install at all emergency safety showers and eyewashes.
  - 3. Size and install in accordance with Plumbing and Drainage Institute Standard PDI-WH201.
  - 4. Shock arresters to have access panels or to be otherwise accessible.
- D. Valves: Install in accordance with manufacturer's recommendations.
- E. Miscellaneous Piping Specialties: Install in accordance with manufacturer's recommendations.
- F. Measuring Devices: Install in accordance with manufacturer's recommendations.

### 3.03 SANITARY AND WASTE DRAINS AND VENTS PIPING

- A. Installation:
  - 1. Set piping above floor slab true and plumb.
  - 2. Set exposed risers as close to walls as possible.
  - 3. Where vent stacks pass through roof slab, fit with flashing sleeve secured to roof.
  - 4. Extend vents minimum 1 foot above roof.
  - 5. Provide cleanouts where shown and where required by code.

### 3.04 HVAC CONDENSATE PIPING

- A. Set piping true and plumb.
- B. Slope piping 1/8 inch per foot minimum.

### 3.05 WATER SUPPLY PIPING

- A. Water supply piping includes potable hot water (HW), systems and nonpotable systems.
- B. Flush water piping systems clean of internal debris, clean faucet aerators, and adjust plumbing fixture valves for manufacturer's recommended flow.
- C. Do not run water piping through electrical rooms, stairwells, or immediately over or within a 3-foot horizontal clearance of electrical panels, motor starters, or environmental control panels.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Provide exterior water piping with minimum 3.0 feet of cover or install below frost line, whichever is greater.
- E. Hose Valves and Hydrants: Attach handle with setscrew and provide manufacturer's recommended gravel fill around drain hole of post hydrants.
- F. Provide valve operators with position indicators, where indicated, to show position of valve disc or plug.
- G. Provide bypass with globe valve for emergency throttling around each reducing valve.
- H. Protect buried copper and steel pipe and fittings with a single wrap of coal-tar saturated felt in accordance with AWWA C203.
- I. Vacuum Breakers 2 Inches and Smaller: Install minimum 6 inches above flood line of equipment they serve.
- J. Provide manual air vents at high points in domestic hot water system.

### 3.06 INSULATION

- A. As specified in Section 22 07 00, Plumbing Piping Insulation.

### 3.07 HANGERS AND SUPPORTS

- A. In accordance with Section 40 05 15, Piping Support Systems.

### 3.08 INTERIM CLEANING

- A. As specified in Section 40 27 00, Process Piping—General.

### 3.09 TESTING

- A. General:
  - 1. Conduct pressure and leakage tests on newly installed pipelines.
  - 2. Provide necessary equipment and material, and make taps in pipe, as required.
  - 3. Plumbing Inspector will monitor tests. Provide 24-hour advance notice of start of testing.
  - 4. Test Pressures: As specified herein and in Piping Schedule.
  - 5. Test Records: Make records of each piping system installation during test to document the following:
    - a. Date of test.
    - b. Description and identification of piping tested.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- c. Test fluid.
  - d. Test pressure.
  - e. Remarks, including:
    - 1) Leaks (type, location).
    - 2) Repairs made on leaks.
  - f. Certification by Contractor and signed acknowledgment by Plumbing Inspector that tests have been satisfactorily completed.
- B. Testing New Pipe Connected to Existing Pipe: Isolate new pipe with grooved end pipe caps, spectacle blinds, or blind flanges.
- C. Preparation and Execution:
- 1. Buried Pressure Piping:
    - a. An initial service leak test may be conducted with a partially backfilled trench and the joints left open for inspection, if field conditions permit, as determined by Engineer.
    - b. Expose joints for the acceptance test on buried pressure piping to be pneumatically tested or subjected to an initial service leak test.
    - c. Conduct final hydrostatic acceptance tests after trench has been completely backfilled.
  - 2. Exposed Piping: Conduct tests after piping has been completely installed including supports, hangers, and anchors, but prior to insulation.
- D. Hydrostatic Leak Tests:

- 1. Equipment: Provide the following:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

- 2. Procedure:
  - a. Use water as the hydrostatic test fluid.
  - b. Provide clean test water of such quality as to minimize corrosion of the materials in the piping system.
  - c. Open vents at high points of the piping system to purge air pockets while the piping system is filling.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- d. Venting during filling of system may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.
  - e. Test piping systems at test pressure specified in Piping Schedule.
  - f. Maintain hydrostatic test pressure continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
  - g. Examine joints and connections for leakage.
  - h. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.
  - i. Correct visible leakage and retest to satisfaction of the Plumbing Inspector.
3. Test Pressure for Water: 1-1/2 times system pressure.
  4. Gravity Sewers and Drains:
    - a. Test by water or air exfiltration tests as prescribed by local or state plumbing codes and visually examine for leaks.
    - b. Repair leaks and retest system until no further leakage is evident.

### 3.10 CLEANING AND DISINFECTION

- A. As specified in Section 33 13 00, Disinfecting of Water Utility Distribution.

### 3.11 PROTECTION OF INSTALLED WORK

- A. Protective Covers:
  1. Provide over floor and shower drains during construction, to prevent damage to drain strainers and keep foreign material from entering drainage system.
  2. Cover roof drains and emergency overflow drains during roofing process so roofing material and gravel do not enter drain piping.
  3. Remove at time of Substantial Completion.

### 3.12 FIELD FINISHING

- A. In accordance with Section 40 27 00, Processing Piping—General.

### 3.13 PIPING IDENTIFICATION

- A. Refer to Section 40 27 00, Process Piping—General and Pipe Schedule.



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 3.14 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this Specification.

1. 22 10 01.01, Plumbing Piping Schedule.
2. 22 10 01.03, Cast Iron Soil Pipe (CISP) and Fittings.

**END OF SECTION**

**SECTION 22 30 00  
PLUMBING EQUIPMENT**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American Gas Association (AGA).
  2. American Society of Heating, Refrigerating & Air-Conditioning Engineers, Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
  3. American Society of Mechanical Engineer's (ASME).
  4. American Society of Sanitary Engineering (ASSE):
    - a. 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Backflow Preventers.
    - b. 1015, Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Backflow Fire Protection Assemblies.
  5. American Water Works Association (AWWA):
    - a. C510, Double Check Valve Backflow Prevention Assembly.
    - b. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
    - c. C550, Protective Interior Coatings for Valves and Hydrants.
  6. ASTM International (ASTM):
    - a. A48/A48M, Standard Specification for Gray Iron Castings.
    - b. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
  7. Canadian Standards Association (CSA):
    - a. B64.4, Backflow Preventers, Reduced Pressure Principle Type (RP).
    - b. B64.5, Backflow Preventers, Double Check Valve Type (DCVA).
  8. FM Global (FM).
  9. Food and Drug Administration (FDA).
  10. Foundation for Cross-Connection Control and Hydraulic Research at University of Southern California (FCCHR): Manual of Cross-Connection Control.
  11. International Code Council (ICC): International Plumbing Code (IPC).
  12. National Electrical Code (NEC).
  13. National Electrical Manufacturers Association, (NEMA): MG 1, Motors and Generators.

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14. NSF International (NSF).
15. Underwriters Laboratories Inc. (UL).

### 1.02 SUBMITTALS

#### A. Action Submittals:

1. Manufacturer's product data.

### 1.03 SPECIAL GUARANTEE

- #### A.
- Where note below, provide manufacturer's extended guarantee in writing with Owner named as beneficiary. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of products found defective during the stated period after date of Substantial Completion.

## **PART 2 PRODUCTS**

### 2.01 REFER TO PLUMBING FIXTURE SCHEDULE ON DRAWINGS.

**END OF SECTION**

**SECTION 22 40 00  
PLUMBING FIXTURES**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Americans with Disabilities Act (ADA).
  2. American Gas Association (AGA).
  3. American Society of Mechanical Engineers (ASME).
  4. American Society of Sanitary Engineering (ASSE): 1010, Performance Requirements for Water Hammer Arresters.
  5. ASTM International (ASTM): D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
  6. Food and Drug Administration (FDA).
  7. Plumbing and Drainage Institute (PDI):
    - a. Code Guide 302 and Glossary of Industry Terms.
    - b. WH-201, Water Hammer Arrester Standard.
  8. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

- A. Action Submittals: Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.03 REGULATORY REQUIREMENTS

- A. Comply with the Americans with Disabilities Act (ADA), and local and state requirements.

**PART 2 PRODUCTS**

2.01 MANUFACTURERS

- A. Fixture Trim:
1. Supply Stops and Traps:
    - a. McGuire.
    - b. American Standard.
    - c. Kohler.
  2. Flush Valves: Sloan.

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3. Water Closet Seats:
    - a. Bemis.
    - b. Church.
    - c. Olsonite.
  4. Lavatory Supply, Tailpiece, and Trap Insulation:
    - a. McGuire.
    - b. Trap Wrap.
    - c. Truebro.
- B. Plumbing Fixtures:
1. Sample Sink:
    - a. Elkay.
    - b. Fiat.
    - c. Just.
  2. Service Sinks:
    - a. Kohler.
    - b. American Standard.
    - c. Crane.
  3. Faucet Fittings:
    - a. Sinks:
      - 1) Chicago.
      - 2) T&S Brass.
  4. Drinking Fountains and Electric Water Coolers:
    - a. Elkay.
    - b. Haws.
    - c. Western.
  5. Boot Wash:
    - a. Lasco.
    - b. Fiat.
- C. Drainage Products:
1. General:
    - a. JR Smith.
    - b. Wade.
    - c. Zum.
- D. Plumbing Specialties:
1. Shock Arresters:
    - a. Smith.
    - b. Sioux Chief.
    - c. Precision Plumbing Products.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Trap Primers:
  - a. Precision Plumbing Products.
  - b. Smith.
  - c. Wade.
3. Pressure/Temperature Relief Valves:
  - a. Cash-Acme.
  - b. Kunkle Valve.
  - c. Watts.
4. Pressure Gauges:
  - a. Ashcroft.
  - b. Marsh.
  - c. Marshalltown.
5. Thermometers:
  - a. Terrice.
  - b. Weksler.

### 2.02 GENERAL

- A. Fixture Trim: Provide plumbing fixture trim where applicable on fixtures.
- B. Plumbing Fixtures: Indicated by fixture number as shown on Drawings.
- C. Drainage Products: Indicated by fixture number as shown on Drawings.
- D. Plumbing Specialties: Indicated by fixture number as shown on Drawings.
- E. Exposed fixture connections and piping shall be polished chrome-plated.

### 2.03 MATERIALS

- A. Fixture Trim:
  1. Supply Stop:
    - a. Flexible supply with heavy cast brass, loose key, 1/2-inch IPS by 3/8-inch outside diameter tubing angle stop to wall with escutcheon plate; chrome-plated finish.
    - b. Provide stop with stuffing box.
    - c. Manufacturer: McGuire Manufacturing Company, Inc.
  2. Trap:
    - a. Chrome-plated, 17-gauge, semicast P-trap with compression ring cast brass waste and vent connection and cleanout.
    - b. 1-1/2 inches for lavatories and drinking fountains.
    - c. 1-1/2 inches for sinks.
    - d. Manufacturer: McGuire Manufacturing Company, Inc.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Water Closet and Urinal Flush Valves: Sloan Valve Co., Royal Continental, low flush, quiet action with screwdriver stop and vacuum breaker.
- B. Plumbing Fixtures:
  1. Refer to Plumbing Fixture Schedule on Drawings.
- C. Drainage Products:
  1. Refer to Plumbing Fixture Schedule on Drawings.
- D. Hose Valves: Refer to Plumbing Fixture Schedule on Drawings.
- E. Plumbing Specialties:
  1. Water Hammer Arresters:
    - a. Materials: ASSE 1010 certified, Type L copper tube, HHPP piston with two lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter.
    - b. Manufacturer and Product: Sioux Chief Mfg. Co., Inc.; Series 650 and 660.
  2. TP-1, Trap Priming Valve:
    - a. Materials: Cast bronze, line pressure drop activated, antisiphon port, 1/2-inch connection.
    - b. Manufacturer and Product: Precision Plumbing Products, Inc.; Model P-1 trap priming valve and Model DU-4, distribution unit.
  3. Pressure/Temperature Relief Valve:
    - a. Materials: ASME/AGA rated, bronze body construction, vacuum relief valve vent in drain, backup emergency safety fuse plug, tamper-resistant bonnet screws, test lever, short thermostat, and automatic reseating.
    - b. Manufacturer and Product: Watts Industries, Inc.; Series 40.
  4. Pressure Gauge:
    - a. Materials: 3-1/2-inch gauge size, 0 to 160 psi range, steel case, glass crystal, brass movement, and 1/3-inch NPT lower connection.
    - b. Manufacturer and Product: Ashcroft Dresser Instrument Division, Dresser Industries, Inc.; Type 1008.
  5. Thermometer:
    - a. Materials: Adjustable angle, red reading mercury type with 9-inch case and 30 degrees F to 180 degrees F range, 3-1/2-inch aluminum stem, and separate NPT brass thermowell.
    - b. Manufacturer and Product: H.O. Trerice Co.; Model A005.

- F. Sealant: In accordance with Section 07 92 00, Joint Sealants.

**PART 3 EXECUTION**

**3.01 PREPARATION**

- A. Drawings do not attempt to show exact details of fixtures. Changes in locations of fixtures, advisable in opinion of Contractor, shall be submitted to Engineer for review before proceeding with the Work.

**3.02 INSTALLATION**

- A. Fixture Trim: Install fixture trim where applicable on fixtures.
- B. Plumbing Fixtures, Mounting Heights:
  - 1. Standard rough-in catalogued heights, unless shown otherwise on Drawings.
  - 2. Caulk fixtures in contact with finished walls with waterproof, white, nonhardening sealant which will not crack, shrink, or change color with age. See Section 07 92 00, Joint Sealants.
- C. Exact fixture location and mounting arrangement shall be as indicated on toilet room elevations and details as shown on Drawings.
- D. Unless noted otherwise and as a minimum, fixtures shall be supported as indicated in PDI Code Guide 302.
- E. Drainage Products:
  - 1. Floor Drains: Set top flush with floor. Provide membrane clamps where required.
  - 2. Cleanouts: Install where shown or required for purposes intended. Set cover flush with finished floor.
  - 3. Hub Drains: Set top of hub 2 inches above finished floor.
- F. Plumbing Specialties:
  - 1. Shock Arresters:
    - a. Install PDI-certified and rated shock arresters, sized and located in accordance with PDI WH-201 and as shown on Drawings.
    - b. Install adjacent to equipment wherein quick closing valves are installed.
    - c. Install at each emergency safety shower.
    - d. Shock arresters to have access panels or to be otherwise accessible.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Drain P-Trap Priming:
    - a. Pipe: Type K, soft copper.
    - b. Trap and prime floor drains and hub drains, unless shown otherwise on the Drawings. No attempt has been made to show trap primer valve locations or trap primer pipe routing.
    - c. Field route trap primer piping during installation of floor drains and hub drains, and install trap primer valves in mechanical rooms, janitor rooms, or other locations acceptable to Engineer.
    - d. Priming System: Complete with connection to serving W1 cold water system.
  3. Trap Priming Valves:
    - a. Floor drain traps primed with priming valves, 1/2-inch copper to floor drain.
    - b. Two traps maximum primed from one priming valve or as recommended by manufacturer. Locate in mechanical spaces or janitor's rooms and as indicated on Drawings.
    - c. Provide shutoff valve ahead of priming valves.
  4. Thermometers and Pressure Gauges:
    - a. Arrange devices to facilitate use and observation.
    - b. Install in orientation that will allow clear observation from ground level.
    - c. Provide pressure gauges with block valves.
    - d. Install thermometers in thermowells.
- G. Caulk penetrations of exterior walls with weatherproof sealant in accordance with Section 07 92 00, Joint Sealants.
- H. Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

### 3.03 FIELD QUALITY CONTROL

- A. Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.
- B. Notify Owner and Engineer 48 hours prior to shower testing. Owner and Engineer reserve the right to witness all tempered water and safety shower testing.

**END OF SECTION**

**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
  2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
  3. Associated Air Balance Council (AABC): National Standards for Field Management and Instrumentation Total System Balance.
  4. National Environmental Balancing Bureau (NEBB):
    - a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
    - b. Procedural Standards for Measuring Sound and Vibration.
  5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.02 SUBMITTALS

- A. Informational Submittals:
1. Documentation of experience record of testing authority.
  2. Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the work under this Contract.
  3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
  4. Written verification of calibration of testing and balancing equipment.
  5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.03 QUALITY ASSURANCE

- A. Air Balancing and Test Agency Qualifications:
1. Certification by AABC or NEBB for testing, adjusting and balancing of HVAC systems.
  2. Corporately and financially independent organization functioning as an unbiased testing authority.
  3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.

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4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.
- B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.
- C. Drives for Belt-Driven Fans:
  1. Furnish cast iron or flanged steel sheaves.
  2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Adjust and balance air systems in accordance with standard procedures and recognized practices of the AABC, NEBB or SMACNA.
- B. Adjust and balance the following systems:
  1. Supply, return and exhaust air systems.
  2. Heating and cooling split system.

### **3.02 ADJUSTING AND BALANCING AIR SIDE**

- A. Preparation:
  1. Prior to beginning the Work, perform the following activities:
    - a. Review shop drawings and installed system for adequate and accessible balancing devices and test points.
    - b. Recommend to Engineer dampers that need to be added or replaced in order to obtain proper air control.
    - c. Verify proper startup procedures have been completed on the system
    - d. Verify controls installation is complete and system is in stable operation under automatic control.
    - e. Verify test instruments have been calibrated to a recognized standard and are within manufacturer's recommended calibration interval before beginning the Work.

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### B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
2. Lock and mark final positions of balancing dampers with permanent felt pen.
3. Correct fan and airflow measurements for Site elevation.

### C. Equipment Data:

1. Collect the following data and included in final report:
  - a. Type of unit.
  - b. Equipment identification number.
  - c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
  - d. Motor data (frame, hp, volts, FLA rpm, and service factor).
  - e. Sheave manufacturer, size, and bore.
  - f. Belt size and number.
  - g. Sheave centerline distance and adjustment limits.
  - h. Starter and motor overload protection data.
  - i. Include changes made during course of system balancing.

### D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
  - a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.
  - b. After final adjustments, do not operate motor above nameplate amperage on any phase.
  - c. After final adjustments, do not operate fan above maximum rated speed.
  - d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
  - e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower. Provide written notice to air handling unit manufacturer and Engineer if drive or belt changes were made.

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4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.
5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

### E. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.
2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus or minus 10 percent.
3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

### F. Building Static Pressure:

1. Measure building static pressure relative to outside in perimeter entrances during normal system conditions that would yield widest range in internal building pressure.
2. Adjust building static pressure control parameters to ensure perimeter entrances are positive to outdoors by 0.05-inch WC with entrance doors closed.
3. For multi-story buildings, test pressure conditions at ground, intermediate, and upper levels.
4. Verify control valves and coil connections are complete and properly installed.

## 3.03 FIELD QUALITY CONTROL

- A. General: Perform functional tests as required by Section 01 91 14, Equipment Testing and Facility Startup.
- B. Performance Testing:
  1. Electric Heating Coil Testing:
    - a. Adjust system as required to achieve full output from coil.
    - b. Read and record amperages and voltages for all phases.

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2. Heating or Sensible Cooling Coil Testing:
  - a. Adjust system as required to achieve design flow conditions for air side of coil.
  - b. Measure and record airflow rate, entering air temperature, and leaving air temperature.
3. Cooling Coil Testing:
  - a. Adjust system as required to achieve design flow conditions for air side of coil.
  - b. Measure and record airflow rate, entering air dry bulb and wet bulb temperatures, leaving air dry bulb and wet bulb temperatures.
4. Vibration Testing:
  - a. Upon completion of air system balance, perform vibration testing as specified below for the following rotating or reciprocating equipment:
    - 1) Air handling equipment.
    - 2) Exhaust fans.
  - b. Vibration Test Procedures:
    - 1) Take measurements at each bearing housing, using a calibrated electronic analyzer.
    - 2) Record log shall include equipment symbol, location, identification, and peak-to-peak displacement in a direction parallel to shaft in a horizontal plane, and in a direction perpendicular to shaft in both horizontal and vertical planes.
    - 3) Maximum Peak-to-Peak Amplitude Levels:
 

<b>Rotational Speed (rpm)</b>	<b>Vibration Amplitude (mils)</b>
250	3.5
500	2.0
750	1.5
1,000	1.0
1,500	0.75
    - 4) Notify Engineer if amplitude exceeds upper limit specified.
    - 5) After readjustment for vibration, measure and record only the readjusted equipment to determine its conformance with design.

**C. Balancing Log Report Requirements:**

1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Log and record operational information from every test for each system, as necessary to accomplish services described.
3. Include equipment data for units tested.
4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.
5. Indicate recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
6. Include separate section in log, if necessary, describing operating difficulties in air systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

### D. Quality Control Verification:

1. After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:
  - a. Air balancing procedures, vibration tests, and verification of test results.
  - b. Perform spot tests on a maximum of 20 percent of total diffusers and grilles, on two air handling fan devices per building, with measuring equipment used in original tests, at random points selected by Engineer.
  - c. Results of these spot tests shall agree with balance logs within plus or minus 10 percent. Where this accuracy cannot be verified, rebalance portions of system as requested by Engineer.
  - d. At completion of rebalance procedures, perform another spot test if required to verify results.

**END OF SECTION**

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## SECTION 23 07 00 HVAC INSULATION

### PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
  2. ASTM International (ASTM):
    - a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    - b. C547, Standard Specification for Mineral Fiber Pipe Insulation.
    - c. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    - d. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
    - e. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
    - f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
    - g. G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
    - h. G22, Standard Practice for Determining Resistance of Plastics to Bacteria.
  3. Association of the Nonwoven Fabric Industry (INDA). IST 80.6, Water Resistance (Hydrostatic Pressure).
  4. National Fire Protection Association (NFPA):
    - a. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
    - b. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
    - c. 259, Standard Test Method for Potential Heat of Building Materials.
  5. Underwriters' Laboratories, Inc. (UL).

#### 1.02 DEFINITIONS

- A. Cold Air Ductwork: Designed to convey mechanically cooled air or outdoor air intake ducts in such systems.



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- B. Warm Air Ductwork: Designed to convey mechanically heated air or return ducts in such systems.

### 1.03 SUBMITTALS

- A. Action Submittals: Product description, list of materials and thickness for each service or equipment scheduled, locations, and manufacturer's installation instructions.
- B. Informational Submittals:
  - 1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
  - 2. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

### 1.04 QUALITY ASSURANCE

- A. Materials furnished under this Specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.
- B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.
- C. UL listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Stamp or Label:
  - 1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Project Site for use must have manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
  - 2. Insulation packages and containers shall be marked "asbestos-free."

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.

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- B. Insulation shall conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.
- C. Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.
- D. Fire Resistance:
  - 1. Insulation, adhesives, vapor barrier materials and other accessories, except as specified herein, shall be noncombustible.
  - 2. Use no fugitive or corrosive treatments to impart flame resistance.
  - 3. Flame proofing treatments subject to deterioration resulting from the effects of moisture or high humidity are not acceptable.
  - 4. Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.
- E. Materials exempt from fire-resistant rating:
  - 1. Nylon anchors.
  - 2. Treated wood inserts.
- F. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
  - 1. Polyurethane insulation.
  - 2. PVC casing.
  - 3. Fiberglass-reinforced plastic casing.

### 2.02 PIPE INSULATION

- A. Type P3—Elastomeric (ASTM C534, Minus 40 Degrees F to 220 Degrees F):
  - 1. Flexible, closed cell elastomeric.
  - 2. Nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
  - 3. Water vapor transmission 0.1 perm-inch, or less.
  - 4. Manufacturers and Products:
    - a. Armacell; AP Armaflex.
    - b. Nomaco; K-Flex LS.
    - c. Rubatex; R-180-FS.

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### 2.03 DUCT INSULATION

- A. Type D1—Blanket (ASTM C553, Type I, Class B3):
  - 1. Fiberglass, nominal 1 pcf density blanket, K factor 0.31 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures to 250 degrees F.
  - 2. Manufacturers and Products:
    - a. CertainTeed; Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Owens/Corning Fiberglass; Soft R.
    - d. Knauf; Ductwrap.
  
- B. Type D3—Liner (ASTM C1071, Type I):
  - 1. Fiberglass, nominal 1.5 pcf density liner, K factor 0.25 maximum at 75 degrees F mean, black composite coated surface exposed to airstream to prevent erosion of glass fibers, for temperatures to 250 degrees F.
  - 2. Liquid water repellency rating not less than 4 when tested in accordance with INDA IST 80.6.
  - 3. Potential heat value not exceeding 3,500 Btu/lb when tested in accordance with NFPA 259 and meeting the classification of “Limited Combustible” as defined by NFPA 90A.
  - 4. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.
  - 5. Resistant to microbial growth using a “no growth criteria” when tested in accordance with ASTM C1139, ASTM G21, and ASTM G22.
  - 6. Manufacturers and Products:
    - a. CertainTeed; Toughgard.
    - b. Johns Manville; Linacoustic (rectangular), Spinacoustic (Round).
    - c. Knauf; Acoustic Duct Liner.
  
- C. Type D4—Ceramic Fiber (to 2,300 degrees F):
  - 1. UL-listed, 2-hour fire-rated, 6 pcf density, inorganic foil encapsulated ceramic fiber blanket.
  - 2. Manufacturer and Product: Thermal Ceramics; Firemaster.
  
- D. Type D5—Flexible Elastomeric (ASTM 534, Type I for tubular materials and Type II for sheet materials):
  - 1. Closed-cell, sponge- or expanded-rubber materials.

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2. Manufacturers and Products:
  - a. Aeroflex USA Inc.; Aerocel.
  - b. Armacell LLC; AP Armaflex.
  - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

### 2.04 EQUIPMENT INSULATION

- A. Type E1—Elastomeric (ASTM C534):
  1. Flexible, closed-cell elastomeric, nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
  2. Manufacturers and Products:
    - a. Armstrong; Armaflex II.
    - b. Nomaco; Therma-Cel.
    - c. Rubatex; R-180-FS.
- B. Type E2—Board:
  1. Fiberglass, minimum 2.75 pcf density board, K factor 0.23 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures from 100 degrees F to 850 degrees F.
  2. Manufacturers and Products:
    - a. CertainTeed; CertaPro Commercial Board.
    - b. Knauf; Duct Slab.
    - c. Owens/Corning Fiberglass; TIW.
    - d. Johns Manville; 1000 Series Spin-Glass.

### 2.05 INSULATION FINISH SYSTEMS

- A. Type F1—PVC:
  1. Polyvinyl chloride (PVC) jacketing, white, for straight run piping and fitting locations, temperatures to 159 degrees F.
  2. Manufacturers and Products:
    - a. Johns Manville; Zeston.
    - b. Ceel-Co; 550.
- B. Type F2—Paint:
  1. Acrylic latex paint, white, and suitable for outdoor use.
  2. Manufacturers and Products:
    - a. Armstrong; WB Armaflex finish.
    - b. Rubatex; 374, white finish.

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- C. Type F3—Aluminum:
  - 1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.016-inch thickness, with smooth mill finish.
  - 2. Moisture Barrier: Provide factory applied moisture barrier, consisting of 40-pound kraft paper with 1-mil-thick low-density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
  - 3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, etc.
  - 4. Manufacturer and Product: RPR Products; INSUL-MATE.
  
- D. Type F4—Ceramic:
  - 1. Insulating duct coating, fluid-applied coating with ceramic insulating particles.
  - 2. Manufacturers and Products: ASTEC, by Insulating Coatings Corp., Inverness, FL.

### **PART 3 EXECUTION**

#### 3.01 APPLICATION OF PIPING INSULATION

- A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices.
- B. Apply insulation over clean, finish painted, and dry surfaces.
- C. Install insulation after piping system has been pressure tested and leaks corrected.
- D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
- E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.
- F. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- G. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal all butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.

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- H. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.
- I. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
- J. Do not allow insulation to cover nameplates or code inspection stamps.
- K. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.
- L. Placement:
  - 1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
  - 2. Insulate fittings with sleeved or cut pieces of same material.
  - 3. Seal and tape joints.
- M. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.
- N. Vapor Barrier:
  - 1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
  - 2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
  - 3. Do not use staples and screws to secure vapor sealed system components.

### 3.02 INSTALLATION OF DUCTWORK INSULATION

- A. General: Install insulation products in accordance with the manufacturer's written instructions and in accordance with recognized industry practices.
- B. Install insulation materials with smooth and even surfaces.
- C. Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.
- E. Seal longitudinal and circumferential joints with FSK tape, and finish with fiberglass mesh fabric embedded in vapor barrier mastic.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- F. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.
- G. Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.
- H. Refer to Section 23 31 13, Metal Ducts and Accessories, for installation of internal duct liner.

### 3.03 INSTALLATION OF EQUIPMENT INSULATION

- A. Application Requirements: Insulate where external surface temperature of equipment is below ambient temperature in the space, including surfaces that have a recognized possibility for condensation.
- B. Install equipment thermal insulation products in accordance with manufacturer's written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- C. Install insulation materials with smooth and even surfaces and on clear and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.
- D. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- E. Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.
- F. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.
- G. Avoid using scrap pieces of insulation where larger sheets will fit.

### 3.04 INSTALLATION OF INSULATION FINISH SYSTEMS

- A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.
- B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
- C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

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- D. Do not use screws or rivets to fasten the fitting covers.
- E. Install removable prefabricated aluminum covers on exterior flanges and unions.
- F. Caulk and seal all exterior joints to make watertight.

### 3.05 PIPING INSULATION REQUIREMENTS

- A. Refrigeration Suction:
  - 1. Type P3, elastomeric.
  - 2. 1/2-inch thickness for pipe sizes up to 1 inch.
  - 3. 3/4-inch thickness for pipe sizes over 1 inch.
- B. Refrigeration Hot Gas Reheat:
  - 1. Type P3, elastomeric.
  - 2. 3/4-inch thickness.
- C. Condensate Drain:
  - 1. Type P3, elastomeric.
  - 2. 1/2-inch thickness for pipe sizes up to 2-5/8 inches ID.
  - 3. 3/4-inch thickness for pipe sizes over 2-5/8 inches ID.

### 3.06 DUCTWORK INSULATION REQUIREMENTS

- A. Mechanically Cooled and Heated Supply and Return Air; (Concealed):
  - 1. Type D1, blanket.
  - 2. 2-inch thickness.
- B. Mechanically Cooled and Heated Supply and Return Air, and Outside Air (Exposed to View):
  - 1. Type D3.
  - 2. 1-1/2-inch thickness.
- C. Mechanically Cooled and Heated Supply Air, Return Air, and Outside Air (outdoors):
  - 1. Type D3, liner.
  - 2. 2-inch thickness.



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- D. Unheated Supply Air:
  - 1. Type D3, liner.
  - 2. 1-inch thickness.
- E. Sheetmetal Plenums:
  - 1. Type D3, liner.
  - 2. 1-1/2-inch thickness.
- F. Air Distribution Devices: Refer to Section 23 37 00, Air Outlets and Inlets, for requirements.

### 3.07 INSULATION FINISH REQUIREMENTS

- A. Piping, Duct, and Equipment Insulation (Concealed Areas): Factory finish.
- B. Piping Insulation (Exposed to View, Indoors):
  - 1. Type F1.
- C. Ductwork Insulation (Exposed to View, Indoors): Factory finish.
- D. Equipment Insulation (Exposed to View, Indoors): Type F2, paint (for use with Type P3, elastomeric).
- E. Piping Insulation (Outdoors):
  - 1. Type F2, paint (for use with Type P3, elastomeric).
  - 2. Type F3, aluminum.
- F. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

### 3.08 FIELD QUALITY CONTROL

- A. Test factory-applied materials assembled. Field-applied materials may be tested individually.

**END OF SECTION**

**SECTION 23 09 00  
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI): INCITS 4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).
  2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
    - a. Handbook Fundamentals.
    - b. Guideline 3, Reducing Emission of Fully Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems.
    - c. 135, Data Communication Protocol for Building Automation and Control Networks.
  3. American Society of Mechanical Engineers (ASME): B19.3, Safety Standard for Compressors for Process Industries.
  4. American Water Works Association (AWWA): C704, Propeller-Type Meters for Waterworks Applications.
  5. Electronic Industries Alliance (EIA):
    - a. TIA-232-F, Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
    - b. 485, Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi-point Systems.
  6. Federal Communications Commission (FCC).
  7. International Organization for Standardization (ISO): 8802-3, Information Technology - Telecommunication and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Carrier Sense Multiple Access with Detection (CSMA/CD) Access Method and Physical Layer Specifications.
  8. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  9. National Fire Protection Association (NFPA):
    - a. 70, National Electrical Code.
    - b. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
  10. Underwriters Laboratories, Inc. (UL): 916, Standard for Safety Energy Management Equipment.

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## 1.02 DEFINITIONS

- A. The terms “HVAC Control System,” “Automatic Temperature Control System,” “Building Automation System,” and “Environmental Management and Control System” shall be considered equivalent and used interchangeably for the purposes of this Contract.
- B. Algorithm: A software procedure for solving a recurrent mathematical or logical problem.
- C. Analog: A continuously varying signal or value (temperature, current, velocity, etc.).
- D. Binary: A two-state system where an “ON” condition is represented by a high signal level and an “OFF” condition is represented by a low signal level.
- E. Control Wiring:
  - 1. Wiring, high or low voltage other than power wiring required for proper operation of mechanical systems.
  - 2. Includes conduit, wire and wiring devices to install complete control system including motor control circuits, interlocks, thermostats, PE and EP switches and like devices.
  - 3. Includes wiring from thermostats as specified herein and required to execute sequence of operation.
  - 4. Includes necessary power wiring to HVAC control devices, including actuators.
- F. Deadband: Temperature range over which no heating or cooling energy is supplied, such as 72 degrees F to 78 degrees F; as opposed to single point changeover or overlap, or a range from set point over which no control action is taken.
- G. Power Wiring: Line voltage wiring to mechanical equipment. Line voltage wiring that also serves as control circuit, such as line voltage thermostat or involves interlocking with damper shall be considered control wiring.
- H. Abbreviations that may be used in this section:
  - 1. AC: Air Conditioning.
  - 2. DX: Direct Expansion.
  - 3. HCP: HVAC Control Panel.
  - 4. HOA: Hand-Off-Auto (Switch).
  - 5. HVAC: Heating, Ventilation, and Air Conditioning.
  - 6. LCD: Liquid Crystal Display.

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7. LED: Light Emitting Diode.

**1.03 SYSTEM DESCRIPTION**

**A. General Requirements:**

1. Provide control wiring, power wiring, conduit, hardware, and electrical work associated with the HVAC control system.
2. Provide control wiring between HVAC equipment and field control devices, such as duct smoke detectors and motor starter control coil contacts.
3. Provide controls necessary for entire system to have fail-safe operation.
4. Control sequences and functions including alarms, monitoring and resetting functions, and operational sequences shall not be limited to point schedules and sequences of operation.
5. Provide sequences and functions as required to deliver a fully functioning HVAC system.

**B. Control System Types:**

1. The following control system types may be used in this Project:
  - a. Electric/Electronic Control System (ELECTRIC):
    - 1) System using simple electric or electronic control devices.
    - 2) User interface at control device.
2. Provide control system(s) of architecture defined in Control Type Schedule, below:

<b>Control Type Schedule</b>		
<b>Location</b>	<b>System</b>	<b>Control Type</b>
All	Where operating sequences call for simple thermostatic or interlock control	ELECTRIC

**C. Performance Requirements: Design control system and equipment to perform under the following conditions:**

1. Temperature, Ambient:
  - a. Summer maximum 75 DB/62 WB degrees F.
  - b. Winter minimum 70 DB degrees F (occupied areas), 60 DB degrees F (unoccupied areas).
  - c. Based on ASHRAE Handbook Fundamentals weather data for the City of Cincinnati, Ohio.

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2. Temperature, Indoor:
  - a. Heated and Ventilated Process Areas: Summer maximum 103 degrees F; winter minimum 50 degrees F.
  - b. Air-conditioned Nonprocess Areas: Summer maximum 75 degrees F; Winter minimum 70 degrees F.

D. Refer to Section 01 61 00, Common Product Requirements, for additional environmental performance requirements.

### 1.04 SUBMITTALS

#### A. Action Submittals:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that includes make, model, dimensions, weight of equipment, and electrical schematics, for all control system components.
2. Complete system power, interlock, control, and data transmission wiring diagrams no smaller than 11 inches by 17 inches.
3. Complete drawings and schematics of proposed control system, including panel power requirements.
4. System operating sequences to be programmed, in exact English language.
5. Complete points list.
6. Interfaces with HVAC equipment.
  - a. Schematic diagram of each equipment item.
  - b. Indicate location of each control item in equipment.
  - c. Show equipment manufacturer controls where installed.
7. Panel face layout drawings.
8. Damper actuator sizing calculations, in schedule form.

#### B. Informational Submittals:

1. Table identifying which member of Contractor's team is responsible for furnishing and setting in-place power wiring and control wiring of each item or component of HVAC equipment.
2. Recommended procedures for protection and handling of equipment and materials prior to installation.
3. Certificates, in accordance with Section 01 43 33, Manufacturer's Field Services:
  - a. Manufacturer's Certificate of Compliance.
  - b. Manufacturer's Certificate of Proper Installation.
4. Draft maintenance agreement for heating and cooling split system(s).
5. Confirmation that the temperature control system Supplier has received, and coordinated with all approved HVAC equipment submittals.

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6. Experience and qualifications of temperature control system Supplier's proposed representative who will supervise installation, adjustment, and calibration of temperature control systems.
7. Performance test plan and schedule.
8. Test Results:
  - a. Functional and performance test documentation.
9. Operation and maintenance data: In accordance with Section 01 78 23, Operation and Maintenance Data. In addition, include the following detailed information:
  - a. Operation and maintenance instructions for heating, cooling on ventilating systems as furnished and installed.
  - b. Record of system adjustments and calibration methods.
  - c. Performance test results.

### 1.05 QUALITY ASSURANCE

- A. Materials, devices, appliances, and equipment used shall be indicated as acceptable by established standards of Underwriters Laboratories, Inc. (UL).
- B. Codes and Standards: Meet requirements of applicable standards and codes, except when more detailed or stringent requirements are indicated by Contract Documents, including requirements of this section.
  1. Underwriters Laboratories: Products shall be UL 916-PAZX listed.
  2. National Electrical Code NFPA 70.
- C. Qualifications of HVAC Controls System Supplier:
  1. Minimum of 5 years' experience as manufacturer's authorized representative in design, installation, and maintenance of manufacturer's system and products.
  2. Capable of furnishing factory-trained technicians, competent to provide instruction, routine maintenance, and emergency service onsite within 4 hours after receipt of request.
  3. Factory trained certified engineering and commissioning staff, and complete offsite training facilities.
  4. Necessary facilities to provide Owner with complete maintenance, periodic inspection, and service contract. Refer to Paragraph, Maintenance.

### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 61 00, Common Product Requirements.

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## B. Corrosion Protection:

1. Thermostats, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through use of corrosion-inhibiting vapor capsules.
2. Prior to shipment, capsules shall be provided within shipping containers and equipment as recommended by capsule manufacturer.
3. During construction period, capsules shall be replaced in accordance with capsule manufacturer's recommendations.

## 1.07 MAINTENANCE

### A. Maintenance Service Agreement:

1. Furnish a draft maintenance agreement, prepared and signed by the Contractor to provide the necessary preventive maintenance to keep the various temperature control systems in proper working condition.
2. Fully describe the maintenance work to be performed and estimate cost of the maintenance during the 1-year correction period and the subsequent year.
3. This service contract shall include 24-hour emergency service, 7 days per week.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

#### A. Materials, equipment, and accessories specified shall be products of the following manufacturers, unless indicated otherwise:

1. Carrier.
2. The Trane Company.
3. Honeywell.
4. Climate Technology.
5. Danfoss.

### 2.02 MATERIALS

#### A. General:

1. Products used in this installation shall be new, currently under manufacture, and shall have been applied in similar installations for minimum of 2 years.
2. System shall not be used as test Site for new products, unless explicitly approved by Owner's representative, in writing.

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### B. Control Components:

1. Control range to obtain specified capacities.
2. Sensitivity to maintain control points close enough to set point for acceptable offset, without cycling equipment more frequently than recommended by manufacturer.
3. Field adjustable to actual set point, ranges.

### C. Controls Interfacing:

1. Interface controls properly with factory supplied components of mechanical systems. Coordinate special control interfacing requirements.
2. For equipment that requires special interfacing with control system, provide equipment with integral controls or provide accessory devices required for operation of total mechanical system.
3. Coordinate interfaces with electrical work as necessary.
4. Provide electric, electronic, and mechanical devices as required to properly interface with prewired control panels furnished with HVAC equipment and with other mechanical and electrical components.

## 2.03 LABELING

- A. All products, namely electrical materials, devices, appliances, and equipment used, shall be indicated as acceptable by established standards of Underwriters Laboratories, Inc. (UL) and Factory Mutual (FM).
- B. Valid label affixed to item shall provide indication of product acceptance by required agencies.
- C. HVAC temperature controls and control components that consist of multiple components shall bear UL listing mark on unit.

## 2.04 SERVICE CONDITIONS

- A. Refer to Section 01 61 00, Common Product Requirements, Section 26 05 02, Basic Electrical Requirements, and Electrical Drawings for classification of areas as hazardous, corrosive, wet, indoor dry, and dust-tight.
- B. Use materials and methods, and enclose devices in NEMA enclosure types suitable for classification indicated, and as required by NFPA 70.
- C. Exhaust ductwork shall be considered same classification as area served.



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- D. Instruments within 3 feet of ducts conveying air from spaces classified as Class I, Division 1 or Division 2 (in accordance with NFPA 70) shall be suitable for same area classification as space exhausted.

### 2.05 ELECTRICAL COMPONENTS AND ACCESSORIES

- A. Electrical components shall be provided in accordance with requirements of Division 26, Electrical.
- B. Wiring:
  - 1. In accordance with Section 26 05 05, Conductors, and NFPA 70.
  - 2. Insulation shall be rated 600 volts, minimum.
- C. Electrical Raceways: In accordance with Section 26 05 33, Raceway and Boxes, and NFPA 70.

### 2.06 ACCESSORIES

- A. Corrosion-inhibiting vapor capsules as manufactured by:
  - 1. Northern Instruments; Model Zerust VC.
  - 2. Hoffman; Model A-HCI.
- B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- C. Equipment Identification Plates:
  - 1. Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4 inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.
  - 2. Provide adjacent to the following control devices, and for equipment whose function is not readily apparent.
    - a. Thermostats.
    - b. Thermostats with manual override.
    - c. START/STOP switches.
- D. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

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## 2.07 EQUIPMENT FINISH

- A. Provide materials and equipment with manufacturer's standard finish system. Provide manufacturer's standard finish color, except where specific color is indicated.
- B. If manufacturer has no standard color, provide gray finish as approved by Owner.

## PART 3 EXECUTION

### 3.01 SEQUENCES OF OPERATION

- A. Reference Contract Drawings.

### 3.02 INSTALLATION

#### A. General:

- 1. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings, and equipment details.
- 2. Changes in location or installation of control devices or equipment shall be approved by Engineer before proceeding with the Work.
- 3. Mount devices requiring manual reset and all other user serviceable control devices in readily accessible locations.

#### B. Wiring:

##### 1. General:

- a. Install electric wire, control wire, cable, fittings, and conduit associated with systems specified in this section, in accordance with requirements of NFPA 70.
- b. Install control and interlock wiring separate from power wiring.
- c. Number code or color code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.
- d. Provide wire markers on each conductor in panel and at load connections. Identify circuit with control wire number.
- e. Restrain wiring in control panels by plastic ties or ducts.
- f. Hinge wiring shall be secured at each end so that any bending or twisting will be around longitudinal axis of wire and bend area shall be protected with sleeve.
- g. Arrange wiring neatly, cut to length, and remove surplus wiring. Provide abrasion protection for any wire bundles that pass through holes or across edges of sheet metal.

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- h. Use manufacturer's recommended tool with proper sized anvil for crimp terminations. No more than two wires may be terminated in single crimp lug and no more than two lugs may be installed on single screw terminal.
  - i. Wiring shall not be spliced or tapped except at device terminals or terminal blocks.
  - j. Properly support and run wiring in a neat manner.
  - k. Run wiring parallel or at right angles to building structure.
2. Concealment:
- a. Generally conceal wiring from view, except in mechanical rooms and areas where other conduit and piping are exposed; install exposed wiring and conduit to be as unobtrusive as possible.
  - b. Install line voltage control wiring, wiring exposed to view, surface-mounted wiring, and wiring concealed within walls in conduit, in accordance with Division 26, Electrical.
  - c. Wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.
  - d. Conduit shall be sized to suit the number, type, and size of conductors as specified in Section 26 05 05, Conductors.

### C. End-User Accessible Control Components:

- 1. Do not mark room thermostats.
- 2. Mount user adjustable control components (room thermostats, humidistats, temperature sensors, humidity sensors, etc.) level and in accordance with applicable accessibility requirements of local Building Code.

## 3.03 FIELD QUALITY CONTROL

### A. Performance and Functional Testing:

- 1. Tests and certification shall be as specified in Section 01 91 14, Equipment Testing and Facility Startup, and Section 01 43 33, Manufacturers' Field Services.
- 2. HVAC controls interface with process control system shall be coordinated with the Work of Section 40 90 00, Instrumentation and Control for Process Systems.

## 3.04 MANUFACTURER'S SERVICES

- 1. Provide manufacturer's services in conformance with requirements of Section 01 43 33, Manufacturers' Field Services.

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2. Manufacturer's Representative: Present at Site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:
  - a. 1 person-days for installation, assistance, and inspection.
  - b. 1 person-days for functional and performance testing and Manufacturer's Certificate of Proper Installation.
  - c. 1 person-days for prestartup classroom or Site training.
  - d. 1 person-days for facility startup.
  - e. 1 person-days for post-startup training.

### 3.05 TRAINING

- A. Provide training of Owner's personnel to enable them to operate HVAC equipment in available modes, to adjust set points, and to interpret alarm signals.
- B. Training sessions shall be prepared in advance, and arranged for clear, effective transfer of information in minimum time.

### 3.06 ADJUSTING AND CALIBRATING

- A. Temperature control system(s) shall be adjusted and calibrated by qualified manufacturer's representative.
- B. Calibrate temperature control devices at time of installation to ensure measuring and reading accuracy.
- C. Adjustment Record:
  1. Prepare complete record of system adjustments for each control system.
  2. Indicate deviations from specified temperatures.
  3. Include copy of completed record in each copy of Operation and Maintenance Manual.

### 3.07 CLEANING AND TOUCHUP PAINTING

- A. Touchup scratches, scrapes, or chips in exterior surfaces with finish matching type, color, consistency, and type of surface of original finish.

**END OF SECTION**



**SECTION 23 31 13**  
**METAL DUCTS AND ACCESSORIES**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.
  2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.
  3. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
  4. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure).
  5. ASTM International (ASTM):
    - a. A36/A36M, Standard Specification for Carbon Structural Steel.
    - b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
    - c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    - d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
    - e. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    - f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
    - g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
    - h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    - i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment.
    - j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.

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- k. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
  - l. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
  - m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  - n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.
  - p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
  - q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
  - r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
6. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.
7. National Fire Protection Association (NFPA):
- a. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - b. 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
  - c. 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
  - d. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
  - e. 259, Standard Test Method for Potential Heat of Building Materials.
  - f. 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
- a. Duct Construction Standards.
  - b. Guidelines for Seismic Restraints of Mechanical Systems.
  - c. Fibrous Glass Duct Construction Standards.

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- d. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
- e. HVAC Air Duct Leakage Test Manual.
- 9. Underwriters Laboratories Inc. (UL):
  - a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
  - b. 214, Standard for Tests for Flame-Propagation of Fabrics and Films.
  - c. 555, Standard for Safety Fire Dampers.
  - d. 555S, Standard for Safety Smoke Dampers.

### 1.02 DEFINITIONS

- A. The following is a list of abbreviations which may be used in this section:
  - 1. CFM: cubic feet per minute.
  - 2. FPM: feet per minute.
  - 3. PCF: pounds per cubic foot.
  - 4. WC: water column.
- B. Sealing Requirements: For the purpose of duct systems sealing requirements specified in this section, the following definitions apply:
  - 1. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
  - 2. Joints, duct surface connections including:
    - a. Girth joints.
    - b. Branch and subbranch intersections.
    - c. Duct collar tap-ins.
    - d. Fitting subsections.
    - e. Louver and air terminal connections to ducts.
    - f. Access door, and access panel frames and jambs.
    - g. Duct, plenum, and casing abutments to building structures.

### 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Product Data:
    - a. Rectangular, Rigid Round, and Oval Ductwork:
      - 1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
      - 2) SMACNA Figure Numbers for each shop fabricated item.
      - 3) Reinforcing details and spacing.
      - 4) Seam and joint construction details.



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- 5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- b. Ductwork Accessories:
  - 1) Manufacturer's product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes, including the following items:
    - a) Fittings and volume control damper installation (both manual and automatic) details.
    - b) Duct liner.
    - c) Sealing materials.
    - d) Dampers; include leakage, pressure drop, and maximum back pressure data.
    - e) Duct-mounted access panels and doors.
    - f) Flexible ducts.
    - g) Sheet metal fasteners.
2. Duct Fabrication Drawings:
  - a. Drawn after actual job measurements are obtained.
  - b. Drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Drawings.
  - c. Include the following features:
    - 1) Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other work.
    - 2) Duct layout, indicating pressure classifications, and sizes in plan view.
    - 3) For materials handling exhaust duct systems, indicate classification of materials handled.
    - 4) Duct material and thickness.
    - 5) Fittings and volume control damper installation (both manual and automatic) details.
    - 6) Reinforcing details and spacing.
    - 7) Seam and joint construction details.
    - 8) Penetrations through fire-rated and other partitions.
    - 9) Duct accessories and control devices such as air distribution devices, etc.
    - 10) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
    - 11) Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installation.
    - 12) Coordination with ceiling suspension members.
    - 13) Spatial coordination with other systems installed in same space with duct systems.

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- 14) Coordination of ceiling- and wall-mounted access doors and panels required for access to dampers and other operating devices.
- 15) Coordination with ceiling-mounted lighting fixtures, air outlets, and inlets.
- 16) Coordination of ductwork with sprinkler piping and other mechanical and electrical services, and equipment.

### B. Informational Submittals:

1. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
2. Sound Attenuators Certified Test Data:
  - a. Dynamic insertion loss.
  - b. Self-noise power levels.
  - c. Static pressure loss.
  - d. Dimensions and weights.
3. Record Drawings: Include duct systems routing, fittings details, and installed accessories and devices.

## 1.04 QUALITY ASSURANCE

### A. Industry Standards:

1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA Duct Construction Standards relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.
2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.
3. NFPA Compliance: NFPA 90A and NFPA 90B.

### B. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

### C. Suppliers of duct and fitting components shall provide on request the following information:

1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
2. Laboratory performance data for fittings, including zero-length dynamic losses.

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- D. Installer shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Project.
- E. Changes or alterations to layout or configuration of duct system shall be:
  - 1. Specifically approved in writing by Engineer.
  - 2. Proposed layout shall provide original design results, without increasing system total pressure.

### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect ductwork from dirt, water, and debris. During storage on Job Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.
- B. If fabricated sound-lined ductwork gets wet during installation, remove and dispose of ductwork from the Site.
- C. Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- D. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- E. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

## PART 2 PRODUCTS

### 2.01 SCHEDULES

- A. Ductwork Schedule: Refer to Drawings.

### 2.02 GENERAL

- A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.
- B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

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- C. Ductwork thinner than 26-gauge will not be allowed.
- D. Ductwork Interior Surfaces:
  - 1. Smooth.
  - 2. No sheet metal parts, tabs, angles, or other items may project into air ducts, unless otherwise specified.
  - 3. Seams and joints shall be external.
  - 4. For ductwork that is required to be reinforced, use only external reinforcing.

### 2.03 SHEET METAL MATERIALS

- A. Where no specific ductwork materials are indicated in Specifications or on Drawings, aluminum ductwork shall be used.
- B. Galvanized Steel Ductwork:
  - 1. Comply with ASTM A653/A653M and ASTM A924/924M.
  - 2. Product Name: Steel Sheet, Zinc Coated (Galvanized Steel).
  - 3. Sheet Designation: CS Type B.
  - 4. Applicable Specification: ASTM A653/A653M.
  - 5. (Zinc) Coating Designation: G90.
  - 6. Coating designation in accordance with Test Method A, ASTM A90/A90M. and ASTM A924/A924M.
  - 7. Provide mill-phosphatized finish for ducts exposed to view and for ducts scheduled to be painted.
  - 8. Provide sheet metal packaged and marked as specified in ASTM A700.
- C. Aluminum Ductwork:
  - 1. Comply with ASTM B209.
  - 2. Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.
  - 3. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or equivalent.
- D. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.
- E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

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### 2.04 DUCT SEALING MATERIALS

- A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.
- B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.
- C. Solvent-Based Sealants:
  - 1. Ultraviolet light resistant.
  - 2. Mildew resistant.
  - 3. Flashpoint: Greater than 70 degrees F, SETA CC.
  - 4. Manufacturers and Products:
    - a. Hardcast, Inc.; Versagrip 102.
    - b. Rectorseal; AT-33.
    - c. Childers CP-140.
- D. Water-Based Sealants:
  - 1. Listed by manufacturer as nonflammable in wet and dry state.
  - 2. Manufacturers and Products:
    - a. Foster; Series 32.
    - b. Childers; CP-145A, 146.
    - c. Rectorseal; Airlok 181.

### 2.05 FIRESTOPPING

- A. Refer to Section 07 84 00, Firestopping.

### 2.06 DUCTWORK FASTENERS

- A. General:
  - 1. Rivets, bolts, or sheet metal screws.
  - 2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.
- B. Self-Drilling Screws:
  - 1. Galvanized Steel Ductwork System: Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated carbon steel with zinc electroplated finish.

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2. Aluminum Ductwork System:
  - a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410 stainless steel and corrosion resistance of Type 304 stainless steel, complete with bonded metal and fiber washer for dielectric separation.
  - b. Manufacturers:
    - 1) DB Building Fasteners Inc., Santa Fe Springs, CA.
    - 2) Clark Craft Fasteners, Tonawanda, NY.

### 2.07 DUCTWORK PRESSURE CLASS

- A. Construct duct systems to pressure classifications indicated as follows:
  1. Supply Ducts: 3-inch WC.
  2. Return Ducts: 2-inch WC, negative pressure.
  3. Exhaust Ducts: 2-inch WC, negative pressure.
- B. Where no specific duct pressure designations are indicated in Specifications or on Drawings, 2-inch WC pressure class shall be basis of Contract.

### 2.08 RECTANGULAR DUCTWORK

- A. Fabricate rectangular ducts in accordance with SMACNA Rectangular Industrial Duct Construction Standards, unless specified otherwise.
- B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20-gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

### 2.09 RECTANGULAR DUCTWORK FITTINGS

- A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA Rectangular Industrial Duct Construction Standard.
- B. Elbows:
  1. Fit square-turn elbows with vane side rails.
  2. Shop fabricate double-blade turning vanes of same material as ductwork.
  3. Fabricate with equal inlet and outlet.
  4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.

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5. Manufacturers and Products:
  - a. Elgen; All-Tight.
  - b. Duro-Dyne; Type TR.

### 2.10 RECTANGULAR DUCTWORK BRANCH CONNECTIONS

- A. Branch duct connections to rectangular duct mains shall be made using factory fabricated fittings with spot welded tap to main duct connections or with factory fabricated, field installed taps, with spin-in or mechanical fastened tap to main duct connections.

### 2.11 RECTANGULAR DUCTWORK INSULATION LINER

- A. Location: Provide ductwork with internal insulation liner where indicated on Drawings.
- B. Material:
  1. Fiberglass, nominal 1.5 pcf density liner, K factor 0.25 maximum at 75 degrees F mean.
  2. Black composite coating on surface exposed to airstream to prevent erosion of glass fibers, for temperatures to 250 degrees F.
  3. Liquid water repellency rating not less than 4.0 when tested in accordance with INDA IST 80.6.
  4. Potential heat value not exceeding 3,500 Btu per hour per pound when tested in accordance with NFPA 259 and meeting classification of "Limited Combustible" as defined by NFPA 90A.
  5. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.
  6. Resistant to microbial growth using a "no growth criteria" when tested in accordance with ASTM C1139.
  7. Manufacturers and Products:
    - a. CertainTeed; Toughgard.
    - b. JohnsManville; Linacoustic RC.
    - c. Knauf; Duct Liner M.
- C. Thickness: Minimum 1-1/2 inches or greater thickness where indicated on Drawings.
- D. R-Value: Minimum 6 hours foot squared degrees F per Btu or greater, where indicated on Drawings.
- E. Liner Adhesive: In accordance with NFPA 90A and ASTM C916.

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### F. Mechanical Fasteners:

1. Same material as ductwork, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.
2. Provide fasteners that do not damage liner when applied as recommended by manufacturer, that do not cause leakage in duct, and will indefinitely sustain 50-pound tensile dead load test perpendicular to duct wall.
3. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
4. Adhesive for Attachment of Mechanical Fasteners: In accordance with Fire Hazard Classification of duct liner system.

### G. Liner Application:

1. Ductwork liner shall be applied at time of ductwork manufacture in an approved sheet metal workshop.
2. Adhere single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.
3. Apply coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
4. Butt transverse joints without gaps and coat joint with adhesive.
5. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.
6. Longitudinal Joints:
  - a. Shall not occur except at corners of ducts, unless size of duct and standard liner product dimensions make longitudinal joints necessary.
  - b. Apply adhesive coating on longitudinal seams in ducts exceeding 2,500 fpm air velocity.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter, at 3 inches from transverse joints, and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing airstream with metal nosing that are either channel or "Z" profile or are integrally formed from duct wall at the following locations:
  - a. Fan discharge.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts.
9. Seal insulation edges.
10. Repair abrasions or tears with mastic.



2.12 RIGID ROUND DUCTWORK

- A. Construct rigid round ducts in accordance with SMACNA Round Industrial Duct Construction Standards, unless specified otherwise.
- B. Basic Round Diameter: As used in this Article, is inside diameter of size of round duct.
- C. Where space limitations prevent use of round duct or where shown on Drawings, provide ductwork of flat oval construction hydraulically equivalent to round ductwork.
- D. Fabricate round ducts with spiral seam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams.
- E. Snaplock seams may only be used for duct systems of construction pressure classification less than 2-inch WC.

2.13 RIGID ROUND DUCTWORK FITTINGS

- A. Construct rigid round ductwork fittings in accordance with SMACNA Round Industrial Duct Construction Standards, unless otherwise specified.
- B. 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.
- C. Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- D. Elbows:
  - 1. Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two piece segment elbows are not allowed, except with turning vanes.
  - 2. Segmented Elbows: Fabricate with welded construction.
  - 3. Round Elbows 8 Inches and Smaller:
    - a. Stamped elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees configuration.
    - b. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 3-1/2 inches and 4-1/2 inches) elbows with segmented construction.
  - 4. Round Elbows 9 Inches Through 14 Inches:
    - a. Segmented or pleated elbows for 30, 45, 60, and 90 degrees.

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- b. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 9-1/2 inches and 10-1/2 inches) elbows with segmented construction.

### 2.14 ROUND DUCTWORK BRANCH CONNECTIONS

- A. Branch duct connections (taps) to round duct mains shall be made using factory fabricated fittings.

### 2.15 ROUND DUCTWORK INSULATION LINER

- A. Location: Provide round ductwork with internal insulation liner where indicated on Drawings.
- B. Material:
  - 1. Fiberglass, nominal 4.0-pcf density, K factor 0.23 maximum at 75 degrees F mean.
  - 2. Black composite coating on surface exposed to air stream, to prevent erosion of glass fibers.
  - 3. Suitable for temperatures up to 250 degrees F.
  - 4. Noise Reduction Coefficient: Minimum 0.75 for 1.0-inch thickness, in accordance with ASTM C423.
  - 5. Liquid water repellency rating not less than 4.0 when tested in accordance with INDA IST 80.6.
  - 6. Potential heat value not exceeding 3,500 Btu per hour per pound when tested in accordance with NFPA 259 and meeting classification of "Limited Combustible" as defined by NFPA 90A.
  - 7. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.
  - 8. Resistant to microbial growth using a "no growth criteria" when tested in accordance with ASTM C1139.
  - 9. Manufacturers and Products:
    - a. CertainTeed.
    - b. Johns Manville; Spiracoustic Plus.
    - c. Knauf.
- C. 1/2 inch(es) or greater thickness where indicated on Drawings.
- D. R-Value: Minimum 6 hour foot squared degrees F per Btu or greater, where indicated on Drawings.
- E. Liner Application:
  - 1. Install liner in accordance with manufacturer's instructions.

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2. In Straight Duct Sections: Apply at time of ductwork manufacture in an approved sheet metal workshop, or field install.
3. In Duct Fittings: Apply at time of ductwork manufacture in an approved sheet metal workshop only.
4. Install single layer of indicated thickness of duct liner. Multiple layers of insulation to achieve indicated thickness is prohibited.
5. Fastening: Interference fit.
6. Seal insulation edges.
7. Repair abrasions or tears with mastic.

### 2.16 INSULATED FLEXIBLE DUCT

#### A. Fabricate in accordance with:

1. UL 181, Class 1.
2. NFPA 90A and NFPA 90B.

#### B. Construction:

1. Outer Jacket: Fire retardant reinforced metalized vapor barrier jacket with reinforced cross-hatched scrim having a permeance of not greater than 0.1 perm when tested in accordance with ASTM E96/E96M, Procedure A.
2. Inner Liner: Tri-laminate of aluminum foil, fiberglass, and aluminized polyester.
3. Reinforcing: Galvanized steel wire helix, mechanically locked to and encapsulated by inner liner fabric.
4. Insulation:
  - a. Factory insulated with fiberglass insulation.
  - b. R-value: 6.0 minimum at a mean temperature of 75 degrees F.
5. Internal Working Pressure: Rating shall be minimum 4-inch WC positive and 5-inch WC negative, with bursting pressure of at least 2-1/2 times working pressure.
6. Air Velocity Rating: 4,000 fpm, minimum.

#### C. Environment: Suitable for continuous operation at temperature range of minus 20 degrees F to plus 200 degrees F.

#### D. Manufacturers and Products:

1. Flex-Master; Type 5M.
2. Thermaflex; Type M-KC.
3. Hart & Cooley; Type F216.

2.17 DUCTWORK HANGERS AND SUPPORTS

A. General:

1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
3. Wire hangers are not acceptable.
4. Hanger Spacing:
  - a. Ducts Up to 60 inches in Largest Dimension: 10 feet, maximum.
  - b. Ducts Over 61 inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:

1. Galvanized Steel Ductwork:
  - a. Indoors: Carbon steel, zinc electroplated.
  - b. Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
2. Aluminum Ductwork Indoors and Outdoors:
  - a. Carbon steel, hot-dipped galvanized after fabrication.
  - b. Non-metallic pad between lower attachment and ductwork, to achieve dielectric separation.

C. Building Attachments:

1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
3. Upper Attachment (Concrete):
  - a. Drive pin fastener and expansion nail anchor may be used for ducts up to 18-inch maximum dimension.
  - b. Threaded stud fastener may be used for ducts up to 36-inch maximum dimension.
  - c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fasteners.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

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### 2.18 DUCTWORK FLEXIBLE CONNECTIONS

#### A. General:

1. Factory fabricated metal-edged fabric flexible connectors for commercial or industrial applications.
2. Sheet metal permanently secured to fabric with double fabric fold, double metal crimp.
3. Comply with NFPA 90A and NFPA 90B requirements.
4. Airtight and waterproof.

#### B. Materials:

1. Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
2. Metal Edges: Construct from same material as ductwork, unless otherwise noted.
3. Fabric:
  - a. Comply with NFPA 701 or UL 214 (except teflon coated).
  - b. Woven polyester or nylon for most applications.
  - c. Woven fiberglass for high temperature applications.
  - d. Coating: Vinyl.

#### C. Construction:

1. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.
2. Standard Metal Edged Connectors: Strip of fabric 3 inches wide attached to two strips of 3-inch-wide sheet metal.
3. Wide Metal Edged Connectors: Strip of fabric 4 inches wide attached to two strips of 4-inch-wide sheet metal.
4. Extra Wide Metal Edged Connectors: Strip of fabric 6 inches wide attached to two strips of 6-inch-wide sheet metal.

#### D. Manufacturers:

1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

### 2.19 DUCT INSPECTION DOORS

#### A. General:

1. Insulated, gasketed, and at least 15 inches by 15 inches when duct dimensions are large enough.

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2. On ductwork where largest side dimension is less than 16 inches, furnish inspection doors at least 8 inches by 8 inches.
3. Complete with necessary hardware and either Amerlock 10 or Ventlock No. 100 latches, and Ventlock Series No. 100 hinges.
4. Fabricated of same material as ductwork.

### B. Manufacturers:

1. Ventlok.
2. Duro-Dyne.
3. Flexmaster.

## 2.20 MANUAL DAMPERS

### A. Butterfly Manual Dampers:

1. Fabricate from two gauges heavier than duct in which installed, of same material as ductwork.
2. Align operating handle with damper blade.
3. Provide 2-inch standoff bracket for insulated duct systems.
4. Damper Manufacturers:
  - a. Ruskin.
  - b. American Warming and Ventilating.
5. Operator Manufacturers:
  - a. Accessible Ductwork: Ventlok; Type 620 or 635.
  - b. Accessible Insulated Ductwork: Ventlok; Type 639.
  - c. Concealed Ductwork: Ventlok; Type 677 with extended operating rod and concealed regulator with plain cover.

### B. Manual Opposed-Blade Balancing Dampers:

1. Externally operated gang airfoil, damper blades.
2. Fabricate from same material as ductwork.
3. Stainless steel or nylon sleeve bearings.
4. Construction shall have interlocking edges and maximum 10-inch blade width.
5. Manufacturers and Products:
  - a. Ruskin; CD102.
  - b. American Warming and Ventilating; Model VC-31.

## 2.21 BACK DRAFT DAMPERS

- ### A. General: Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

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### B. Steel Frame, Nonmetallic Blades:

1. Fabrication:
  - a. Frame: 2 inches by minimum 18-gauge (51 mm by minimum 1.6 mm) galvanized steel with windstops to reduce backflow.
  - b. Blades:
    - 1) Style: Single piece, independent.
    - 2) Action: Parallel.
    - 3) Material: Noncombustible, neoprene coated fiberglass.
    - 4) Orientation: Horizontal.
    - 5) Width: Maximum 6 inches (152 mm).
  - c. Rear Bird Screen: Galvanized expanded metal.
  - d. Mounting:
    - 1) Suitable for mounting in vertical or horizontal airflow up positions.
    - 2) Configured for positions as shown on Drawings.
  - e. Finish: Mill galvanized. Factory applied air-dried epoxy paint on steel damper parts.
2. Performance Data:
  - a. Temperature Rating: Withstand minus 30 degrees to 200 degrees F (minus 34 degrees to 93 degrees C).
  - b. Maximum Back Pressure: 4-inch WC (1.0 kPa).
  - c. Maximum System Air Velocity: 1,000 fpm (5.1 m/s).
  - d. Maximum Spot Air Velocity: 1,200 fpm (6.1 m/s).
3. Accessories:
  - a. Duct Transition Connection: Rectangular.
  - b. Factory Sleeve: Minimum 20-gauge (1.0 mm) thickness, minimum 8 inch (203 mm) length.
  - c. Screen:
    - 1) Type: Bird.
    - 2) Location: Front with sleeve.
    - 3) Material: Aluminum.
4. Manufacturers and Products:
  - a. Ruskin; Model NMS2.
  - b. Vent Products, Co.

### C. Aluminum, Counterbalanced, Standard Duty:

1. Fabrication:
  - a. Frame: 2 inches by minimum 0.06 inch (51 mm by minimum 1.5 mm), 6063-T5 extruded aluminum channel with front flange and mitered corners.
  - b. Blades:
    - 1) Style: Single piece, overlap frame.

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- 2) Action: Parallel.
- 3) Material: Minimum 0.025-inch (0.6 mm) 6063-T5 formed aluminum.
- 4) Width: Maximum 6 inches (152 mm).
- c. Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.
- d. Blade Seals: Extruded vinyl, mechanically attached to blade edge.
- e. Linkage: Concealed in frame.
- f. Axles: Corrosion-resistant, long-life, synthetic, locked to blade and formed as single piece with bearings.
- g. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade enabling damper to operate over wide range of pressures.
- h. Mounting:
  - 1) Suitable for mounting in vertical, horizontal airflow up, and horizontal airflow down positions.
  - 2) Configured for positions as shown on Drawings.
- i. Finish: Mill aluminum.
2. Performance Data:
  - a. Temperature Rating: Withstand minus 40 degrees to 200 degrees F (minus 40 degrees to 93 degrees C).
  - b. Maximum Back Pressure: 2-inch WC (500 Pa).
  - c. Maximum Spot Air Velocity: 1,000 fpm (5 mps).
  - d. Operation of Blades:
    - 1) Start to Open: 0.01-inch WC (0.002 kPa).
    - 2) Fully Open: 0.06-inch WC (0.01 kPa).
  - e. Pressure Drop: Maximum 0.04-inch WC (0.01 kPa) at 1,000 fpm (305 mpm) through 24-inch by 24-inch (610 mm by 610 mm) damper.
3. Accessories:
  - a. Duct Transition Connection: Rectangular.
  - b. Factory Sleeve: Minimum 20-gauge (1.0 mm) thickness, minimum 12-inch (305 mm) length.
  - c. Screen:
    - 1) Type: Insect.
    - 2) Location: Front with sleeve.
    - 3) Material: Aluminum.
4. Manufacturers and Products:
  - a. Ruskin; Model CBD2.
  - b. Greenheck; Series 160, 360, 460.



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### D. Aluminum, Counterbalanced, Heavy Duty:

1. Fabrication:
  - a. Frame: 2-1/4 inches by minimum 0.125 inch (57 mm by minimum 3.2 mm) 6063-T5 extruded aluminum channel with front flange and galvanized steel braces at mitered corners.
  - b. Blades:
    - 1) Style: Single piece, overlap frame.
    - 2) Action: Parallel.
    - 3) Orientation: Horizontal.
    - 4) Material: Minimum 0.070-inch (1.8 mm) 6063-T5 extruded aluminum.
    - 5) Width: Maximum 6 inches (152 mm).
  - c. Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.
  - d. Blade Seals: Extruded vinyl, mechanically attached to blade edge.
  - e. Linkage: Minimum 1/2-inch (13 mm) aluminum tie bar with stainless steel pivot pins mounted on blades.
  - f. Axles: Corrosion-resistant, long-life, synthetic, locked to blade and formed as single piece with bearings.
  - g. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade enabling damper to operate over wide range of pressures.
  - h. Mounting:
    - 1) Suitable for mounting in vertical, horizontal airflow up, and horizontal airflow down positions.
    - 2) Configured for positions as shown on Drawings.
  - i. Finish: Factory applied anodizing on all aluminum damper parts.
2. Performance Data:
  - a. Temperature Rating: Withstand minus 40 degrees to 200 degrees F (minus 40 degrees to 93 degrees C).
  - b. Maximum Back Pressure: 16-inch WC (4 kPa).
  - c. Maximum Air Velocity: 2,500 fpm (12.7 mps).
  - d. Operation of Blades:
    - 1) Start to Open: 0.01-inch WC (2 Pa).
    - 2) Fully Open: 0.05-inch WC (10 Pa).
  - e. Pressure Drop: Maximum 0.15-inch WC (30 Pa) at 1,500 fpm (7.6 mps) through 24-inch by 24-inch (610 mm by 610 mm) damper.
3. Accessories:
  - a. Duct Transition Connection: Rectangular.
  - b. Factory Sleeve: Minimum 20-gauge (1 mm) thickness, minimum 12 inch (305 mm) length.

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### c. Screen:

- 1) Type: Insect.
  - 2) Location: Front with sleeve.
  - 3) Material: Aluminum.
4. Manufacturer and Product: Ruskin; Model CBD6.

## 2.22 FIRE, FIRE/SMOKE, SMOKE DAMPERS

### A. Duct Mounted Fire Dampers in Fire Walls with Rating of 2 Hours or Less:

1. NFPA 90A rated for 1-1/2-hour service.
2. Blades, frame, and mounting angles same material as ductwork.
3. Accordion style folded blades.
4. 165 degrees F fusible link.
5. Approved for installation with 2-hour fire rating.
6. Rated, manufactured, tested, and approved in accordance with UL 555.
7. Blades out of airstream when open (Style B).
8. Furnish with sleeved frame for duct connections.
9. Labeled for use in dynamic mode.
10. Furnish dynamic and horizontal mounted dampers with springs for proper closure.
11. Corrosive Service Dampers: Type 316 stainless steel.
12. Manufacturers and Products:
  - a. Nailor Industries; Model 0130, Type B.
  - b. Ruskin; (D)IBD20, Type B.

## 2.23 EXTERNAL DUCT INSULATION

- A. Refer to Section 23 07 00, HVAC Insulation.

## 2.24 MISCELLANEOUS ACCESSORIES

### A. Louver and Grille Blank-Off Sections:

1. Fabricate from 20-gauge sheets of same material as louver/grille.
2. Line with sound attenuation/insulating material.
3. Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.

### B. Auxiliary Drain Pans:

1. Dimensions: Minimum 6 inches larger in both dimensions than equipment it is serving and 2 inches high, minimum.
2. Construction: 16-gauge stainless steel with welded joints. Pans shall be watertight and have hemmed edges.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Drain Connection:
  - a. Minimum 1-inch IPS or as shown on Drawings.
  - b. Locate at lowest point of drain pan.
  - c. In lieu of drain connection, float switch may be installed. Float switch shall shut down air handling equipment upon sensing water.

### C. Accessories Hardware:

1. Instrument Test Holes:
  - a. Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.
  - b. Size to allow insertion of pitot tube and other testing instruments.
  - c. Provide in length to suit duct insulation thickness.
2. Flexible Duct Clamps:
  - a. Stainless steel band with cadmium-plated hex screw to tighten band with worm-gear action.
  - b. Provide in sizes from 3 inches to 18 inches to suit duct size.
3. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

## 2.25 DUCTWORK IDENTIFICATION

### A. Painted Identification Materials:

1. Stencils: Standard metal stencils, prepared for required applications with letter sizes generally comply with recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch high letters for ductwork and not less than 3/4-inch-high letters for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
3. Identification Paint: Standard identification enamel of colors indicated or in accordance with ASME A13.1 for colors for systems not identified herein.

### B. Plastic Duct Markers

1. General: Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color code:
  - a. White text on blue background: Services other than hazardous exhaust and odorous air.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Nomenclature: Include the following:
1. Direction of air flow.
  2. Duct service (supply, return, exhaust).
  3. Duct origin (from).
  4. Duct destination (to).

- D. Manufacturers:
1. W.H. Brady, Co.
  2. Seton Identification Products.
  3. Craftmark.
  4. Brimar Industries, Inc.

### 2.26 PAINTING OF DUCTWORK

- A. Refer to Section 09 90 00, Painting and Coating.

## PART 3 EXECUTION

### 3.01 GENERAL INSTALLATION

- A. Miscellaneous:
1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
  2. Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.
  3. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth.
  4. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.
- B. Ductwork Location:
1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
  2. Avoid diagonal runs wherever possible.
  3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
  4. In general, install as close to bottom of structure as possible.
  5. For ductwork concealed above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

### C. Penetrations:

1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
2. Clearances:
  - a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.
  - b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.
3. Closure Collars:
  - a. Minimum 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed.
  - b. Fit collars snugly around ducts and insulation.
  - c. Same gauge and material as duct.
  - d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
  - e. Use fasteners with maximum 6-inch centers on collars.
4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

### D. Concealment:

1. Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.
2. Do not encase horizontal runs in solid partitions, except as specifically shown.
3. Limit clearance to 1 inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

### E. Coordination with Other Trades:

1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
3. Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

### F. Toilet Room Exhaust Ductwork:

1. Joints and Seams: Seal watertight.
2. Slope branch ducts downward to grille.

## 3.02 RECTANGULAR DUCTWORK

### A. General:

1. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.
2. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

### B. Low Pressure Taps:

1. Use bell mouth or conical fittings with integral locking quadrant damper. Spin-in fitting shall be sealed at duct tap with a gasket or sealed with sealant as specified for medium pressure ductwork.
2. Determine location of spin-in after outlet location is determined.
3. Fitting shall be securely attached to shaft to prevent damper from rotating around shaft.

### C. Fittings:

1. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.
2. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.
3. Make offsets with maximum angle of 45 degrees.
4. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

### D. Rectangular Ductwork Transverse Joints:

1. Install each run with a minimum of joints.
2. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Mechanical Joint Option:
  - a. Construct transverse joints with Ductmate 25/35 duct connector systems, Ductmate W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system. Slip-on duct flange connectors shall have integral sealant pocket with permanently flexible sealant.
  - b. When using Ductmate W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the Ductmate W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.
  - c. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
  - d. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
  - e. Conform to SMACNA Class A sealing requirements.

### 3.03 DUCTWORK HANGERS AND SUPPORTS

- A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.
- B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.
- C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.
- D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- E. Support vertical ducts at maximum interval of 16 feet and at each floor.
- F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.
- G. In new construction, install concrete insert prior to placing concrete.
- H. Install seismic restraints on ductwork systems and sway bracing as described in SMACNA Guidelines for Seismic Restraints of Mechanical Systems.

### 3.04 FLEXIBLE CONNECTIONS

- A. Flexible Collars and Connections:
  1. Use between fans and ducts.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.
3. For rectangular ducts, lock flexible connections to metal collars.

### 3.05 DAMPERS

#### A. General:

1. Inspection:
  - a. Inspect areas to receive dampers.
  - b. Notify Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.
  - c. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Install dampers at locations indicated on Drawings and in accordance with manufacturer's installation instructions.
3. Install square and level.
4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
5. Damper blades and hardware shall operate freely without obstruction.
6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
8. Head and sill shall have stops.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

#### B. Manual Dampers:

1. Provide balancing dampers for grilles and diffusers as indicated on Drawings in branch duct as near main as possible.
2. Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

#### C. Back Draft Dampers:

1. Install dampers square and free from racking with blades running horizontally.
2. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### D. Fire Dampers:

1. At ceiling grille and diffuser fire dampers, provide thermal blankets where required by local authorities.
2. Install 1-1/2-hour rated, unless otherwise indicated, at locations shown and in accordance with SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.

### 3.06 ACCESS DOORS

- A. Ductwork: Install access doors in ductwork, in accordance with manufacturer's instructions, at each:
1. Duct mounted fire damper.
  2. Motorized damper.
  3. Sail switch.
  4. Turning vane.
  5. Volume damper.

### 3.07 EXTERNAL DUCT INSULATION

- A. Refer to Section 23 07 00, HVAC Insulation.

### 3.08 MISCELLANEOUS ACCESSORIES

#### A. Auxiliary Drain Pans:

1. Under equipment for which pan is shown on Drawings and under all horizontal air handling units located above ceilings and piping located in ceiling space directly above computer facility areas; furnish and install auxiliary drain pans.
2. Route drain lines to nearest floor or hub drain independent of any other drain.
3. Slope drain pans toward drain connection to promote drainage.

- B. Louver and Grille Blank-Off Sections: Attach airtight to louver or grille and install to allow for easy removal.

#### C. Inspection Plates and Test Holes:

1. Where required in ductwork for balance measurements.
2. Test holes shall be airtight and noncorrosive with screw cap and gasket.
3. Extend cap through insulation.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.09 DUCT SEALING

- A. Seal duct seams and joints as follows:
  - 1. In accordance with SMACNA requirements.
  - 2. In accordance with the following:
    - a. Pressure Classification Less than 2-Inch WC: Transverse joints only.
  - 3. In addition to other requirements, provide the following duct sealing:
    - a. For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape.
    - b. For exterior ductwork, tape joints with Hardcast outdoor tape and rosin.
- B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.
- C. Seal externally insulated ducts prior to insulation installation.
- D. Provide additional duct sealing as required to comply with Article Ductwork Leakage Testing.
- E. Seal all audible leaks.

### 3.10 FIRESTOPPING

- A. Refer to Section 07 84 00, Firestopping.

### 3.11 PAINTING OF DUCTWORK

- A. Refer to Section 09 90 00, Painting and Coating.

### 3.12 DUCTWORK LEAKAGE TESTING

- A. General:
  - 1. Tests shall be conducted on completed ductwork systems.
  - 2. Testing of partial installations or limited sections of ductwork will not be acceptable.
  - 3. All ductwork leakage test procedures and results shall be submitted to Engineer for review.
  - 4. Engineer shall retain the right to witness some or all ductwork leakage testing procedures.
  - 5. Contractor shall notify Engineer in writing at least 5 working days prior to ductwork testing.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### B. Leakage Criteria:

1. Assemble and install ductwork with maximum leakage limited as follows:
2. Constant Volume Systems:
  - a. Supply Ductwork:
    - 1) Operating Pressure: 0- to 2-inch WC.
      - a) Allowable Leakage: 2 percent of design airflow.
      - b) Exhaust Ductwork:
        - (1) Operating Pressure: All
        - (2) Allowable Leakage: 2 percent of design airflow.

### C. Leakage Testing Method:

1. Contractor shall be responsible for providing all necessary test fans and calibrated measuring devices to accomplish ductwork leakage test and to demonstrate that ductwork systems leakage rate is less than maximum rate specified.
2. Pressure testing shall be accomplished using a pressure blower with a calibrated orifice and manometer.
3. Blower shall maintain SMACNA construction pressure classification during test.
4. Perform testing in accordance with procedures given in SMACNA HVAC Air Duct Leakage Test Manual.

## 3.13 BALANCING OF AIR SYSTEMS

- A. Perform air balancing in accordance with requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

## 3.14 PROTECTION OF INSTALLED WORK

- A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.
- B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

## 3.15 CLEANING

- A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

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- B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.
- C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

**END OF SECTION**



**SECTION 23 34 00  
HVAC FANS**

**PART 1 GENERAL**

**1.01 REFERENCES**

A. The following is a list of standards which may be referenced in this section:

1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.
2. Air Movement and Control Association International (AMCA):
  - a. 99, Standards Handbook.
  - b. 201, Fans and Systems.
  - c. 203, Field Performance Measurement of Fan Systems.
  - d. 210, Laboratory Methods of Testing Fans for Rating.
  - e. 300, Reverberant Room Method for Sound Testing of Fans.
  - f. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
  - a. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
  - b. HVAC Applications Handbook.
5. ASTM International (ASTM):
  - a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
  - b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
  - c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
  - d. D3363, Standard Test Method for Film Hardness by Pencil Test.
  - e. D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
  - f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA): 45, Fire Protection for Laboratories Using Chemicals.
8. Occupational Safety and Health Act (OSHA).

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9. Society for Protective Coatings (SSPC):
  - a. SP 3, Power Tool Cleaning.
  - b. SP 5, White Metal Blast Cleaning.
  - c. SP 6, Commercial Blast Cleaning.
  - d. SP 10, Near-White Blast Cleaning.
10. Underwriters Laboratories Inc. (UL): 507, Electric Fans.

## 1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. SWSI: Single Width, Single Inlet.
9. TEFC: Totally Enclosed, Fan Cooled.
10. UV: Ultra Violet
11. XP: Explosion Proof.

## 1.03 SUBMITTALS

A. Action Submittals:

1. Provide for all products specified, as follows:
  - a. Identification as referenced in Contract Documents.
  - b. Manufacturer's name and model number.
  - c. Descriptive specifications, literature and drawings.
  - d. Dimensions and weights.
  - e. Fan sound power level data (reference 10 to power minus 12 Watts) at design operating point.
  - f. Fan Curves:
    - 1) Performance Curves Indicating:
      - a) Relationship of flow rate to static pressure for various fan speeds.
      - b) Brake horsepower curves.
      - c) Acceptable selection range (surge curves, maximum revolutions per minute, etc).
      - d) Static pressure, capacity, horsepower demand and overall efficiency required at the duty point, including drive losses.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- 2) For variable air volume applications, indicate operating points at 100, 80, 60 and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and brake horsepower.
    - g. Capacities and ratings.
    - h. Construction materials.
    - i. Fan type, size, class, drive arrangement, discharge, rotation, and bearings.
    - j. Wheel type, diameter, revolutions per minute, and tip speed.
    - k. Motor data.
    - l. Power and control wiring diagrams, including terminals and numbers.
    - m. Vibration isolation.
    - n. Factory finish system.
    - o. Color selection charts where applicable.
    - p. Corrosion protection coating product data as indicated in Fan Schedule listed on Drawings.
  2. "Or Equal" Equipment:
    - a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on Drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
    - b. Where submitted equipment results in change to ductwork and equipment configuration shown on Drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.
- B. Informational Submittals:
1. Recommended procedures for protection and handling of products prior to installation.
  2. Manufacturer's installation instructions.
  3. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Manufacturers' Field Services, for the following:
    - a. Motors specified to be premium efficient type.
    - b. FRP fans.
  4. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
  5. Test reports.



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- 6. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

- A. Performance Ratings: Tested in accordance with AMCA 210.
- B. Sound Ratings: Tested in accordance with AMCA 300.
- C. Fabrication: In accordance with AMCA 99.

1.05 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts:

Item	Quantity
Vee Belts	Two complete sets per unit

- B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

**PART 2 PRODUCTS**

2.01 EQUIPMENT SCHEDULES

- A. Some specific equipment requirements are listed in Equipment Schedules. Refer to Drawings.

2.02 SPARK RESISTANT CONSTRUCTION

- A. Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.

2.03 NAMEPLATES

- A. All units shall include factory installed permanently attached nameplate displaying unit model and serial number.

2.04 OPERATING LIMITS

- A. Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408-69.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.05 ACOUSTICAL LEVELS

- A. Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule.

### 2.06 FAN DRIVES

- A. Furnish multiple drive belts where motor horsepower is 2 hp or larger.
- B. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.
- C. Sheaves shall be capable of providing 150 percent of motor horsepower.
- D. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.
- E. Belts: Oil and heat resistant, nonstatic type.
- F. Furnish motors for V-belt drives with adjustable rails or bases.
- G. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.
- H. Motors 20 hp or Smaller:
  - 1. Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
  - 2. Final operating point shall be at approximate sheave midpoint.
- I. Motors Larger than 20 hp: Fixed-pitch sheaves.
- J. Drive Adjustment:
  - 1. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
  - 2. Provide trial and final sheaves, as well as drive belts, as required.
- K. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.
- L. Belt and Shaft Guards:
  - 1. Easily removable and to enclose entire drive assembly, meeting federal, OSHA, and State of Kentucky requirements.

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2. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
3. Bright yellow finish.

M. Provide speed test openings at shaft locations.

### 2.07 FINISHES

- A. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.
1. Parts cleaned and chemically pretreated with a phosphatizing process.
  2. Alkyd enamel primer.
  3. Air-dry enamel topcoat.
- B. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.
- C. Stainless Steel Parts: Finished smooth and left unpainted.
- D. Fiberglass Parts: Finished in accordance with Paragraph, Fiberglass Material.

### 2.08 WALL FAN, CENTRIFUGAL

- A. General:
1. Factory-assembled centrifugal wall fan; including housing, fan wheel, drive assembly, motor and accessories.
  2. Bearing AMCA Certified Ratings Seal for sound and air performance.
- B. Housing:
1. Construction: Spun-formed aluminum, minimum 16-gauge marine alloy.
  2. Windband: Finish with rolled bead.
  3. Cap: Motor access via quick release latches.
  4. Motor completely sealed from exhaust air stream.
  5. Motor cooling via air breather tubes.
  6. Integral conduit chase for wiring.
  7. Fan Inlet:
    - a. Full inlet cone of aluminum construction.
    - b. Match inlet shroud.
  8. Wall Flange: Aluminum construction, with prepunched key slot holes.
- C. Fan Wheels:
1. Aluminum construction, backward inclined centrifugal, nonoverloading type.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Machined, cast aluminum hub.
3. Matched to deep spun inlet venturi.

### D. Shaft, Bearings, Drive:

1. Shaft:
  - a. Turned, ground and polished carbon steel.
  - b. Keyed for sheave installation.
  - c. Zinc-phosphate coated and oil emulsion-dipped.
2. Bearings:
  - a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
  - b. Selected for average life (ABMA 9 L<sub>50</sub>) of not less than 200,000 hours operation at maximum cataloged operating speed.
  - c. Terminate with zerk fittings.
3. Drives:
  - a. In accordance with Article Fan Drives.
  - b. Factory set to the specified fan revolutions per minute.
  - c. Type: Belt.

### E. Accessories: Provide as scheduled in Exhaust Fan Schedule.

### F. Manufacturers and Products:

1. Cook; ACWB (Belt Drive).
2. Greenheck; CWB (Belt Drive).
3. ACME; PNU (Belt Drive).
4. Jenn Fan; TXBW (Belt Drive).

## 2.09 CORROSION PROTECTION COATING

### A. General:

1. Factory-applied corrosion protection coating for application to fan components and accessories, where required by this section.
2. Quality Control:
  - a. Verify dry film thickness before final baking.
  - b. Finished coating system shall be free from voids, checks, cracks and blisters.
3. Surface Cleaning: Clean parts to be coated as follows:
  - a. Immerse parts in heated cleaning solution to remove lubricants, machining oils, and residual factory contamination.
  - b. Follow with immersion in potable water bath to neutralize and remove cleaning solution.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- c. Chemical Pretreatment: Immerse parts in heated chemical solution, iron phosphate for steel, clear/yellow chromate for aluminum.

### B. Baked Epoxy Phenolic:

1. Material:
  - a. Baking cross-linked epoxy-phenolic.
  - b. For outdoor applications, apply an UV-resistant topcoat.
2. Surface Preparation: Sandblast surface to SSPC-SP 5.
3. Application: Electrostatic or conventional compressed air spray equipment.
4. Curing: Oven baked at a metal temperature not to exceed 400 degrees F.
5. Finished Thickness: 6-mil to 8-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
  - a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
  - b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
  - c. Impact Resistance: 160 inch pounds, ASTM D2794 test method.
  - d. Pencil Hardness: 3H, ASTM D3363 test method.
7. Service Temperature: Maximum 200 degrees F, continuous.

## 2.10 MOTORS

### A. General:

1. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction Motors.
2. Provide integral self-resetting overload protection on single-phase motors.
3. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
4. Motors shall not operate into service factor in any case.

### B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
3. Space Heater: No.
4. Number of Speeds: Single.
5. Number of Windings: One.
6. Motor Efficiency: Energy efficient.

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7. Shaft Type: Solid, carbon steel.
8. Mounting: As required for fan arrangement.
9. Service Factor: 1.15.

### 2.11 ACCESSORIES

- A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown on Drawings.
- B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

### 2.12 SOURCE QUALITY CONTROL

- A. General:
  1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
  2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
  3. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA 203, Appendix L.
- B. Testing Provisions:
  1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
  2. Center punch fan shaft to accommodate tachometer readings.
- C. Acoustical Levels:
  1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
  2. Fan sound power levels (dB, Reference  $10^{-12}$  Watts) shall be no greater than scheduled values.

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### D. Balancing:

1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

### E. Vibration Test:

1. Each fan furnished with a 5-hp or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
2. Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
  - a. Belt Drive (except Vane Axial): 0.15 inch per second peak velocity.
  - b. Belt Drive Vane Axial: 0.08 inch per second peak velocity.
  - c. Direct Drive: 0.08 inch per second peak velocity.
3. Written records of run test and vibration test shall be made available upon request.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install fans level and plumb.
- B. Secure wall-mounted fans to roof curbs with Type 316 stainless steel hardware.
- C. Labeling:
  1. Label fans in accordance with Article Accessories.
  2. Mark exhaust fans with arrows to indicate proper direction of rotation, in accordance with NFPA 45.
- D. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.
- E. Equipment Support and Restraints:
  1. Install floor-mounted units on concrete bases designed to withstand, without damage to equipment, the seismic force required by code.
  2. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

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3. Seismic Restraint Snubbers: Install with sufficient clearance so unit isolators are not restricted for proper free isolation, but do limit movement in all directions.

### F. Connections:

1. Isolate duct connections to fans.
2. Install ductwork adjacent to fans to allow proper service and maintenance.

## 3.02 FIELD QUALITY CONTROL

### A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.
2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

### B. Performance Tests:

1. Starting Procedures:
  - a. Energize motor and adjust fan to indicated revolutions per minute.
  - b. Measure and record motor voltage and amperage.
2. Operational Test:
  - a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
  - c. Test and adjust control safeties.
  - d. Replace damaged and malfunctioning controls and equipment.

## 3.03 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance,



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inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

- B. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
  - 1. One person-day for installation assistance and inspection.
  - 2. One person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
  - 3. One person-day for prestartup classroom or site training.
  - 4. One person-day for facility startup.
  - 5. One person-day for post-startup training of Owner's personnel.
  - 6. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.
- C. Refer Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

### 3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.
- D. Balancing:
  - 1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
  - 2. Replace fan and motor sheaves as required to achieve design airflow.
- E. Vibration Testing:
  - 1. Perform field testing on rotating equipment, where specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.
  - 2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.

### 3.05 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

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- B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

**END OF SECTION**



**SECTION 23 37 00  
AIR OUTLETS AND INLETS**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
  - 1. Air-Conditioning, Heating, and Refrigeration Institute (AHR1): 880, Air Terminals.
  - 2. ASTM International (ASTM): C636/C636M, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
  - 3. Underwriters Laboratories Inc. (UL).

**1.02 DEFINITIONS**

- A. NC: Noise Criteria; background sound rating method for indoor sound.
- B. WC: Water column.

**1.03 SUBMITTALS**

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. Manufacturer's data and descriptive literature for products specified.
    - b. Furnish the following information for each type of diffuser, register, and grille furnished.
      - 1) NC sound data.
      - 2) Static pressure loss data.
      - 3) Throw data.
  - 2. Samples: Finish color samples.
- B. Informational Submittals:
  - 1. List of recommended spare parts for products specified.

**PART 2 PRODUCTS**

**2.01 EQUIPMENT SCHEDULES**

- A. Refer to Drawings.

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### 2.02 SUPPLY GRILLES AND REGISTERS

#### A. Supply Grilles and Registers (WR):

1. Construction: Refer to Air Device Schedule (MP.M.601).
  - a. WR Register Accessories:
    - 1) Gang-operated opposed-blade volume control damper.
    - 2) Material to match grille.
2. Adjustable front horizontal and rear vertical vanes on 3/4-inch centers.
3. Continuous sponge rubber gasket at face flange.
4. 1-inch minimum flat rectangular frame.
5. Performance: Refer to Air Device Schedule (MP.M.601).
6. Manufacturers and Products:
  - a. Titus; 272FL Series.
  - b. Kvneger; 5880 Series.

### 2.03 RETURN, EXHAUST AND TRANSFER GRILLES AND REGISTERS

#### A. Exhaust Grilles (CG):

1. Construction: Refer to Air Device Schedule (MP-M-601).
  - a. CG Accessories:
    - 1) Gang-operated opposed-blade volume control damper.
    - 2) Material to match grille.
2. Fixed horizontal louvers set at 35 degrees to 45 degrees.
3. 1-inch minimum flat, rectangular frame.
4. Manufacturers and Products:
  - a. Titus; 4FL Series.
  - b. Krueger; S80/S580H Series.
  - c. Carnes; Type RAAAH.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Refer to architectural reflected ceiling plans for coordination of locations of ceiling-mounted air outlets and inlets with ceiling grids and lighting. Where locations of devices shown on mechanical drawings do not agree with locations that are shown on architectural reflected ceiling plans, reflected ceiling plans shall take precedence. If air outlets or inlets are shown on mechanical drawings, but are not shown on architectural reflected ceiling plans, devices shall be located as near as possible to locations shown on mechanical drawings when coordinating with ceiling.

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- B. Install grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

**END OF SECTION**



**SECTION 23 77 00  
AIR HANDLING UNITS**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 410, Forced-Circulation Air-Cooling and Air-Heating Coils.
  2. Air Movement and Control Association International, Inc. (AMCA):
    - a. 201, Fans and Systems.
    - b. 203, Field Performance Measurement of Fan Systems.
    - c. 204, Balance Quality and Vibration Levels for Fans.
    - d. 300, Reverberant Room Method for Sound Testing of Fans.
    - e. 301, Methods for Calculating Fan Sound Ratings From Laboratory Test Data.
    - f. 99-0401, Classifications for Spark Resistant Construction.
    - g. 99-2408, Operating Limits for Centrifugal Fans.
  3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
  4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
    - a. 15, Safety Standard for Refrigeration Systems.
    - b. 52.1, Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
    - c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
    - d. 62.1, Ventilation for Acceptable Indoor Air Quality.
  5. ASTM International (ASTM):
    - a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
    - b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
    - c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
    - d. D3363, Standard Test Method for Film Hardness by Pencil Test.
    - e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  6. CSA America (CSA):
    - a. B149.1, Natural Gas and Propane Installation Code.
    - b. Z83.4, Non-Recirculating Direct Gas-Fired Industrial Air Heaters.



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- c. Z83.18, Recirculating Direct Gas-Fired Industrial Air Heaters.
7. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 841, Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).
8. International Standards Organization (ISO): 9001, Quality Management Systems – Requirements.
9. National Electrical Manufacturers Association (NEMA).
10. National Fire Protection Association (NFPA):
  - a. 54, National Fuel Gas Code.
  - b. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - c. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
11. Occupational Safety and Health Act (OSHA).
12. Society of Protective Coatings (SSPC):
  - a. SP 3, Power Tool Cleaning.
  - b. SP 5, White Metal Blast Cleaning.
  - c. SP 6, Commercial Blast Cleaning.
  - d. SP 10, Near-White Blast Cleaning.
13. Underwriters Laboratories Inc. (UL):
  - a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
  - b. 723, Standard for Safety Test for Surface Burning Characteristics of Building Materials.

### 1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. ac: alternating current.
2. AFD: Adjustable Frequency Drive.
3. AHU: Air Handling Unit.
4. cfm: cubic feet per minute.
5. CISD: Chemical Industry, Severe-Duty.
6. dB: Decibel.
7. DX: Direct Expansion.
8. DWDI: Double Width, Double Inlet.
9. ETL: ETL Testing Laboratories, Inc.
10. FM: Factory Mutual Insurance.
11. fpm: feet per minute.
12. hp: Horsepower.
13. IAQ: Indoor Air Quality.
14. IEC: International Electro-technical Commission.
15. IRI: Industrial Risk Insurance.

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16. MAU: Make-Up Air Unit.
17. NRC: Noise Reduction Coefficient.
18. OD: Outside Diameter.
19. ODP: Open Drip Proof.
20. O&M: Operations and Maintenance.
21. psi: pounds per square inch.
22. PVC: Polyvinyl Chloride.
23. rpm: revolutions per minute.
24. SCR: Silicon Control Rectifier.
25. SWSI: Single Width, Single Inlet.
26. TEFC: Totally Enclosed, Fan Cooled.
27. UV: Ultra Violet.
28. VFD: Variable Frequency Drive.
29. WC: Water Column.
30. XP: Explosion Proof.

### 1.03 SUBMITTALS

#### A. Action Submittals:

1. Provide Shop Drawings for products specified, including, as a minimum:
  - a. Unit identification as referenced in Contract Documents.
  - b. Manufacturer's name and model number.
  - c. Descriptive specifications, literature, and drawings.
  - d. Dimensions and weights for unit, including fully assembled and shipping sections.
  - e. Acoustics:
    - 1) Fan sound power level data (ref. 10 to power minus 12 Watts) at design operating point, based on AMCA 300 for unit discharge, inlet and casing.
    - 2) Additional requirements (including by others) to achieve specified sound performance levels.
  - f. Fans:
    - 1) Type, size, quantity, class, drive arrangement, discharge, rotation and bearings.
    - 2) Wheel type, diameter, rpm, and tip speed.
    - 3) Performance curves indicating:
      - a) Relationship of flow rate to static pressure for various fan speeds.
      - b) Brake horsepower curves.
      - c) Acceptable selection range (surge curves, maximum safe operating rpm).

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- d) Static pressure, capacity, horsepower demand and overall efficiency required at the duty point, including drive losses.
- 4) For variable air volume applications, indicate operating points at 100, 80, 60, and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and brake horsepower.
- g. Coils:
  - 1) Type, quantity, dimensions, material of construction, coatings, if applicable, energy transfer capacity, air pressure drop, air inlet, and discharge temperature at design conditions.
  - 2) DX Coils: Refrigerant saturated suction temperature at design conditions, refrigerant piping configuration (row split, face split, intertwined), coil fin spacing, coil row depth.
  - 3) Electric Resistance Coils: Voltage, phase, number of stages, safety features, controls.
  - 4) Drain pan details.
  - 5) Coil pull details and dimensions for service.
- h. Motor(s) type, quantity, and performance data.
- i. Air filter(s) type, quantity, and performance data.
- j. Unit capacities and ratings, including airflow and static pressure summary.
- k. Construction materials.
- l. Power and control wiring diagrams, including terminals and numbers.
- m. Vibration Isolation:
  - 1) Vibration isolation methods with maximum deflection data.
  - 2) Additional requirements (including by others) to achieve specified vibration isolation levels.
- n. Factory finish system, with color selection charts where applicable.
- 2. "Or Equal" Equipment:
  - a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
  - b. Where submitted equipment results in change to ductwork and equipment configuration shown on drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.

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### B. Informational Submittals:

1. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Manufacturers' Field Services.
2. Sample copy of guarantee.
3. Manufacturer's Test Reports for the following:
  - a. Electric heating coil.
  - b. DX cooling coil.
  - c. Air handling unit leak tests.
  - d. Acoustical tests.
  - e. Vibration tests.
4. Recommended procedures for protection and handling of products prior to installation.
5. Manufacturer's installation instructions, including component spacing requirements.
6. Operation and Maintenance Data:
  - a. In conformance with Section 01 78 23, Operation and Maintenance Data.
  - b. Include as-built version of equipment schedules.
  - c. Methods for accessing components for maintenance with required service clearances.

### 1.04 QUALITY ASSURANCE

A. Fans: Licensed to bear AMCA seal for air flow and sound performance.

### B. Manufacturer's Qualifications:

1. The air handling unit manufacturer shall have been successfully manufacturing air handling units for a period of no less than 5 years.
2. Manufacturer's qualifications are subject to review by the Owner/Engineer to determine acceptance.

### C. Fan Performance:

1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure.
3. Motor shall not operate into motor service factor in any listed case.
4. Accommodate drive efficiency in motor selection according to manufacturer's published recommendation, or according to AMCA 203, Appendix L.

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- D. Thermal Insulation: Shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM E84 and UL 723).

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Air handling unit manufacturer shall coordinate with the Contractor as to the requirements for proper delivery, storage, and handling of the air handling unit and its components required in this Specification to ensure that the unit is properly cared for prior to final installation.

1.06 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts and materials:

<u>Item</u>	<u>Quantity</u>
V-Belts	One complete set per unit
High Efficiency Filters	Two complete sets per unit

- B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.07 SPECIAL GUARANTEE

- A. Schedule Delay Guarantee:
  - 1. Air handling unit shall be manufactured and shipped to designated jobsite on time as determined through coordinated Owner/Contractor schedule.
  - 2. Delaying shipping and/or installation of this complete system beyond written "agreed-upon" date shall result in Owner taking a credit of 5 percent until unit is back on schedule.

**PART 2 PRODUCTS**

2.01 EQUIPMENT SCHEDULES

- A. Refer to Drawings.

2.02 SPARK RESISTANT CONSTRUCTION

- A. Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.

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### 2.03 OPERATING LIMITS

- A. Fans designated to meet a specified Fan Class shall comply with requirements of AMCA 99-2408.

### 2.04 ACOUSTICAL LEVELS

- A. Equipment selections shall produce sound power levels in each octave band no greater than shown in fan equipment schedule.
- B. Perform noise tests in accordance with AMCA 300.

### 2.05 FAN DRIVES

- A. Furnish multiple drive belts.
- B. Drive assembly shall be sized for a minimum 150 percent of fan motor horsepower rating.
- C. Motors for V-belt drives shall be furnished with adjustable rails or bases.
- D. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel fixed sheaves.
- E. Motors: Fixed-pitch sheaves required.
- F. Drive Adjustment:
  - 1. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
  - 2. Provide trial and final sheaves, as well as drive belts, as required.
- G. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.
- H. Belt and Shaft Guards:
  - 1. Easily removable and to enclose entire drive assembly, meeting federal, OSHA, and State of Kentucky requirements.
  - 2. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
  - 3. Bright yellow finish.
- I. Provide speed test openings at shaft locations.

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## 2.06 FINISHES

- A. Carbon Steel Parts: Factory finished as follows, unless indicated otherwise.
  - 1. Parts cleaned and chemically pretreated with a phosphatizing process.
  - 2. Alkyd enamel primer.
  - 3. Air-dry enamel topcoat.
- B. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.
- C. Stainless Steel Parts: Finished smooth and left unpainted.

## 2.07 AIR HANDLING UNITS—PACKAGED

- A. General:
  - 1. Packaged air handling unit, factory assembled containing components such as fan units, motor and drive assembly, heat transfer devices, and condensate pans. Contractor shall field install supply plenum and return plenum.
  - 2. As indicated on plans and Air Handling Unit Schedule.
  - 3. Assembly shall be a complete and fully functioning system with all components and accessories as specified.
  - 4. Fan Air and Sound Performance: Tested and rated in accordance with AMCA and guaranteed by manufacturer.
- B. Casing:
  - 1. General:
    - a. Fully enclosed housing, with casing consisting of sheet metal side panels, mechanically fastened to structural metal internal frame.
    - b. Access panels shall be easily removable. Panel removal shall not affect structural integrity of unit.
  - 2. Fasteners: Constructed of same material as respective panel materials.
  - 3. Outer Panels:
    - a. Material: Mild galvanized steel.
  - 4. Insulation:
    - a. Single Wall Casing Units:
      - 1) Insulation secured with adhesive and metal pins.
      - 2) Longitudinal insulation joints and butt ends covered by a sheet metal break to prevent erosion of exposed edges.
    - b. Properties:
      - 1) 1/2-inch thickness.

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5. Access Doors:
  - a. Sized and located to provide easy access to unit internal components.
  - b. Provide doors as required for component access.
- C. Drain Pans:
  1. Location: Inside packed unit under cooling coil.
  2. IAQ style drain pans, complying with requirements of ASHRAE 62.1.
  3. Pitched for complete drainage, with no standing water in unit.
  4. Non-corroding.
- D. Supply Fan:
  1. General:
    - a. Supply air fan, consisting of housing (where applicable), wheel, fan shaft, bearings, motor, drive assembly, support structure and accessories.
    - b. Fan Performance: AMCA 99-2408 class rating corresponding to the static pressure at which the fan is designed to operate.
    - c. Fan Assemblies: Statically and dynamically balanced, designed for continuous operation at maximum rated fan speed and motor horsepower.
  2. Centrifugal Fan Housing:
    - a. Material: G-90 galvanized steel.
    - b. Forward curved belt driven.
  3. Fan Wheel:
    - a. Centrifugal, one-piece, blade type as scheduled.
    - b. Forward-Curved Fans:
      - 1) DWDI forward curved fan wheel.
  4. Accessories:
    - a. Return-air grille.
    - b. Subbase.
    - c. Condensate drain trap with alarm.
    - d. Electric resistant heat coil.
- E. Refrigerant Coil:
  1. General:
    - a. Fin-tube direct expansion refrigerant cooling coil, complete with refrigerant controls, and related accessories.
    - b. Casing constructed in accordance with Article Module Casing.
    - c. AHRI 410 performance rated and certified.
    - d. Factory tested with air at 300 psig while immersed in an illuminated water tank.



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- e. Designed and tested in accordance with ASHRAE 15.
  - f. Coils designed for use with refrigerant type in associated refrigerant compressor.
2. Fins:
    - a. Sine wave aluminum fins bonded to copper tube.
    - b. Fin density no greater than 15 fins per inch.
  3. Tubes:
    - a. Material: Seamless copper tubing.
  4. Headers:
    - a. Located inside coil section.
    - b. Constructed from seamless copper tubing with die formed tube holes and brazed joints.
    - c. Refrigerant Piping Connections: Terminate with OD sweat copper.
  5. Drain Pan:
    - a. Construction in accordance with Paragraph, Drain Pans.
    - b. Furnish drain pan under cooling coil.
- F. Electric Heating Coil Module:
1. General:
    - a. As specified in Air Handling Unit Schedule.
    - b. Electric heaters shall be UL or ETL listed for zero clearance and shall meet all applicable NEC requirements.
    - c. Element assembly furnished with mounting flanges, allowing individual element removal from terminal box.
- G. Unit Electrical and Controls:
1. General:
    - a. Electrical and control components shall meet requirements of Division 26 Electrical.
    - b. All electrical and controls components and assemblies UL or ETL listed and labeled.
    - c. Factory wired units shall bear an ETL or UL label with all necessary identification marks, electrical data, and cautions, as required by NEC.
    - d. Provide as-built wiring diagrams and schematics for electrical and control systems, secured to inside of control panel door, or enclosed in plastic jackets placed inside control panel.
    - e. For additional requirements, refer to Specification paragraphs for individual modules, and Section 23 09 00, Instrumentation and Control Devices for HVAC.
  2. Main Power Connection: Provide single point power connection to unit, serving both primary unit voltage and unit control voltage.

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H. Accessories: Provide where scheduled in Equipment Schedule.

I. Manufacturers:

1. McQuay.
2. Trane.
3. Carrier.
4. Temtrol.
5. York.

### 2.08 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

### 2.09 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test equipment actually identical to that furnished.

B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
2. Center punch fan shaft to accommodate tachometer readings.

C. Manufacturer's Tests:

1. Electric Heating Coil Test: 2,000-volt dielectric test.
2. DX Coil Test: Leak tested under water with 300 psi air.
3. Electrical Circuits:
  - a. Tested and checked as to proper function.
  - b. Perform dielectric strength test.
4. Air Handling Unit Cabinet Tests:
  - a. Air Pressure Leak Testing: For modules under positive pressure located on discharge side of a fan, maximum permissible air leakage shall not exceed one percent of specified airflow, when subject to 8-inch water gauge differential pressure.

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- b. Leakage Test Failure Guarantee: Upon completion of leakage test, if unit does not meet specified performance for deflection or leakage, Owner may elect to have unit modified to meet specified performance or may request a credit according to performance failure.
- D. Acoustical Test:
1. Perform factory noise tests in accordance with AMCA 300 and AMCA 301.
  2. Fan sound power levels (dB, Reference  $10^{-12}$  Watts) shall be no greater than scheduled values.
- E. Balancing:
1. Completed fan assemblies shall be dynamically balanced to minimum grade of G 6.3 per AMCA 204 at design operating speed.
  2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design RPM.
- F. Vibration Test:
1. Each fan furnished with a 5-hp or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
  2. Vibration reading as measured at fan scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
    - a. Belt Drive (except Vane Axial): 0.15 in/sec peak velocity.
    - b. Belt Drive Vane Axial: 0.08 in/sec peak velocity.
    - c. Direct Drive: 0.08 in/sec peak velocity.
    - d. Written records of run test and vibration test shall be made available upon request.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install units level and plumb.
- B. Install floor-mounted units on factory sub base.
- C. Secure vibration controls to concrete floor using anchor bolts cast in concrete base.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Inspect internal casing insulation, seal all exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.
- E. All condensate drain connections piped and trapped separately for proper drainage.
- F. Labeling: In accordance with Article Accessories.
- G. Service Access: Locate units to provide access spaces required for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.
- H. Equipment Restraints:
  - 1. Restrain equipment against seismic forces as required by Code.
  - 2. Restrain equipment against wind loads as required by Code.
  - 3. Seismic Restraint Snubbers:
    - a. Rubber-faced, securely anchored to floor or structure.
    - b. Install with sufficient clearance so unit isolators are not restricted for proper free isolation, but do limit movement in all directions.
- I. Connections:
  - 1. Isolate sheet metal duct connections from all noninternally spring-isolated fan units or other rotating equipment.
  - 2. Install ductwork adjacent to fans so as to allow proper service and maintenance.
  - 3. Pipe drain pan connection through trap running to floor drain.

### 3.02 FIELD QUALITY CONTROL

- A. Functional Tests:
  - 1. Verify shipping blocking and bracing are removed.
  - 2. Verify unit is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
  - 3. Verify proper thermal-overload protection is installed in motors, starters and disconnect switches.
  - 4. Verify cleaning and adjusting are complete.
  - 5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
  - 6. Reconnect fan drive system, align and adjust belts and install belt guards.
  - 7. Verify lubrication for bearings and other moving parts.
  - 8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### B. Performance Tests:

1. Starting Procedures:
  - a. Energize motor and adjust fan to indicated rpm.
  - b. Measure and record motor voltage and amperage.
2. Operational Test:
  - a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
  - c. Test and adjust control safeties.
  - d. Replace damaged and malfunctioning controls and equipment.

### 3.03 ADJUSTING

- A. Adjust belt tension.
- B. Lubricate non-sealed bearings prior to startup.
- C. Air Balancing:
  1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
  2. Replace fan and motor sheaves as required to achieve design airflow.
- D. Vibration Testing:
  1. Perform field testing on rotating equipment, where specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.
  2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.

### 3.04 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.05 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.
- B. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
  - 1. 1 person-days for installation assistance and inspection.
  - 2. 1 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
  - 3. 1 person-days for prestartup classroom or site training.
  - 4. 1 person-days for facility startup.
  - 5. 1 person-days for post-startup training.
  - 6. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.
- C. Refer Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

**END OF SECTION**



**SECTION 23 84 00**  
**HUMIDITY CONTROL EQUIPMENT**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 410, Forced-Circulation Air-Cooling and Air-Heating Coils.
  2. Air Moving and Conditioning Association (AMCA): 300, Reverberant Room Method for Sound Testing of Fans.
  3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
    - a. 52.1, Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
    - b. 84, Method of Testing Air-to-Air Heat Exchangers.
    - c. 90.1 IP/SI, Energy Standard for Buildings Except Low-Rise Residential Buildings.
  4. ASTM International (ASTM):
    - a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
    - b. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
    - c. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning Plastics in a Horizontal Position.
    - d. D2370, Standard Test Method for Tensile of Organic Coatings.
    - e. D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
    - f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  5. Canadian Standards Association (CSA).
  6. Electrical Test Laboratories (ETL).
  7. International Standards Organization (ISO): 9001, Quality Management Systems – Requirements.
  8. National Fire Protection Association (NFPA):
    - a. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
    - b. 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
    - c. 255, Standard Method of Test for Surface Burning Characteristics of Building Materials.



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9. Nationally Recognized Testing Laboratories (NRTL).
10. Underwriters Laboratories Inc. (UL): 1995, UL Standard for Safety Heating and Cooling Equipment.

## 1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Air Conditioning.
2. COP: Coefficient of Performance.
3. DX: Direct Expansion.
4. EER: Energy Efficiency Ratio.
5. HP: Heat Pump.
6. IR: Infrared.
7. LED: Light Emitting Diode.
8. OSA: Outside Air.
9. PSC: Permanent Split Capacitor.
10. PTAC: Packaged Terminal Air Conditioner.
11. SPST: Single Pole, Single Throw.
12. TXV: Thermostatic Expansion Valve.
13. UV: Ultraviolet.

## 1.03 SUBMITTALS

A. Action Submittals:

1. Specifications, descriptive drawings, catalog cuts, and descriptive literature; include make, model, dimensions, weight of products, and electrical schematics, for products specified.
2. Manufacturer's standard finish color selection for enclosure finishes.
3. Complete performance data that indicates full compliance with Specifications:
  - a. Include fan sound power level data (ref. 10 watts to 12 watts) at design operating point, based on AMCA 300, Setup No. 1.
  - b. Include heating and cooling performance data at design operating conditions.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
2. Recommended procedures for protection and handling of equipment and materials prior to installation.

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3. Operation and maintenance data as specified in Section 01 43 33, Operation and Maintenance Data.
4. Special guarantees.

### 1.04 QUALITY ASSURANCE

- A. High efficiency.

### 1.05 SPECIAL GUARANTEE

- A. Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee.
- B. Special guarantee shall provide for correction, or at the option of Owner, removal and replacement of the Work specified in this Specification found defective during a period of 5 years after date of Substantial Completion.
- C. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

## **PART 2 PRODUCTS**

### 2.01 GENERAL

- A. Specified components of this section, including insulation, facings, mastics, and adhesives shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

### 2.02 EQUIPMENT SCHEDULES

- A. Refer to Drawings.

### 2.03 DEHUMIDIFIER, PORTABLE

- A. General:
  1. Self contained portable type.
  2. Consisting of the following components:
    - a. Condenser coil.
    - b. Fan.
    - c. Motor.
    - d. Compressor.
    - e. Self contained controls.
  3. Bearing UL label.

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4. Fan motor and compressor shall be UL or CSA listed.
5. Units shall be completely factory assembled, wired, piped, precharged and fully tested in all modes of operation.
6. Test report shall be available on request. Engineer reserves the right to witness factory performance testing.
7. Manufacturer shall have a minimum of 5 years' experience in the production of dehumidification systems.

### B. Hardware:

1. Exterior Nuts, Bolts and Washers: Type 304 stainless steel.
2. Exterior Screws: Type 304 stainless steel or coated with an epoxy finish that meets or exceeds minimum 4,000-hour salt spray test per ASTM B117.

## 2.04 OUTDOOR UNIT, SPLIT SYSTEM DX COOLING SYSTEM

### A. General:

1. Match with associated indoor unit.
2. Consisting of the following components:
  - a. Condenser coil.
  - b. Fan.
  - c. Motor.
  - d. Reciprocating or scroll compressor.
  - e. Refrigerant specialties.
  - f. Controls.
3. Contained in a weatherproof casing.
4. Bearing the UL label.
5. Low ambient controls.
6. Design to conform to ETL or CSA standards.
7. Coils shall be UL or CSA listed.
8. Fan motor and compressor shall be UL or CSA listed.
9. Refrigerant Pipe: Type L copper; vinyl coated for corrosion prevention.
10. Units shall be completely factory assembled, wired, piped, precharged with R-410A, and fully tested in all modes of operation.
11. Controls shall be factory adjusted and preset to design conditions.
12. Test report shall be available on request. Engineer reserves right to witness factory performance testing.
13. Manufacturer shall have a minimum of 5 years experience in production of dehumidification systems.

### B. Cabinet:

1. Supported on steel full-length mounting rails.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Removable access panels to internal components and electrical panel without impairing unit operation.
3. Protective guards on each fan discharge and each coil inlet.
4. Constructed of galvanized steel.
5. Paint internally and externally, as detailed below.

### C. Base:

1. Heavy-gage roll-formed perimeter base rail with fork lift slots.

### D. Paint Finish:

1. Bonderized and coated with a pre-painted baked enamel finish.
2. Finish shall meet or exceed a 1,000-hour salt spray test per ASTM B117.

### E. Compressor:

1. Hermetic, scroll type suction gas cooled, suitable for refrigerant R-410A, equipped with internal thermal protection, and resilient type external mounting.
2. Provide with crankcase heaters and motors equipped with internal overheat-overload protection.
3. Compressor manufacturer shall have a wholesale outlet for replacement parts in nearest major city.
4. Warranty: 5 years.

### F. Condenser Coil:

1. Aluminum plate fins formed on multiple rows of seamless copper tubing arranged in a staggered tube configuration.
2. Tubes shall be mechanically expanded, firmly bonding tube to shoulder of each fin.
3. Coat coil with anticorrosion protective coating.

### G. Condenser Fan and Motor:

1. Fan: Propeller type, electronically balanced, and direct-driven by fan motor.
2. Motor: Inherent protected, with sealed ball bearings that do not require lubrication.
3. Outdoor air shall be discharged through a vinyl coated fan guard.

### H. Refrigerant Circuit:

1. Rubber grommet mounted hermetic scroll compressor.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Crankcase heater.
  3. Liquid line solenoid.
  4. Suction line accumulator.
  5. Condenser coil.
  6. Upflow propeller condenser fans.
  7. Connections for refrigerant piping and specialties.
  8. Filter-drier.
  9. Sight glass-moisture indicator.
  10. Suction line accumulator.
  11. Refrigerant pressure service valves.
- I. Controls:
1. Compressor and fan motor contactors or starters with thermal protection (auto-reset) on inductive loads.
  2. Overload protection in each leg.
  3. Complete with thermostats, and electrical control circuit factory prewired in control panel.
  4. Terminal strip for connection of remote controls.
  5. Compressor winding and overheat protection.
  6. Refrigerant controls shall include a high pressure control (manual-reset), low pressure control (auto-reset), head pressure control, field adjustable refrigerant system lock-out, and compressor anti-short cycle timer.
- J. Accessories: Provide as scheduled in Condensing Unit Schedule (MP-M-601).
1. Heresite coating.
- K. Manufacturers:
1. Carrier.
  2. Trane.
  3. York.

### 2.05 ELECTRICAL

- A. General:
1. Units shall include high and low voltage terminal block connections.
  2. Control voltage to indoor unit fan shall be 24 volts.
  3. Motor Starters/Contactors: Factory installed with equipment, unless otherwise noted.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Motors:
  - 1. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
  - 2. Unless otherwise stated, electric motors shall comply with the following:
    - a. Voltage, Phase, Horsepower.

### 2.06 ACCESSORIES

- A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown on the Drawings.
- B. Forklift slots.

### 2.07 SOURCE QUALITY CONTROL

- A. ARI Standard 360-2000.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Condensing Unit:
  - 1. Install according to manufacturer's instructions.

### 3.02 ADJUSTING AND CLEANING

- A. Air System Balancing: As specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
- B. Air Handlers:
  - 1. Lubricate nonsealed bearings prior to startup.
  - 2. Do not operate units until filters are installed. If operated without filters, completely clean coils and interior of units.
- C. Vibration:
  - 1. Statically and dynamically balance fan equipment.

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2. Perform field testing on rotating equipment, as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.
3. If vibration limits described therein are exceeded, rebalance equipment in-place, if directed by Engineer, until design tolerances are met.

### 3.03 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified equipment.
- B. Condensing Unit manufacturer's representative shall conduct a performance test on the condensing unit.
  1. Perform under active and approval simulated operating conditions.
  2. Test for a continuous 3-hour period without malfunction.
  3. Test Log: Upon completion of test, record, and report results.
  4. Adjust or modify units as necessary and retest.
  5. Submit results to Engineer.

**END OF SECTION**

**SECTION 26 05 02**  
**BASIC ELECTRICAL REQUIREMENTS**

**PART 1 GENERAL**

1.01 RELATED SECTIONS

- A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
  - 2. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    - b. Z535.4, Product Safety Signs and Labels.
  - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 4. Underwriters Laboratories, Inc. (UL).

1.03 ELECTRIC SERVICE DIVISION OF RESPONSIBILITY

- A. Incoming underground electrical, 12470 volt service with primary metering. Under this Contract provide customer required service provisions and electrical work including, but not limited to, primary cable, primary trench and backfill, primary duct system, pad mount transformers, transformer pad site preparation, transformer pad, metering components and associated conduit, and secondary facilities. Schedule and coordinate work of serving utility as required to provide electric service to the Work.

1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Provide manufacturers' data for the following:
    - a. Electrical service components.
    - b. Nameplates, signs, and labels.



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.05 QUALITY ASSURANCE

- A. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for area indicated.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F.
- C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range stated in Section 01 61 00, Common Product Requirements.
- D. Equip panels installed outdoors in direct sun with sun shields.

### 2.02 EQUIPMENT FINISH

- A. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with , light gray color finish as approved by Owner.

### 2.03 NAMEPLATES

- A. Material: Laminated plastic.
- B. Attachment Screws: Stainless steel.
- C. Color: White, engraved to a black core.

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- D. Letter Height:
  - 1. Pushbuttons/Selector Switches: 1/8 inch.
  - 2. Other electrical equipment: 1/4 inch.

### 2.04 SIGNS AND LABELS

- A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.
- B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.
- C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Keep openings in boxes and equipment closed during construction.
- E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

### 3.02 ANCHORING AND MOUNTING

- A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements.

### 3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

- A. Drawings show each homerun circuit to be provided. Do not combine power or control circuits into common raceways without authorization of Engineer.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Homerun circuits shown on Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:
1. Analog control circuits from devices in same general area to same destination.
    - a. No power or AC discrete control circuits shall be combined in same conduit with analog circuits.
    - b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, paging system circuits shall be combined with power or Class 1 circuits.
    - c. Analog circuits shall be continuous from source to destination. Do not add TJB, splice, or combine into a multi-pair cable without authorization of Engineer.
    - d. Raceways shall be sized per General Circuit and Raceway Schedule and do not exceed 40 percent fill.
    - e. Changes shall be documented on record drawings.
  2. Discrete control circuits from devices in the same general area to the same destination.
    - a. No power or analog control circuits shall be combined in same conduit with discrete circuits.
    - b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
    - c. Raceways shall be sized per the General Circuit and Raceway Schedule and do not exceed 40 percent fill.
    - d. Changes shall be documented on record drawings.
  3. Power circuits from loads in same general area to same source location (such as: panelboard, switchboard, low voltage motor control center).
    - a. Lighting Circuits: Combine no more than three circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
    - b. Receptacle Circuits, 120-Volt Only: Combine no more than three circuits to a single raceway. Provide a separate neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
    - c. All Other Power Circuits: Do not combine power circuits without authorization of Engineer.

3.04 NAMEPLATES, SIGNS, AND LABELS

- A. Arc Flash Protection Warning Signs:
  - 1. Field mark switchboards, motor control centers, panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
  - 2. Use arc flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis as basis for warning signs.
- B. Multiple Power Supply Sign: Install permanent plaque or directory at each service disconnect location denoting other services, feeders, and branch circuits supplying the building, and the area served by each.
- C. Equipment Nameplates:
  - 1. Provide a nameplate to label electrical equipment including switchgear, switchboards, motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
  - 2. Switchgear, motor control center, transformer, and terminal junction box nameplates shall include equipment designation.
  - 3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
  - 4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.

3.05 LOAD BALANCE

- A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.
- B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.
- C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.06 CLEANING AND TOUCHUP PAINTING

- A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

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### B. Touchup Paint:

1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

### 3.07 PROTECTION FOLLOWING INSTALLATION

- A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.
- B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

**END OF SECTION**

**SECTION 26 05 04**  
**BASIC ELECTRICAL MATERIALS AND METHODS**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
    - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    - b. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
    - c. E814, Method of Fire Tests of Through-Penetration Fire Stops.
  2. Canadian Standards Association (CSA).
  3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
  4. Instrumentation, Systems, and Automation Society (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation—Part 1: Intrinsic Safety.
  5. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - b. AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
    - c. C12.1 Code for Electricity Metering
    - d. C12.6 Phase-Shifting Devices Used in Metering, Marking and Arrangement of, Terminals for
    - e. CP 1, Shunt Capacitors.
    - f. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
    - g. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
    - h. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
  6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  7. Underwriters Laboratories Inc. (UL):
    - a. 98, Standard for Enclosed and Dead-Front Switches.
    - b. 248, Standard for Low Voltage Fuses.
    - c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.

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- d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
- e. 508, Standard for Industrial Control Equipment.
- f. 810, Standard for Capacitors.
- g. 943, Standard for Ground-Fault Circuit-Interrupters.
- h. 1059, Standard for Terminal Blocks.
- i. 1479, Fire Tests of Through-Penetration Fire Stops.

### 1.02 SUBMITTALS

#### A. Action Submittals:

- 1. Provide manufacturers' data for the following:
  - a. Control devices.
  - b. Control relays.
  - c. Circuit breakers.
  - d. Fused switches.
  - e. Nonfused switches.
  - f. Timers.
  - g. Fuses.
  - h. Magnetic contactors.
  - i. Firestopping.
  - j. Enclosures: Include enclosure data for products having enclosures.

### 1.03 EXTRA MATERIALS

#### A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

- 1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

## PART 2 PRODUCTS

### 2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

#### A. General:

- 1. Type: Molded case.
- 2. Trip Ratings: 15-800 amps.
- 3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
- 4. Suitable for mounting and operating in any position.
- 5. NEMA AB 1 and UL 489.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### B. Operating Mechanism:

1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in open position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a center position when tripped.

### C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

### D. Short Circuit Interrupting Ratings:

1. Equal to, or greater than, available fault current or interrupting rating shown.

### E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).

1. Ground fault sensor shall be rated same as circuit breaker.
2. Push-to-test button.

### F. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL-listed for equipment ground fault protection).

### G. Magnetic Only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.

### H. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- I. Connections:
  - 1. Supply (line side) at either end.
  - 2. Mechanical wire lugs, except crimp compression lugs where shown.
  - 3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
  - 4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
  - 5. Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.
  
- J. Enclosures for Independent Mounting:
  - 1. See Article Enclosures.
  - 2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
  - 3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

### 2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

- A. UL 98 listed for use and location of installation.
- B. NEMA KS 1.
- C. Short Circuit Rating: 200,000 amps RMS symmetrical with Class R, Class J, or Class L fuses installed.
- D. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
- E. Connections:
  - 1. Mechanical lugs, except crimp compression lugs where shown.
  - 2. Lugs removable/replaceable.
  - 3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.
- F. Fuse Provisions:
  - 1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
  - 2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- G. Enclosures: See Article Enclosures.
- H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

### 2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

- A. NEMA KS 1.
- B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
- C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.
- D. Auxiliary Contact:
  - 1. Operation: Make before power contacts make and break before power contacts break.
  - 2. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.
- E. Enclosures: See Article Enclosures.
- F. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

### 2.04 FUSE, 250-VOLT AND 600-VOLT

- A. Power Distribution, General:
  - 1. Current-limiting, with 200,000 ampere rms interrupting rating.
  - 2. Provide to fit mountings specified with switches.
  - 3. UL 248.
- B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:
  - 1. Class: RK-1.
  - 2. Type: Dual element, with time delay.
  - 3. Manufacturers and Products:
    - a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).
    - b. Littelfuse; Types LLS-RK (600 volts) and LLN-RK (250 volts).
- C. Power Distribution, Ampere Ratings 601 Amps to 6,000 Amps:
  - 1. Class: L.
  - 2. Double O-rings and silver links.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Manufacturers and Products:
  - a. Bussmann; Type KRP-C.
  - b. Littelfuse, Inc.; Type KLPC.

### D. Cable Limiters:

1. 600V or less; crimp to copper cable, bolt to bus or terminal pad.
2. Manufacturer and Product: Bussmann; K Series.

### E. Ferrule:

1. 600V or less, rated for applied voltage, small dimension.
2. Ampere Ratings: 1/10 amp to 30 amps.
3. Dual-element time-delay, time-delay, or nontime-delay as required.
4. Provide with blocks or holders as indicated and suitable for location and use.
5. Manufacturers:
  - a. Bussmann.
  - b. Littlefuse, Inc.

## 2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

- A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.
- B. Selector Switch Operating Lever: Standard.
- C. Indicating Light: Transformer.
- D. Pushbutton Color:
  1. ON or START: Black.
  2. OFF or STOP: Red.
- E. Pushbutton and selector switch lockable in OFF position where indicated.
- F. Legend Plate:
  1. Material: Aluminum.
  2. Engraving: Enamel filled in high contrasting color.
  3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
  4. Letter Height: 7/64-inch.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- G. Manufacturers and Products:
  - 1. Heavy-Duty, Oil-Tight Type:
    - a. General Electric Co.; Type CR 104P.
    - b. Square D Co.; Type T.
    - c. Eaton/Cutler-Hammer; Type 10250T.
  - 2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
    - a. Square D Co.; Type SK.
    - b. General Electric Co.; Type CR 104P.
    - c. Eaton/Cutler-Hammer; Type E34.
    - d. Crouse-Hinds; Type NCS.

### 2.06 TERMINAL BLOCK, 600 VOLTS

- A. UL 486E and UL 1059.
- B. Size components to allow insertion of necessary wire sizes.
- C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.
- D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.
- E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.
- F. Yoke shall guide all strands of wire into terminal.
- G. Current bar shall ensure vibration-proof connection.
- H. Terminals:
  - 1. Capable of wire connections without special preparation other than stripping.
  - 2. Capable of jumper installation with no loss of terminal or rail space.
  - 3. Individual, rail mounted.
- I. Marking system, allowing use of preprinted or field-marked tags.
- J. Manufacturers:
  - 1. Weidmuller, Inc.
  - 2. Ideal.
  - 3. Electrovert USA Corp.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.07 MAGNETIC CONTROL RELAY

- A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.
- B. NEMA ICS 2, Designation A: A300 (300 volts)
- C. Time Delay Relay Attachment:
  - 1. Pneumatic type, timer adjustable from 0.2 second to 60 seconds (minimum).
  - 2. Field convertible from ON delay to OFF delay and vice versa.
- D. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.
- E. Manufacturers and Products:
  - 1. Eaton/Cutler-Hammer; Type M-300.
  - 2. General Electric Co.; Type CR120A.

### 2.08 TIME DELAY RELAY

- A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.
- B. NEMA ICS 2 Designation: B150 (150 volts).
- C. Solid-state electronic, field convertible ON/OFF delay.
- D. One normally open and one normally closed contact (minimum).
- E. Repeat accuracy plus or minus 2 percent.
- F. Timer adjustment from 1 second to 60 seconds, unless otherwise indicated on Drawings.
- G. Manufacturers and Products:
  - 1. Square D Co.; Type F.
  - 2. Eaton/Cutler-Hammer.
  - 3. General Electric Co.

### 2.09 RESET TIMER

- A. Drive: Synchronous motor, solenoid-operated clutch.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Mounting: Semiflush panel.
- C. Contacts: 10 amps, 120 volts.
- D. Manufacturers and Products:
  - 1. Eagle Signal Controls; Bulletin 125.
  - 2. Automatic Timing and Controls; Bulletin 305.

### 2.10 ELAPSED TIME METER

- A. Drive: Synchronous motor.
- B. Range: 0 hour to 99,999.9 hours, nonreset type.
- C. Mounting: Semiflush panel.
- D. Manufacturers and Products:
  - 1. General Electric Co.; Type 240, 2-1/2-inch Big Look.
  - 2. Eagle Signal Controls; Bulletin 705.

### 2.11 MAGNETIC CONTACTOR

- A. UL listed.
- B. Electrically operated, electrically held.
- C. Main Contacts:
  - 1. Power driven in one direction with mechanical spring dropout.
  - 2. Silver alloy with wiping action and arc quenchers.
  - 3. Continuous-duty, rated: As shown.
  - 4. Poles: As shown.
- D. Control: As shown.
- E. Auxiliary Contacts: Quantity as shown, rated 7200VA make, 720VA break, at 600V, A600 per NEMA ICS 5.
- F. Enclosures: See Article Enclosures.
- G. Manufacturers and Products:
  - 1. Eaton/Cutler-Hammer; Class A201.
  - 2. General Electric Co.; CR 353.
  - 3. Square D Co.; Class 8910.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.12 PHASE MONITOR RELAY

#### A. Features:

1. Voltage and phase monitor relay shall drop out on low voltage, voltage unbalance, loss of phase, or phase reversal.
2. Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.
3. Adjustable trip and time delay settings.
4. Transient Protection: 1,000V ac.
5. Mounting: Multipin plug-in socket base.

#### B. Manufacturer and Product: Automatic Timing and Controls; SLD Series.

### 2.13 MAGNETIC LIGHTING CONTACTOR

#### A. Comply with NEMA ICS 2; provide UL 508 listing.

#### B. Electrically operated by dual-acting, single coil mechanism.

#### C. Inherently interlocked and electrically held in CLOSED position.

#### D. Main Contacts:

1. Double-break, continuous-duty, rated 20 amperes, 600 volts, withstand rating of: 22,000 amps rms symmetrical at 250 volts and 14,000 amps rms symmetrical at 480 volts.
2. Marked for electric discharge lamps, tungsten, and general purpose loads.
3. Position not dependent on gravity, hooks, latches, or semipermanent magnets.
4. Capable of operating in any position.
5. Visual indication for each contact.

#### E. Auxiliary contact relay for two-wire Form 3 control.

#### F. One normally open and one normally closed auxiliary contact rated 10 amperes continuous, 7,200VA make, 720VA break with NEMA designation of A600 (600 volts).

#### G. Fully rated neutral terminal.

#### H. Provision for remote pilot lamp with use of auxiliary contacts.

#### I. Clamp type, self-rising terminal plates for solderless connections.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- J. Enclosures: See Article Enclosures.
- K. Manufacturers and Products:
  - 1. ASCO.
  - 2. Eaton/Cutler-Hammer; Class A202.
  - 3. General Electric Co.; Class 360 (electrically held).
  - 4. Square D; Class 8903, Type L (electrically held).

### 2.14 SUPPORT AND FRAMING CHANNELS

- A. Carbon Steel Framing Channel:
  - 1. Material: Rolled, mild strip steel, 12-gauge minimum, ASTM A1011/A1011M, Grade 33.
  - 2. Finish: Hot-dip galvanized after fabrication.
- B. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.
- C. PVC Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.
- D. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge minimum.
- E. Extruded Aluminum Framing Channel:
  - 1. Material: Extruded from Type 6063-T6 aluminum alloy.
  - 2. Fittings fabricated from Alloy 5052-H32.
- F. Nonmetallic Framing Channel:
  - 1. Material: Fire retardant, fiber reinforced vinyl ester resin.
  - 2. Channel fitting of same material as channel.
  - 3. Nuts and bolts of long glass fiber reinforced polyurethane.
- G. Manufacturers:
  - 1. B-Line Systems, Inc.
  - 2. Unistrut Corp.
  - 3. Aickinstrut.

### 2.15 SWITCHBOARD MATTING

- A. Provide matting having a breakdown of 20 kV minimum.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

B. Manufacturer: U.S. Mat and Rubber Company.

### 2.16 FIRESTOPS

A. General:

1. Provide UL 1479 classified hourly fire-rating equal to, or greater than, the assembly penetrated.
2. Prevent the passage of cold smoke, toxic fumes, and water before and after exposure to flame.
3. Sealants and accessories shall have fire-resistance ratings as established by testing identical assemblies in accordance with ASTM E814, by Underwriters Laboratories Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

B. Comply with Section 07 84 00, Firestopping.

C. Firestop System:

1. Formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
2. Fill, Void, or Cavity Material: 3M Brand Fire Barrier Caulk CP25, Putty 303, Wrap/Strip FS195, Composite Sheet CS195 and Penetration Sealing Systems 7902 and 7904 Series.
3. Two-Part, Foamed-In-Place, Silicone Sealant: Dow Corning Corp. Fire Stop Foam, General Electric Co. Pensil 851.
4. Fire Stop Devices: See Section 26 05 33, Raceway and Boxes, for raceway and cable fittings.

### 2.17 ENCLOSURES

- A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.
- B. Color: Manufacturer's standard color (gray) baked-on enamel, unless otherwise shown.
- C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Enclosure Selections: Except as shown otherwise, provide electrical enclosures according to the following table:

ENCLOSURES			
Location	Finish	Environment	NEMA 250 Type
Indoor	Finished	Dry	1
Indoor	Unfinished	Dry	1
Indoor	Unfinished	Industrial Use	12
Indoor and Outdoor	Any	Wet	4
Indoor and Outdoor	Any	Wet and Corrosive	4X 304 Stainless Steel FRP
Indoor and Outdoor	Any	Wet, Dust or Oil	13
Indoor and Outdoor	Any	Hazardous Gas	7
Indoor and Outdoor	Any	Hazardous Dust	9

2.18 ENERGY MONITORING SYSTEM (EMS)

- A. Multifunction, microprocessor-based, programmable digital device.
- B. Energy monitoring unit (EMU), single self-contained, door-mounted unit with data input pushbutton on face, for total power monitoring of each UV Unit (CPP/Reactor) including ballast power, control power, ventilation power, and other items powered through the CPP.
- C. Inputs:
1. Current Range: 0 to 5 amp or 0 to 1 amp CT for 20-5000A primary.
  2. Voltage: Nominal 480V.
  3. Accuracy: Nominal plus or minus 1.0 percent of display.
- D. Outputs:
1. Multiple parameter choices for output display (kWh, kW, KVAR, PF, kW max, volts, amps, and kW demand).
  2. RS-485 serial communications with MODBUS RTU protocol.
- E. Capable of measuring harmonics on power system, total harmonic distortion parameter available to at least 25<sup>th</sup> harmonic for voltage and current.
- F. Alarms: Common dry contact output, Form C, programmable parameter choices.

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- G. Programmable by off-line PC software as specified herein. Programmable CT, PT ratios, alarm limits.
- H. Approved Manufacturers: GE Multilin, EPM 5200P, SquareD PowerLogic Energy Meter, or equal.
- I. Schedule:
  - 1. MDP-AT.
  - 2. UV LCP-1.
  - 3. UV LCP-2.

### **PART 3 EXECUTION**

#### 3.01 GENERAL

- A. Install equipment in accordance with manufacturer's recommendations.

#### 3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

- A. Unless otherwise shown, install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.
- B. Unless otherwise shown, install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas.

#### 3.03 SUPPORT AND FRAMING CHANNEL

- A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.
- B. Channel Type:
  - 1. Interior, Wet or Dry (Noncorrosive) Locations:
    - a. Aluminum Raceway: Extruded aluminum.
    - b. PVC-Coated Conduit: PVC coated.
    - c. Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.
  - 2. Interior, Corrosive (Wet or Dry) Locations:
    - a. Aluminum Raceway: Extruded aluminum.
    - b. PVC Conduit: Type 316 stainless steel or nonmetallic.
    - c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.

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3. Outdoor, Noncorrosive Locations:
    - a. Steel Raceway: Carbon steel or paint coated framing channel, except where mounted on aluminum handrail, then use aluminum framing channel.
    - b. Aluminum Raceway and Other Systems Not Covered: Aluminum framing channel.
  4. Outdoor Corrosive Locations:
    - a. PVC Conduit: Type 316 stainless steel or nonmetallic.
    - b. Aluminum Raceway: Aluminum.
    - c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC coated steel.
- C. Paint cut ends prior to installation with the following:
1. Carbon Steel Channel: Zinc-rich primer.
  2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.
  3. Nonmetallic Channel: Epoxy resin sealer.
  4. PVC-Coated Channel: PVC patch.

### 3.04 SWITCHBOARD MATTING

- A. Install 36-inch width at switchgear, switchboard, motor control centers, and panelboards.
- B. Matting shall run full length of all sides of equipment that have operator controls or afford access to devices.

### 3.05 FIRESTOPS

- A. Install in strict conformance with manufacturer's instructions. Comply with installation requirements established by testing and inspecting agency.
- B. Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide firestops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs.

**END OF SECTION**



**SECTION 26 05 05  
CONDUCTORS**

**PART 1 GENERAL**

**1.01 REFERENCES**

A. The following is a list of standards which may be referenced in this section:

1. Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
2. ASTM International (ASTM):
  - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
  - b. B3, Standard Specification for Soft or Annealed Copper Wire.
  - c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
  - d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
3. Electronic Industries Alliance (EIA), Telecommunications Industry Association (TIA): TIA-568-B, Commercial Building Telecommunications Cabling Standard.
4. Insulated Cable Engineer's Association, Inc. (ICEA):
  - a. S-58-679, Standard for Control Cable Conductor Identification.
  - b. S-73-532, Standard for Control Cables.
  - c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - a. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations 2.5 kV through 765 kV
  - b. 386, Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
  - c. 404, Standard for Extruded And Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500000 V.
6. National Electrical Manufacturers' Association (NEMA):
  - a. CC 1, Electric Power Connectors for Substations.
  - b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables - ICEA S-73-532.
  - c. WC 70, Standard for Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
  - d. WC 71, Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy.

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- e. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
- 7. National Fire Protection Association (NFPA):
  - a. 70, National Electrical Code (NEC).
  - b. 262, Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- 8. Underwriters Laboratories Inc. (UL):
  - a. 13, Standard for Safety Power-Limited Circuit Cables.
  - b. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
  - c. 62, Standard for Safety Flexible Cord and Cables.
  - d. 486A-486B, Wire Connectors.
  - e. 486C, Standard for Splicing Wire Connections.
  - f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
  - g. 854, Standard for Safety Service-Entrance Cables.
  - h. 1072, Standard for Safety Medium-Voltage Power Cables.
  - i. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
  - j. 1569, Metal Clad Cables.
  - k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

### 1.02 SUBMITTALS

#### A. Action Submittals:

- 1. Wire and cable descriptive product information.
- 2. Wire and cable accessories descriptive product information.
- 3. Cable fault detection system descriptive product information.
- 4. Manufactured wiring systems descriptive product information.
- 5. Manufactured wire systems rating information.
- 6. Manufactured wire systems dimensional drawings.
- 7. Manufactured wire systems special fittings.
- 8. Busway descriptive product information.
- 9. Busway rating information.
- 10. Busway dimensional drawings.
- 11. Busway special fitting information.
- 12. Busway-equipment interface information for equipment to be connected to busways.
- 13. Cable Pulling Calculations:
  - a. Calculations shall be submitted and reviewed before cable installation.

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- b. Provide cable pulling calculations for the following cable installations:
  - 1) Medium voltage cable runs that cannot be hand pulled.
  - 2) Multi-conductor 600-volt cable sizes larger than #2 AWG that cannot be hand pulled.

### B. Informational Submittals:

- 1. Factory Test Report for conductors 600 volts and below.
- 2. Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

## 1.03 QUALITY ASSURANCE

### A. Authority Having Jurisdiction (AHJ):

- 1. Provide the Work in accordance with NFPA 70. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
- 2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark.

## PART 2 PRODUCTS

### 2.01 CONDUCTORS 600 VOLTS AND BELOW

- A. Conform to applicable requirements of NEMA WC 70.
- B. Conductor Type:
  - 1. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
  - 2. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
  - 3. All Other Circuits: Stranded copper.
- C. Insulation: Type THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.
- D. Flexible Cords and Cables:
  - 1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
  - 2. Conform to physical and minimum thickness requirements of NEMA WC 70.



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.02 CONDUCTORS ABOVE 600 VOLTS

### A. EPR Insulated Cable:

1. Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.
2. Type: 15 kV, shielded, UL 1072, Type MV-105.
3. Conductors: Copper, concentric lay Class B round stranded in accordance with ASTM B3, ASTM B8, and ASTM B496.
4. Conductor Screen: Extruded, semiconducting ethylene-propylene rubber in accordance with NEMA WC 71 and AEIC CS 8.
5. Insulation: 133 percent insulation level, ethylene-propylene rubber (EPR), containing no polyethylene in accordance with NEMA WC 71, and AEIC CS 8.
6. Insulation Thickness: 220-mil, 15 kV, nominal.
7. Insulation Screen: Thermosetting, semiconducting ethylene-propylene rubber (EPR), extruded directly over insulation in accordance with NEMA WC 74 and AEIC CS 8.
8. Metallic Shield: Uncoated, 5-mil, copper shielding tape, helically applied with 12-1/2 percent minimum overlap.
9. Jacket: Extruded polyvinyl chloride (PVC) chlorinated polyethylene (CPE) compound applied over the metallic shield in accordance with NEMA WC 71.
10. Operating Temperature: 105 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.
11. Manufacturers:
  - a. Okonite Co.
  - b. Pirelli Wire and Cable.
  - c. General Cable.
  - d. Southwire Co.

## 2.03 600-VOLT RATED CABLE

### A. General:

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 1, Multiconductor Control Cable:

1. Conductors:
  - a. 14 AWG, seven-strand copper.
  - b. Insulation: 15-mil PVC with 4-mil nylon.
  - c. UL 1581 listed as Type THHN/THWN rated VW-1.
  - d. Conductor group bound with spiral wrap of barrier tape.
  - e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
2. Cable: Passes the ICEA T-29-520 210,000 Btu per hour Vertical Tray Flame Test.
3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
  - a. Okonite Co.
  - b. Southwire.

C. Type 2, Multiconductor Power Cable:

1. General:
  - a. Meet or exceed UL 1581 for cable tray use.
  - b. Meet or exceed UL 1277 for direct burial and sunlight-resistance.
  - c. Overall jacket: PVC.
2. Conductors:
  - a. Class B stranded, coated copper.
  - b. Insulation: Chemically cross-linked ethylene-propylene or cross-linked polyethylene.
  - c. UL rated VW-1 or listed Type XHHW-2.

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- d. Color Code:
  - 1) Conductors, size 8 AWG and smaller, colored conductors, ICEA S-58-679, Method 1, Table 1.
  - 2) Conductors, size 6 AWG and larger, ICEA S-73-532, Method 4.
- 3. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
- 4. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Current Carrying Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2	0.42	45
		3	0.45	45
		4	0.49	45
10	10	2	0.54	60
		3	0.58	60
		4	0.63	60
8	10	3	0.66	60
		4	0.75	60
6	8	3	0.74	60
		4	0.88	60
4	6	3	0.88	60
		4	1.04	80
2	6	3	1.01	80
		4	1.16	80
1	6	3	1.10	80
		4	1.25	80
1/0	6	3	1.22	80
		4	1.35	80
2/0	4	3	1.32	80
		4	1.53	80
3/0	4	3	1.40	80
		4	1.60	80
4/0	4	3	1.56	80
		4	1.78	110

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5. Manufacturers:
  - a. Okonite Co.
  - b. Southwire.
  
- D. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.
  1. Outer Jacket: 45-mil nominal thickness.
  2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
  3. Dimension: 0.31-inch nominal OD.
  4. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    - b. 20 AWG, seven-strand tinned copper drain wire.
    - c. Insulation: 15-mil nominal PVC.
    - d. Jacket: 4-mil nominal nylon.
    - e. Color Code: Pair conductors, black and red.
  5. Manufacturers:
    - a. Okonite Co.
    - b. Alpha Wire Corp.
    - c. Belden.
  
- E. Type 4, 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.
  1. Outer Jacket: 45-mil nominal.
  2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
  3. Dimension: 0.32-inch nominal OD.
  4. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    - b. 20 AWG, seven-strand, tinned copper drain wire.
    - c. Insulation: 15-mil nominal PVC.
    - d. Jacket: 4-mil nylon.
    - e. Color Code: Triad conductors black, red, and blue.
  5. Manufacturers:
    - a. Okonite Co.
    - b. Alpha Wire Corp.
    - c. Belden.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

F. Type 5, 18 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 57 requirements.

1. Conductors:

- a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
- b. Tinned copper drain wires.
- c. Pair drain wire size AWG 20, group drain wire size AWG 18.
- d. Insulation: 15-mil PVC.
- e. Jacket: 4-mil nylon.
- f. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification.
- g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.

2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers:

- a. Okonite Co.
- b. Alpha Wire Corp.
- c. Belden.

G. Type 6, 18 AWG, Multi-Twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 57.

1. Conductors:

- a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. Tinned copper drain wire size AWG 18.
  - c. Insulation: 15-mil nominal PVC.
  - d. Jacket: 4-mil nylon.
  - e. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

Cable Sizes: Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.48	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.10	80
36	1.21	80
50	1.50	80

3. Manufacturers:
- a. Okonite Co.
  - b. Alpha Wire Corp.
  - c. Belden.

H. Type 7, Multi-Conductor Metal-Clad (UL Type MC) Power Cable:

- 1. Meeting requirements of UL 44 and UL 1569.
- 2. Conductors:
  - a. Class B stranded, coated copper.
  - b. Insulation: 600-volt cross-linked polyethylene, UL Type XHHW or EPR.
  - c. Grounding Conductors: Bare, stranded copper.
- 3. Sheath:
  - a. UL listed Type MC.
  - b. Continuous welded, corrugated aluminum sheath.
  - c. Suitable for use as grounding conductor.
- 4. Outer Jacket: PVC per UL 1569.
- 5. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

6. Cable Sizes:

Conductor Size	Minimum Ground Wire Size (AWG)	No. of Insulated Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
12 AWG	12 or 3x16	3	0.79	50
		4	0.85	
10 AWG	10 or 3x14	3	0.82	50
		4	0.90	
8 AWG	10 or 3x14	3	0.85	50
		4	1.00	
6 AWG	8 or 3x12	3	0.99	50
		4	1.10	
4 AWG	8 or 3x12	3	1.08	50
		4	1.20	
2 AWG	6 or 3x10	3	1.24	50
		4	1.45	
1 AWG	6 or 3x10	3	1.40	50
		4	1.55	
1/0 KCM	6 or 3x10	3	1.52	50
		4	1.60	
2/0 AWG	4 or 3x8	3	1.67	50
		4	1.75	
4/0 AWG	4 or 3x8	3	1.93	60
		4	2.10	
250 KCM	4 or 3x8	3	2.11	60
		4	2.20	
350 KCM	3 or 3x8	3	2.39	60
		4	2.50	
500 KCM	2 or 3x8	3	2.80	75
		4	2.90	

7. Manufacturers and Products:

- a. Okonite Co.; Type CLX.
- b. Southwire Type MC.
- c. General Cable, CCW Armored Power.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- I. Type 8, Multi-Conductor Adjustable Frequency Drive Power Cable:
  1. Conductors:
    - a. Class B, stranded coated copper.
    - b. Insulation: 600-volt cross-linked polyethylene, UL Type XHHW-2.
    - c. Grounding Conductors: Insulated stranded copper.
  2. Sheath:
    - a. UL 1277 Type TC, 90 degrees C.
    - b. Continuous shield, Al/polyester foil, drain wires, overall copper braid.
  3. Outer Jacket: Polyvinyl chloride (PVC) per UL 1569.
  4. Cable Sizes:

Conductor Size	Minimum Ground Wire Size (AWG)	No. of Insulated Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
12 AWG	12	4	0.610	50
10 AWG	10	4	0.670	50
8 AWG	8	4	0.910	50
6 AWG	6	4	1.010	50
4 AWG	4	4	1.150	50
2 AWG	2	4	1.310	50

5. Manufacturers and Products:
  - a. Alpha Wire, Series V.
  - b. Belden, Series 29500.
  - c. LAPP USA, OLFLEX VFD Slim.

2.04 300-VOLT RATED CABLE

- A. General:
  1. Type PLTC, meeting requirements of UL 13 and NFPA 70, Article 725.
  2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
  3. Suitable for installation in open air, in cable trays, or conduit.
  4. Minimum Temperature Rating: 105 degrees C.
  5. Passes Vertical Tray Flame Test.
  6. Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Type 20, 16 AWG, Twisted, Shielded Pair Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57.
1. Outer Jacket: 35-mil nominal.
  2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
  3. Dimension: 0.26-inch nominal OD.
  4. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, ASTM B8.
    - b. 20 AWG, seven-strand tinned copper drain wire.
    - c. Insulation: 15-mil PVC.
    - d. Color Code: Pair conductors black and white.
  5. Manufacturers:
    - a. Okonite Co.
    - b. Alpha Wire Corp.
- C. Type 21, 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting requirements of NEMA WC 57.
1. Outer Jacket: 35-mil nominal thickness.
  2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
  3. Dimension: 0.28-inch nominal OD.
  4. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, ASTM B8.
    - b. 20 AWG, seven-strand tinned copper drain wire.
    - c. Insulation: 15-mil PVC.
    - d. Color Code: Triad conductors; black, red, and white.
  5. Manufacturers:
    - a. Okonite Co.
    - b. Alpha Wire Corp.
- D. Type 22, 18 AWG, Multi-Twisted, Shielded Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 57.
1. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, ASTM B8.
    - b. Tinned copper drain wires.
    - c. Pair drain wire size AWG 20, group drain wire size AWG 18.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- d. Insulation: 15-mil PVC.
  - e. Color Code: Pair conductors black and white, with white conductor numerically printed for group identification.
  - f. Individual Pair Shield: 1.35-mil aluminum/mylar.
  - g. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
2. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.50	50
8	0.66	60
12	0.79	60
16	0.91	60
24	1.13	70
36	1.31	70
50	1.55	80

3. Manufacturers:
- a. Okonite Co.
  - b. Alpha Wire Corp.
  - c. Belden.
- E. Type 23, 18 AWG, Multi-Twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 57.
1. Conductors:
- a. Bare soft annealed copper, Class B, seven-strand concentric, ASTM B8.
  - b. Tinned copper.
  - c. Group drain wire size AWG 20, minimum.
  - d. Insulation: 15-mil PVC.
  - e. Color Code: Pair conductors black and white, with white conductor numerically printed for group identification.
  - f. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.48	50
8	0.63	60
12	0.73	60
16	0.77	60
24	0.96	70
36	1.09	70
50	1.45	50

3. Manufacturers:

- a. Okonite Co.
- b. Alpha Wire Corp.
- c. Belden.

F. Type 24, Twisted Pair Fire Alarm Cable, Shielded: Power limited fire protective signaling circuit cable meeting requirements of NFPA 70, Article 760.

- 1. Cable: Pass NFPA 262, 70,000 Btu flame test and listed by State Fire Marshall.
- 2. Outer Jacket: Red in color, identified along its entire length as fire protective signaling circuit cable.
- 3. Conductors:
  - a. Solid, tinned, or bare copper, shielded, with stranded tinned copper drain wire.
  - b. Insulation: 15-mil PVC.
- 4. Cable Sizes:

Wire Size	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Inches)
12	0.36	0.042
14	0.32	0.042
16	0.26	0.037
18	0.23	0.037

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

5. Manufacturers:
  - a. West Penn Wire.
  - b. Coleman Cable, Inc.

### 2.05 SPECIAL CABLES

- A. Type 30, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:
  1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-B.2-1 Category 6 requirements.
  2. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.
  3. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
  4. NFPA 70 Plenum (CMP) rated, comply with flammability plenum requirements of NFPA 70 and NFPA 262.
  5. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
  6. Manufacturer and Product: Belden; 7852A.
- B. Type 32, DeviceNet Round Cable, 600V, Class 1, Two Twisted, Shielded Pairs with a Common Overall Shield:
  1. Outer Jacket: PVC.
  2. Overall Shield: Tinned copper braid, 18 AWG tinned copper drain wire.
  3. Individual Pair Shield: Aluminum foil-polyester tape.
  4. Dimension: 0.460-inch nominal OD.
  5. Conductors:
    - a. 15 AWG stranded tinned copper.
    - b. Insulation: FEP.
  6. Manufacturer and Product: Belden; 7897A.
- C. Type 33, DeviceNet Flat Cable, 600V, Class 1, Four Conductor Unshielded Network Trunk Cable:
  1. Outer Jacket: Thermoplastic Elastomer (TPE).
  2. Conductors: Four conductor, unshielded, flat configuration.
  3. Manufacturer and Product: Allen-Bradley; 1485C-PIE.

### 2.06 GROUNDING CONDUCTORS

- A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

B. Direct Buried: Bare stranded copper.

### 2.07 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
  - a. 30-mil, elastomer.
  - b. Manufacturers and Products:
    - 1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
    - 2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve:
  - a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
  - b. Manufacturers and Products:
    - 1) Raychem; Type D-SCE or ZH-SCE.
    - 2) Brady, Type 3PS.
2. Heat Bond Marker:
  - a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
  - b. Self-laminating protective shield over text.
  - c. Machine printed black text.
  - d. Manufacturer and Product: 3M Co.; Type SCS-HB.
3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
4. Tie-On Cable Marker Tags:
  - a. Chemical-resistant white tag.
  - b. Size: 1/2 inch by 2 inches.
  - c. Manufacturer and Product: Raychem; Type CM-SCE.
5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Capable of making splices with a current rating equal to, or greater than the cable ampacity, conforming to IEEE 404.
  3. Class 15 kV, with compression connector, splice insulating and conducting sleeves, stress-relief materials, shielding braid and mesh, and abrasion-resistant heat shrinkable adhesive-lined re-jacketing sleeve to provide a waterproof seal.
  4. Manufacturers:
    - a. Raychem.
    - b. 3M Co.
- C. Termination Kits:
1. Capable of terminating 15 kV, single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.
  2. Capable of producing a termination with a current rating equal to, or greater than, the cable ampacity, meeting Class 1 requirements of IEEE 48.
  3. Capable of accommodating any form of cable shielding or construction without the need for special adapters or accessories.
  4. Manufacturers:
    - a. Raychem.
    - b. 3M Co.
- D. Bus Connection Insulation:
1. Heat shrinkable tubing, tape, and sheets of flexible cross-linked polymeric material formulated for high dielectric strength.
  2. Tape and sheet products to have coating to prevent adhesion to metal surfaces.
  3. Manufacturer: Raychem.
- E. Elbow Connector Systems:
1. Molded, peroxide-cured, EPDM-insulated, Class 15 kV, 95 kV BIL, 200A, 10,000A rms load-break elbows as shown, having all copper current-carrying parts in accordance with IEEE 386.
  2. Protective Caps: Class 15 kV, 95 kV BIL, 200: and: 600 amperes, with molded EPDM insulated body.
  3. Insulated Standoff Bushings: Class 15 kV, 95 kV BIL, 200 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.
  4. Bushing Inserts: Class 15 kV, 95 kV BIL, 200A, load-break with EPDM rubber body and all-copper, current-carrying parts.
  5. Junctions: Class 15 kV, 95 kV two-way, three-way, four-way, 200A, load-break, having EPDM rubber body mounted on adjustable bracket.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

6. Mounting Plates: Two, Three or four -way as required, ASTM A167 stainless steel, complete with universal mounting brackets, grounding lugs and two parking stands.
7. Manufacturers:
  - a. Cooper Industries.
  - b. Elastimold.

### F. Cable Lugs:

1. In accordance with NEMA CC1.
2. Rated 5 and 15 kV of same material as conductor metal.
3. Manufacturers and Products, Uninsulated Compression Connectors and Terminators:
  - a. Burndy; Hydent.
  - b. Thomas & Betts; Color-Keyed.
  - c. ILSCO.
4. Manufacturers and Products, Uninsulated, Bolted, Two-Way Connectors and Terminators:
  - a. Thomas & Betts; Locktite.
  - b. ILSCO.

## 2.09 PULLING COMPOUND

- A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.
- B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.
- C. Approved for intended use by cable manufacturer.
- D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.
- E. Manufacturers:
  1. Ideal Co.
  2. Polywater, Inc.
  3. Cable Grip Co.

## 2.10 MANUFACTURED WIRING SYSTEMS

- A. System Rating:
  1. 20 amperes load-carrying capacity each phase with final assemblies consisting of maximum of three phase conductors.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Composition: Type MC cable with 90 degrees C insulation and stranded copper conductors.
  - B. Cable Configuration: Three, single-phase, five-wire circuit with standard color wire coding:
    1. 208/120 Volt: Black, red, blue, white, green.
    2. 480/277 Volt: Brown, orange, yellow, white, green.
  - C. Locking Mechanism: Latch/strike with voltage clearly marked on latch.
  - D. NFPA 262 listed for use in air handling plenums, listed to connect or disconnect under load, and manufactured in accordance with NFPA 70, Article No. 604.
- 2.11 WARNING TAPE
- A. As specified in Section 26 05 33, Raceways and Boxes.
- 2.12 SOURCE QUALITY CONTROL
- A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.
  - B. Conductors Above 600 Volts: Test in accordance with NEMA WC 71 and AEIC CS 6 partial discharge level test for EPR insulated cable.

### **PART 3 EXECUTION**

#### 3.01 GENERAL

- A. Conductor installation shall be in accordance with manufacturer's recommendations.
- B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.
- C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- D. Terminate all conductors and cables, unless otherwise indicated.
- E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.
- G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches on center.
- H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.
- I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

### 3.02 POWER CONDUCTOR COLOR CODING

#### A. Conductors 600 Volts and Below:

- 1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
- 2. 8 AWG and Smaller: Provide colored conductors.
- 3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

System	Conductor	Color
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral	White
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with an identifiable colored strip, other than green, in accordance with NFPA 70.
- B. Conductors Above 600 Volts: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
  1. Colors:
    - a. Grounded Neutral: White.

### 3.03 CIRCUIT IDENTIFICATION

- A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
- B. Circuits Appearing in Circuit Schedules: Identify using circuit schedule designations.
- C. Circuits Not Appearing in Circuit Schedules:
  1. Assign circuit name based on device or equipment at load end of circuit.
  2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
- D. Method:
  1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
  2. Cables and Conductors 2 AWG and Larger:
    - a. Identify with marker plates or tie-on cable marker tags.
    - b. Attach with nylon tie cord.
  3. Taped-on markers or tags relying on adhesives not permitted.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.04 CONDUCTORS 600 VOLTS AND BELOW

- A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.
- B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.
- C. Connections and Terminations:
  - 1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
  - 2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
  - 3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
  - 4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
  - 5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
  - 6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
  - 7. Place no more than one conductor in any single-barrel pressure connection.
  - 8. Install crimp connectors with tools approved by connector manufacturer.
  - 9. Install terminals and connectors acceptable for type of material used.
  - 10. Compression Lugs:
    - a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    - b. Do not use plier type crimpers.
- D. Do not use soldered mechanical joints.
- E. Splices and Terminations:
  - 1. Insulate all uninsulated connections.
  - 2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
  - 3. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
  - 4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- F. Cap spare conductors with UL listed end caps.
- G. Cabinets, Panels, and Motor Control Centers:
  - 1. Remove surplus wire, bridle and secure.
  - 2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
- H. Control and Instrumentation Wiring:
  - 1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
  - 2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
  - 3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
  - 4. Where connections of cables installed under this section are to be made under Section 40 90 00, Instrumentation and Control for Process Systems, leave pigtails of adequate length for bundled connections.
  - 5. Cable Protection:
    - a. Under Infinite Access Floors: May install without bundling.
    - b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under floor or grouped into bundles at least 1/2 inch in diameter.
    - c. Maintain integrity of shielding of instrumentation cables.
    - d. Ensure grounds do not occur because of damage to jacket over the shield.
- I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

### 3.05 CONDUCTORS ABOVE 600 VOLTS

- A. Do not splice unless specifically indicated or approved by Engineer.
- B. Make joints and terminations with splice and termination kits, in accordance with kit manufacturer's instructions.
- C. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Single Conductor Cable Terminations: Provide heat shrinkable stress control and outer nontracking insulation tubings, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing, plus a ground braid and clamp.
- E. Install terminals or connectors acceptable for type of conductor material used.
- F. Provide shield termination and grounding for terminations.
- G. Provide necessary mounting hardware, covers, and connectors.
- H. Where elbow connectors are specified, install in accordance with manufacturer's instructions.
- I. Connections and Terminations:
  - 1. Install uninsulated crimp connectors and terminators for power circuit conductors 4 AWG through 2/0 AWG.
  - 2. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 4/0 AWG and larger.
  - 3. Install uninsulated, bolted, two-way connectors for motor circuit conductors No. 12 and larger.
  - 4. Insulate bus connections with heat shrinking tubing, tape, and sheets.
  - 5. Make bus connections removable and reusable in accordance with manufacturer's instructions.
- J. Give 2 working days notice to Engineer prior to making splices or terminations.

### 3.06 CONDUCTOR ARC AND FIREPROOFING

- A. Install arc and fireproofing tape on 600-volt single conductors and cables, except those rated Type TC throughout their entire exposed length at splices in manholes, handholes, vaults, cable trays, and other indicated locations.
- B. Install arc and fireproofing tape on 15 kV cables at splices in manholes, handholes, vaults, cable trays, and other indicated locations.
- C. Wrap conductors of same circuit entering from separate conduit together as a single cable.
- D. Follow tape manufacturer's installation instructions.
- E. Secure tape at intervals of 5 feet with bands of tapebinder. Each band to consist of a minimum of two wraps directly over each other.

**END OF SECTION**

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
  2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings: Product data for the following:
    - a. Exothermic weld connectors.
    - b. Mechanical connectors.
    - c. Compression connectors.

1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
  2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

**PART 2 PRODUCTS**

2.01 GROUND ROD

- A. Material: Copper-clad.
- B. Diameter: Minimum 3/4 inch.
- C. Length: 10 feet.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.02 GROUND CONDUCTORS

- A. As specified in Section 26 05 05, Conductors.

## 2.03 CONNECTORS

- A. Exothermic Weld Type:

- 1. Outdoor Weld: Suitable for exposure to elements or direct burial.
- 2. Indoor Weld: Utilize low-smoke, low-emission process.
- 3. Manufacturers:
  - a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
  - b. Thermoweld.

- B. Compression Type:

- 1. Compress-deforming type; wrought copper extrusion material.
- 2. Single indentation for conductors 6 AWG and smaller.
- 3. Double indentation with extended barrel for conductors 4 AWG and larger.
- 4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
- 5. Manufacturers:
  - a. Burndy Corp.
  - b. Thomas and Betts Co.
  - c. ILSCO.

- C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

- 1. Manufacturers:
  - a. Burndy Corp.
  - b. Thomas and Betts Co.

## 2.04 GROUNDING WELLS

- A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

- B. Manufacturers and Products:

- 1. Christy Co.
- 2. Lightning and Grounding Systems, Inc.

**PART 3 EXECUTION**

**3.01 GENERAL**

- A. Grounding shall be in compliance with NFPA 70 and IEEE C2.
- B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.
- C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.
- D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
- E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.
- F. Shielded Instrumentation Cables:
  - 1. Ground shield to ground bus at power supply for analog signal.
  - 2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
  - 3. Do not ground instrumentation cable shield at more than one point.

**3.02 WIRE CONNECTIONS**

- A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.
- B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.
- C. Connect ground conductors to raceway grounding bushings.
- D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.
- E. Connect enclosure of equipment containing ground bus to that bus.
- F. Bolt connections to equipment ground bus.
- G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

### 3.03 MOTOR GROUNDING

- A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.
- B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.
- C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.
- D. Motors 10 hp and Above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.
- E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

### 3.04 GROUND RODS

- A. Install full length with conductor connection at upper end.
- B. Install with connection point below finished grade, unless otherwise shown.
- C. Space multiple ground rods by one rod length.

### 3.05 GROUNDING WELLS

- A. Install inside buildings, asphalt, and paved areas.
- B. Install riser ring and cover flush with surface.
- C. Place 6 inches of crushed rock in bottom of each well.

### 3.06 CONNECTIONS

- A. General:
  - 1. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
  - 2. Belowgrade Connections: Install exothermic weld or compression type connectors.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify Engineer prior to backfilling ground connections.

### B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

### C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies.

### D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

## 3.07 METAL STRUCTURE GROUNDING

- A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.
- B. Bond electrical equipment supported by metal platforms to the platforms.
- C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

## 3.08 MANHOLE AND HANDHOLE GROUNDING

- A. Install one ground rod inside each.
- B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Make connections of grounding conductors fully visible and accessible.
- D. Connect all noncurrent-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

### 3.09 TRANSFORMER GROUNDING

- A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.
- B. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

### 3.10 SURGE PROTECTION EQUIPMENT GROUNDING

- A. Connect surge arrester ground terminals to equipment ground bus.

**END OF SECTION**

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## SECTION 26 05 33 RACEWAY AND BOXES

### PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges, Sixteenth Edition.
  2. ASTM International (ASTM):
    - a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
    - b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    - c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    - d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
    - e. D149, Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
  3. Electronic Industry Alliance (EIA) and Telecommunications Industry Association (TIA): 569, Commercial Building Standard for Telecommunications Pathways and Spaces.
  4. National Electrical Contractor's Association, Inc. (NECA):
    - a. 101, Standard for Installing Steel Conduit (Rigid, IMC, EMT).
    - b. 102, Standard for Installing Aluminum Conduits.
    - c. 105, Recommended Practice for Installing Metal Cable Trays.
    - d. 111, Standard for Installing Nonmetallic Raceway (RNC, ENT, LFNC).
  5. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    - b. C80.1, Specification for Rigid Steel Conduit, Zinc Coated.
    - c. C80.3, Specification for Electrical Metallic Tubing, Zinc Coated.
    - d. C80.5, Specification for Rigid Aluminum Conduit.
    - e. C80.6, Intermediate Metal Conduit (IMC) – Zinc Coated.
    - f. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
    - g. TC 2, Electrical Polyvinyl Chloride (PVC) Plastic Tubing and Conduit.

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- h. TC 3, Polyvinyl-Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- i. TC 6, PVC Plastic Utilities Duct for Underground Installation.
- j. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
- k. VE 1, Metallic Cable Tray Systems.
- 6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
- 7. Underwriters Laboratories Inc. (UL):
  - a. 1, Standard for Flexible Metal Conduit.
  - b. 5, Standard for Surface Metal Raceways and Fittings
  - c. 6, Standard for Electrical Rigid Metal Conduit – Steel.
  - d. 6A, Standard for Electrical Rigid Metal Conduit – Aluminum, Bronze, and Stainless.
  - e. 50, Standard for Enclosures for Electrical Equipment.
  - f. 360, Standard for Liquid-Tight Flexible Steel Conduit.
  - g. 514B, Standard for Conduit, Tubing, and Cable Fittings.
  - h. 514C, Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
  - i. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit.
  - j. 651A, Standard for Type EB and A Rigid PVC Conduit and HDPE Conduit.
  - k. 797, Standard for Electrical Metallic Tubing.
  - l. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
  - m. 1242, Standard for Intermediate Metal Conduit.
  - n. 1660, Standard for Liquid-Tight Flexible Nonmetallic Conduit.
  - o. 1684, Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
  - p. Standard for Optical Fiber and Communication Cable Raceway.

### 1.02 SUBMITTALS

#### A. Action Submittals:

- 1. Manufacturer's Literature:
  - a. Rigid galvanized steel conduit.
  - b. Intermediate metal conduit.
  - c. Electric metallic tubing.
  - d. Rigid aluminum conduit.
  - e. PVC Schedule 40 conduit.
  - f. PVC Schedule 80 conduit.
  - g. PVC tubing (Type EB) conduit.
  - h. Flexible metal, liquid-tight conduit.
  - i. Flexible, nonmetallic, liquid-tight conduit.

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- j. Flexible metal, nonliquid-tight conduit.
- k. Conduit fittings.
- l. Junction and pull boxes used at or below grade.
- m. Large junction and pull boxes.
- n. Terminal junction boxes.
- 2. Precast Manholes and Handholes:
  - a. Dimensional drawings and descriptive literature.
  - b. Traffic loading calculations.
  - c. Accessory information.
  - d. .
- 3. Equipment and machinery proposed for bending metal conduit.
- 4. Method for bending PVC conduit less than 30 degrees.
- 5. Conduit Layout:
  - a. Provide drawings for underground and concealed conduits including, but not limited to ductbanks, those under floor slabs, concealed in floor slabs and concealed in walls.
  - b. Provide plans and section showing arrangement and location of conduit and duct bank required for:
    - 1) Low and medium voltage feeder and branch circuits.
    - 2) Instrumentation and control systems.
    - 3) Communications systems.
    - 4) Empty conduit for future use.
  - c. Electronic CAD; scale not greater than 1 inch equals 20 feet.

### 1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
  - 1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
  - 2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.
- B. PVC-Coated, Rigid Steel Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## PART 2 PRODUCTS

### 2.01 CONDUIT AND TUBING

- A. Rigid Galvanized Steel Conduit (RGS):
  - 1. Meet requirements of NEMA C80.1 and UL 6.
  - 2. Material: Hot-dip galvanized, with chromated protective layer.
- B. Intermediate Metal Conduit (IMC):
  - 1. Meet requirements of NEMA C80.6 and UL 1242.
  - 2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.
- C. Electric Metallic Tubing (EMT):
  - 1. Meet requirements of NEMA C80.3 and UL 797.
  - 2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.
- D. Rigid Aluminum Conduit:
  - 1. Meet requirements of NEMA C80.5 and UL 6A.
  - 2. Material: Type 6063, copper-free aluminum alloy.
- E. PVC Schedule 40 Conduit:
  - 1. Meet requirements of NEMA TC 2 and UL 651.
  - 2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.
  - 3. Furnish without factory-formed bell.
- F. PVC Schedule 80 Conduit:
  - 1. Meet requirements of NEMA TC 2 and UL 651.
  - 2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.
- G. Fiberglass Conduit:
  - 1. Meet requirements of NEMA TC 14 and UL 1684.
  - 2. Winding: Single circuit with angle as close to 54.75 as possible.
  - 3. Resin System: Epoxy based using an anhydride curing agent.
  - 4. Use carbon black as an ultraviolet inhibitor.
  - 5. Toxicity: Conduit shall not contain any compounds that can release halogens in more than trace amounts when burning.

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6. Dielectric Strength: Shall exceed 400 volts/mil when tested in accordance with ASTM D149.
  7. Jointing System: Two-part epoxy adhesive supplied by manufacturer of conduit.
  8. Manufacturer:
    - a. Champion Fiberglass.
    - b. Osburn Associates.
    - c. FRE Composites, Inc.
- H. PVC Tubing (Type EB):
1. Meet requirements of NEMA TC 6 and UL 651A.
  2. UL listed for reinforced concrete encasement and 90 degrees C insulated conductors.
  3. Furnish without factory-formed bell.
- I. Flexible Metal, Liquid-Tight Conduit:
1. UL 360 listed for 105 degrees C insulated conductors.
  2. Material: Galvanized steel, with an extruded PVC jacket.
- J. Flexible Metal, Nonliquid-Tight Conduit:
1. Meet requirements of UL 1.
  2. Material: Galvanized steel.
- K. Flexible, Nonmetallic, Liquid-Tight Conduit:
1. Material: PVC core with fused flexible PVC jacket.
  2. UL 1660 listed for:
    - a. Dry Conditions: 80 degrees C insulated conductors.
    - b. Wet Conditions: 60 degrees C insulated conductors.
  3. Manufacturers and Products:
    - a. Carlon; Carflex or X-Flex.
    - b. T & B; Xtraflex LTC or EFC.
- L. Innerduct:
1. Resistant to spread of fire, per requirements of UL 2024.
  2. Smooth or corrugated HDPE.
  3. [B: Textile:
    - a. Manufacturer: Maxcell.



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.02 FITTINGS

### A. Rigid Galvanized Steel and Intermediate Metal Conduit:

1. General:
  - a. Meet requirements of UL 514B.
  - b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.
2. Bushing:
  - a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
  - b. Manufacturers and Products:
    - 1) Appleton; Series BU-1.
    - 2) O-Z/Gedney; Type HB.
3. Grounding Bushing:
  - a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
  - b. Manufacturers and Products:
    - 1) Appleton; Series GIB.
    - 2) O-Z/Gedney; Type HBLG.
4. Conduit Hub:
  - a. Material: Malleable iron with insulated throat with bonding screw.
  - b. UL listed for use in wet locations.
  - c. Manufacturers and Products:
    - 1) Appleton, Series HUB-B.
    - 2) O-Z/Gedney; Series CH.
    - 3) Meyers; ST Series.
5. Conduit Bodies:
  - a. Sized as required by NFPA 70.
  - b. Manufacturers and Products (For Normal Conditions):
    - 1) Appleton; Form 35 threaded unilets.
    - 2) Crouse-Hinds; Form 7 or 8 threaded condulets.
    - 3) Killark; Series O electrolets.
    - 4) Thomas & Betts; Form 7 or 8.
    - 5) .
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
  - a. Concrete tight, hot-dip galvanized malleable iron.
  - b. Manufacturers and Products:
    - 1) Appleton; Series SCC Bolt-On Coupling or Series EC Three-Piece Union.
    - 2) O-Z/Gedney; Type SSP split coupling or Type 4 Series, three-piece coupling.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

8. Conduit Sealing Fitting Manufacturers and Products:
    - a. Appleton; Type EYF, EYM, or ESU.
    - b. Crouse-Hinds; Type EYS or EZS.
    - c. Killark; Type EY or EYS.
  9. Drain Seal Manufacturers and Products:
    - a. Appleton; Type EYD.
    - b. Crouse-Hinds; Type EYD or EZD.
  10. Drain/Breather Fitting Manufacturers and Products:
    - a. Appleton; Type ECDB.
    - b. Crouse-Hinds; ECD.
  11. Expansion Fitting Manufacturers and Products:
    - a. Deflection/Expansion Movement:
      - 1) Appleton; Type DF.
      - 2) Crouse-Hinds; Type XD.
    - b. Expansion Movement Only:
      - 1) Appleton; Type XJ.
      - 2) Crouse-Hinds; Type XJ.
      - 3) Thomas & Betts; XJG-TP.
  12. Cable Sealing Fittings:
    - a. To form watertight nonslip cord or cable connection to conduit.
    - b. For Conductors with OD of 1/2 inch or Less: Neoprene bushing at connector entry.
    - c. Manufacturers and Products:
      - 1) Appleton; CG-S.
      - 2) Crouse-Hinds; CGBS.
- B. Electric Metallic Tubing:
1. Meet requirements of UL 514B.
  2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
  3. Electro zinc-plated inside and out.
  4. Raintight.
  5. Coupling Manufacturers and Products:
    - a. Appleton; Type 95T.
    - b. Crouse-Hinds.
    - c. Thomas & Betts.
  6. Connector Manufacturers and Products:
    - a. Appleton; Type ETP.
    - b. Crouse-Hinds.
    - c. Thomas & Betts.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### C. Rigid Aluminum Conduit:

1. General:
  - a. Meet requirements of UL 514B.
  - b. Type: Threaded, copper-free. Set screw fittings not permitted.
2. Insulated Bushing:
  - a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
  - b. Manufacturer and Product: O-Z/Gedney; Type AB.
3. Grounding Bushing:
  - a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
  - b. Manufacturer and Product: O-Z/Gedney; Type ABLG.
4. Conduit Hub:
  - a. Material: Cast aluminum, with insulated throat.
  - b. UL listed for use in wet locations.
  - c. Manufacturers and Products:
    - 1) O-Z/Gedney; Type CHA.
    - 2) Thomas & Betts; Series 370AL.
    - 3) Meyers; Series SA.
5. Conduit Bodies:
  - a. Manufacturers and Products (For Normal Conditions):
    - 1) Appleton; Form 85 threaded unilets.
    - 2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
    - 3) Killark; Series O electrolets.
  - b. Manufacturers (For Hazardous Locations):
    - 1) Appleton.
    - 2) Crouse-Hinds.
    - 3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers and Products:
  - a. Appleton; Type EYF-AL or EYM-AL.
  - b. Crouse-Hinds; Type EYS-SA or EZS-SA.
  - c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers and Products:
  - a. Appleton; Type EYDM-A.
  - b. Crouse-Hinds; Type EYD-SA or EZD-SA.
9. Drain/Breather Fitting Manufacturers and Products:
  - a. Appleton; Type ECDB.
  - b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers and Products:
  - a. Deflection/Expansion Movement: Steel City; Type DF-A.
  - b. Expansion Movement Only: Steel City; Type AF-A.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.
  - a. Bushing: Neoprene at connector entry.
  - b. Manufacturer: Appleton; CG-S.
  
- D. PVC Conduit and Tubing:
  1. Meet requirements of NEMA TC-3.
  2. Type: PVC, slip-on.
  
- E. Fiberglass Conduit:
  1. Manufactured by the same process as the conduit.
  2. Supplied by the manufacturer of the conduit.
  
- F. Flexible Metal, Liquid-Tight Conduit:
  1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
  2. Insulated throat and sealing O-rings.
  3. Manufacturers and Products:
    - a. Thomas & Betts; Series 5331.
    - b. O-Z/Gedney; Series 4Q.
  
- G. Flexible Metal, Nonliquid-Tight Conduit:
  1. Meet requirements of UL 514B.
  2. Body: Galvanized steel or malleable iron.
  3. Throat: Nylon insulated.
  4. 1-1/4-Inch Conduit and Smaller: One screw body.
  5. 1-1/2-Inch Conduit and Larger: Two screw body.
  6. Manufacturer and Product: Appleton; Series 7400.
  
- H. Flexible, Nonmetallic, Liquid-Tight Conduit:
  1. Meet requirements of UL 514B.
  2. Type: High strength plastic body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
  3. Body/compression nut (gland) design to ensure high mechanical pullout strength and watertight seal.
  4. Manufacturers and Products:
    - a. Carlon; Type LT.
    - b. O-Z/Gedney; Type 4Q-P.
    - c. Thomas & Betts; Series 6300.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- I. Watertight Entrance Seal Device:
  1. New Construction:
    - a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
    - b. Manufacturer and Product: O-Z/Gedney; Type FSK or WSK, as required.
  2. Cored-Hole Application:
    - a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
    - b. Manufacturer and Product: O-Z/Gedney; Series CSM.

### 2.03 OUTLET AND DEVICE BOXES

- A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.
- B. Cast Metal:
  1. Box: Malleable iron or Cast ferrous metal.
  2. Cover: Gasketed, weatherproof, malleable iron, or cast ferrous metal, with stainless steel screws.
  3. Hubs: Threaded.
  4. Lugs: Cast Mounting.
  5. Manufacturers and Products, Nonhazardous Locations:
    - a. Crouse-Hinds; Type FS or FD.
    - b. Appleton; Type FS or FD.
    - c. Killark.
- C. Cast Aluminum:
  1. Material:
    - a. Box: Cast, copper-free aluminum.
    - b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.
  2. Hubs: Threaded.
  3. Lugs: Cast mounting.
  4. Manufacturers and Products, Nonhazardous Locations:
    - a. Crouse-Hinds; Type FS-SA or FD-SA.
    - b. Appleton; Type FS or FD.
    - c. Killark.
- D. Nonmetallic:
  1. Box: PVC.
  2. Cover: PVC, weatherproof, with stainless steel screws.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Manufacturer and Product: Carlon; Type FS or FD, with Type E98 or E96 covers.

### 2.04 JUNCTION AND PULL BOXES

- A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.
- B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.
- C. Large Sheet Steel Box:
  1. NEMA 250, Type 1.
  2. Box: Code-gauge, galvanized steel.
  3. Cover: Full access, screw type.
  4. Machine Screws: Corrosion-resistant.
- D. Large Cast Metal Box:
  1. NEMA 250, Type 4.
  2. Box: Cast malleable iron, or ferrous metal, electro galvanized finished, with drilled and tapped conduit entrances and exterior mounting lugs.
  3. Cover: Hinged with clamps.
  4. Gasket: Neoprene.
  5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
  6. Manufacturers and Products, Surface Mounted Nonhinged Type:
    - a. Crouse-Hinds; Series W.
    - b. O-Z/Gedney; Series Y.
  7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney; Series YW.
  8. Manufacturers and Products, Recessed Type:
    - a. Crouse-Hinds; Type WJBF.
    - b. O-Z/Gedney; Series YR.
- E. Large Cast Aluminum Box:
  1. NEMA 250 Type 4.
  2. Box: Cast copper-free aluminum, with drilled and tapped conduit entrances and exterior mounting lugs.
  3. Cover: Nonhinged.
  4. Gasket: Neoprene.
  5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
  6. Manufacturers and Products, Surface Mounted Type:
    - a. Crouse-Hinds; Series W-SA.
    - b. O-Z/Gedney; Series YS-A, YL-A.
    - c. Killark.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### F. Large Stainless Steel Box:

1. NEMA 250 Type 4X.
2. Box: 14-gauge, ASTM A240/A240M, Type 316 stainless steel, with white enamel painted interior mounting panel.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 304 stainless steel.
5. Manufacturers:
  - a. Hoffman Engineering Co.
  - b. Robroy Industries.
  - c. Wiegman.

### G. Large Steel Box:

1. NEMA 250 Type 12.
2. Box: 14--gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces. Provide gray finish as approved by Owner.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
  - a. Hoffman Engineering Co.
  - b. Robroy Industries.
  - c. Wiegman.

### H. Large Nonmetallic Box:

1. NEMA 250 Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers and Products:
  - a. Crouse-Hinds; Type NJB.
  - b. Carlon; Series N, C, or H.
  - c. Robroy Industries.

### I. Concrete Box, Nontraffic Areas:

1. Box: Reinforced, cast concrete with extension.
2. Cover: Steel diamond plate with locking bolts.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Size: 10 inches by 17 inches, minimum.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

5. Manufacturers and Products:
  - a. Utility Vault Co.; Series 36-1017.
  - b. Christy, Concrete Products, Inc.; N9.
  - c. Quazite; "PG" Style.

### J. Concrete Box, Traffic Areas:

1. Box: Reinforced, cast concrete with extension and bottom slab.
2. Cover: Steel checked plate; H/20 loading with screw down.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Manufacturers and Products:
  - a. Christy, Concrete Products, Inc.; B1017BOX.
  - b. Utility Vault Co.; 3030 SB.

### 2.05 TELEPHONE TERMINAL CABINET

- A. Material: Code-gauge galvanized steel box with hinged doors and 3/4-inch fire-resistant plywood backboard, meeting requirements of telephone service provider.
- B. Finish: Provide gray finish as approved by Owner.
- C. Minimum Size: 18 inches high by 18 inches wide by 6 inches deep.

### 2.06 TELEPHONE AND DATA OUTLET

- A. Provide outlet boxes and cover plates meeting requirements of EIA/TIA 569.

### 2.07 TERMINAL JUNCTION BOX

- A. Cover: Hinged, unless otherwise shown.
- B. Interior Finish: Paint with white enamel or lacquer.
- C. Terminal Blocks:
  1. Separate connection point for each conductor entering or leaving box.
  2. Spare Terminal Points: 25 percent, minimum.

### 2.08 PRECAST MANHOLES AND HANDHOLES

- A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.
- B. Loading: AASHTO, H-20 in accordance with ASTM C857.
- C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### D. Drainage:

1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and a minimum 4-inch outlet and outlet pipe.

### E. Raceway Entrances:

1. Provide on all four sides.
2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

### F. Embedded Pulling Iron:

1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
2. Location:
  - a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
  - b. Floor: Centered below manhole or handhole cover.

### G. Cable Racks:

1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
2. Wall Attachment:
  - a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
  - b. Insert Spacing: Maximum 3 feet on center for entire inside perimeter of manhole.
  - c. Arrange so that spare raceway ends are clear for future cable installation.

### H. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Diameter: 36-1/2 inch.
3. Cover Type: Indented, solid top design, with two drop handles each.
4. Cover Loading: AASHTO H-20.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

5. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
  - a. Above 600 Volts: ELECTRIC HV.
  - b. 600 Volts and Below: ELECTRIC LV.
  - c. TELEPHONE.

I. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt-on, of checkered design.
3. Cover Loading: Nontraffic AASHTO H-20.
4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
  - a. 600 Volts and Below: ELECTRIC LV.
  - b. TELEPHONE.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:

1. Utility Vault Co.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Pipe, Inc.

### 2.09 ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturers:
  - a. Underground Device, Inc.
  - b. Carlon.

B. Identification Devices:

1. Raceway Tags:
  - a. Material: Permanent, nonferrous metal nylon polyethylene.
  - b. Shape: Round.
  - c. Raceway Designation: Pressure stamped, embossed, or engraved.
  - d. Tags relying on adhesives or taped-on markers not permitted.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Warning Tape:
  - a. Material: Polyethylene, 4-mil gauge with detectable strip.
  - b. Color: Red.
  - c. Width: Minimum: 3inches.
  - d. Designation: Warning on tape that electric circuit is located below tape.
  - e. Identifying Letters: Minimum 1-inch high permanent black lettering imprinted continuously over entire length.
  - f. Manufacturers and Products:
    - 1) Panduit; Type HTDU.
    - 2) Reef Industries; Terra Tape.
3. Buried Raceway Marker:
  - a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
  - b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES, in letters 1/4-inch high.
  - c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

### C. Heat Shrinkable Tubing:

1. Material: Heat-shrinkable, cross-linked polyolefin.
2. Semi-flexible with meltable adhesive inner liner.
3. Color: Black.
4. Manufacturers:
  - a. Raychem.
  - b. 3M.

### D. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Width: 50 mm minimum.
3. Manufacturer and Product: Raychem; Type TWDB.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum conductors.
- B. All installed Work shall comply with NECA Installation Standards.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Crushed or deformed raceways not permitted.
- D. Maintain raceway entirely free of obstructions and moisture.
- E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
- F. Aluminum Conduit: Do not install in direct contact with concrete. Install in PVC sleeve or cored hole through concrete walls and slabs.
- G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
- H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
- I. Group raceways installed in same area.
- J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.
- K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
- L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
- M. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.
- N. Install watertight fittings in outdoor, underground, or wet locations.
- O. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
- P. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
- Q. Do not install raceways in concrete equipment pads, foundations, or beams.
- R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
- S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- T. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of EIA/TIA 569-A.

### 3.02 REUSE OF EXISTING CONDUITS

- A. Where Drawings indicate existing conduits may be reused, they may be reused only where they meet the following criteria.
  - 1. Conduit is in useable condition with no deformation, corrosion, or damage to the exterior surface.
  - 2. Conduit is sized per the NEC.
  - 3. Conduit is of the type specified in Contract Documents.
  - 4. Conduit is supported as specified in Contract Documents.
- B. Conduit shall be reamed with wire brush, then with a mandrel approximately 1/4 inch smaller than raceway inside diameter then cleaned prior to pulling new conductors.

### 3.03 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

- A. Minimum Cover: 2 inches, including all fittings.
- B. Conduit placement shall not require changes in reinforcing steel location or configuration.
- C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
- D. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by Engineer.
- E. Slabs and Walls:
  - 1. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
  - 2. Install within middle two-fourths of slab or wall.
  - 3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
  - 4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
  - 5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
  - 6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
  - 7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### F. Columns and Beams:

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

### 3.04 CONDUIT APPLICATION

#### A. Diameter: Minimum 3/4 inch.

#### B. Exterior, Exposed:

1. Rigid galvanized steel.
2. Rigid aluminum.
3. PVC Schedule 40.
4. PVC Schedule 80.

#### C. Interior, Exposed:

1. Rigid galvanized steel.
2. Rigid aluminum over 2 inches.
3. PVC Schedule 40.
4. PVC Schedule 80.

#### D. Interior, Concealed (Not Embedded in Concrete):

1. Rigid galvanized steel.
2. Intermediate metal.
3. Electric metallic tubing.
4. PVC Schedule 40.

#### E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors:

1. Rigid galvanized steel.
2. PVC Schedule 40.

#### F. Direct Earth Burial:

1. PVC Schedule 40.
2. PVC Schedule 80.

#### G. Concrete-Encased Raceways:

1. PVC Schedule 40.
2. PVC Schedule 80.
3. PVC tubing (Type EB).

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- H. Under Slabs-On-Grade:
  - 1. Rigid galvanized steel.
  - 2. PVC Schedule 40.
  - 3. PVC Schedule 80.
- I. Transition from Underground or Concrete Embedded to Exposed: Rigid galvanized steel conduit.
- J. Under Equipment Mounting Pads: 1. Rigid galvanized steel 2. PVC Schedule 40 PVC 3. Schedule 80 conduit.
- K. Exterior Light Pole Foundations: 1. PVC Schedule 2. 40 PVC Schedule 80 conduit.
- L. Corrosive Areas:
  - 1. PVC Schedule 40.
  - 2. PVC Schedule 80.

### 3.05 FLEXIBLE CONNECTIONS

- A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:
  - 1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
  - 2. Conduit Size Over 4 Inches: Nonflexible.
  - 3. Wet or Corrosive Areas: Flexible, nonmetallic or flexible metal liquid-tight.
  - 4. Dry Areas: Flexible, metallic liquid-tight.
  - 5. Length: 18-inch minimum, 60-inch maximum, sufficient to allow movement or adjustment of equipment.
- B. Suspended Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.
- C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

### 3.06 PENETRATIONS

- A. Make at right angles, unless otherwise shown.
- B. Notching or penetration of structural members, including footings and beams, not permitted.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance as specified in Section 26 05 04, Basic Electrical Materials and Methods.
- D. Apply heat shrinkable tubing or single layer of wraparound duct band to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.
- E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.
- F. Entering Structures:
  - 1. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
  - 2. Concrete Roof or Membrane Waterproofed Wall or Floor:
    - a. Provide a watertight seal.
    - b. Without Concrete Encasement: Install watertight entrance seal device on each side.
    - c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
    - d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
    - e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
  - 3. Heating, Ventilating, and Air Conditioning Equipment:
    - a. Penetrate equipment in area established by manufacturer.
    - b. Terminate conduit with flexible nonmetallic conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
    - c. Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
  - 4. Corrosive-Sensitive Areas:
    - a. Seal all conduit passing through chemical room walls.
    - b. Seal conduit entering equipment panel boards and field panels containing electronic equipment.
    - c. Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
  - 5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
  - 6. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
    - a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint, on each side.
- 7. Manholes and Handholes:
  - a. Metallic Raceways: Provide insulated grounding bushings.
  - b. Nonmetallic Raceways: Provide bell ends flush with wall.
  - c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

### 3.07 SUPPORT

- A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 8 feet. Do not support from piping, pipe supports, or other raceways.
- B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 10 percent extra space for future conduit.
- C. Application/Type of Conduit Strap:
  - 1. Aluminum Conduit: Aluminum or stainless steel.
  - 2. Rigid Steel or EMT Conduit: Zinc coated steel, pregalvanized steel or malleable iron.
  - 3. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
  - 4. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.
- D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
  - 1. Wood: Wood screws.
  - 2. Hollow Masonry Units: Toggle bolts.
  - 3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
  - 4. Steelwork: Machine screws.
  - 5. Location/Type of Hardware:
    - a. Dry, Noncorrosive Areas: Galvanized.
    - b. Wet, Noncorrosive Areas: Stainless steel.
    - c. Corrosive Areas: Stainless steel.
- E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.
- F. Support aluminum conduit on concrete surfaces with stainless steel or nonmetallic spacers, or aluminum or nonmetallic framing channel.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.08 BENDS

- A. Install concealed raceways with a minimum of bends in the shortest practical distance.
- B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
- C. Install with symmetrical bends or cast metal fittings.
- D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
- E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
- F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.
- G. PVC Conduit:
  - 1. Bends 30 Degrees and Larger: Provide factory-made elbows.
  - 2. 90-Degree Bends: Provide rigid steel elbows, PVC-coated where direct buried.
  - 3. Use manufacturer's recommended method for forming smaller bends.
- H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

### 3.09 EXPANSION/DEFLECTION FITTINGS

- A. Provide on all raceways at all structural expansion joints, and in long tangential runs.
- B. Provide expansion/deflection joints for 25 degrees F maximum temperature variation.
- C. Install in accordance with manufacturer's instructions.

### 3.10 PVC CONDUIT

- A. Solvent Welding:
  - 1. Provide manufacturer recommended solvent; apply to all joints.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Install such that joint is watertight.
- B. Adapters:
1. PVC to Metallic Fittings: PVC terminal type.
  2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.
- C. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

### 3.11 TERMINATION AT ENCLOSURES

- A. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
- B. Nonmetallic, Cabinets, and Enclosures:
1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
  2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.
- C. Sheet Metal Boxes, Cabinets, and Enclosures:
1. General:
    - a. Install insulated bushing on ends of conduit where grounding is not required.
    - b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
    - c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
    - d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.
    - e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
  2. Rigid Galvanized, Intermediate or Aluminum Conduit:
    - a. Provide one lock nut each on inside and outside of enclosure.
    - b. Install grounding bushing at source enclosure.
    - c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
  3. Electric Metallic Tubing: Provide gland compression, insulated connectors.
  4. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
  5. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

6. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
  7. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.
- D. Motor Control Center, Switchboard, Switchgear , and Free-Standing Enclosures:
1. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.
  2. Terminate PVC conduit entering bottom with bell end fittings.

### 3.12 UNDERGROUND RACEWAYS

- A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
- B. Cover: Maintain minimum 1-foot cover above conduit and concrete encasement, unless otherwise shown.
- C. Make routing changes as necessary to avoid obstructions or conflicts.
- D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
- E. Union type fittings not permitted.
- F. Spacers:
  1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
  2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
- G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.
- H. Transition from Underground to Exposed: Rigid galvanized steel conduit.
- I. Installation with Other Piping Systems:
  1. Crossings: Maintain minimum 12-inch vertical separation.
  2. Parallel Runs: Maintain minimum 12-inch separation.
  3. Installation over valves or couplings not permitted.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- J. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.
- K. Provide deflectional/expansion fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.
- L. Concrete Encasement:
  - 1. As specified in Section 03 30 00, Cast-in-Place Concrete.
  - 2. Concrete Color: Red.
- M. Backfill:
  - 1. As specified in Section 31 23 23.15, Trench Backfill. Controlled low strength fill is an acceptable bedding and pipe zone material and backfill material to within 12 inches of the surface.
  - 2. Do not backfill until inspected by Engineer.

### 3.13 OUTLET AND DEVICE BOXES

- A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
- B. Size:
  - 1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
    - a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
  - 2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
  - 3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.
- C. Locations:
  - 1. Drawing locations are approximate.
  - 2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.
  - 3. Light Switch: Install on lock side of doors.
  - 4. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Mounting Height:
1. General:
    - a. Dimensions given to centerline of box.
    - b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference. Do not straddle CMU block or other construction joints.
  2. Light Switch: 48 inches above floor.
  3. Thermostat: 54 inches above floor.
  4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
  5. Wall Mounted Telephone Outlet: 52 inches above floor.
  6. Convenience Receptacle:
    - a. General Interior Areas: 15 inches above floor.
    - b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above counter tops without splashback.
    - c. Industrial Areas, Workshops: 48 inches above floor.
    - d. Outdoor, All Areas: 24 inches above finished grade.
  7. Special-Purpose Receptacle: 48 inches above floor or as shown.
  8. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on Drawings.
- E. Install plumb and level.
- F. Flush Mounted:
1. Install with concealed conduit.
  2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
  3. Holes in surrounding surface shall be no larger than required to receive box.
- G. Support boxes independently of conduit by attachment to building structure or structural member.
- H. Install bar hangers in frame construction or fasten boxes directly as follows:
1. Wood: Wood screws.
  2. Concrete or Brick: Bolts and expansion shields.
  3. Hollow Masonry Units: Toggle bolts.
  4. Steelwork: Machine screws.
- I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
- J. Provide plaster rings where necessary.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- K. Boxes embedded in concrete or masonry need not be additionally supported.
- L. Install galvanized mounting hardware in industrial areas.
- M. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.
- N. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.
- O. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

### 3.14 JUNCTION AND PULL BOXES

- A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
- B. Install pull boxes where necessary in raceway system to facilitate conductor installation.
- C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.
- D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
- E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.
- F. Installed boxes shall be accessible.
- G. Do not install on finished surfaces.
- H. Install plumb and level.
- I. Support boxes independently of conduit by attachment to building structure or structural member.
- J. Install bar hangers in frame construction or fasten boxes directly as follows:
  - 1. Wood: Wood screws.
  - 2. Concrete or Brick: Bolts and expansion shields.
  - 3. Hollow Masonry Units: Toggle bolts.
  - 4. Steelwork: Machine screws.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- K. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
- L. Boxes embedded in concrete or masonry need not be additionally supported.
- M. At or Below grade:
  - 1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
  - 2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
  - 3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.
  - 4. Use boxes and covers suitable to support anticipated weights.
- N. Flush Mounted:
  - 1. Install with concealed conduit.
  - 2. Holes in surrounding surface shall be no larger than required to receive box.
  - 3. Make edges of boxes flush with final surface.
- O. Mounting Hardware:
  - 1. Noncorrosive Dry Areas: Galvanized.
  - 2. Noncorrosive Wet Areas: Stainless steel.
  - 3. Corrosive Areas: Stainless steel.
- P. Install Drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

### 3.15 TELEPHONE TERMINAL CABINET

- A. Install with top of cabinet 6-feet above floor.
- B. Minimum Installed Door Opening: 120 degrees.

### 3.16 TELEPHONE AND DATA OUTLET

- A. Provide empty 4-11/16-inch square, deep outlet box.
- B. B. Provide blank single gang raised device cover if cables are not installed.

### 3.17 MANHOLES AND HANDHOLES

- A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Do not install until final raceway grading has been determined.
- C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.
- D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.
- E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

### 3.18 EMPTY RACEWAYS

- A. Provide permanent, removable cap over each end.
- B. Provide PVC plug with pull tab for underground raceways with end bells.
- C. Provide nylon pull cord.
- D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

### 3.19 IDENTIFICATION DEVICES

- A. Raceway Tags:
  - 1. Identify origin and destination.
  - 2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface mounted.
  - 3. Install tags at each terminus for concealed raceways.
  - 4. Provide noncorrosive wire for attachment.
- B. Warning Tape: Install approximately 18 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.
- C. Buried Raceway Markers:
  - 1. Install at grade to indicate direction of underground raceways.
  - 2. Install at all bends and at intervals not exceeding 100 feet in straight runs.
  - 3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

**SECTION 26 05 70  
ELECTRICAL SYSTEMS ANALYSIS**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI).
  2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
    - b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
    - c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
    - d. 1584, Guide for Performing Arc Flash Hazard Calculations.
  3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
  4. National Fire Protection Association (NFPA):
    - a. 70, National Electrical Code (NEC).
    - b. 70E, Standard for Electrical Safety in the Workplace.
  5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910 Subpart S, Electrical.

**1.02 SUBMITTALS**

- A. Action Submittals:
1. Short circuit study.
  2. Protective Device Coordination Study: Submit within 90-days after approval of short circuit study.
  3. Harmonic study.
  4. Arc flash study.
  5. Arc flash warning labels.

**1.03 QUALITY ASSURANCE**

- A. Short circuit and protective device coordination and arc flash studies shall be prepared by manufacturer furnishing switchgear, switchboard equipment for incoming service or a professional electrical engineer registered in the State of Kentucky.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 1.04 SEQUENCING AND SCHEDULING

- A. Initial complete short circuit study shall be submitted and reviewed before Engineer will review Shop Drawings for switchgear switchboard equipment for incoming service equipment.
- B. Initial complete protective device coordination and arc flash studies shall be submitted within 90 days after approval of initial short circuit study.
- C. Revised short circuit, protective device coordination, and arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.
- D. Final short circuit, protective device coordination, harmonic, and arc flash studies shall be completed prior to Project Substantial Completion. Final version of study shall include as-installed equipment, materials, and parameter data or settings entered into equipment based on study.
- E. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

### 1.05 GENERAL

- A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on Drawings.
- B. Perform studies using one of the following electrical engineering software packages:
  - 1. SKM Power Tools for Windows.
  - 2. ETAP.
  - 3. EDSA.
  - 4. Easy Power.
- C. Perform complete fault calculations for each existing proposed and ultimate source combination.
  - 1. Source combination may include present and future power company supply circuits, large motors, or generators.
- D. Utilize proposed and existing load data for the study obtained from Contract Documents.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- E. Existing System and Equipment:
  - 1. Extent of the existing system to be included in the study is limited to system elements that effect the new system and equipment.
  - 2. Include fault contribution of existing motors and equipment in the study.
  - 3. Include impedance elements that affect new system and equipment.
  - 4. Include protective devices in series with new equipment.
- F. Device coordination time-current curves for medium and low voltage distribution system; include individual protective device time-current characteristics.

### 1.06 SHORT CIRCUIT STUDY

- A. General:
  - 1. Prepare in accordance with IEEE 399.
  - 2. Use cable impedances based on copper conductors, except where aluminum conductors are specified or shown.
  - 3. Use bus impedances based on copper bus bars, except where aluminum bus bars are specified or shown.
  - 4. Use cable and bus resistances calculated at 25 degrees C.
  - 5. Use medium voltage cable reactances based on use of typical dimensions of shielded cables with 133 percent insulation levels.
  - 6. Use 600-volt cable reactances based on use of typical dimensions of THHN/THWN XHHW conductors.
  - 7. Use transformer impedances 92.5 percent of "nominal" impedance based on tolerances specified in IEEE C57.12.00.
- B. Provide:
  - 1. Calculation methods and assumptions.
  - 2. Typical calculation.
  - 3. Tabulations of calculated quantities.
  - 4. Results, conclusions, and recommendations.
  - 5. Selected base per unit quantities.
  - 6. One-line diagrams.
  - 7. Source impedance data, including electric utility system and motor fault contribution characteristics.
  - 8. Impedance diagrams.
  - 9. Zero-sequence impedance diagrams.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:
  - 1. Electric utility's supply termination point.
  - 2. Main switchgear switchboard.
  - 3. Low voltage switchgear and switchboards.
  - 4. Motor control centers.
  - 5. Standby generators.
  - 6. Branch circuit panelboards.
  - 7. Future load contributions as shown on one-line diagram.
  
- D. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.
  
- E. Provide bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.
  
- F. Verify:
  - 1. Equipment and protective devices are applied within their ratings.
  - 2. Adequacy of switchgear switchboard and motor control centers bus bars to withstand short circuit stresses.
  - 3. Adequacy of transformer windings to withstand short circuit stresses.
  - 4. Cable and busway sizes for ability to withstand short circuit heating, in addition to normal load currents.
  
- G. Tabulations:
  - 1. General Data:
    - a. Short circuit reactances of rotating machines.
    - b. Cable and conduit material data.
    - c. Bus data.
    - d. Transformer data.
    - e. Circuit resistance and reactance values.
  - 2. Short Circuit Data(for each source combination):
    - a. Fault impedances.
    - b. X to R ratios.
    - c. Asymmetry factors.
    - d. Motor contributions.
    - e. Short circuit kVA.
    - f. Symmetrical and asymmetrical fault currents.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Equipment Evaluation:
  - a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
  - b. Maximum fault current available.

### H. Written Summary:

1. Scope of studies performed.
  2. Explanation of bus and branch numbering system.
  3. Prevailing conditions.
  4. Selected equipment deficiencies.
  5. Results of short circuit study.
  6. Comments or suggestions.
- I. Suggest changes and additions to equipment rating and/or characteristics.
  - J. Notify Engineer in writing of existing circuit protective devices improperly rated for new fault conditions.
  - K. Revise data for "as-installed" condition.

## 1.07 PROTECTIVE DEVICE COORDINATION STUDY

### A. General:

1. Prepare in accordance with IEEE 242.
2. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.
  - a. Provide separate curve sheets for phase and ground fault coordination for each scenario.
  - b. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet. Limit number of devices shown to four to six.
  - c. Identify device associated with each curve by manufacturer type, function, and, if applicable, recommended tap, time delay, instantaneous and other settings recommended.
  - d. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
  - e. Apply motor protection methods that comply with NFPA 70.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### B. Plot Characteristics on Curve Sheets:

1. Electric utility's relays.
2. Electric utility's fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
3. Medium voltage equipment relays.
4. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
5. Low voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
6. Pertinent transformer full-load currents at 100 percent.
7. Transformer magnetizing inrush currents.
8. Transformer damage curves; appropriate for system operation and location.
9. ANSI transformer withstand parameters.
10. Significant symmetrical and asymmetrical fault currents.
11. Motor overload relay settings for motors greater than 40 horsepower.
12. Ground fault protective device settings.
13. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.

### C. Primary Protective Device Settings for Delta-Wye Connected Transformer:

1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of IEEE C57.12.00 withstand point.
2. Secondary Line-To-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

### D. Separate medium voltage relay characteristics curves from curves for other devices by at least 0.4-second time margin.

### E. Tabulate Recommended Protective Device Settings:

1. Relays:
  - a. Current tap.
  - b. Time dial.
  - c. Instantaneous pickup.
  - d. Electronic settings data file.
2. Circuit Breakers:
  - a. Adjustable pickups.
  - b. Adjustable time-current characteristics.
  - c. Adjustable time delays.
  - d. Adjustable instantaneous pickups.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## **PART 2 PRODUCTS**

### 2.01 ARC FLASH WARNING LABELS

- A. Printed in multi-color on laminated plastic and be riveted on equipment. An example label is located following end of section in Figure 1.

## **PART 3 EXECUTION**

### 3.01 GENERAL

- A. Adjust relay and protective device settings according to values established by coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with the short circuit and protective device coordination studies.
- C. Notify Engineer in writing of required major equipment modifications.
- D. Provide laminated one-line diagrams (minimum size 11 inches by 17 inches) to post on interior of electrical room doors.
- E. Provide arc flash warning labels on equipment as specified in this section.

### 3.02 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification:
  - 1. Figure 1: Example Arc Flash Label.

**END OF SECTION**






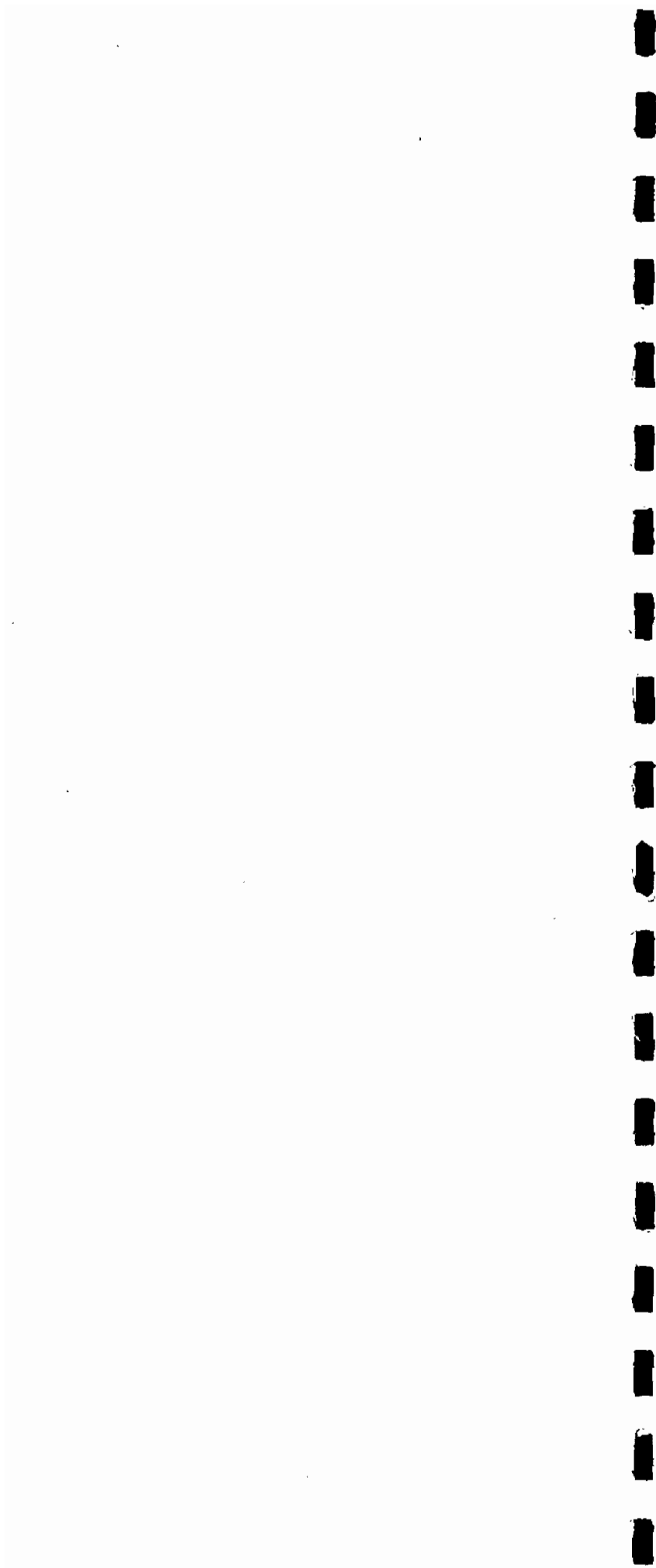
 <b>WARNING</b>	
<b>Arc Flash and Shock Hazard Appropriate PPE Required</b>	
3' - 4' 4.9 #2	Flash Hazard Boundary cal/cm <sup>2</sup> Flash Hazard at 18 Inches PPE Level Cotton underwear plus FR shirt and FR pants
0.48 3' - 6" 1' - 0" 0' - 1"	kV Shock Hazard when cover is removed Limited Approach Restricted Approach - Class 00 Voltage Gloves Prohibited Approach - Class 00 Voltage Gloves
Equipment Name SWG-2A	
IEEE 1584 Hazards; Project 1289A - Safety Procedure #A6D24 - EasyPower File: "Plant-A6.dez" - Date: September 9, 2003	

Figure 1  
Example Arc Flash Label



**SECTION 26 08 00**  
**COMMISSIONING OF ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
  - a. D665, Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
  - b. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
  - c. D923, Standard Practices for Sampling Electrical Insulating Liquids.
  - d. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
  - e. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
  - f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
  - g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
  - h. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
  - i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
  - j. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
  - k. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
  - l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop-Weight Method.
2. Insulated Cable Engineers Association (ICEA):
  - a. S-93-639, Shielded Power Cables 5000V-4600V.
  - b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
  - c. S-97-682, Utility Shielded Power Cables Rated 5 through 46 kV.
3. Institute of Electrical and Electronics Engineers (IEEE):
  - a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators 2.5 kV through 765 kV.
  - c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1): Normal Measurements.
  - d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.
  - e. 386, Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
  - f. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
  - g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
  - h. C2, National Electrical Safety Code.
  - i. C37.20.1, Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
  - j. C37.20.2, Standard for Metal-Clad Switchgear.
  - k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
  - l. C62.33, Test Specifications for Varistor Surge-Protective Devices.
4. InterNational Electrical Testing Association (NETA): Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (ATS).
  5. National Electrical Manufacturers Association (NEMA):
    - a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
    - b. PB 2, Deadfront Distribution Switchboards.
    - c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
  6. National Fire Protection Association (NFPA):
    - a. 70, National Electrical Code (NEC).
    - b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.
    - c. 101, Life Safety Code.
  7. National Institute for Certification in Engineering Technologies (NICET).
  8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 1.02 SUBMITTALS

#### A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
  - a. Schedule for performing inspection and tests.
  - b. List of references to be used for each test.
  - c. Sample copy of equipment and materials inspection form(s).
  - d. Sample copy of individual device test form.
  - e. Sample copy of individual system test form.
2. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
3. Operation and Maintenance Data:
  - a. In accordance with Section 01 78 23, Operation and Maintenance Data.
  - b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.

### 1.03 QUALITY ASSURANCE

#### A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

- B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Test instrument calibration shall be in accordance with NETA ATS.

## 1.04 SEQUENCING AND SCHEDULING

- A. Perform inspection and electrical tests after equipment here in listed has been installed.
- B. Perform tests with apparatus de-energized whenever feasible.
- C. Inspection and electrical tests on energized equipment shall be:
  - 1. Scheduled with Engineer prior to de-energization.
  - 2. Minimized to avoid extended period of interruption to the operating plant equipment.
- D. Notify Engineer at least 24 hours prior to performing tests on energized electrical equipment.

## **PART 2 PRODUCTS (NOT USED)**

## **PART 3 EXECUTION**

### 3.01 GENERAL

- A. Tests specified in this section shall be performed in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.
- B. Tests and inspections shall establish:
  - 1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
  - 2. Installation operates properly.
  - 3. Equipment is suitable for energization.
  - 4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.
- C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- D. Set, test, and calibrate protective relays, circuit breakers, fuses power monitoring meters, and other applicable devices in accordance with values established by the short circuit, coordination and harmonics studies as specified in Section 26 05 70, Electrical Systems Analysis.
- E. Adjust mechanisms and moving parts of equipment for free mechanical movement.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- G. Verify nameplate data for conformance to Contract Documents and approved Submittals.
- H. Realign equipment not properly aligned and correct unlevelness.
- I. Properly anchor electrical equipment found to be inadequately anchored.
- J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.
- K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- L. Provide proper lubrication of applicable moving parts.
- M. Inform Engineer of working clearances not in accordance with NFPA 70.
- N. Investigate and repair or replace:
  - 1. Electrical items that fail tests.
  - 2. Active components not operating in accordance with manufacturer's instructions.
  - 3. Damaged electrical equipment.
- O. Electrical Enclosures:
  - 1. Remove foreign material and moisture from enclosure interior.
  - 2. Vacuum and wipe clean enclosure interior.
  - 3. Remove corrosion found on metal surfaces.
  - 4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
  - 5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
  - 6. Repair or replace improperly operating latching, locking, or interlocking devices.
  - 7. Replace missing or damaged hardware.
  - 8. Finish:
    - a. Provide matching paint and touch up scratches and mars.
    - b. If required due to extensive damage, as determined by Engineer, refinish entire assembly.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.
- Q. Replace transformer insulating oil not in compliance with ASTM D923.

### 3.02 CHECKOUT AND STARTUP

#### A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.
  - a. Submit Voltage Field Test Report within 5 days of test.
4. Unbalance Corrections:
  - a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
  - b. Obtain a written certification from a responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

#### B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

### 3.03 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

#### A. Visual and Mechanical Inspection:

1. Insulator damage and contaminated surfaces.
2. Proper barrier and shutter installation and operation.
3. Proper operation of indicating devices.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

7. Check door and device interlocking system by:
  - a. Closure attempt of device when door is in OFF or OPEN position.
  - b. Opening attempt of door when device is in ON or CLOSED position.
8. Check key interlocking systems for:
  - a. Key captivity when device is in ON or CLOSED position.
  - b. Key removal when device is in ON or CLOSED position.
  - c. Closure attempt of device when key has been removed.
  - d. Correct number of keys in relationship to number of lock cylinders.
  - e. Existence of other keys capable of operating lock cylinders:  
Destroy duplicate sets of keys.
9. Check nameplates for proper identification of:
  - a. Equipment title and tag number with latest one-line diagram.
  - b. Pushbutton.
  - c. Control switch.
  - d. Pilot light.
  - e. Control relay.
  - f. Circuit breaker.
  - g. Indicating meter.
10. Verify that fuse and circuit breaker ratings, sizes, and types conform to those specified.
11. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.
  - a. Ohmic value to be zero.
  - b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
12. Check operation and sequencing of electrical and mechanical interlock systems by:
  - a. Closure attempt for locked open devices.
  - b. Opening attempt for locked closed devices.
  - c. Key exchange to operate devices in OFF-NORMAL positions.
13. Verify performance of each control device and feature.
14. Control Wiring:
  - a. Compare wiring to local and remote control and protective devices with elementary diagrams.
  - b. Proper conductor lacing and bundling.
  - c. Proper conductor identification.
  - d. Proper conductor lugs and connections.
15. Exercise active components.
16. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### B. Electrical Tests:

1. Insulation Resistance Tests:
  - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
  - b. Each phase of each bus section.
  - c. Phase-to-phase and phase-to-ground for 1 minute.
  - d. With switches and breakers open.
  - e. With switches and breakers closed.
  - f. Control wiring except that connected to solid state components.
  - g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Control Wiring:
  - a. Apply secondary voltage to control power and potential circuits.
  - b. Check voltage levels at each point on terminal boards and each device terminal.
3. Operational Test:
  - a. Initiate control devices.
  - b. Check proper operation of control system in each section.

### 3.04 PANELBOARDS

- A. Visual and Mechanical Inspection: Include the following inspections and related work:
1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
  2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
  3. Check panelboard mounting, area clearances, and alignment and fit of components.
  4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
  5. Perform visual and mechanical inspection for overcurrent protective devices.

### 3.05 DRY TYPE TRANSFORMERS

- A. Visual and Mechanical Inspection:
1. Physical and insulator damage.
  2. Proper winding connections.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

### 3.06 LIQUID FILLED TRANSFORMERS

#### A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Effective core and equipment grounding.
7. Removal of shipping brackets, fixtures, or bracing.
8. Tank leaks and proper liquid level.
9. Integrity and contamination of bus insulation system.
10. Verify that tap-changer is set at correct ratio for rated voltage under normal operating conditions.
11. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

#### B. Electrical Tests:

1. Insulation Resistance Tests:
  - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
    - 1) Winding-to-winding.
    - 2) Winding-to-ground.
  - b. 10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
  - c. Results temperature corrected in accordance with NETA ATS Table, 100.14.
  - d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.
3. Sample insulating oil in accordance with ASTM D923 and have laboratory test for:
  - a. Dielectric breakdown voltage in accordance with ASTM D877 or ASTM D1816.
  - b. Acid neutralization number in accordance with ASTM D974.
  - c. Interfacial tension in accordance with ASTM D971 or ASTM D2285.
  - d. Color in accordance with ASTM D1500.
  - e. Visual condition in accordance with ASTM D1524.
  - f. Specific gravity in accordance with ASTM D1298.
  - g. Water content, in parts per million, in accordance with ASTM D1533.
  - h. Dielectric fluid test results in accordance with NETA ATS, Table 100.4.
  - i. Power factor at 25 degrees C and at 100 degrees, in accordance with ASTM D924.
  - j. Maximum power factor, corrected to 20 degrees C, in accordance with manufacturer's specifications.

### 3.07 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

#### A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 6 and larger for:
  - a. Physical damage.
  - b. Proper connections in accordance with single-line diagram.
  - c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
  - d. Color coding conformance with Specifications.
  - e. Proper circuit identification.
2. Mechanical Connections For:
  - a. Proper lug type for conductor material.
  - b. Proper lug installation.
  - c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
  - a. Proper shield grounding.
  - b. Proper terminations.
  - c. Proper circuit identification.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

4. Control Cables For:
  - a. Proper termination.
  - b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

### 3.08 MEDIUM VOLTAGE CABLES, 15 KV MAXIMUM

#### A. Visual and Mechanical Inspection:

1. Inspect each individual exposed cable for:
  - a. Physical damage plus jacket and insulation condition.
  - b. Proper connections in accordance with single-line diagram or approved Submittals.
  - c. Proper shield grounding.
  - d. Proper cable support.
  - e. Proper cable termination.
  - f. Cable bends not in conformance with manufacturer's minimum allowable bending radius.
  - g. Proper arc and fireproofing in common cable areas.
  - h. Proper circuit and phase identification.
2. Mechanical Connections:
  - a. Proper lug type for conductor material.
  - b. Proper lug installation.
  - c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturers.
3. Conductors Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

#### B. Electrical Tests:

1. Insulation Resistance Tests:
  - a. Utilize 5,000-volt megohmmeter for 8 kV and 15 kV conductors.
  - b. Test each cable individually with remaining cables and shields grounded.
  - c. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
  - d. Evaluate ohmic values by comparison with conductors of same length and type.
  - e. Investigate values less than 50 megohms.
2. Shield Continuity Tests:
  - a. By ohmmeter method on each section of conductor.
  - b. Investigate values in excess of 10 ohms per 1,000 feet of conductors.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Acceptance Tests:
  - a. In accordance with IEEE 400, ICEA S-93-639/NEMA WC 74, ICEA S-94-649, and ICEA S-97-682 for insulated conductors.
  - b. Each conductor section tested with:
    - 1) Splices and terminations in-place but disconnected from equipment.
    - 2) Remaining conductors and shields grounded in accordance with IEEE 400.
  - c. Apply maximum test voltage per NETA ATS Table 100.6 based on method (DC, AC, PD or VLF) used.
  - d. Measure only the leakage current associated with conductor.
  - e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.
  - f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48, IEEE 386, or manufacturer's specifications.
  - g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.
    - 1) Increments not to exceed ac voltage rating of conductor.
    - 2) Record dc leakage current at each step after a constant stabilization time consistent with system charging current.
  - h. Raise conductor to specified maximum test voltage and hold for 15 minutes or as specified by conductor manufacturer. Record leakage current at 30 seconds and 1 minute, and at 1-minute intervals, thereafter.
  - i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.
  - j. Test results evaluated on a pass/fail basis.
4. New Conductors Spliced to Existing Conductors:
  - a. Prior to performing splices, high potential dc test new conductor sections.
  - b. After splicing new conductors to existing conductors, disconnect the existing conductors and perform the following tests:
    - 1) Shield continuity test.
    - 2) Insulation resistance test.
    - 3) High potential test with test voltage not to exceed 60 percent of applied acceptance dc test voltage.

### 3.09 SAFETY SWITCHES, 600 VOLTS MAXIMUM

#### A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

### 3.10 MEDIUM VOLTAGE METAL ENCLOSED SWITCHES

#### A. Visual and Mechanical Inspection:

1. Proper blade pressure, alignment, and arch interrupter operation.
2. Proper operation of operating mechanism.
3. Proper contact condition.
4. Bus and cable connection tightness.
5. Proper phase barrier material and installation.
6. Proper operation of indicating devices.
7. Perform mechanical operational test to verify electrical and mechanical interlocking system operation and sequencing.
8. Perform phasing check on double-ended air switch arrangements to ensure proper bus phasing from each source.

#### B. Electrical Tests:

1. Insulation Resistance Tests:
  - a. Applied megohmmeter dc voltage in accordance with NETA ATS Table 100.1.
  - b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
  - c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
  - a. Contact resistance in microhms across each switch blade and fuse holder.
  - b. Investigate values exceeding 500 microhms or deviation of 50 percent or more from adjacent poles or similar switches.
3. Overpotential Tests:
  - a. Applied ac or dc voltage in accordance with NETA ATS Table 100.19.
  - b. Phase-to-phase and phase-to-ground for 1 minute.
  - c. Test results evaluated on pass/fail basis.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.11 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

- A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.
- B. Visual and Mechanical Inspection:
  - 1. Proper mounting.
  - 2. Proper conductor size.
  - 3. Feeder designation according to nameplate and one-line diagram.
  - 4. Cracked casings.
  - 5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
  - 6. Operate breaker to verify smooth operation.
  - 7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
  - 8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

### 3.12 LOW VOLTAGE POWER CIRCUIT BREAKERS

- A. Visual and Mechanical Inspection:
  - 1. Proper mounting, cell fit, and element alignment.
  - 2. Proper operation of racking interlocks.
  - 3. Check for damaged arc chutes.
  - 4. Proper contact condition.
  - 5. Bolt torque level in accordance with NETA ATS, Table 100.12.
  - 6. Perform mechanical operational and contact alignment tests in accordance with manufacturer's instructions.
  - 7. Check operation of closing and tripping functions of trip devices by activating ground fault relays, undervoltage shunt relays, and other auxiliary protective devices.
  - 8. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operation are correct.
  - 9. Check charging motor, motor brushes, associated mechanism, and limit switches for proper operation and condition.
  - 10. Check operation of electrically operated breakers in accordance with manufacturer's instructions.
  - 11. Check for adequate lubrication on contact, moving, and sliding surfaces.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.13 PROTECTIVE RELAYS

#### A. Visual and Mechanical Inspection:

1. Visually check each relay for:
  - a. Tight cover gasket and proper seal.
  - b. Unbroken cover glass.
  - c. Condition of spiral spring and contacts.
  - d. Disc clearance.
  - e. Condition of case shorting contacts if present.
2. Mechanically check each relay for:
  - a. Freedom of movement.
  - b. Proper travel and alignment.
3. Verify each relay:
  - a. Complies with Contract Documents, approved Submittal, and application.
  - b. Is set in accordance with recommended settings from Coordination Study.

### 3.14 INSTRUMENT TRANSFORMERS

#### A. Visual and Mechanical Inspection:

1. Visually check current, potential, and control transformers for:
  - a. Cracked insulation.
  - b. Broken leads or defective wiring.
  - c. Proper connections.
  - d. Adequate clearances between primary and secondary circuit wiring.
2. Verify mechanically:
  - a. Grounding and shorting connections have good contact.
  - b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

### 3.15 METERING

#### A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.16 GROUNDING SYSTEMS

#### A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control center, panelboard, switchboard, and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in motor control center, panelboard, switchboard, and switchgear assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

#### B. Electrical Tests:

1. Fall-of-Potential Test:
  - a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
  - b. Main ground electrode system resistance to ground to be no greater than: **5** ohm(s).
2. Two-Point Direct Method Test:
  - a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
  - b. Equipment ground resistance shall not exceed main ground system resistance by: **0.25** ohm.

### 3.17 GROUND FAULT SYSTEMS

#### A. Inspection and testing limited to:

1. Zero sequence grounding systems.
2. Residual ground fault systems.

#### B. Visual and Manual Inspection:

1. Neutral main bonding connection to assure:
  - a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
  - b. Ground strap sensing system is grounded through sensing device.
  - c. Neutral ground conductor is solidly grounded.
2. Verify control power has adequate capacity for system.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Manually operate monitor panels for:
  - a. Trip test.
  - b. No trip test.
  - c. Nonautomatic rest.
4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
5. Relay check for pickup and time under simulated ground fault conditions.
6. Verify nameplate identification by device operation.

### 3.18 AC INDUCTION MOTORS

- A. General: Inspection and testing limited to motors rated 1/2 hp and larger.
- B. Visual and Mechanical Inspection:
  1. Proper electrical and grounding connections.
  2. Shaft alignment.
  3. Blockage of ventilating air passageways.
  4. Operate motor and check for:
    - a. Excessive mechanical and electrical noise.
    - b. Overheating.
    - c. Correct rotation.
    - d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
    - e. Excessive vibration, in excess of values in NETA ATS Table 100.10.
  5. Check operation of space heaters.

### 3.19 LOW VOLTAGE MOTOR CONTROL

- A. Visual and Mechanical Inspection:
  1. Proper barrier and shutter installation and operation.
  2. Proper operation of indicating and monitoring devices.
  3. Proper overload protection for each motor.
  4. Improper blockage of air-cooling passages.
  5. Proper operation of drawout elements.
  6. Integrity and contamination of bus insulation system.
  7. Check door and device interlocking system by:
    - a. Closure attempt of device when door is in OFF or OPEN position.
    - b. Opening attempt of door when device is in ON or CLOSED position.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

8. Check key interlocking systems for:
  - a. Key captivity when device is in ON or CLOSED position.
  - b. Key removal when device is in OFF or OPEN position.
  - c. Closure attempt of device when key has been removed.
  - d. Correct number of keys in relationship to number of lock cylinders.
  - e. Existence of other keys capable of operating lock cylinders; destroy duplicate sets of keys.
9. Check nameplates for proper identification of:
  - a. Equipment title and tag number with latest one-line diagram.
  - b. Pushbuttons.
  - c. Control switches.
  - d. Pilot lights.
  - e. Control relays.
  - f. Circuit breakers.
  - g. Indicating meters.
10. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
11. Verify current and potential transformer ratios conform to Contract Documents.
12. Check operation and sequencing of electrical and mechanical interlock systems by:
  - a. Closure attempt for locked open devices.
  - b. Opening attempt for locked closed devices.
  - c. Key exchange to operate devices in OFF-NORMAL positions.
13. Verify performance of each control device and feature furnished as part of motor control center.
14. Control Wiring:
  - a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
  - b. Check for proper conductor lacing and bundling.
  - c. Check for proper conductor identification.
  - d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect contactors for:
  - a. Correct mechanical operations.
  - b. Correct contact gap, wipe, alignment, and pressure.
  - c. Correct torque of all connections.
17. Compare overload heater rating with full-load current for proper size.
18. Compare fuse motor protector and circuit breaker with motor characteristics for proper size.
19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.20 LOW VOLTAGE SURGE ARRESTORS

#### A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground bus electrode.

#### B. Electrical Tests:

1. Varistor Type Arrestors:
  - a. Clamping voltage test.
  - b. Rated RMS voltage test.
  - c. Rated dc voltage test.
  - d. Varistor arrestor test values in accordance with IEEE C62.33, Sections 4.4 and 4.9.

### 3.21 MEDIUM VOLTAGE SURGE ARRESTORS

#### A. Visual Inspection:

1. Ground connections to ground bus electrode.
2. Shortest practical jumper connections to line.

#### B. Electrical Tests:

1. Grounding electrode resistance test in accordance with IEEE 81, Section 8.2.1.5 using three-point fall-of-potential method.
2. Insulation power factor.
3. Insulation resistance.
4. RF noise test using Stodard Noise Test set with applied voltage of 1.18 times maximum continuous operating voltage.
5. Insulation power factor leakage current, watts loss, and insulation resistance tests in accordance with manufacturer's test values. RIV value not to exceed 10 microvolts above background noise.
6. Leakage current and watts loss tests.

### 3.22 STANDBY AND EMERGENCY GENERATOR SYSTEMS

#### A. Visual and Mechanical Inspection:

1. Proper grounding.
2. Blockage of ventilating passageways.
3. Proper operation of jack water heaters.
4. Integrity of engine cooling and fuel supply systems.
5. Excessive mechanical and electrical noise.
6. Overheating of engine or generator.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

7. Proper installation of vibration isolators.
8. Proper cooling liquid type and level.
9. Operate engine-generator and check for:
  - a. Excessive mechanical and electrical noise.
  - b. Overheating.
  - c. Correct rotation.
  - d. Check resistance temperature detectors or generator inherent thermal protectors for functionality and proper operation.
  - e. Excessive vibration.
10. Verify voltage regulator and governor operation will cause unit speed and output voltage to stabilize at proper values within reasonable length of time.
11. Proper operation of meters and instruments.
12. Compare generator nameplate rating and connection with one-line diagram or approved Submittal.
13. Verify engine-generator operation with adjustable frequency drives energized and operating under normal load conditions.

### B. Electrical and Mechanical Tests:

1. Cold start test by interrupting normal power source with test load consisting of connected building load to verify:
  - a. Transfer switch operation.
  - b. Automatic starting operation.
  - c. Operating ability of engine-generator.
  - d. Overcurrent devices capability to withstand inrush currents.
2. Phase rotation tests.
3. Test engine protective shutdown features for:
  - a. Low oil pressure.
  - b. Overtemperature.
  - c. Overspeed.
4. Load bank test with reactors and resistors adjusted to 80 percent power factor for each load step. Record voltage, frequency, load current, oil pressure, and engine coolant temperature at 15-minute intervals:
  - a. 25 percent applied load for 30 minutes.
  - b. 50 percent applied load for 30 minutes.
  - c. 75 percent applied load for 30 minutes.
  - d. 100 percent applied load for 3 hours.
  - e. Load test results to demonstrate ability of unit to deliver rated load for test period.
5. One-Step Rated kW Load Pickup Test:
  - a. Perform test immediately after performing load bank test.
  - b. Apply rated load, minus largest rated hp motor, to generator.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- c. Start largest rated hp motor and record voltage drop for 20 cycles minimum with high-speed chart recorder or digital storage oscilloscope.
- d. Compare voltage drop with maximum allowable voltage dip for specified starting situation.

**END OF SECTION**





**SECTION 26 12 02  
OIL-FILLED PAD MOUNTED TRANSFORMERS**

**PART 1 GENERAL**

**1.01 REFERENCES**

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): D3487, Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
  - b. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
  - c. C57.12.22, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller.
  - d. C57.12.26, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors.
  - e. C57.12.28, Switchgear and Transformers—Pad-Mounted Equipment, Enclosure Integrity.
  - f. C57.12.90, Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers.
  - g. C57.106, Guide for Acceptance and Maintenance of Insulating Oil in Equipment.
  - h. C62.11, Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 kV).
3. National Electrical Manufacturers Association (NEMA):
  - a. TR 1, Transformers, Regulators, Reactors.
  - b. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL).

**1.02 SUBMITTALS**

A. Action Submittals:

1. Descriptive information.
2. Dimensional drawings.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Transformer nameplate data.
4. Schematic and connection diagrams.

### B. Informational Submittals:

1. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
2. Factory test reports.

## 1.03 QUALITY ASSURANCE

- A. Design, test, and assemble in accordance with applicable standards of NEMA TR 1, IEEE C57.12.00, IEEE C57.12.22, IEEE C57.12.26, and IEEE C57.12.90.

## 1.04 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts:
  1. One quart of paint to match color and quality of equipment final shop finish.
  2. One spare fuse: links for each replaceable fuse size.
  3. Pentahead socket for 1/2-inch socket drive.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Cutler-Hammer.
- B. Square D Co.
- C. General Electric.
- D. Cooper Power System.

### 2.02 GENERAL

- A. Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartments, assembled on a common structural base.
- B. Anchor Bolts: Galvanized sized by equipment manufacturer.

### 2.03 TRANSFORMER

- A. kVA Rating: As shown on the Drawings.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Primary Voltage: 12.47 kV line-to-line, volts, three-phase four-wire, 60-Hz.
- C. Secondary Voltage: 480/277 volts, three-phase four-wire, 60 Hz.
- D. BIL Rating:
  - 1. 95 BIL for 15 kV insulation class transformers.
  - 2. 30 BIL for secondary.
- E. Temperature Rise: 65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 40 degrees C.
- F. Impedance:
  - 1. 5.75 percent for transformers rated 750 kVA and above.
- G. Efficiency: Meet or exceed values in Table 4-1 of NEMA TP 1.
- H. Dielectric Coolant: Fully biodegradable, nontoxic, and nonbio-accumulating fluid, qualifying as "less flammable" per NEC 450.23; Factory Mutual Approved or UL Classified.
  - I. Primary Taps:
    - 1. Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.
    - 2. Externally operated no-load tap changer.
    - 3. Provisions for locking handle in any position.
- J. Coil Conductors: Copper windings.
- K. Wye-wye transformers wound on five-legged ortriplex cores.
- L. Sound Level: In accordance with manufacturer's standards.

### 2.04 ENCLOSURE

- A. In accordance with IEEE C57.12.28 requirements.
- B. Welded carbon steel transformer tank, with cooling panels when required, and lifting eyes.
- C. 12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.
- D. Color: Provide finish as approved by

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.05 TERMINAL COMPARTMENTS

- A. General: IEEE C57.12.28, enclosed high and low voltage compartments side by side, separated by steel barrier, bolted to transformer tank.
  - 1. Doors:
    - a. Individual, full-height, air-filled.
    - b. Low voltage door with three-point latching mechanism, vault type handle, and single padlocking provision.
    - c. High voltage door fastenings inaccessible until low voltage door has been opened.
    - d. Door Bolts Penta-head type.
    - e. Lift-off, stainless steel hinges and door stops.
    - f. Removable front sill to facilitate rolling or skidding over conduit stubs.
    - g. Recessed lock pocket, with steel door release bolt adjacent to secondary compartment door handle.
- B. High Voltage Compartment:
  - 1. Deadfront in accordance with IEEE C57.12.26 type construction.
  - 2. Protective fuses.
  - 3. High voltage bushings.
  - 4. Transformer grounding pad.
  - 5. Surge arrestors without barriers.
  - 6. Radial feed, two position sectionalizing load-break switch.
- C. Low Voltage Compartment:
  - 1. Livefront in accordance with IEEE C57.12.26 type construction.
  - 2. Low voltage bushings.
  - 3. Grounding pad.
  - 4. Stainless steel equipment nameplate.
  - 5. Liquid level gauge.
  - 6. 1-inch upper filter press and filling plug.
  - 7. Drain valve with sampling device.
  - 8. Dial type thermometer.
  - 9. Pressure relief valve.
  - 10. Nameplate.

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### 2.06 BUSHINGS

#### A. High Voltage:

1. Deadfront Termination:
  - a. Universal bushing well rated at 15 Kv in accordance with IEEE 386.
  - b. Bushings externally clamped and front removable.
  - c. Rated for 200 amperes continuous, 95 kV BIL.
  - d. Standoff brackets located adjacent to bushings.

#### B. Low Voltage:

1. Molded epoxy bushing clamped to tank with 8 hole spade type terminals.
2. Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.
3. Internally connected neutral extending to neutral bushing.

### 2.07 HIGH VOLTAGE SWITCHING

- A. Internal, oil-immersed, gang-operated load-break, manually operated switches.
- B. Hot stick operated handle located in high voltage compartment.
- C. Capable of operating at full-load current.
- D. Feed Switch: Two-position, ON/OFF radial.

### 2.08 HIGH VOLTAGE PROTECTION

#### A. Internally Mounted, Oil-Immersed Cartridge Fuses:

1. Accessible through tank handhole.
2. Sized approximately three times primary current.
3. Interrupting capability of 2,500 amperes rms asymmetrical.

### 2.09 SURGE ARRESTORS

- A. Elbow Valve Type: Uninsulated body, 9 kV with barriers in accordance with IEEE C62.11.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.10 TANK GROUNDING PADS

### A. High and Low Voltage Compartments:

1. Connected together with bare No. 2/0 stranded copper conductors.
2. Wye-wye high and low voltage neutrals internally connected with link and brought out to insulated low voltage bushing externally grounded to tank.
3. Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

## 2.11 TAP CHANGER WARNING SIGN

- A. Red laminated plastic, engraved to white core.
- B. Engrave to read: DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.
- C. Mount above tap changer handle.

## 2.12 FACTORY TESTS

- A. Production tests in accordance with IEEE C57.12.90 and IEEE C57.12.00, Section 8 and Table 16.

## **PART 3 EXECUTION**

### 3.01 GENERAL

- A. Secure to mounting pads with anchor bolts.
- B. Install plumb and longitudinally in alignment with pad or adjacent building wall.
- C. Ground neutrals and enclosures in accordance with applicable codes.

### 3.02 ADJUSTMENTS

- A. Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

**END OF SECTION**

**SECTION 26 13 16.01**  
**PAD-MOUNT METAL-ENCLOSED SWITCHGEAR**

**PART 1 GENERAL**

1.01 SUMMARY

- A. This section includes standard pre-fabricated outdoor pad-mount 15 kV automatic source transfer distribution switchgear as shown on the Drawings.

1.02 REFERENCES

- A. Material and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
1. American National Standards Institute (ANSI): C39.1, Electrical Analog Indicating Instruments, Requirements for.
  2. ASTM International (ASTM):
    - a. B117, Standard Test Method for Salt Spray (FOG) testing.
    - b. B236, Standard Specifications for Aluminum Bars for Electrical Purposes.
    - c. D523, Standard Test Method for Specular Gloss.
    - d. D659, Standard Method of Evaluating Degree of Chalking of Exterior Paints.
    - e. D714, Standard Test Method for Evaluating Degree of Blistering of Paint.
    - f. D1654, Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
    - g. D2247, Standard Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
    - h. D2794, Standard Test Method for Resistance of Organic Coating to the Effects of Rapid Deformation.
    - i. D3359, Standard Test Methods for Measuring Adhesion by Tape Test.
    - j. D4060, Standard Test Method for Abrasion Resistance to Organic Coatings by the Tabor Abraser.
  3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. C37.20.3, Metal-Enclosed Interrupter Switchgear.
    - b. C37.46, Specifications for Power Fuses and Fused Disconnecting Switches.
    - c. C37.57, Metal-Enclosed Interrupter Switchgear Assemblies-Conformance Testing.
    - d. C37.58, Indoor AC Medium Voltage Switches for Use in Metal-Enclosed Switchgear.
    - e. C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus.



- f. C37.90.1, Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
  - g. C37.91, Guide for Protective Relay Applications to Power Transformers.
  - h. C57.12.28, Switchgear and Transformers-Pad-Mounted Equipment-Enclosure Integrity.
  - i. C57.13, Standard Requirements for Instrument Transformers.
  - j. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Power Circuits.
- 4. National Electrical Manufacturers Association (NEMA):
    - a. C29.9, Wet-Process Porcelain Insulators, Apparatus Post Type.
    - b. C29.10, Wet-Process Porcelain Insulators, Indoor Apparatus Type.
    - c. LA 1, Surge Arrestors.
    - d. SG 2, High Voltage Fuses.
  - 5. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)

### 1.03 SUBMITTALS

#### A. Action Submittals:

- 1. Descriptive product information.
- 2. Dimensional drawings.
- 3. Itemized bill of material.
- 4. Operational description.
- 5. Switchgear configuration.
- 6. Interrupter switch data.
- 7. Bus data.
- 8. One-line, three-line, and control schematic drawings.
- 9. Fuse-data and time-current characteristics on transparencies.
- 10. Conduit entrance locations.
- 11. Power operator and source transfer controller with voltage sensor data.
- 12. Anchoring instructions and details.

#### B. Informational Submittals:

- 1. Factory Test Reports.
- 2. Manufacturer's installation instructions.
- 3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
- 4. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Shipping Splits Established by Contractor to facilitate ingress of equipment to final installation location within the building.

1.05 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:
  - 1. Voltage tester with audio and visual signals, batteries, shotgun clamp-stick adapter, and storage case.
  - 2. Portable test accessory for preliminary checkout of source transfer system.

**PART 2 PRODUCTS**

2.01 MANUFACTURERS

- A. S&C Vista Series Co.
- B. Approved equal.
- C. Provide metal-enclosed switchgear that is the product of a single manufacturer. Assembled units with component parts of several manufacturers will not be acceptable with the exception that minor items as terminal blacks, test switch, wiring, etc., may be manufactured by others.

2.02 GENERAL

- A. Equipment suitable 12,500 volts, three-phase: three-wiresolid grounded-wye electrical system having an available short-circuit current at line terminals of amperes rms symmetrical as shown.
- B. Front accessible, metal-enclosed switchgear complete with one or more outdoor self-supporting bays having interrupter switches, power fuses, and necessary accessory components.
- C. Designed, tested, and assembled in accordance with IEEE 37.20.3, IEEE C37.57, and IEEE C57.12.28, and UL Listed per Certificate of Compliance File No. E138023.
- D. Operating Conditions:
  - 1. Altitude not greater than 3,300 feet above sea level.
  - 2. Ambient Temperature: Maximum 40 degrees C.
  - 3. Equipment shall be fully rated without derating for these operating conditions.

- E. Anchor Bolts: Type 316 stainless steel, 5/8-inch diameter, length sized by manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

## 2.03 EQUIPMENT RATINGS

- A. Integrated Switchgear Assembly Ratings At 60-Hz:
  - 1. Voltage: 13.8 kV nominal, 17 kV maximum.
  - 2. Insulation Level: 95 kV BIL.
  - 3. Main Bus Current: 600 continuous amperes
  - 4. Three-Pole Interrupter Switches:
    - a. Current: 600 amperes continuous and live switching rating: as shown on one-line diagram.
    - b. Two-Time Duty-Cycle Fault Closing: 20,000 amperes rms asymmetrical rated at 13.8 kV nominal voltage.
  - 5. Short-Circuit Rating: 12,500 amperes symmetrical, at rated 13.8 kV nominal voltage.
- B. Fault-closing ratings to equal, or exceed, the short-circuit ratings of the metal-enclosed switchgear with:
  - 1. Momentary and two-time duty-cycle rating of switches.
  - 2. Momentary rating of bus.
  - 3. Interrupting ratings of fuses.

## 2.04 ENCLOSURE PAD MOUNT STYLE

- A. The switchgear shall be provided with a pad-mounted enclosure suitable for installation of the gear on a concrete pad.
- B. The pad-mounted enclosure shall be separable from the switchgear to allow clear access to the bushings and bushing wells for cable termination.
- C. The basic material shall be 14-gauge hot-rolled, pickled and oiled steel sheet.
- D. The enclosure shall be provided with removable front and back panels, and hinged lift-up roof sections for access to the operating and termination compartments. Each roof section shall have a retainer to hold it in the open position.
- E. Lift-up roof sections shall overlap the panels and shall have provisions for pad-locking that incorporate a means to protect the padlock shackle from tampering.
- F. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

- G. Panel openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between panels and panel openings to guard against water entry.
- H. For bushings rated 600 amperes continuous, the termination compartment shall be of an adequate depth to accommodate encapsulated surge arresters mounted on 600-ampere elbows having 200-ampere interfaces.
- I. For bushing wells rated 200 amperes continuous, the termination compartment shall be of an adequate depth to accommodate 200-ampere elbows mounted on feed-through inserts.
- J. An instruction manual holder shall be provided.
- K. Non-removable lifting tabs shall be provided.
- L. To guard against corrosion due to extremely harsh environmental conditions, the entire exterior of the enclosure shall be fabricated from Type 304 stainless steel.
- M. Enclosure Finish:
  - 1. All exterior welded seams shall be filled and sanded smooth for neat appearance.
  - 2. The finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.
  - 3. The finish shall be olive green, Munsell 7GY3.29/1.5.

#### 2.05 HIGH VOLTAGE BUS

- A. Aluminum bus bar extending entire length of switchgear, bus supports and interconnections to have short-circuit rating equal to that of integrated assembly.
- B. Bus rated 600 ampere with provisions for one-cable terminations per phase.

#### 2.06 GROUND BUS

- A. Aluminum bus bar, bolted to nickel-plated steel brackets, extending throughout switchgear and having short-circuit rating equal to that of the integrated assembly.
- B. Two No. 2 through 500 kc mil copper ground cable connectors for connecting ground bus to station ground.

#### 2.07 GROUND CONNECTION

- A. Aluminum ground connected, bolted to nickel-plated bracket having short-circuit rating equal to that of the integrated module.

- B. Welded in-place nickel-plated, steel bracket with one Belleville spring washer.
- C. Two No. 2 through 500 kc mil copper ground cable connections for connecting to station ground.

## 2.08 INTERRUPTER SWITCHES

### A. General:

1. The switchgear shall be in accordance with the single-line diagram, and shall conform to the following specification.
2. The switchgear shall consist of a gas-tight tank containing SF6 gas, load-interrupter switches and resettable fault interrupters with visible open gaps and integral visible grounds, sensing, motor operators and controls, low-voltage compartment/enclosure, microprocessor-based overcurrent control for the fault interrupters, and microprocessor-based source-transfer control. Load-interrupter switch terminals shall be equipped with bushings rated 600 amperes continuous, and fault-interrupter terminals shall be equipped with bushing wells rated 200 amperes continuous (as specified) to provide for elbow connection. Manual operating mechanisms and viewing windows shall be located on the opposite side of the tank from the bushings and bushing wells, so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables.

### B. Load Interrupter Switches:

1. The three-phase, group-operated load-interrupter switches shall have a three-time and ten-time duty-cycle fault-closing rating.
2. Each switch shall be provided with an integral ground position that is readily visible through the viewing window, eliminating the need for cable handling and exposure to high voltage to ground the equipment.
3. The ground position shall have a three-time and ten-time duty-cycle fault-closing rating.
4. The switch shall be provided with an open position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to establish a visible gap.
5. The open gaps of the switch shall be sized to allow cable testing through a feed-thru bushing or the back of the elbow.

### C. Fault Interrupter Switches:

1. Fault interrupters shall have a three-time and ten-time duty-cycle fault-closing and fault interrupting rating.

2. The fault interrupter shall be provided with a disconnect with an integral ground position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to ground the equipment.
3. The ground position shall have a three-time and ten-time duty-cycle fault-closing rating.
4. The disconnect shall be provided with an open position that is readily visible through the viewing window, eliminating the need for cable handling and exposure to high voltage to establish a visible gap.
5. The fault interrupter, including its three-position disconnect, shall be a single integrated design so that operation between the closed and open positions or the open and grounded positions is accomplished with a single, intuitive movement.
6. The open gaps of the disconnect shall be sized to allow cable testing through a feed-thru bushing or the back of the elbow.
7. An internal indicator shall be provided for each fault interrupter to show when it is in the tripped condition. The indicator shall be clearly visible through the viewing window.
8. Operating Mechanisms:
  - a. Load-interrupter switches and fault interrupters shall be operated by means of a quick-make, quick-break mechanism.
  - b. The manual handle shall charge the operating mechanism for closing, opening, and grounding of the switches and fault interrupters.
  - c. A single, integrated operating mechanism shall fully operate each fault interrupter or load interrupter switch in a continuous movement, so that additional operations are not required to establish open or grounded positions.
  - d. Operating mechanisms shall be equipped with an operation selector to prevent inadvertent operation from the closed position directly to the grounded position, or from the grounded position directly to the closed position. The operation selector shall require physical movement to the proper position to permit the next operation.
  - e. Operating shafts shall be padlockable in any position to prevent operation.
  - f. The operation selector shall be padlockable to prevent operation to the grounded position.
  - g. The operating mechanism shall indicate switch position which shall be clearly visible from the normal operating position.

## 2.09 AUTOMATIC SOURCE TRANSFER

- A. Transfer on Loss and Return of Source Voltage in Common-Bus Primary-Selective Systems

- B. The normal condition shall be with one source load-interrupter switch (for the preferred source, as field-programmed) closed to energize the high-voltage bus, and with the other source load-interrupter switch (for the alternate source) open with its associated circuit available as a standby.
- C. The control shall monitor the conditions of the preferred power sources and shall send a start command to the generator upon loss of the preferred source. Once the generator supplies good voltage to the alternate switch, automatic switching shall take place to transfer to the generator. Automatic switching shall open the preferred-source load-interrupter switch and then close the alternate-source load-interrupter switch to restore power to the high-voltage bus.
- D. When normal voltage returns to the preferred source for a preset time, the control shall initiate retransfer to the preferred source if in the automatic return mode, or await manual retransfer if in the hold return mode. In the hold return mode, if the alternate source fails and the preferred source has been restored, the control shall initiate automatic retransfer to the preferred source.
- E. In the automatic return mode, the control shall provide either open transition (non-parallel) on retransfer.
- F. Transfer on Unbalance Condition
- G. A field-programmable unbalance detection feature shall initiate automatic switching on detection of source-side open-phase conditions at the same system voltage level as the switchgear, whether caused by utility-line burn down, broken conductors, single-phase switching, equipment malfunctions, or single-phasing resulting from blown source-side fuses. The control shall continuously develop and monitor the negative-sequence voltage to detect any unbalance present as a result of an open-phase condition. Automatic switching shall occur when the system unbalance exceeds a predetermined unbalance-detect voltage for a period of time sufficient to confirm that the condition is not transient.
- H. When normal phase voltages return to the preferred source, the control shall initiate retransfer as described above.
- I. Control Features:
  - 1. The operating characteristics of the source-transfer control and its voltage-, current-, and time-related operating parameters shall be field-programmable and entered into the control by means of a keypad. To simplify entry of this information, a menu arrangement shall be utilized including keys dedicated to the operating characteristics and to each of the operating parameters. Entry of an access code shall be necessary before any operating characteristic or operating parameter can be changed.

2. All operating characteristics and operating parameters shall be available for review on a liquid-crystal display with backlighting.
3. Light-emitting diode lamps shall be furnished for indicating the presence of acceptable voltage on each high-voltage source.
4. A light-emitting diode lamp shall be furnished for indicating that the control is in the automatic mode, the operation selector for each operator is in the operating position, and all control circuitry is properly connected for automatic transfer.
5. A selector switch shall be furnished for choosing manual or automatic operating mode. In the manual mode, local electrical open and closed operation by means of push buttons shall be enabled while automatic switching shall be inhibited.
6. Test keys shall be furnished for simulating loss of voltage on each of the two sources, as well as for checking the functioning of the lamps, display, and keypad.
7. The control shall automatically record system status and source-transfer control status every time a control operation occurs, for use in analyzing system events. All such operations shall be indicated by the illumination of a light-emitting diode lamp and shall be available for display by means of a dedicated event key.
8. The present source voltage and current inputs, and the present status of discrete inputs to and outputs from the control shall be available for display by means of a dedicated examine key.
9. The control shall have the capability to automatically calibrate to a known voltage on each source. This capability shall be keypad-selectable.

J. Construction Features:

1. The source-transfer control shall use an advanced microprocessor and other solid-state electronic components to provide the superior reliability and serviceability required for use in power equipment. All components shall be soldered on printed-circuit boards to minimize the number of interconnections for increased reliability.
2. All interconnecting-cable connector pins and receptacle contacts shall be gold-over-nickel plated to minimize contact pressure.
3. The surge withstand capability of the control shall be verified by subjecting the device to both the ANSI/IEEE Surge Withstand Capability Test (ANSI Standard C37.90.1), and to ANSI Standard C62.41 Category B Power Line Surge.
4. The control shall be located in the grounded, steel-enclosed low-voltage compartment/enclosure, with the operators. The compartment shall provide isolation from high voltage.

K. Voltage Sensing and Control Power:

1. Voltage sensing shall be provided by three capacitively coupled voltage sensors on the line side of each source load-interrupter switch.



2. The output of the voltage sensors shall be directly proportional to line-to-ground voltage.
  3. Control power shall be provided by unfused voltage transformers internal to the tank.
- L. An overcurrent-lockout feature shall be provided to prevent an automatic transfer operation that would close a source load-interrupter switch into a fault. The feature shall include a light-emitting diode lamp for indicating when a lockout condition has occurred, a reset key for manually resetting the lockout condition, and three current sensors for each source. Provisions shall be furnished for manually resetting the overcurrent-lockout feature from a remote location. Test keys shall be provided for simulating an overcurrent condition on each source.
- M. Remote-indication provisions shall be provided to permit remote monitoring of the presence or absence of preferred- and alternate-source voltage; the operating mode of the source-transfer control (i.e., automatic or manual); and the status of the indicating lamp and overcurrent lockout.
- N. A communications card shall be provided to permit local loading, to a user-furnished personal computer, of system events recorded by the source-transfer control; operating characteristics and voltage-, current-, and time-related operating parameters programmed in the control; discrete inputs and outputs from the control; and messages explaining why the indicating lamp furnished in is not lighted. The communications card shall also permit local downloading of the user's standard operating parameters from the personal computer to the control.

## 2.10 LABELING

### A. Hazard-Alerting Signs:

1. The exterior of the pad-mounted enclosure (if furnished) shall be provided with "Warning—Keep Out-Hazardous Voltage Inside—Can Shock, Burn, or Cause Death" signs.
2. Each unit of switchgear shall be provided with a "Danger—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.
3. Each unit of switchgear shall be provided with a "Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death" sign.

B. Nameplates, Ratings Labels, and Connection Diagrams

1. Each unit of switchgear shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.
2. Each unit of switchgear shall be provided with a ratings label indicating the following: voltage rating; main bus continuous current rating; short-circuit rating; fault-interrupter ratings including interrupting and duty-cycle fault-closing; and load-interrupter switch ratings including duty-cycle fault-closing and short-time.

2.11 SOURCE QUALITY CONTROL

- A. Switchgear assembly production tested in accordance with IEEE C37.20.3.

**PART 3 EXECUTION**

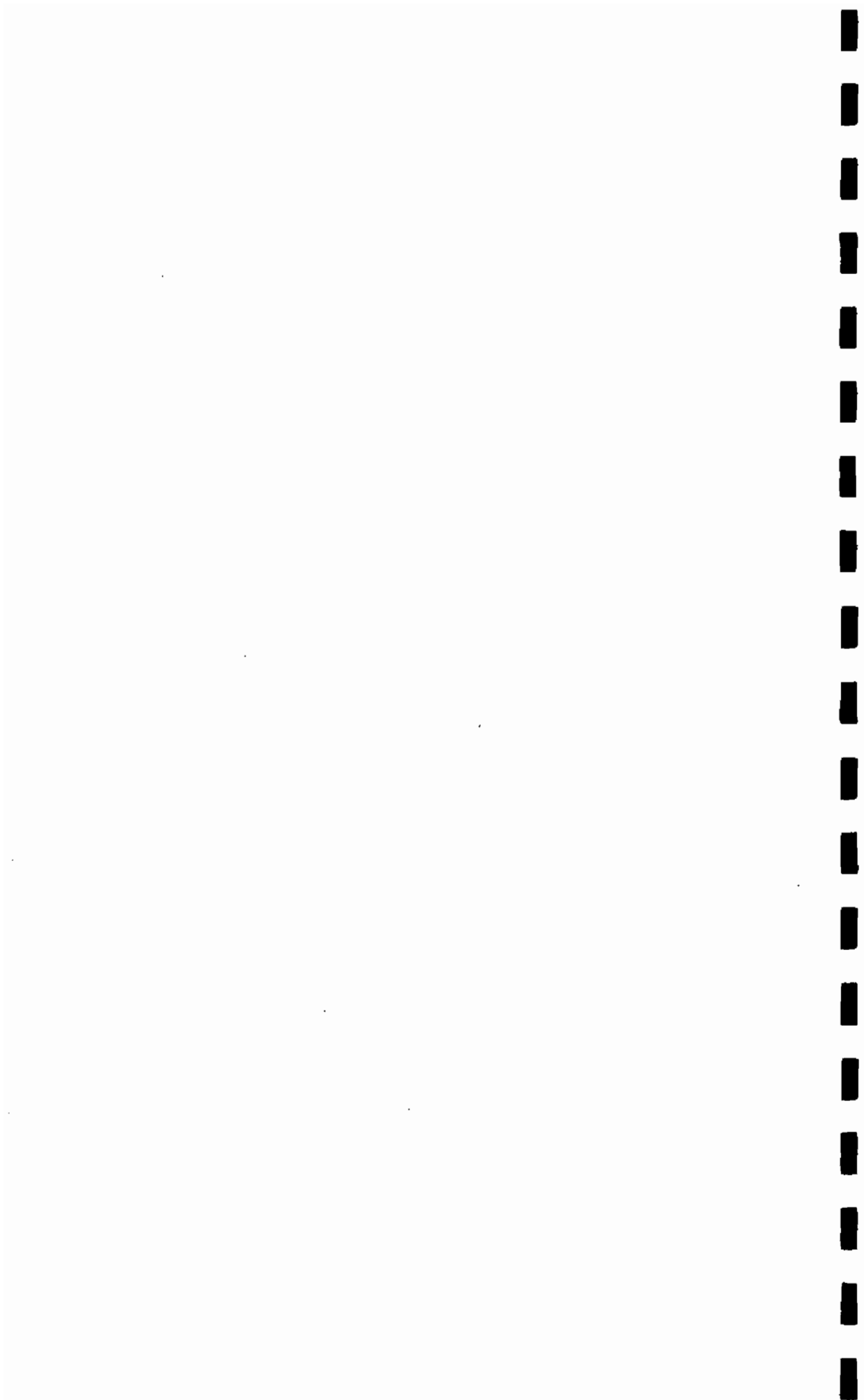
3.01 INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions and recommendations.
- B. Secure equipment to concrete pad with anchor bolts of sufficient number for specified conditions.
- C. Tighten current-carrying bolted bus connections and enclosure framing and panel bolts to manufacturer's recommendations.
- D. Coordinate terminal connections with installation of secondary feeders.

3.02 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services, for the following services at Site, for minimum person-days listed below, travel time excluded:
  1. Four person-days for installation assistance, final adjustment, and initial energization of equipment.
  2. Two person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
  3. One person-days for post-startup training.
- B. Furnish training of Owner's personnel at such times as requested by Owner.

**END OF SECTION**



**SECTION 26 14 13  
SWITCHBOARDS**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel-Plated Steel Plate, Sheet, and Strip.
  2. National Electrical Manufacturers Association (NEMA):
    - a. AB 1, Molded-Case Circuit Breakers and Molded-Case Switches.
    - b. PB 2, Deadfront Distribution Switchboards.
    - c. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  3. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
  4. Underwriters Laboratories (UL):
    - a. 489, Standard for Safety Molded-Case Circuit Breakers and Circuit Breaker Enclosures.
    - b. 891, Standard for Safety Dead-front Switchboards.
    - c. 1025, Standard for Safety Electric Air Heaters.
    - d. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

**1.02 SUBMITTALS**

- A. Action Submittals:
1. Descriptive product information.
  2. Itemized Bill of Material.
  3. Dimensional drawings.
  4. Operational description.
  5. One-line, three-line, and control schematic drawings.
  6. Connection and interconnection drawings.
  7. Circuit Breakers: Copies of time-current characteristics.
  8. Ground Fault Protection: Relay time-current characteristics.
  9. Bus data.
  10. Incoming line section equipment data.
  11. Transformer section equipment data.
  12. Conduit entrance locations.
  13. Anchoring instructions and details.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Certified Factory Test Report.
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
4. Manufacturer's Certification of Proper Installation in as specified in Section 01 43 33, Manufacturers' Field Services.

## 1.03 QUALITY ASSURANCE

### A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

## 1.04 EXTRA MATERIALS

### A. Furnish, tag, and box for shipment and storage and deliver prior to 90 percent Project completion the following spare parts:

1. Fuses: One complete set of spare fuses of each current rating, both power and control.
2. Lights: One complete set of spare indicating lights.
3. Paint: One pint, to match enclosure exterior finish in color and quality.
4. Indicating Lamp Pullers: Two each.
5. Indicating Lamp Resistors and Sockets: Two each.

## **PART 2 PRODUCTS**

### 2.01 MANUFACTURERS

#### A. Materials, equipment, and accessories specified in this section shall be products of:

1. General Electric.
2. Westinghouse.
3. Siemens.
4. Square D.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.02 GENERAL

- A. Equipment suitable for 480Y/277-volt, three-phase; four-wire grounded-wye electrical system having an available short-circuit current at line terminals of 50,000 amperes rms symmetrical as shown.
- B. Comply with NEMA PB 2 and UL 891.
- C. Switchboard and all its major components to be manufactured and assembled by a single manufacturer in order to achieve standardization for appearance, operation and maintenance, spare parts replacement, and manufacturer's services.
- D. Lifting lugs on all equipment and devices weighing over 100 pounds.
- E. Operating Conditions:
  - 1. Ambient Temperature: Maximum 40 degrees C.
  - 2. Equipment shall be fully rated without derating for the above operating conditions.

### 2.03 STATIONARY STRUCTURE

- A. Type: NEMA PB 2 construction, dead front, completely metal enclosed, self-supporting.
- B. Sections bolted together to form one rigid assembly capable of being moved into position and bolted directly to the floor without use of floor sills.

### 2.04 ENCLOSURE

- A. Equipment Finish: Baked enamel applied over rust-inhibiting phosphated base coating.
  - 1. Color:
    - a. Exterior: Gray finish as approved by Owner.
    - b. Interior: White.
    - c. Unpainted Parts: Plated for corrosion resistance.
- B. Indoor Enclosure: NEMA 250, Type 1:
  - 1. Rear, full-height, bolt-on panels for each enclosure section.
  - 2. Cable Termination Access: Padlock provision.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Front Access:
  - a. Service line and load terminations, internal devices, device and bolted bus connections, and protective device removal, serviceable from the front only.
  - b. Sections aligned across the back to permit placement flush against wall.
  - c. Working Space: As required by NFPA 70.
4. Transition sections as required or shown.
5. Side and Top Covers: Removable, captive, screw-on plates with formed edges on each side.
6. Front Cover: Hinged door with formed edges.

### 2.05 BUSWORK

- A. Material: Phase noninsulated tin-plated copper throughout entire length of sufficient cross section to limit temperature rise at rated current to 55 degrees C.
- B. Bus Arrangement: A-B-C, left-to-right, top-to-bottom, and front-to-rear, as viewed from front.
- C. Brace for short-circuit currents 50,000-amperes rms symmetrical.
- D. Main Horizontal Bus: Nontapered, continuous current rating as shown.
- E. Neutral Bus: Continuous current rating: 100 percent of main horizontal bus rating.
- F. Ground Bus:
  1. Tin-plated copper.
  2. Rating: As shown
  3. Bolted to each vertical section.
  4. Bus Connections and Joints: Bolted with Belleville washers.
- G. Extend each bus entire length of switchboard with provisions for extension to future units.

### 2.06 PROTECTIVE DEVICES

- A. Insulated-Case Circuit Breakers:
  1. Main and Feeder Protective Devices: Individually mounted draw-out, UL 489 listed for 100 percent of continuous ampere rating, suitable for use with 75 degrees C wire at full 75 degrees C ampacity when mounted in switchboard.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Arrangement: Fully rated main and branch feeder.
3. Frame Sizes: As shown with solid-state trip units.
4. Interrupting Rating: 50,000 amperes rms symmetrical at rated voltage of 480 and 50,000 amperes rms symmetrical short-time rating.
5. Selective override circuit having short-time adjustment for selectivity up to rated rms short-time rating.
6. Two-step, stored energy mechanism with maximum of five cycle closings.
7. Operation: Electrical with multiple charge/close and anti-pump provisions.
8. Control Power Voltage: 48V dc.
9. Operational Sequence: CHARGE-CLOSE-RECHARGE-OPEN-CLOSE-OPEN.
10. Color-Coded Visual Indicators: Contact OPEN and CLOSE, plus mechanism CHARGE and DISCHARGED.
11. Draw-Out Construction:
  - a. Individual compartments, sheet steel top, bottom, and sides with padlockable door.
  - b. Flame retardant, arc track resistance nonmetallic rear barrier.
  - c. CTs, where shown, mounted within appropriate breaker compartment.
  - d. Stationary contacts extended to bus through rear barrier.
  - e. Secondary contact engagement maintained in CONNECTED and TEST positions.
  - f. Draw-out mechanism with disconnecting contacts, wheels, and interlocks.
    - 1) Equipped with means to rack breaker into CONNECTED, TEST, and DISCONNECTED positions.
    - 2) Full withdraw position allowing breaker removal and tilt for inspection.
    - 3) Door closable with breaker in any position.
  - g. External visual breaker position indicator.
  - h. Each compartment designed for specific breaker frame size.
  - i. Each breaker compartment fully equipped with all electrical connections, bolted metal barrier across compartment face and compartment door.
12. Breaker Control: Charge pushbutton, control switch, and red and green indicating lights.
13. Provisions for blocking local, manual closing, and padlocking breaker in OPEN position.
14. Test Facilities:
  - a. Breakers with integral external test points for portable test kit.
  - b. One, hand-held test kit for functional testing of trip circuitry.
  - c. Separately mounted panel to test ground fault by tripping breaker.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

15. Mechanical interlock to prevent opening compartment door while breaker is in closed position.

### B. Molded-Case Circuit Breakers:

1. Main, Tie, and Branch Feeder Protective Devices: Individually mounted, suitable for use with 75 degree C wire at full 75 degree C ampacity when mounted in switchboard.
2. Arrangement: Fully rated main and branch feeder.
3. Breakers 225-Ampere Frame and Above: Continuously adjustable magnetic pickups five to ten times trip rating.
4. Breakers 600-Ampere Frame and Above: Solid-state trip unit.
5. Interrupting Rating: 50,000 amperes rms symmetrical at rated voltage of 480.
6. Breakers 2,000-Ampere through 3,000-Ampere Frame: UL 489 listed and labeled 100 percent application in accordance with NFPA 70.
7. Mechanical interlock to prevent opening compartment door while breaker is in closed position.

### C. Ground Fault Protection:

1. Ground sensor encircling phase conductors and neutral conductor, where used.
2. Solid-state sensing relay and monitor/test panel.
3. Zero sequence current detection, adjustable over range shown.
4. Monitor panel with fault detection indicating light, test, and reset buttons.
5. Control Power Source: Suitable to operate circuit protective device when connected to faulted phase conductor.

### D. Breaker Accessories:

1. Undervoltage trip for mains and feeders.
2. Ground fault shunt trip for mains and feeders.

## 2.07 SOLID-STATE TRIP UNIT

### A. Flux-shift trip and current sensors.

### B. Protective Programmers:

1. Self-powered, automatic rms sensing micro-electronic processor.
2. No external relays or accessories.
3. Printed circuit cards with gold-plated contacts.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

4. Programmable Controls:
  - a. Fixed-point, with repetitive accuracy and precise unit settings.
  - b. Trip adjustments made by nonremovable, discrete step switching.
5. Field-Installable Rating Plugs:
  - a. Long-time pickup LED indicator and test receptacle.
  - b. Matching load and cable requirements.
  - c. Interlocked with tripping mechanism.
  - d. Breaker to remain trip-free with plug removed.
  - e. Keyed rating plugs to prevent incorrect application.
6. Long-time pickup light.
7. Selective Coordination Time/Current Curve Shaping Adjustable Functions:
  - a. Current setting.
  - b. Long-time pickup.
  - c. Long-time delay.
  - d. Instantaneous pickup
  - e. Short-time pickup for main tie and feeders
  - f. Short-time delay for main tie and feeders with I2T function, and IN-OUT switch.
  - g. Ground fault pickup.
  - h. Ground fault delay with I2T function.
  - i. High instantaneous pickup with short-time delay.
8. Fixed, instantaneous pickup for main tie and feeders
9. Fault Trip Indicators: Mechanical push-to-reset type for overload and short-circuit overload plus ground fault trip.
10. Rejection Pins: For each programmer frame size.

### C. Phase Current Sensors:

1. Single-ratio type.
2. Fixed, mounted on breaker frame.
3. Molded epoxy construction.
4. One toroidal type for each phase.

### D. Ground Fault Sensor:

1. Neutral bar single-ratio CT mounted in cable compartment.
2. Molded epoxy construction.
3. Shorting bar.

## 2.08 CONTROL WIRING

- A. Control, Instrumentation, and Power/Current Circuits: NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Transducer Output/Analog Circuits: Shielded cable rated 600 volts, 90 degrees C minimum.
- C. Conductor Lugs: Preinsulated, self-locking, spade-type, with reinforced sleeves.
- D. Identification: Individually, with permanent wire markers at each end.
- E. Enclose in top and vertical steel wiring troughs, and front-to-rear in nonmetallic wiring troughs.
- F. Splices: Not permitted in switchboard wiring.

### 2.09 TERMINAL BLOCKS

- A. Enclosed in steel wiring troughs.
- B. Rated 600 volts, 30 amperes minimum, one-piece barrier type with strap screws.
- C. Shorting type for current transformer leads.
- D. Provide terminal blocks for:
  - 1. Conductors connecting to circuits external to switchboard.
  - 2. Internal circuits crossing shipping splits.
  - 3. Equipment parts requiring replacement and maintenance.
- E. Spare Terminals: Not less than 20 percent.
- F. Group terminal blocks for external circuit wiring leads.
- G. Maintain 6-inch minimum space between columns of terminal blocks.
- H. Identification: Permanent, for each terminal and columns of terminal blocks.
- I. Manufacturer: General Electric; Type EB-5.

### 2.10 ENERGY MONITORING SYSTEM (EMS)

- A. MDP-AT is to have an EMS. Refer to Section 26 05 04, Paragraph 2.18 for requirements.

2.11 IDENTIFICATION

A. Nameplates:

1. Master:
  - a. Deep-etched aluminum, with manufacturer's name and model number.
  - b. Riveted to main vertical section.
2. Circuit Breaker Cubicle and Door-Mounted Device:
  - a. Engraved, acrylic.
  - b. Color: Black with white.
  - c. Characters: Block-type, 3/16-inch high.
  - d. Size: Manufacturer's standard.
  - e. Inscription: As shown on one-line diagram.
  - f. Blank plates for future spaces.
  - g. Attachment Screws: Stainless steel panhead.

B. Section Identification:

1. Stamped metallic, riveted to each vertical section.
2. Serial number, bus rating, and section reference number.
3. Size: Manufacturer's standard.

C. Cubicle Labels:

1. Nonmetallic, applied inside each cubicle compartment.
2. Device serial number, rating, and description.

D. Metering Instruments: Meter type identified on meter face below pointer or dial.

E. Control Switches: Deep etched, aluminum escutcheon plate.

F. Relays and Devices:

1. Stamped metallic, riveted to instrument case.
2. Manufacturer's name, model number, relay type, and rating data.

G. Switchboard Sign:

1. Two signs each on front of switchboard.
2. Engraved, acrylic.
3. Size: Manufacturer's standard.
4. Color: Red with white.
5. Characters: Gothic-type, 1 inch(es) high.
6. Inscription: DANGER/HIGH VOLTAGE/KEEP OUT.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

7. Attachment: Four rivets each sign.

### 2.12 FACTORY TESTING

- A. Perform performance tests in accordance with UL 891 and production tests in accordance with NEMA PB-2.

## **PART 3 EXECUTION**

### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Secure to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
- C. Install plumb and in longitudinal alignment with pad or wall.
- D. Coordinate terminal connections with installation of secondary feeders.

### 3.02 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services, for the following services at Site, for minimum person-days listed below, travel time excluded:
  1. One person-days for installation assistance, final adjustment, and initial energization of equipment.
  2. One person-days for functional and performance testing.
  3. One person-days for adjustment of relay settings.
- B. Furnish startup services and training of Owner's personnel at such times as requested by Owner.

**END OF SECTION**

**SECTION 26 20 00**  
**LOW-VOLTAGE AC INDUCTION MOTORS**

**PART I GENERAL**

1.01 RELATED SECTIONS

- A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Bearing Manufacturers Association (ABMA):
    - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
    - b. 11, Load Ratings and Fatigue Life for Roller Bearings.
  2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. 85, Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery.
    - b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.
    - c. 114, Standard Test Procedures for Single-Phase Induction Motors.
    - d. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Motors.
    - e. 841, Standard for Petroleum and Chemical Industry—Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—up to and Including 500 hp.
  3. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - b. C50.41, Polyphase Induction Motors for Power Generating Stations.
    - c. MG 1, Motors and Generators.
    - d. MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.
  4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

5. Underwriters Laboratories (UL):
  - a. 1, Flexible Metal Conduit.
  - b. 674, Standard for Safety Electric Motors and Generators for use in Division I Hazardous (Classified) Locations.
  - c. 2111, Overheating Protection for Motors.

### 1.03 DEFINITIONS

- A. CISD-TEFC: Chemical industry, severe-duty enclosure.
- B. DIP: Dust-ignition-proof enclosure.
- C. EXP: Explosion-proof enclosure.
- D. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.
- E. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.
- F. ODP: Open drip-proof enclosure.
- G. TEFC: Totally enclosed, fan cooled enclosure.
- H. TENV: Totally enclosed, nonventilated enclosure.
- I. WPI: Open weather protected enclosure, Type I.
- J. WPII: Open weather protected enclosure, Type II.

### 1.04 SUBMITTALS

- A. Action Submittals:
  1. Descriptive information.
  2. Nameplate data in accordance with NEMA MG 1.
  3. Additional Rating Information:
    - a. Service factor.
    - b. Locked rotor current.
    - c. No load current.
    - d. Safe stall time for motors 50 hp and larger.
    - e. Multispeed load classification (for example, variable torque).
    - f. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.

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- g. Guaranteed minimum full load efficiency and power factor.
  4. Enclosure type and mounting (such as, horizontal, vertical).
  5. Dimensions and total weight.
  6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
  7. Bearing type.
  8. Bearing lubrication.
  9. Bearing life.
  10. Space heater voltage and watts.
  11. Description, ratings, and wiring diagram of motor thermal protection.
  12. Motor sound power level in accordance with NEMA MG 1.
  13. Maximum brake horsepower required by the equipment driven by the motor.
  14. Description and rating of submersible motor moisture sensing system.
- B. Informational Submittals:
1. Factory test reports, certified.
  2. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
  3. Manufacturer's Certificate of Proper Installation in accordance with 01 43 33, Manufacturers' Field Services.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. General Electric.
- B. Reliance Electric.
- C. MagneTek.
- D. Siemens Energy and Automation, Inc., Motors and Drives Division.
- E. Baldor.
- F. U.S. Electrical Motors.
- G. TECO-Westinghouse Motor Co.
- H. Toshiba International Corp., Industrial Division.
- I. WEG Electric Motors Corp.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.02 GENERAL

- A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
- B. In order to obtain single source responsibility, utilize a single supplier to provide a drive motor, its driven equipment, and specified motor accessories.
- C. Meet requirements of NEMA MG 1.
- D. Frame assignments in accordance with NEMA MG 13.
- E. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.
- F. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
- G. Lifting lugs on all motors weighing 100 pounds or more.
- H. Operating Conditions:
  - 1. Maximum ambient temperature not greater than 40 degrees C.
  - 2. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.
  - 3. Overspeed in either direction in accordance with NEMA MG 1.

### 2.03 HORSEPOWER RATING

- A. As designated in motor-driven equipment specifications.
- B. Constant Speed Applications: Brake horsepower of the driven equipment at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor.
- C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor.

### 2.04 SERVICE FACTOR

- A. Inverter-duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.

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- B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

## 2.05 VOLTAGE AND FREQUENCY RATING

- A. System Frequency: 60 Hz.
- B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

Size	Voltage	Phases
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3
450 hp and larger	4,000	3

- C. Suitable for full voltage starting.
- D. 100 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.
- E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

## 2.06 EFFICIENCY AND POWER FACTOR

- A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:
  - 1. Efficiency:
    - a. Tested in accordance with NEMA MG 1, Paragraph 12.59.
    - b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-11, Full-load Efficiencies of Energy Efficient Motors, Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specifications.
  - 2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment Specification.

## 2.07 LOCKED ROTOR RATINGS

- A. Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 tables.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Safe stall time 12 seconds or greater.

### 2.08 INSULATION SYSTEMS

- A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.
- B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.
- C. Three-Phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specifications, Class B or Class F at nameplate horsepower and designated operating conditions, except EXP and DIP motors which must be Class B with Class B rise.
- D. Motors With Form-Wound Coils: Locked coil bracing system in accordance with NEMA C50.41.

### 2.09 ENCLOSURES

- A. Enclosures to conform to NEMA MG 1.
- B. TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.
- C. Explosion-Proof (EXP):
  - 1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class I, Division 1, Group C and D hazardous locations.
  - 2. Drain holes with drain and breather fittings.
  - 3. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
  - 4. Terminate thermostat leads in terminal box separate from main terminal box.
- D. Dust-Ignition-Proof (DIP):
  - 1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class II, Division 1, Group E.
  - 2. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
  - 3. Thermostat leads to terminate in a terminal box separate from main terminal box.
- E. Submersible: In accordance with Article Special Motors.

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- F. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article Special Motors.

## 2.10 TERMINAL (CONDUIT) BOXES

- A. Oversize main terminal boxes for all motors.
- B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.
- C. Except ODP, furnish gaskets between box halves and between box and motor frame.
- D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

Terminal Box Usable Values		
Voltage	Horsepower	Percentage
Below 600	15 through 125	500
Below 600	150 through 300	275
Below 600	350 through 600	225
Above 600	All sizes	200

- E. Terminal for connection of equipment grounding wire in each terminal box.

## 2.11 BEARINGS AND LUBRICATION

- A. Horizontal Motors:
  - 1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
  - 2. 1 through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
  - 3. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.
- B. Vertical Motors:
  - 1. Thrust Bearings:
    - a. Antifriction bearing.
    - b. Manufacturer's standard lubrication 100 hp and smaller.
    - c. Oil lubricated 125 hp and larger.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- d. Minimum 50,000 hours L-10 bearing life.
      2. Guide Bearings:
        - a. Manufacturer's standard bearing type.
        - b. Manufacturer's standard lubrication 200 hp and smaller.
        - c. Oil lubricated 250 hp and larger.
        - d. Minimum 100,000 hours L-10 bearing life.
    - C. Regreasable Antifriction Bearings:
      1. Readily accessible, grease injection fittings.
      2. Readily accessible, removable grease relief plugs.
    - D. Oil Lubrication Systems:
      1. Oil reservoirs with sight level gauge.
      2. Oil fill and drain openings with opening plugs.
      3. Provisions for necessary oil circulation and cooling.
    - E. Inverter Duty Rated Motors:
      1. Bearing Isolation: Motors larger than 20 hp shall have electrically isolated bearings to prevent stray current damage.
      2. Shaft Grounding Device: Motors larger than 1 hp shall be provided with a shaft grounding brush or conductive micro fiber shaft grounding ring. Shaft grounding device shall be solidly bonded to the grounded motor frame per manufacturer's recommendations.
        - a. Manufacturers:
          - 1) Grounding Brush: Sohre Turbomachinery, Inc.
          - 2) Grounding Ring: EST-Aegis.
- 2.12 NOISE
- A. Measured in accordance with IEEE 85 and NEMA MG 1.
  - B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.
- 2.13 BALANCE AND VIBRATION CONTROL
- A. In accordance with NEMA MG 1, Part 7.
- 2.14 EQUIPMENT FINISH
- A. Protect Motor for Service Conditions:
    1. ODP Enclosures: Indoor industrial atmospheres.

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### B. Chemical Industry, Severe-Duty (CISD-TEFC):

1. In accordance with IEEE 841.
2. TEFC in accordance with NEMA MG 1.
3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.
4. Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.
5. Ventilating Fan: Corrosion-resistant, nonsparking, external.
6. Drain and Breather Fittings: Stainless steel.
7. Nameplate: Stainless steel.
8. Gaskets between terminal box halves and terminal box and motor frame.
9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
10. Double shielded bearings.
11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
12. External Finish: Double-coated epoxy enamel.
13. Coated rotor and stator air gap surfaces.
14. Insulation System, Windings, and Connections:
  - a. Class F insulation, Class B rise or better at 1.0 service factor.
  - b. Multiple dips and bakes of nonhygroscopic polyester varnish.
15. Service Factor:
  - a. At 40 Degrees C Ambient: 1.15.
  - b. At 65 Degrees C Ambient: 1.00.
16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.

### C. Inverter Duty Motor:

1. Motor supplied power by adjustable voltage and adjustable frequency drives shall be inverter duty rated.
2. Motor shall be suitable for operation over entire speed range indicated.
3. Provide forced ventilation where speed ratio is greater than published range for motor provided.
4. Motor installed in Division 1 hazardous (classified) location shall be identified as acceptable for variable speed when used in a Division 1 location.

### D. Submersible Pump Motor:

1. Manufacturers:
  - a. Reliance Electric.
  - b. ITT Flygt Corp.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. At 100 Percent Load:

<b>Submersible Pump Motors</b>		
<b>Horsepower</b>	<b>Guaranteed Minimum Efficiency</b>	<b>Guaranteed Minimum Power Factor</b>
5 through 10	80	82
10.1 through 50	85	82
50.1 through 100	87	82
Over 100	89	82

3. Insulation System: Manufacturer's standard Class B or Class F.
4. Motor capable of running dry continuously.
5. Enclosure:
  - a. Hermetically sealed, watertight, for continuous submergence up to 65-foot depth.
  - b. Listed to meet UL 674 and NFPA 70 requirements for Class 1, Division 1, Group D hazardous atmosphere.
  - c. Seals: Tandem mechanical.
6. Bearing and Lubrication:
  - a. Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.
  - b. Minimum 15,000 hours L-10 bearing life.
7. Inrush kVA/horsepower no greater than NEMA MG 1 and NFPA 70, Code F.
8. Winding Thermal Protection:
  - a. Thermal sensor and switch assembly, one each phase, embedded in stator windings and wired in series.
  - b. Switches normally closed, open upon excessive winding temperature, and automatically reclose when temperature has cooled to safe operating level.
  - c. Switch contacts rated at 5 amps, 120V ac.
9. Motor Seal Failure Moisture Detection:
  - a. Probes or sensors to detect moisture beyond seals.
  - b. Probe or sensor monitoring module for mounting in motor controller, suitable for operation from 120V ac supply.
  - c. Monitoring module with control power transformer, probe test switch and test light, and two independent 120V ac contacts, one opening and one closing when the flux of moisture is detected.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

10. Bearing Overtemperature Protection for Motors Larger than 100 hp:
  - a. Sensor on lower bearing housing monitoring bearing temperature.
  - b. Any monitoring relay necessary to provide 120V ac contact opening on bearing overtemperature.
11. Winding thermal protection, moisture detection, and bearing overtemperature specified above may be monitored by a single device providing two independent 120V ac contacts, one closing and one opening on malfunction.
12. Connecting Cables:
  - a. One cable containing power, control, and grounding conductors.
  - b. Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.
  - c. Length: 30 feet minimum.
  - d. UL 1 listed and sized in accordance with NFPA 70.

### 2.17 FACTORY TESTING

#### A. Tests:

1. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
2. Routine (production) tests on all motors in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
  - a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
  - b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
  - c. On motors of 100 hp and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.
4. Provide certified test reports for all polyphase motors 100 hp and larger.

#### B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-11, Table 12-12.]
3. Efficiency and power factor by Test Method F, IEEE 112, Forms F-1, F-2, and F-3.
4. Temperature Test: IEEE 112, Form A-2.



MEMORIAL PARKWAY WTP ADVANCED TREATMENT

**PART 3 EXECUTION**

3.01 INSTALLATION

- A. In accordance with manufacturer's instructions and recommendations.
- B. Align motor carefully and properly with driven equipment.
- C. Secure equipment to mounting surface with anchor bolts.

3.02 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 10 hp.
- B. Manufacturer's Certificate of Proper Installation.

**END OF SECTION**

**SECTION 26 22 00  
LOW-VOLTAGE TRANSFORMERS**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
  2. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
  3. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    - b. ST 20, Dry-Type Transformers for General Applications.
    - c. TP 1, Guide For Determining Energy Efficiency for Distribution Transformers.
  4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  5. Underwriters Laboratories Inc. (UL):
    - a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
    - b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
    - c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

**1.02 SUBMITTALS**

- A. Action Submittals:
1. Descriptive information.
  2. Dimensions and weight.
  3. Transformer nameplate data.
  4. Schematic and connection diagrams.
- B. Informational Submittals:
1. Test Report: Sound test certification for dry type power transformers (0 to 600-volt, primary).

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. UL 1561, NEMA ST 20, unless otherwise indicated.
- B. Dry-type, self-cooled, two-winding, with aluminum windings.
- C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- D. Efficiency: Meet or exceed values in Table 4.2 of NEMA TP 1. 15 kVA and larger shall comply with Title 20 and Title 24.
- E. Maximum Sound Level per NEMA ST 20:
  - 1. 40 decibels for 0 kVA to 9 kVA.
  - 2. 45 decibels for 10 kVA to 50 kVA.
  - 3. 50 decibels for 51 kVA to 150 kVA.
  - 4. 55 decibels for 151 kVA to 300 kVA.
  - 5. 60 decibels for 301 kVA to 500 kVA.
- F. Overload capability: Short-term overload per IEEE C57.96.
- G. Wall Bracket: For single-phase units, 15 kVA to 37-1/2 kVA, and for three-phase units, 15 kVA to 30 kVA.
- H. Vibration Isolators:
  - 1. Rated for transformer's weight.
  - 2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
  - 3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
  - 4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.
- I. Manufacturers:
  - 1. General Electric Co.
  - 2. Square D Co.
  - 3. Eaton/Cutler-Hammer.

### 2.02 GENERAL PURPOSE TRANSFORMER

- A. Insulation Class and Temperature Rise: Manufacturer's standard.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### B. Core and Coil:

1. Encapsulated for single-phase units 1/2 kVA to 25 kVA and for three-phase units 3 kVA to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

### C. Enclosure:

1. Single-Phase, 3 kVA to 25 kVA: NEMA 250, Type 3R, nonventilated.
2. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
3. Three-Phase, 3 kVA to 15 kVA: NEMA 250, Type 3R, nonventilated.
4. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
5. Outdoor Locations: NEMA 250, Type 3R.
6. Corrosive Locations: NEMA 250, Type 3R stainless steel.

### D. Voltage Taps:

1. Single-Phase, 3 kVA to 10 kVA: Two 5 percent, full capacity, below normal voltage rating.
2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
3. Three-Phase, 3 kVA to 15 kVA: Two 5 percent, full capacity, normal voltage rating.
4. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

### E. Impedance: 4.5 percent minimum on units 75 kVA and larger.

## 2.03 SHIELDED, ISOLATION TRANSFORMER

### A. Enclosure: NEMA 250, Type 2.

### B. Primary Winding Taps: Six percent, full capacity; two above and four below rated voltage.

### C. Insulation Class and Temperature Rise: Manufacturer's standard. 15 degrees C temperature rise.

### D. Core and coils to not exceed rated temperature rise at rated ambient with neutral current 200 percent of phase current.

### E. Isolation and Noise Suppression:

1. Electrostatic Shield (Including Core and Coils): One-foil type, located between primary and secondary windings.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Ground Lead: From each shield to unit enclosure.
3. Common Mode Attenuation: 120.
4. Transverse Mode Attenuation: 20 dB.
5. Impedance: 4.3 percent, maximum.
6. Reactance: Minimum 3 percent; maximum 4.2 percent.
7. Regulation, No-Load to Full-Load: Plus or minus 1.2 percent.
8. Output Distortion: None added.
9. Fused Transient Suppression:
  - a. Peak Transient Current: 30,000 amps (8 by 20 microsecond wave).
  - b. Maximum Clamping Voltage: 360 volts at 1,000 amps.
  - c. Pulse Transient Energy: 420 joules.
  - d. Response Time: Less than 25 nano-seconds.
10. Primary Surge Protection:
  - a. Peak Transient Current: 40,000 amps.
  - b. 10-Microsecond Rise Time Volts: 2.9 kV.
11. Magnetic field strength around transformer shall be less than 0.1 gauss at 1-1/2 feet.
12. Thermal Switches:
  - a. Two, located in center cove "hot spot" to provide two-stage (high and high-high alarm) thermal sensing.
  - b. Rating: 5 amps, 120 volts, with one normally open and one normally closed contact.
  - c. Visual indicator to signal blown transient suppressor fuse.
13. Units larger than 5 kVA suitable for use with 75 degrees C wire at NEC, 75 degrees C ampacity.

### **PART 3 EXECUTION**

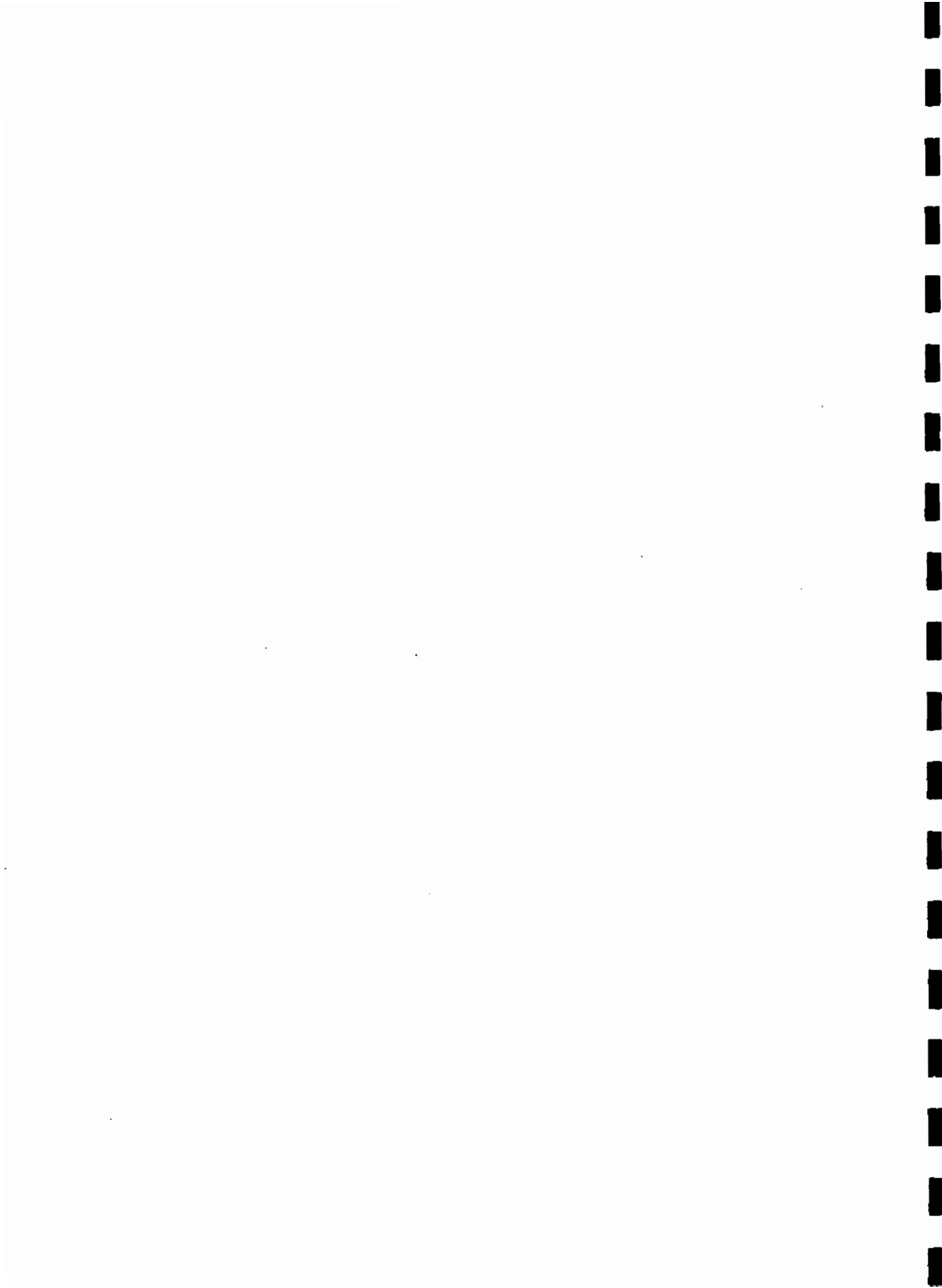
#### **3.01 INSTALLATION**

- A. Install in accordance with NECA and manufacturer's instructions.
- B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.
- C. Provide moisture-proof, flexible conduit for electrical connections.
- D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.
- E. Provide wall brackets for single-phase units, 15 kVA to 167-1/2 kVA, and three-phase units, 15 kVA to 112 kVA.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- F. Isolation Transformer: Ground isolation shields to unit enclosure with conductor of same material, and same size minimum, as shield ground lead provided with unit.

**END OF SECTION**



**SECTION 26 24 16  
PANELBOARDS**

**PART 1 GENERAL**

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE):
  - a. C62.1, Surge Arresters for Alternating Current Power Circuits.
  - b. C62.11, Standards for Metal-Oxide Surge Arrestors for AC Power Circuits.
2. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
3. National Electrical Manufacturers Association (NEMA):
  - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  - b. 289, Application Guide for Ground Fault Circuit Interrupters.
  - c. AB 1, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
  - d. KS 1, Enclosed Switches
  - e. LA 1, Surge Arrestors.
  - f. PB 1, Panelboards.
  - g. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL):
  - a. 67, Standard for Panelboards.
  - b. 98, Standard for Enclosed and Dead-Front Switches.
  - c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
  - d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
  - e. 508, Standard for Industrial Control Equipment.
  - f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
  - g. 943, Standard for Ground-Fault Circuit-Interrupters.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Manufacturer's shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
3. Tabulation of features for each panelboard to include the following:
  - a. Protective devices with factory settings.
  - b. Provisions for future protective devices.
  - c. Space for future protective devices.
  - d. Voltage, frequency, and phase ratings.
  - e. Enclosure type.
  - f. Bus and terminal bar configurations and current ratings.
  - g. Provisions for circuit terminations with wire range.
  - h. Short circuit current rating of assembled panelboard at system voltage.
  - i. Features, characteristics, ratings, and factory settings of auxiliary components.
  - j. Wiring and schematic diagrams detailing control wiring, and differentiating between manufacturer-installed and field-installed wiring.

## B. Informational Submittals:

1. Manufacturer's recommended installation instructions.

## 1.03 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled as defined in NEC Article 100.

## 1.04 EXTRA MATERIALS

- A. Extra Materials: Furnish, tag, and box for shipment and storage the following special tools and material:

<u>Item</u>	<u>Quantity</u>
Touch-up paint for panelboards	One half-pint container
Special tools required to maintain or dismantle	One complete set

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
  1. Eaton/Cutler-Hammer.

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2. General Electric Co.
  3. Square D Co.
- B. Panelboards shall be of the same manufacturer as equipment furnished under Section 26 14 13, Switchboards and 26 24 19, Low-Voltage Motor Control.

### 2.02 GENERAL

- A. Provide low voltage panelboards for application at 600V or less in accordance with this Section
- B. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.
- C. Wire Terminations:
1. Panelboard assemblies, including protective devices, shall be suitable for use with 75 degrees C or greater wire insulation systems at NEC 75 degrees C conductor ampacity.
  2. In accordance with UL 486E.
- D. Load Current Ratings:
1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
  2. Where indicated "continuous", "100 percent", etc., selected components and protective devices shall be rated for continuous load current at value shown.
- E. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the following:
1. Minimum SCCR at 208Y/120 or 120/240 volts shall be 10,000 amperes rms symmetrical.
  2. Minimum SCCR at 480Y/277 volts shall be 14,000 amperes rms symmetrical.
- F. Overcurrent Protective Devices:
1. In accordance with NEMA AB 1, NEMA KS 1, UL 98, and UL 489.
  2. Protective devices shall be adapted to panelboard installation.
    - a. Capable of device replacement without disturbing adjacent devices and without removing main bus.
    - b. Spaces: Cover openings with easily removable cover.

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3. Series-Connected Short Circuit Ratings: UL 67 listed, series-connected ratings are acceptable except NEC Article 700 Emergency System devices shall be fully rated.

### G. Circuit Breakers:

1. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
2. Noninterchangeable: In accordance with NEC.
3. Bus Connection: Bolt-on circuit breakers in all panelboards.
4. Trip Mechanism:
  - a. Individual permanent thermal and magnetic trip elements in each pole.
  - b. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
  - c. Two and three pole, common trip.
  - d. Automatically opens all poles when overcurrent occurs on one pole.
  - e. Test button on cover.
  - f. Calibrated for 40 degrees C ambient, unless shown otherwise.
5. Unacceptable Substitution:
  - a. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
  - b. Do not use tandem or dual circuit breakers in normal single-pole spaces.
6. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).
  - a. Ground fault sensor shall be rated same as circuit breaker.
  - b. Push-to-test button.
  - c. Reset button.
7. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).

### H. Enclosures:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Material: Type 1, Type 3R, and Type 3S shall be code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Finish: Rust inhibitor prime followed by manufacturer's standard gray baked enamel or lacquer.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- I. Bus:
  - 1. Material: tin-plated copper full sized throughout length.
  - 2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
- J. Feeder Lugs: Main, feed-through, and neutral shall be replaceable, bolted mechanical or crimp compression type.
- K. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.
  - 1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
  - 2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.
  - 3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.
- L. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.
  - 1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
  - 2. Provide individual termination points for all other neutral conductors.
  - 3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.
  - 4. Oversize Neutral: Provide oversized neutral terminal bus as indicated.
- M. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.
- N. Special Features: Where indicated, provide the following features:
  - 1. Isolated Equipment Ground Terminal Bar:
    - a. Provide in addition to equipment ground terminal bar specified above.
    - b. Insulated from box.
    - c. Provide individual conductor termination points equal to quantity of breaker pole positions plus all feeder, subfeeder, and feed-through isolated ground conductors.
  - 2. Controls:
    - a. Provide controls in accordance with UL 508.
    - b. Controls shall be Class I, 120V ac.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- c. Control circuits shall be protected by fuse or circuit breaker.
3. Surge Arresters:
  - a. In accordance with NEMA LA 1, IEEE C62.1, and IEEE C62.11.
  - b. Comply with Section 26 43 00, Transient Voltage Suppression.
  - c. Coordinate impulse sparkover voltage with system voltage.
  - d. Provide protective device within panelboard as disconnecting means and short circuit protection per manufacturer's recommendation.
  - e. TVSS shall be provided external to panelboard. Provide panelboard circuit breaker for TVSS.

### 2.03 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

- A. Protective Device Locking: Furnish provisions for handle padlocking for main and subfeed devices; also provide for branch devices where indicated.
- B. Multi-Section Panelboards: Where more than 42 poles are required or more than one section is otherwise indicated, provide multiple panelboards with separate fronts.
  1. Panelboard sections shall be individually installed and field interconnected to form a single electrical unit.
  2. Unless otherwise indicated, provide feed-through lugs on each section but last.
  3. Surface-mount panels shall be individually mounted and may be different sizes.
  4. Recessed-mount panels shall be individually mounted and the same size tub and flush cover.
  5. Surface-mount multi-section panelboards may be comprised of sections of unequal heights.
  6. Provide feed-through and main lugs in individual sections as required for field assembly of a complete multi-section panelboard.
  7. Provide neutral and ground terminal bars in each section.
- C. NEMA 250 Type 1 Branch Panelboard Enclosure:
  1. Front trim shall be secured to box with concealed trim clamps.
  2. Surface-mount panelboard front trim shall have same dimensions as box.
  3. Flush panelboards front trims shall overlap box nominal 3/4 inch on all sides.
  4. Door in panelboard front trim, with concealed hinges, shall provide access to protective device operating handles.
  5. Doors over 30 inches in height shall have multi-point latching.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

6. Door lock shall be secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
7. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.
8. Hinged Front Cover (Door In Door): Entire front trim hinged to surface box with standard door within hinged trim cover.

### 2.04 POWER DISTRIBUTION PANELBOARDS

#### A. Branch Protective Devices:

1. Locking: Furnish devices with provisions for handle padlocking.
2. Load Connections: Wire lugs shall be mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
3. Provide a nameplate for each circuit, blanks for spares.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Install in accordance with NECA 407, NEMA PB 1.1 and manufacturers' written installation instructions.
- B. Install securely, plumb, in-line and square with walls.
- C. Install top of cabinet trim 78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.
- D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.
- E. Install filler plates in unused spaces.
- F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle, and wrap with nylon wire ties.

### 3.02 BRANCH CIRCUIT PANELBOARD

- A. Mount flush panels uniformly flush with wall finish.
- B. Provide typewritten circuit directory for each panelboard.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. In addition to conduit or nipples otherwise required for feeder and branch circuit wiring between multi-section panelboard sections, provide nipples for branch circuits two trade sizes larger than required for installed branch circuit wires or an empty 2-inch nipple, or a 1-1/4-inch trade size conduit if tubs are more than 24 inches apart.
- D. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panel into accessible ceiling space or space designated to be ceiling space in future. Stub four 1-inch empty conduits into raised floor space or below slab other than slabs on grade.

### 3.03 POWER DISTRIBUTION PANELBOARD

- A. Provide engraved identification for each protective device.

### 3.04 PANELBOARD SCHEDULES

- A. Refer to the Drawings for Panelboard Schedules.

**END OF SECTION**

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## SECTION 26 24 19 LOW-VOLTAGE MOTOR CONTROL

### PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which shall be followed for this section:
1. American National Standard Institute (ANSI): C2, National Electrical Safety Code (NESC).
  2. National Electrical Contractors Association (NECA): 402, Recommended Practice for Installing Motor Control Centers (ANSI).
  3. National Electrical Manufacturers Association (NEMA):
    - a. ABI, Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.
    - b. ICS 1, Industrial Control and Systems: General Requirements.
    - c. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
    - d. ICS 2.3, Industrial Control and Systems: Instructions for Handling, Installation, Operation, and Maintenance of Motor Control Centers.
    - e. ICS 18, Motor Control Centers.
    - f. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
    - g. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
  4. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
  5. Underwriters Laboratories, Inc. (UL):
    - a. 0098, Enclosed and Dead-Front Switches.
    - b. 489, Molded Case Circuit Breakers and Circuit Breaker Enclosures.

#### 1.02 DEFINITIONS

- A. CT: Current Transformer.
- B. LCD: Liquid Crystal Display.
- C. N.C.: Normally Closed.
- D. N.O.: Normally Open.
- E. THD: Total Harmonic Distortion.



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

F. VT: Voltage Transformer.

## 1.03 SUBMITTALS

### A. Action Submittals:

1. Itemized bill of material.
2. Descriptive information.
3. Dimensional drawings.
4. Front Panel Elevations.
5. Conduit entrance locations.
6. Bus data.
7. Protective Devices: Copies of time-current characteristics.
8. Operational description.
9. Typed tabulation:
  - a. Motor name; tag (equipment) numbers as shown on Drawings.
  - b. Motor horsepower.
  - c. Nameplate full load current.
  - d. Measured load current and voltage.
  - e. Heater model number and relay setting.
  - f. Protective device trip settings.
  - g. Manufacturer's solid state starter switch or dip switch or program settings.
  - h. Attach above typed, tabulated data to a copy of starter manufacturer's overload heater or setting selection tables for starters provided.
10. Control diagrams.
11. One-line diagrams.
12. Schematic (elementary) diagrams.
13. Outline diagrams.
14. Wireless unit connection diagrams.
15. Interconnection diagrams.
16. Anchoring instructions and details.

### B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Factory test reports, certified.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

## 1.04 QUALITY ASSURANCE

- A. Provide products manufactured within scope of Underwriters Laboratories that conform to UL Standards and have applied UL Listing Mark.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Shipping Splits: Established by Contractor to facilitate ingress of equipment to final installation location within building.

**PART 2 PRODUCTS**

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
  - 1. Eaton Electrical/Cutler-Hammer.
  - 2. GE Industrial Systems.
  - 3. Schneider Electric/Square D Services.
  - 4. Allen-Bradley.
  - 5. Siemens.

2.02 GENERAL

- A. Like Items of Equipment: End product of one manufacturer and same manufacturer as low voltage switchboard and panelboards for standardization.
- B. Make adjustments necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.
- C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.
- D. Control Transformer:
  - 1. Two winding, 120-volt secondary, primary voltage to suit.
  - 2. Two current-limiting fuses for primary circuit.
  - 3. One fuse in secondary circuit with blown fuse indicator.
  - 4. Mount within starter unit.
- E. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- F. Lifting lugs on all equipment and devices weighing over 100 pounds.
- G. Anchor Bolts: Type 316 stainless steel, 1/2-inch minimum diameter.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### H. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Altitude: Zero feet.
3. Equipment to be fully rated.

### I. Enclosures: In accordance with NEMA 250.

### J. Equipment Finish:

1. Electrocoating process applied over rust-inhibiting phosphated base coating.
2. Exterior Color: Manufacturer's standard.

## 2.03 SEPARATELY MOUNTED MOTOR CONTROL

### A. Manually Operated Starter, Fractional Horsepower:

1. Rating: 16 amperes continuous at 277 volts maximum.
2. Single-phase, nonreversing, full voltage with overload protection.
3. Toggle operated, keyed where shown.
4. Enclosure: NEMA 250, Type 1.
5. Neon Light: Green.
6. Handle guard/lock-off attachment.

### B. Manually Operated Starter, Integral Horsepower:

1. Rating: Horsepower rated to maximum of 10 horsepower at 600 volts with overload protection.
2. Single- or three-phase, nonreversing, full voltage.
3. Control: Toggle or pushbutton.
4. Enclosure: NEMA 250, Type 1 4X
5. Red indicating light in series with auxiliary contact.
6. Locking in OFF position.
7. Two spare auxiliary, field-changeable contacts.

### C. Combination Full-Voltage, Magnetic Starter:

1. Rating: Horsepower rated at 600 volts, UL labeled for 22,000 amperes at 480-volts short circuit capacity with overload protection.
2. Three-phase, nonreversing, full voltage.
3. Control: As shown.
4. Disconnect Type: Motor circuit protector.
5. Enclosure: NEMA 250, Type 1 4X.
6. Indicating Lights: Green—ON and Red—OFF.
7. Padlockable operating handle, capable of up to three locks.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### D. Combination Reduced Voltage, Solid State Starter:

1. Rating: Horsepower rated at 600 volts, UL labeled for 22,000 amperes at 480-volts short circuit capacity with overload protection.
2. Three-phase, nonreversing with bypass run contactor.
3. Control: As shown.
4. Disconnect Type: Motor circuit protector.
5. Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
6. Kick start, with adjustable torque and time settings.
7. Ramp start, selectable current or torque, and adjustable time.
8. Smooth stop ramp, adjustable time.
9. Phase loss unbalance and phase reversal protection.
10. LED display or LCD of fault, N.O. contact to communicate fault conditions.
11. Enclosure: NEMA 250, Type I.
12. Indicating Lights: Green-ON and Red-OFF.
13. Padlockable operating handle, capable of up to three locks.

### E. Combination Two-Speed Motor, Magnetic Starter:

1. Rating: Hp rated at 600 volts, UL labeled for 22,000 amperes at 480-volts short circuit capacity with overload protection.
2. Three-phase, nonreversing, full voltage.
3. Control: As shown.
4. Disconnect Type: Motor circuit protector.
5. Suitable for two-speed, two winding motors.
6. Enclosure: NEMA 250, Type 1 4X.
7. Indicating Lights: Red-OFF Green-HIGH SPEED and Amber-LOW SPEED.
8. Padlockable operating handle, capable of up to three locks.

### F. Full Voltage, Magnetic Starter:

1. Rating: Horsepower rated at 600 volts with overload protection.
2. Three-phase, nonreversing, full voltage.
3. Control: As shown.
4. Enclosure: NEMA 250, Type 1 4X.
5. Indicating Lights: Green-ON and Red-OFF.
6. Padlockable operating handle, capable of up to three locks.
7. Reduced Voltage, Solid State Starter:
8. Rating: Horsepower rated at 600 volts with overload protection.
9. Three-phase, nonreversing with bypass run contactor.
10. Control: As shown.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

11. Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
12. Kick start, with adjustable torque and time settings.
13. Ramp start, selectable current or torque, and adjustable time.
14. Smooth stop ramp, adjustable time.
15. Phase loss unbalance and phase reversal protection.
16. LED display or LCD of fault, N.O. contact to communicate fault conditions.

### G. Two-Speed, Magnetic Starter:

1. Rating: Horsepower rated at 600 volts with overload protection.
2. Three-phase, nonreversing, full voltage.
3. Control: As shown.
4. Suitable for two-speed, two winding.
5. Enclosure: NEMA 250, Type 1 4X.
6. Indicating Lights: Red-OFF, Green-HIGH SPEED, Amber-LOW SPEED.
7. Padlockable operating handle, capable of up to three locks.

### H. Thermal Motor Overload Protection:

1. Inverse-time-limit characteristic.
2. Heater: Bimetallic overload, adjustable trip, or directly heated melting alloy, ratchet principle type element.
3. Relay Trip: Quick, Class 10. Manual reset.
4. Provide in each ungrounded phase.
5. Mount within starter unit.

### I. Solid State Motor Overload Protection:

1. Inverse-time-limit characteristic.
2. Phase loss, phase unbalanced and Class II ground fault protection.
3. Current operated electronic circuitry with adjustable trip.
4. Class 10/20/30 relay trip, switch selectable.
5. N.O. auxiliary contact for remote monitoring.
6. Manual reset.
7. Provide in each ungrounded phase.
8. Mount within starter unit.
9. Communications: None.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install equipment in accordance with NEMA ICS 2.3, ANSI C2, Submittals, and manufacturer's written instructions and recommendations.
- B. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
- C. Install equipment plumb and in longitudinal alignment with pad or wall.
- D. Coordinate terminal connections with installation of secondary feeders.
- E. Grout mounting channels into floor or mounting pads.
- F. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

**3.02 CIRCUIT BREAKERS**

- A. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.
- B. Adjust to approximately 11 times motor rated current.
- C. Determine motor rated current from motor nameplate following installation.

**3.03 OVERLOAD RELAY**

- A. Select and install overload relay heaters and switch settings after actual nameplate full-load current rating of motor has been determined.

**3.04 MOTOR DATA**

- A. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
  - 1. Motor served by tag number and equipment name.
  - 2. Nameplate horsepower.
  - 3. Motor code letter.
  - 4. Full load amperes.
  - 5. Service factor.
  - 6. Installed overload relay heater catalog number.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.05 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative in accordance with Section 01 43 33, **Manufacturers' Field Services**, for the following services at jobsite or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:
1. One person-days for installation assistance, and inspection of installation.
  2. One person-days for plant startup.

**END OF SECTION**

**SECTION 26 27 26  
WIRING DEVICES**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
  2. Federal Specifications (FS):
    - a. W-C-596, General Specification for Connector, Electrical, Power.
    - b. W-S-896F/GEN, Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
  3. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    - b. WD 1, General Requirements for Wiring Devices.
  4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  5. Underwriters Laboratories Inc. (UL):
    - a. 498, Standard for Attachment Plugs and Receptacles.
    - b. 508, Standard for Safety for Industrial Control Equipment.
    - c. 943, Standard for Ground-Fault Circuit-Interrupters.
    - d. 1449, Standard for Transient Voltage Surge Suppressors.

1.02 SUBMITTALS

- A. Action Submittals: Manufacturer's product data for wiring devices.

**PART 2 PRODUCTS**

2.01 SWITCHES

- A. Switch, General Purpose:
1. NEMA WD 1 and FS W-S-896F/GEN.
  2. Totally enclosed, ac type, with quiet tumbler switches and screw terminals.
  3. Rivetless one-piece brass or copper alloy contact arm with silver alloy contacts.
  4. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
  5. Rating: 15 amps, 120/277 volts.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

6. Color:
    - a. Office Areas: Gray.
    - b. Other Areas: Gray.
  7. Switch with Pilot Light: 125 volts, neon light with red jewel, or lighted toggle when switch is ON.
  8. Automatic grounding clip and integral grounding terminal on mounting strap.
  9. Manufacturers and Products, Industrial Grade:
    - a. Arrow Hart; 1201/2221 Series.
    - b. Bryant; 4801/4901 Series.
    - c. Hubbell; 1202/1222 Series.
    - d. Leviton; 1201/1221 Series.
  10. Manufacturers and Products, Commercial Grade:
    - a. Arrow Hart; CSB115/CSB120.
    - b. Bryant; CSB115/CSB120.
    - c. Hubbell; CSB115/CSB120.
    - d. Leviton; CSB1-15/CSB1-20 Series.
- B. Switch, Motor Rated:
1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
  2. Enclosure/Mounting and Rating:
    - a. General Purpose:
      - 1) Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts. UL 508 listed.
      - 2) General Purpose Rating: 30 amperes, 600V ac.
      - 3) Minimum Motor Ratings:
        - a) 2 hp for 120V ac, single-phase, two-pole.
        - b) 3 hp for 240V ac, single-phase, two-pole.
        - c) 15 hp for 480V ac, three-phase, three-pole.
      - 4) Screw-type terminals.
    - b. Explosion-Proof:
      - 1) Provide enclosed manual motor starter-type. Three-pole nonreversing contactor.
      - 2) Minimum Motor Rating: 10 hp, 480V ac, three-phase, three-pole.
      - 3) Enclosure: NEMA 250, Type 7.
      - 4) Provide lockable external handle operator.
  3. Manufacturers:
    - a. General Purpose:
      - 1) Bryant.
      - 2) Hubbell.
    - b. Explosion-Proof: Eaton, Type B101.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.02 RECEPTACLES

#### A. Receptacle, General Purpose:

1. NEMA WD 1 and FS W-C-596.
2. Duplex, two-pole, three-wire grounding type with screw type wire terminals.
3. Impact resistant nylon cover and body.
4. One-piece mounting strap with integral ground contact (rivetless construction).
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. Size: For 2-inch by 4-inch outlet boxes.
8. Industrial Grade:
  - a. Color:
    - 1) Office Areas: Gray.
    - 2) Other Areas: Gray.
  - b. Manufacturers and Products:
    - 1) Arrow Hart; 5262/5362 Series.
    - 2) Bryant; 5262/5362 Series.
    - 3) Hubbell; 5262/5362 Series.
    - 4) Leviton; 5262/5362 Series.
    - 5) Receptacle, Ground Fault Circuit Interrupter:
9. Meet requirements of general-purpose receptacles.
10. Listed Class A to UL 943, tripping at 5 mA.
11. Color: Ivory.
12. Standard Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails screw terminals and provisions for testing.
13. Feed-Through Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails feed-through screw terminals and provisions for testing.
14. Manufacturers:
  - a. Bryant.
  - b. Hubbell.
  - c. Arrow Hart.
  - d. Leviton.

#### B. Receptacle, Corrosion-Resistant.

1. Meet requirements of general-purpose receptacles.
2. Nickel coated metal parts.
3. Color: Yellow.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

4. Manufacturer and Product:
  - a. Hubbell; 52CM62/53CM62
  - b. Leviton; 52CM-62/53CM-62.

### C. Receptacle, Special-Purpose:

1. Rating and number of poles as indicated or required for anticipated purpose.
2. One matching plug with cord-grip features for each special-purpose receptacle.

## 2.03 DEVICE PLATES

### A. General: Sectional type plates not permitted.

### B. Plastic:

1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
2. Color: To match associated wiring device.
3. Mounting Screw: Oval-head metal, color matched to plate.

### C. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

### D. Cast Metal:

1. Material: Copper-free aluminum, with gaskets.
2. Screw: Oval-head stainless steel.

### E. Sheet Steel:

1. Finish: Zinc electroplate.
2. Screws: Oval-head stainless steel.
3. Manufacturers:
  - a. Appleton.
  - b. Crouse-Hinds.

### F. Engraved:

1. Character Height: 1/8 inch.
2. Filler: Red.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- G. Weatherproof:
  - 1. Receptacles, Weatherproof Type 1:
    - a. Gasketed, cast-aluminum, with individual cap over each receptacle opening.
    - b. Mounting Screw and Cap Spring: Stainless steel.
    - c. Manufacturers and Products:
      - 1) Crouse-Hinds; Type WLRD-1.
      - 2) Appleton; Type FSK-WRD.
  - 2. Receptacles, Weatherproof Type 2:
    - a. UL listed for WET location while in use.
    - b. Polycarbonate cover.
    - c. Locking type.
    - d. Manufacturers and Products: TayMac; Type Multi-Mac.
  - 3. Switches:
    - a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
    - b. Mounting Screw: Stainless steel.
    - c. Manufacturers and Products:
      - 1) Crouse-Hinds; DS-181 or DS-185.
      - 2) Appleton; FSK-1VTS or FSK-1VS.
- H. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.
- I. Sheet Steel: Formed sheet steel or Feraloy designed for installation on cast metal boxes.

### **PART 3 EXECUTION**

#### **3.01 SWITCHES**

- A. Switch, General Purpose:
  - 1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
  - 2. Install with switch operation in vertical position.
  - 3. Install single-pole, two-way switches so toggle is in up position when switch is on.
- B. Switch, Motor Rated:
  - 1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
  - 2. Install with switch operation in vertical position so toggle is in up position when ON.
  - 3. Install within sight of motor when used as a disconnect switch.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.02 RECEPTACLES

#### A. Duplex Receptacles:

1. Install with grounding slot up, down, except where horizontal mounting is shown, in which case install with neutral slot up, down.
2. Ground receptacles to boxes with grounding wire only.
3. Weatherproof Receptacles:
  - a. Install in cast metal box.
  - b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

### 3.03 DEVICE PLATES

- A. Securely fasten to wiring device; ensure a tight fit to box.
- B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.
- C. Surface Mounted: Plate shall not extend beyond sides of box, unless plates have no sharp corners or edges.
- D. Install with alignment tolerance to box of 1/16 inch.
- E. Engrave with designated titles.
- F. Types (Unless Otherwise Shown):
  1. Office: Plastic.
  2. Exterior:
    - a. Switch: Weatherproof.
    - b. Receptacle in DAMP location: Weatherproof Type 1.
    - c. Receptacle in WET location: Weatherproof Type 2.
- G. Interior:
  1. Flush Mounted Boxes: Plastic.
  2. Surface Mounted, Metal Boxes:
    - a. General Purpose Areas: Sheet Steel.
    - b. Other Areas: Cast.

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3. Surface Mounted, Aluminum Boxes:
  - a. General Purpose Areas: Stamped.
  - b. Other Areas: Cast.
4. Surface Mounted, Sheet Steel Boxes: Raised sheet steel.
5. Surface Mounted, Nonmetallic Boxes: Manufacturer's standard.
6. Receptacle shown as Weatherproof on Drawings: Weatherproof Type I.

**END OF SECTION**



**SECTION 26 29 23**  
**LOW-VOLTAGE ADJUSTABLE FREQUENCY DRIVE SYSTEM**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Electronic Industries Alliance (EIA), Telecommunications Industry Association (TIA): 359-1, Special Colors.
  2. Institute of Electrical and Electronics Engineers (IEEE):
    - a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
    - b. 519, Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.
    - c. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
  3. National Electrical Manufacturer's Association (NEMA):
    - a. CP 1, Shunt Capacitors.
    - b. MG 1, Motors and Generators.
    - c. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - d. WC-57, Control Cables.
  4. National Fire Protection Association (NFPA): Electrical Standard for Industrial Machinery.

1.02 DEFINITIONS

- A. Terms that may be used in this section:
1. AFD: Adjustable frequency drive.
  2. CMOS: Complementary metal oxide semiconductor.
  3. CSI: Current Source Inverter.
  4. EMU: Energy monitoring unit.
  5. GTO: Gate Turn-Off Thyristor.
  6. MPR: Motor protection relay.
  7. MTBF: Mean time between failure
  8. PWM: Pulse width modulation.
  9. ROM: Read only memory.
  10. RTD: Resistance temperature detector.
  11. RTU: Remote Telemetry Unit.
  12. Rated Load: Load specified for the equipment.



13. Rated Speed: Nominal rated (100 percent) speed specified for the equipment.
14. TDD: Total demand distortion.
15. THD: Total harmonic distortion.
16. TTL: Transistor transistor logic.

### 1.03 SYSTEM DESCRIPTION

#### A. Performance Requirements:

1. Composite drive/motor efficiency (CE) is defined as ratio of motor shaft kW to drive input kW. AFD system minimum composite efficiency requirements:
  - a. At 60-Hz drive output and 100 percent load, CE = 92 percent.
  - b. At 50-Hz drive output and 60 percent load CE = 89 percent.
  - c. At 40-Hz drive output and 30 percent load CE = 84 percent.
  - d. At 30-Hz drive output and 12.5 percent load CE = 77 percent.
2. Rated Continuous Operation Capacity: Not less than 1.15 times full load current rating of driven motor, as indicated on the motor nameplates, and suitable for continuous operation at any continuous overload which may be imposed on motor by driven pump operating over specified speed range.
3. Basis for Harmonic Computations: Using Simplified Plant One-Line Diagram for current and voltage distortion computations, furnish harmonic filters, line reactors, isolation transformers, or higher pulse converter arrangements required to meet current/voltage distortion and line notching limits.
4. Normal Source Current Harmonic Distortion:
  - a. Compute normal source individual and total current harmonic distortion at the location identified as PCC1, in accordance with IEEE Standard 519, Table 10.2. Individual current harmonic distortion and the total demand distortion expressed as percent of maximum demand load current  $I_L$  shall not exceed values specified in IEEE Standard 519.

#### B. Design Requirements:

1. Design and provide drive system consisting of adjustable frequency controller, drive motor, certain auxiliary items, and components necessary for complete operating system.
2. Other equipment is being powered from same bus as adjustable frequency drives. Ensure proper operation of drives and other loads under normal and emergency conditions.
3. Furnish AFDs rated on basis of actual motor full load nameplate current rating.
4. Drive System: Convert incoming three-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of a standard ac induction squirrel-cage motor, using the

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- pulse-width-modulation (PWM) technique to produce the adjustable frequency output.
5. System rated for continuous industrial duty and suitable for use with Standard NEMA MG 1, Design B motors.
  6. Incoming Line Circuit Breaker: Provide positive means of disconnecting incoming power, and overcurrent protection for the drive system.
  7. Incoming Line Reactor: Design to minimize harmonic distortion on the incoming power feeder.

### 1.04 SUBMITTALS

#### A. Action Submittals:

1. Overall drive system operating data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, 100, and 110 percent of rated speed.
2. Individual and total harmonic content (voltage and current) reflected in system normal source supply at driven equipment actual load at 70 and 100 percent of rated speed at locations specified in Simplified Plant One-Line Diagram, and load conditions specified. Normal source system short-circuit available at drive shall be calculated from data furnished in Supplements to this section. Use TDD and THD factors as defined in IEEE Standard 519 to designate total harmonic content.
3. Individual and total current and voltage harmonic content reflected in STANDBY power source, at locations specified in Supplements to this section, at driven equipment actual load at 70 and 100 percent of rated speed determined by using actual size and subtransient reactance of STANDBY system obtained from standby source manufacturer. Use TDD and THD factors as defined in IEEE Standard 519 to designate total harmonic content.
4. AFD output pulse maximum peak voltage, pulse rise time and pulse rate of rise, including any justification for proposed deviation from specified values. Include motor manufacturer's certification that motor insulation will withstand long-term overvoltages caused at motor terminals due to specified output pulse data or any proposed deviation from this data.
5. Data on the shelf life of "dc link" capacitor.
6. Complete system rating, including all nameplate data, continuous operation load capability throughout speed range of 0 to 120 percent of rated speed.
7. Complete adjustable frequency controller rating coordinated with motor full load nameplate current rating; list any controller special features being supplied.

8. Controller, reactor, harmonic filter, and isolating transformer (if applicable) dimensional drawings; information on size and location of space for incoming and outgoing conduit.
9. Maximum heat dissipation from enclosure.
10. Should separate enclosures and equipment be necessary for filter elements provide complete dimensional information including location of space for incoming and outgoing conduit, weight, maximum heat loss, and minimum current carrying capacity and recommended wire size for required interconnecting circuits.
11. Layout of controller face showing pushbuttons, switches, instruments, indicating lights, etc.
12. Complete system operating description.
13. Complete system schematic (elementary) wiring diagrams.
14. Complete system interconnection diagrams between controller, drive motor, and all related components or controls external to system, including wire numbers and terminal board point identification.
15. One-line diagram of system, including component ratings.
16. Description of diagnostic features being provided.
17. Descriptive literature for all control devices such as relays, timers, etc.
18. Itemized bill-of-materials listing all system components.
19. Specific description of provisions, such as filtering and harmonic suppression, being made to ensure proper system operation when and system is supplied from standby engine generator specified in these Documents.
20. Description of EMU and MPR being furnished or how these functions are accomplished within drive system.

**B. Informational Submittals:**

1. Statement of Supplier qualifications.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Factory functional test reports.
5. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B, showing rated load, rated speed efficiency meeting or exceeding specified values; motors not as specified will be rejected.
6. Field test reports.
7. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
8. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
9. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

10. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

### 1.05 QUALITY ASSURANCE

- A. Supplier: Minimum 5 years' experience in furnishing similar size and type adjustable frequency, controlled speed, drive systems.

### 1.06 EXTRA MATERIALS

- A. Furnish for each drive unit:
  1. Complete set of components likely to fail in normal service.
  2. Plug-in subassemblies.
  3. Printed circuit boards.
  4. SCRs.
  5. Potentiometers.
  6. Integrated circuits.
  7. One complete power bridge and one spare printed circuit card for each modular, plug-in type card in controller.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Components and accessories specified in this section shall be products of: Allen-Bradley or equal.

### 2.02 SUPPLEMENTS

- A. Some specific requirements are attached to this section as supplements.

### 2.03 SERVICE CONDITIONS

- A. Ambient Operating Temperature: 32 to 104 degrees F.
- B. Storage Temperature: Minus 40 to 158 degrees F.
- C. Humidity: 0 to 95 percent relative (noncondensing).
- D. Altitude: 0 to 3,300 feet.
- E. Frequency Stability: Plus or minus 0.1 percent of maximum frequency.

## 2.04 COMPONENTS

### A. Drive Units:

1. Incorporate a switching power supply operating from a dc bus, to produce a PWM output waveform simulating a sine wave and providing power loss ride through of 2 milliseconds at full load, full speed.
2. Current-limiting semiconductor fuses for protection of internal power semiconductors.
3. Employ a diode bridge rectifier providing a constant displacement power factor of 0.95 minimum at all operating speeds and loads.
4. Use transistors for output section, providing a minimum 97 percent drive efficiency at full speed, full load.
5. Employ dc power discharge circuit so that after removal of input power dc link capacitor voltage level will decay below 50 volts dc within 1 minute after de-energizing following NEMA CP 1 and NFPA 79. Design dc link capacitor for a MTBF of 5 years.
6. Operate with an open circuited output.
7. Input Voltage: 480V ac plus or minus 10 percent.
8. Output Voltage: 0 to 480 volts, three-phase, 0 to 66-Hz, minimum.
9. Maximum peak voltage of PWM AFD output pulse of 1,000 volts, with pulse rise time of not less than 2 microseconds, and a maximum rate of rise of 500 volts per microsecond. Maximum frequency of PWM AFD output pulse (carrier) frequency of 3,000-Hz. Should magnitudes of these characteristics be more stressful to motor insulation than specified values, furnish insulation systems on the motors suitable for the proposed values.
10. Motor Audible Noise Level: When operating throughout speed range of PWM AFD, no more than 3 dBA above that designated in NEMA MG 1 for same motor operated at constant speed with a 60-Hz supply voltage.
11. Short-Time Overload Capacity: 125 percent of rated load in rms current for 1 minute following full load, full speed operation.
12. Equipment Short-Circuit Rating: Suitable for connection to system with maximum source three-phase, bolted fault, short-circuit available of 42,000 amps rms symmetrical at 480 volts.
13. Furnish drives with output current-limiting reactors mounted within equipment enclosure.
14. Diagnostics: Comprehensive for drive adjustment and troubleshooting:
  - a. Memory battery backup; 100-hour minimum during a power loss.
  - b. Status messages will not stop drive from running but will prevent it from starting.
  - c. Fault Condition Messages and History: First fault protection function to be activated, ability to store six successive fault occurrences in order. Minimum faults numerically:
    - 1) Overcurrent (time and instantaneous).
    - 2) Overvoltage.
    - 3) Undervoltage (dc and ac).

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- 4) Overtemperature (drive, motor windings, motor bearing, pump bearing).
  - 5) Serial communication fault.
  - 6) Short-circuit/ground fault (motor and drive).
  - 7) Motor stalled.
  - 8) Semiconductor fault.
  - 9) Microprocessor fault.
  - 10) Single-phase voltage condition.
15. Drive Protection:
- a. Fast-acting semiconductor fuses.
  - b. Overcurrent, instantaneous overcurrent trip.
  - c. Dc undervoltage protection, 70 percent dropout.
  - d. Dc overvoltage protection, 130 percent pickup.
  - e. Overtemperature, drive, inverter, converter, and dc link components.
  - f. Overtemperature, motor, and pump.
  - g. Single-phase protection.
  - h. Reset overcurrent protection (manual or automatic reset).
  - i. Active current limit/torque limit protection.
  - j. Semiconductor fault protection.
  - k. Short-circuit/ground fault protection.
  - l. Serial communication fault protection.
  - m. Microprocessor fault.
  - n. Surge protection for transient overvoltage (6,000 volts, 80 joule surge, tested per IEEE C62.41).
  - o. Visual display of specific fault conditions.
16. Operational Features:
- a. Use manufacturer's standard unless otherwise indicated.
  - b. Sustained power loss.
  - c. Momentary power loss.
  - d. Power interruption.
  - e. Power loss ride through (0.1 second).
  - f. Start on the fly.
  - g. Electronic motor overload protection.
  - h. Stall protection.
  - i. Slip compensation.
  - j. Automatic restart after power return (ability to enable/disable function).
  - k. Critical frequency lockout (three selectable points minimum, by 1.5-Hz steps in 10-Hz bands, to prevent resonance of system).
  - l. Drive maintenance system software for complete programming and diagnostics.
  - m. Ground fault protection, drive, and motor.
  - n. Operate with no motor connected to output terminals.

- B. Rectifiers: 1. Greater than 50 HP - Three-phase 18-pulse full wave diode bridge rectifier to provide a constant dc voltage to the drive's dc bus. 2. 50 HP and below – Three-phase 6 pulse full wave diode bridge rectifier with minimum impedance, 5 percent input line reactors
- C. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.
- D. Controller: Microprocessor-controller PWM inverter to convert to dc voltage to variable voltage, adjustable frequency three-phase ac output. The output voltage shall vary proportionally with the frequency to maintain a constant ratio of volts to hertz up to 60-Hz. Above 60-Hz, the voltage shall remain constant, with the drive operating in a constant horsepower output mode.
- E. Enclosure:
  - 1. NEMA 250, Type 1, gasketed, freestanding, enclosure for mounting against wall, completely front accessible, and hinged doors. Properly sized to dissipate heat generated by controller within limits of specified operating conditions (including ambient temperature and ambient airflow). Enclosure not to exceed dimensions shown on Drawings.
  - 2. Furnish drive complete with cable termination compartment door interlocked main circuit breaker, defeatable (lockable in the open position), emergency stop pushbutton, alphanumeric keypad and display, and operator's controls. Components and controls specified in Section 26 05 04, Basic Electrical Materials and Methods.
  - 3. Wire drive from below and above for power and control wiring.
  - 4. Size forced-ventilation for periodic operation to cool each unit with maximum room ambient temperature of 95 degrees F. Furnish redundant fans such that if one fan fails remaining fans furnish adequate ventilation for the drive when operating at maximum capacity. Furnish filters on ventilation intakes.
  - 5. Bundle stranded copper wiring neatly with nylon tie wraps or with continuous plastic spiral binding; label each terminal for permanent identification of leads; identify each wire at each end with imprinted mylar adhesive-back wire markers; incorporate in as-installed wiring diagrams for wire and terminal numbers shown; wiring across door hinges use 19-strand, NEMA WC-57 Class C stranding looped for proper twist rather than bending at hinge; wire connections internal to panels by crimp-on terminal types. For multiple enclosure systems, complete interconnection wiring with gasketed enclosure openings for wiring; multipoint plug receptacles for any control wiring crossing equipment shipping splits.
  - 6. Selector switches, indicating lights, potentiometers, instruments, protective devices, major system components, etc., identified by means of mechanically attached, engraved, laminated nameplates.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### F. Operator Interface:

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1. Controls: Mount drive local control on front door of enclosure and include control switch and membrane type keypad for the following operator functions:
  - a. Start (when in local mode).
  - b. Stop (when in local mode).
  - c. Speed increase (when in local mode).
  - d. Speed decrease (when in local mode).
  - e. Parameter mode selection (recall programmed parameters).
  - f. LOCAL/OFF/REMOTE control selection (in remote, furnish for remote RUN command digital input and speed increase/decrease via remote 4 to 20 mA analog signal).
  - g. Fault reset, manual for all faults (except loss of ac voltage which is automatic upon return).
  - h. RUN/preset speed.
  - i. Parameter lock (password or key switch lockout of changes to parameters).
  - j. Start disable (key switch or programmed code).
2. Control circuit disconnect shall de-energize circuits in units that are not de-energized by main power disconnect device
3. 120 volts, single-phase, 60-Hz circuits for control power and operator controls from internal control power transformer. Furnish power for motor space heaters rated 120 volts.
4. Arrange component and circuit such that failure of any single component cannot cause cascading failure(s) of any other component(s).
5. Alphanumeric Display: During normal operation and routine test, the following parameters shall be available:
  - a. Motor current (percent of drive rated current).
  - b. Output frequency (Hertz).
  - c. Output voltage.
  - d. Running time.
  - e. Local/remote indicator.
  - f. Status of digital inputs and outputs.
  - g. Analog input and output values.
  - h. Output motor current per leg.
  - i. All test points.
6. Adjustable Parameters: Set drive operating parameters and indicate in a numeric form. Potentiometers may not be used for parameter adjustment. Minimum setup parameters available:
  - a. Frequency range, minimum, maximum.
  - b. Adjustable acceleration/deceleration rate.
  - c. Volts per Hertz (field weakening point).
  - d. Active current limit/torque limit, 0 to 140 percent of drive rating.



- e. Adjustable voltage boost (IR compensation).
- f. Preset speed (adjustable, preset operating point).
- g. Provision for adjustment of minimum and maximum pump speed to be furnished as function of 4 to 20 mA remote speed signal.

G. Signal Interface:

1. Digital Input:
  - a. Accept a remote RUN command contact closure input.
  - b. High temperature contact closure input from field mounted motor temperature monitoring relay.
2. Digital Output: Furnish three discrete output dry contact closures rated 5 amps at 120 volts ac.
  - a. DRIVE RUNNING.
  - b. DRIVE FAULT (with common contact closure for all fault conditions).
  - c. DRIVE IN REMOTE MODE.
3. Analog Input: When LOCAL/OFF/REMOTE switch is in REMOTE, control drive speed from a remote 4 to 20 mA dc signal. Make provisions for adjustment of minimum and maximum motor speed which shall result from this signal. Factory set this adjustment to comply with operating speed range designated in driven equipment specifications. Frequency resolution shall be 0.1 percent of base speed.
4. Analog Output: Furnish two 4 to 20 mA dc signals, for actual frequency, actual load.
5. Communication Interface: Provide VFD with communication card , protocol and required programming digital communication of all VFD program and operational parameters to the plant SCADA system via DeviceNet.

H. Accessories:

1. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
2. Lifting Lugs: Equipment weighing over 100 pounds.
3. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, diameter, and as specified in Section 05 50 00, Metal Fabrications.
4. Motor Protection Relay (MPR): For each drive include a MPR as specified in Section 26 05 04, Basic Electrical Materials and Methods, or furnish functions within drive system. Communications protocol and signal compatibility shall be as required for MPRs.  
Reactors (50 HP and below): Impedance: 5 percent  
Continuous current: Not less than drive rating.  
Current overload: 150 percent  
Insulation temperature rating: 180 Deg C.  
Copper windings.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

Saturation current rating: 3.5 to 5 times rated current.

Hi-potential rating: 2500VAC line to ground and line to line for 1 minute.

Noise reduction features: Epoxy over cast coil

Extra dips and bakes of varnish over continuous wound coil.

### 2.05 FACTORY FINISHING

#### A. Enclosure:

1. Primer: One coat of rust-inhibiting coating.
2. Finish:
  - a. Interior: One coat white enamel.
  - b. Exterior: One coat manufacturer's standard gray enamel.
3. Manufacturer's standard baked enamel finish.

### 2.06 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: Test one control panels actually furnished.
- C. Record test data for report.
- D. Functional Test: Perform manufacturer's standard, following tests:
  1. Test diodes, transistors, and GTOs at a thermal level of 125 degrees C.
  2. Test TTL and CMOS chips at 70 degrees C.
  3. Test printed circuit boards while heat cycled to maximum temperature of 65 degrees C.
  4. Test run power sections at maximum 40 degrees C for 12 hours and run with motors for 6 hours.
  5. Test assembled drive at maximum 40 degrees C and full load, full speed for 4 hours.
  6. Test power capacitors and active components.
  7. Operate controller with motor throughout its specified range, and at rated power supply load for 1 hour.
  8. Resonance: When harmonic filters are furnished to meet specified harmonic distortion requirements, perform analysis and furnish documentary evidence that filter elements do not resonate with the remainder of system parameters at any of harmonic frequencies present.
- E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's printed instructions.

### **3.02 FIELD QUALITY CONTROL**

#### **A. Functional Test:**

1. Conduct on each controller.
2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.
3. Vibration Test: Complete assembly, consisting of motor, load, and flexible shafting, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by current edition of Hydraulic Institute Standards. Where loads and drives are separated by intermediate flexible shafting, measure vibration both at top motor bearing and at two points on top pump bearing, 90 degrees apart.
4. Record test data for report.

#### **B. Performance Test:**

1. Conduct on each controller.
2. Perform under actual or approved simulated operating conditions.
3. Test for continuous 12-hour period without malfunction.
4. Demonstrate performance by operating the continuous period while varying the application load, as the input conditions allow, to verify system performance.
5. Record test data for report.
6. With plant load connected to normal utility source, measure the following to show parameters within specified limits:
  - a. Total and individual current harmonic distortion (up to and including 35th harmonic) at location identified as PCC1 in Simplified Plant One-Line Diagram, under following load conditions:
    - 1) AFDs running at full load and half load.
    - 2) Half of the specified AFDs running at full load and half load.
  - b. Power factor at input side of each drive. Documented verification that power factor is maintained at 95 percent as speed of drive goes down from 100 percent to 33 percent.
  - c. THD at location identified as PCC3 under following conditions:
    - 1) AFDs running at full load and half load.
    - 2) Half of specified AFDs running at full load and half load.
7. With plant load connected to standby power source, measure the following to show parameters within specified limits:

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- a. Total and individual current harmonic distortion (up to and including 35th harmonic) at location identified as PCC2 in Simplified Plant One-Line Diagram, with 2 drives running at:
  - 1) Full load.
  - 2) Half load.
- b. THD at location identified as PCC3 in Simplified Plant One-Line Diagram, with 2 drives running at:
  - 1) Full load.
  - 2) Half load.

### C. Test Equipment:

1. Use Dranetz, Model No. 626-PA, harmonic distortion monitor and Series 626 disturbance analyzer or equivalent instrument to document results.
2. Provide diagnostic plug-in test card complete with instructions, multiposition selector switch, and meters or built-in diagnostic control panel or ROM-based processor for monitoring ac, dc, and digital signals to assist in troubleshooting and startup of drive.

### 3.03 MANUFACTURERS' SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner for minimum person-days listed below, travel time excluded:
  1. One person-day for installation assistance and inspection.
  2. One person-day for facility startup.

### 3.04 PLANT ONE-LINE DIAGRAM

- A. Refer to the Drawings for a One-Line Diagram.

**END OF SECTION**



**SECTION 26 32 13.13  
DIESEL ENGINE GENERATOR SET**

**PART 1 GENERAL**

**1.01 REFERENCES**

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): A335/A335M, Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service.
2. Code of Federal Regulations (CRF): Title 40 Volume 18, Control of Emissions from New and In-Use Non-road Compression-Ignition Engines.
3. International Organization for Standardization (DIN/ISO): 9001, Quality Management Systems—Fundamentals and Vocabulary.
4. National Electric Manufacturer's Association (NEMA):
  - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  - b. MG 1, Motors and Generators.
5. National Electrical Contractors Association (NECA): 404, Recommended Practice for Installing Generator Sets.
6. National Fire Protection Association (NFPA):
  - a. 37, Installation and Use of Stationary Combustion Engines and Gas Turbines.
  - b. 70, National Electric Code.
  - c. 110, Emergency and Standby Power Systems.
7. School of Audio Engineering (SAE): J1074, Engine Sound Level Measurement.
8. Underwriters Laboratories, Inc. (UL):
  - a. 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
  - b. 508, Industrial Control Equipment.
  - c. 1236, Battery Chargers for Charging Engine-Starter Batteries.
  - d. 2085, Protected Aboveground Tanks for Flammable and Combustible Liquids.
  - e. 2200, Stationary Engine Generator.

**1.02 SUBMITTALS**

A. Action Submittals:

1. Dimensioned outline drawing showing plan and elevations of engine generator set and drive system.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. Paragraph by paragraph specification compliance statement, describing differences between specified and proposed equipment.
  3. Engine and generator weight, and anchoring requirements.
  4. Catalog information and technical description; include materials for block, heads, valves, rings, cylinders, pistons, crankshaft, and major bearings and wear surfaces.
  5. Complete list of accessories provided.
  6. Performance curves showing engine efficiency (fuel consumed per kWh output), gross fuel consumption rate, and kW output at design rated output, one-half load, and one-quarter load. Account for design altitude, temperature corrections, and engine parasitic loads.
  7. Transient and subtransient reactances per unit.
  8. Output waveform and telephone interference factor (TIF).
  9. Circuit breaker data, including make model, catalog number, settings, and time current curves.
  10. Control panel instrument identification inscriptions.
  11. Sample guarantee.
  12. Electrical schematic and wiring diagrams for the following:
    - a. Generator control panel.
    - b. Main generator.
    - c. Voltage regulator.
    - d. Battery charging system.
    - e. Governing system.
    - f. Interconnection wiring diagram for pad mount metal enclosed switchgear specified in Section 26 13 16.01, Pad-Mount Metal-Enclosed Switchgear.
    - g. Enclosed electrical components.
  13. Engine generator set motor starting capability and percent voltage dip curve.
  14. Block heater size and voltage.
  15. Heated fuel strainer system size and voltage.
  16. Jacket water heater size and voltage.
  17. Fuel transfer pump size and voltage.
  18. Subbase tank size and dimensions.
  19. Noise data for enclosed engine generator at 50 percent, 75 percent, and full load.
- B. Informational Submittals:
1. Manufacturer's Certificate of compliance with specified EPA and CARB emissions requirements in accordance with Section 01 43 33, Manufacturers' Field Services.
  2. Certification, copies of analyses, or test reports demonstrating appropriate vibration analysis and design in all modes.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Certified Factory Test Report.
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
5. Description of parts and service availability.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
7. Special guarantee.
8. Air quality permit.

### 1.03 QUALITY ASSURANCE

#### A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

#### B. Manufacturer Special Requirements:

1. Generator set shall be listed to UL 2200 or submitted to an independent third party certification process to verify compliance as installed.
2. Manufacturer of generator set shall be certified to ISO 9001 and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

### 1.04 AIR QUALITY PERMIT

- #### A. Obtain prior to releasing generator for production.

### 1.05 SPECIAL GUARANTEE

- #### A. Provide manufacturer's guarantee or warranty with no deductibles and including travel time, service hours, repair parts and expendables (oil, filters, antifreeze and other items required for the complete repair) with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction of the Work specified in this Specification section found defective during a period of 2 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.



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## 1.06 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

<u>Item</u>	<u>Quantity</u>
Diesel fuel line filter elements	3 complete sets
Lubricating oil filter elements with gasket	3 complete sets
Air cleaner filter element	1 complete set
Auxiliary fuel and jacket water pump packing/seals	1 complete set
Cooling fan drive belt (if applicable)	2 complete sets
Hydrometer	1 each
Two-pronged battery voltmeter	1 each
Spare fuses, if used in control panel	1 complete set
Spare indicating lamps (if applicable)	4 each type used
Touch up paint	1 quart each color used
Special tools required to maintain or dismantle engine generator set	1 complete set

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Materials and equipment specified in this section shall be products of:
1. Cummins.
  2. Caterpillar.
  3. Kohler Power Series.
  4. Detroit Diesel.

### 2.02 SERVICE CONDITIONS

- A. Ambient Temperature at Air Intake: 100 degrees F maximum.
- B. Ambient Temperature at Engine Generator Set: 100 degrees F maximum.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.03 GENERAL

#### A. Ratings:

1. Operate at 1,800 rpm.
2. Rated at 1500 kW, 1875 kVA at 0.8 PF, based on specified service conditions.
3. Voltage:480Y/277 volts, three-phase, 4-wire, 60-Hz.
4. Rated based on standby service.

#### B. Emissions:

1. Engines shall meet emission requirements specified in 40 CFR Chapter I Part 89 for off-highway Internal Combustion (IC) engines.
2. CARB Certified.

#### C. Vibration Design:

1. Use vibration analytical techniques to determine shaft critical speeds, and to develop bearing design and shaft balancing to mitigate vibration.
2. Apply torsional analysis and design to mitigate torsional vibration.
3. Engine and generator, individually, shall not exhibit vibration in any plane exceeding 10 mils at continuous rating point, when measured at attachment points to common steel subbase.

### 2.04 ENGINE

#### A. General:

1. Manufacturer's standard design, unless otherwise specified.
2. Engine parts designed with adequate strength for specified duty.

#### B. Type:

1. Diesel Cycle, 4-stroke type with unit mounted radiator and fan cooling.
2. Minimum displacement shall be as recommended by generator manufacturer.
3. Minimum number of cylinders shall be as recommended by generator manufacturer.

#### C. Starting System:

1. Type: Automatic, using 12-volt or 24-volt battery-driven starter acting in response to control panel.
2. Starter shall be capable of three complete cranking cycles without overheating.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Batteries:
  - a. Sized as recommended by engine manufacturer.
  - b. Lead-acid type.
  - c. Capable of providing 15 seconds minimum of cranking current at 0 degree C and three complete 15-second cranking cycles at 40 degrees C.
  - d. Housed in acid-resistant frame isolated from engine generator main frame.
  - e. Located such that maintenance and inspection of engine is not hindered.
  - f. Complete with battery cables and connectors.
  - g. Electric battery warmer plate.
4. Battery Charger:
  - a. UL 1236 listed and labeled.
  - b. 10-amp automatic float, taper and equalize charge type, with plus or minus 1 percent voltage regulation over a plus or minus 10 percent input voltage variation.
  - c. Temperature compensated to operate over an ambient range of minus 30 degrees C to 50 degrees C.
  - d. Locate charger in automatic transfer switch, generator control panel, or wall mounted in generator enclosure. Generator manufacturer shall coordinate location.
  - e. Include:
    - 1) Ammeter and voltmeter.
    - 2) Fused ac input and dc output.
    - 3) Power ON pilot light.
    - 4) AC failure relay and light.
    - 5) Low and high dc voltage alarm relay and light.
  - f. Alarm relay dry contacts rated 4 amps at 120V ac.
  - g. Wire battery charger status and alarm contacts back to generator control panel, terminate and identify contacts.

### D. Fuel System:

1. Engine driven, mechanical, positive displacement fuel pump.
2. Fuel filter with replaceable spin-on canister element.
3. Provide fuel cooler, suitable for operation of generator set at full rated load in ambient temperature specified if required for operation due to design of engine and installation.
4. Heated fuel strainer system.
5. As specified under Article, Integral Subbase Fuel Tank.
6. Fuel Connections to Engine: Flexible hose, suitable for application.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### E. Governing System:

1. Electro-mechanical or electro-hydraulic type.
2. Regulates speed as required to hold generating frequency within tolerable limits and within 5 percent of nominal design speed.
3. Accessories:
  - a. Manual speed control device.
  - b. Positive overspeed trip switch.

### F. Jacket Water Cooling System:

1. Radiator:
  - a. Consisting of jacket water pump, fan assembly, fan guard, and duct flange outlet.
  - b. Cooling System: Rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at alternator air inlet.
  - c. Fan: Suitable for use in a system with 0.5 in H<sub>2</sub>O restriction.
  - d. Sized based on a core temperature that is 20 degrees F higher than rated operation temperature.
2. Engine Thermostat: As recommended by manufacturer to regulate engine water temperature.
3. Jacket Water Heater:
  - a. Suitable for operation 480-volt, three-phase, 60-Hz current.
  - b. Maintain engine water temperature at 120 degrees F with an ambient temperature of 50 degrees F.
  - c. Thermostatically controlled.
4. Engine Cooling Liquid: Fill cooling system with a 50/50-ethylene glycol/water mixture prior to shipping.

### G. Lubrication System:

1. Type: Full-pressure.
2. Accessories:
  - a. Pressure switch to initiate shutdown on low oil pressure.
  - b. Oil filter with replaceable element.
  - c. Bayonet type oil level stick.
  - d. Valved oil drain extension.
3. Oil Cooling System: Water-cooled heat exchanger utilizing jacket water.

### H. Exhaust System:

1. Muffler: Rated for residential silencing.
2. Wrap exposed length of exhaust pipe and silencer with thermal insulating wrap.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Exhaust Pipe: ASTM A335, Grade P11, standard wall, with fittings selected to match piping materials.
4. Pipe Connections: Welded.
5. Engine Connection:
  - a. Flanged, flexible, corrugated, Type 321 stainless steel expansion fitting, specifically suited for diesel exhaust service.
  - b. Length as required for flexibility and expansion in piping arrangement shown on Drawings.
- I. Air Intake System: Equip with dry type air cleaner with filter service (restriction) indicator.

### 2.05 GENERATOR

#### A. General:

1. Meet requirements of NEMA MG 1.
2. Synchronous type with 2/3 pitch, revolving field, drip-proof construction, air cooled by a direct drive centrifugal blower fan.
3. Stator Windings:
  - a. Skewed for smooth voltage waveform.
  - b. Reconnectable, 12 lead.
4. Overspeed Capability: 125 percent.
5. Waveform Deviation from Sine Wave: 5 percent maximum.
6. Telephone Interference Factor: 50 maximum.
7. Total Harmonic Current and Voltage Distortion: 5 percent maximum, measured at generator main circuit breaker.

#### B. Insulation System:

1. Class H, with a maximum rise of 125 degrees C over 40 degree C ambient in accordance with NEMA MG 1.
2. Vacuum pressure impregnated (VPI).

#### C. Excitation System:

1. Field brushless type or permanent magnet generator (PMG) exciter.
2. PMG and Controls: Capable of providing regulated current, at a rate of 300 percent of nameplate current, to a single-phase or three-phase fault for 10 seconds.

#### D. Voltage Regulation:

1. Solid state, three-phase sensing type.
2. Adjustable output voltage level to plus or minus 5 percent.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Provisions for proper voltage regulation for existing or future adjustable frequency drives as part of generator load.
  4. Conformal coating environmental protection.
- E. Voltage and Frequency Regulation Performance:
1. Steady State Voltage Regulation: Less than plus or minus 1 percent from no load to continuous rating point.
  2. NEMA MG 1 Defined Transient Voltage Dip:
    - a. Less than 20 percent at rapid application of rated load.
    - b. Recovery to rated voltage and frequency within 2 seconds following initial load application.
  3. Steady State Frequency Regulation: Plus or minus 1.5-Hz overload range.
- F. Short Circuit Capabilities: Sustain 300 percent of rated current for 10 seconds for external three-phase bolted fault without exceeding rated temperatures.
- G. Main Circuit Breaker:
1. Type: Molded case.
  2. Current Rating: As recommended by generator manufacturer.
  3. Interrupt Rating: 50,000 amps RMS symmetrical at 480 volts.
  4. Short Time Rating: 50,000 amps RMS symmetrical.
  5. Trips:
    - a. Thermal-magnetic with inverse time characteristics and adjustable magnetic pickup.
    - b. Solid state, RMS sensing.
    - c. Adjustable Functions:
      - 1) Long-time current pickup.
      - 2) Long-time delay.
      - 3) Normal range instantaneous short-time pickup, short-time delay.
      - 4) Short-time delay with I<sup>2</sup>t function.
      - 5) Ground fault pickup.
      - 6) Ground fault delay.
      - 7) Zone selective interlock.
  6. Enclosure:
    - a. Rating: NEMA 250, Type 12 3R.
    - b. Mounted with vibration isolation from engine generator set.
  7. Surge Protective Devices: Three-phase capacitors and arresters mounted in terminal compartment.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.06 BASEPLATE

- A. Mount engine generator set on a rigid common steel base frame.
- B. Base frame shall be stiffened to minimize deflections.

### 2.07 INTEGRAL SUBBASE FUEL TANK

- A. General:
  - 1. 75 percent of full load operation of generator set for 72 hours.
  - 2. UL 142 listed and labeled.
  - 3. UL 2085 listed and labeled.
  - 4. Installation shall be in compliance to NFPA 37.
  - 5. Double-walled, steel construction and shall include the following features:
    - a. Emergency tank and basin vents.
    - b. Mechanical level gauge.
    - c. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by engine manufacturer and in compliance to UL 2200 and NFPA 37 requirements.
    - d. Leak detection provisions, wired to generator set control for local and remote alarm indication.
    - e. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level.
    - f. Basin drain.
    - g. Integral lifting provisions.

### 2.08 VIBRATION ISOLATORS

- A. Performance: To meet code requirements specified in Section 01 61 00, Common Product Requirements.
- B. Provide vibration isolators, spring/pad type.
- C. Include seismic restraints if required by Site location.

### 2.09 AUTOMATIC LOAD TRANSFER CONTROL

- A. Automatic run controls shall be suitable for remote interface and control by automatic transfer switch. Engine generator set shall start and run upon closure of a remote dry contact provided in Section 26 13 16.01, Pad-Mount Metal-Enclosed Switchgear.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.10 CONTROL SYSTEM

#### A. Control Panel:

1. Rating: NEMA 250, Type 12.
2. Material: Steel.
3. Instrument Identification: Face label or engraved, black, laminated plastic nameplate with white 1/4-inch-high letters, attached with Type 422 stainless steel screws.
4. UL 508 listed.
5. Tested to meet or exceed IEEE 587 requirements for voltage surge resistance.
6. Controls shall be solid-state, microprocessor based. Control panel shall be designed and built by generator manufacturer and shall provide operating, monitoring, and control functions for generator set. Control Panel mounting height shall not exceed 6 feet 6 inches above where personnel will access panel, Manufacturer shall modify mounting height if a sub-base fuel tank is used.

#### B. Instrumentation:

1. Type: Suitable for engine-mounted vibration environment.
2. Mounting: Nonshock mounted.
3. Alarm and Signal Contacts: Rated 5 amps at 120V ac, dry.
4. Fault Indication Lamps: Manufacturer's standard.
5. Meters: Digital with analog display, plus or minus 2 percent accuracy.

#### C. Operator Controls and Indicators:

1. HANDCRANK/STOP/AUTO/ENGINE TEST selector switch.
2. Generator voltage adjustment.
3. Voltmeter PHASE SELECTOR switch.
4. Ammeter PHASE SELECTOR switch.
5. Voltmeter.
6. Ammeter.
7. Kilo-Watts (kW).
8. Percent kW.
9. Power Factor.
10. FREQUENCY meter.
11. Engine OIL PRESSURE indicator.
12. Engine jacket WATER TEMPERATURE indicator.
13. Engine SPEED indicator (RPM).
14. Engine OIL TEMPERATURE indicator.
15. RUNNING TIME indicator.
16. DC battery voltage.



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17. Emergency Stop button.
- D. Alarm Indicators with Manual Pushbutton RESET:
1. Low oil pressure.
  2. High jacket water temperature.
  3. Engine overspeed.
  4. Engine overcrank.
  5. Low/high dc voltage.
- E. External Interfaces:
1. Furnish a single, common DPDT relay output upon occurrence of alarm condition.
  2. Output: Dry contact rated 5 amps at 120V ac.
  3. Accept remote dry start contact closure from automatic transfer switch, rated 10 amps at 32V dc.
- F. Functional Requirements:
1. LCD text display of alarm/event descriptions.
  2. Recracking Lockout: When engine fires, starting control shall automatically disconnect cranking control to prevent recracking for a preset period of time after engine stop.
  3. Overcranking Lockout: Initiate after four cranking cycles of 10 seconds on and 10 seconds off or provide continuous cranking cycle with crank time limiter.
  4. Cooldown timer, adjustable from 5 minutes to 60 minutes.
  5. Alarms:
    - a. Low coolant level.
    - b. Low fuel level.
    - c. Low battery voltage
    - d. High battery voltage.
    - e. Battery charger failure.
  6. Engine shutdown upon any of the following conditions:
    - a. Engine overspeed.
    - b. Emergency stop button depressed.
    - c. High jacket water temperature alarm setpoint and shutdown setpoint.
    - d. Low oil pressure alarm setpoint and shutdown setpoint.
  7. Air Inlet Damper Opening:
    - a. Upon engine start sequence initiation, a normally closed, dry contact, rated 5 amps at 120V ac, from engine start circuit shall open to provide a signal to open air inlet dampers.
    - b. Air inlet dampers shall fail open.

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### G. Special Requirements:

1. Mount battery charger in control panel.

### 2.11 OUTDOOR WEATHER-PROTECTIVE ENCLOSURE

#### A. General:

1. Provide generator set with outdoor enclosure, with entire package listed under UL 2200.
2. Package shall comply with requirements of NEC for wiring materials and component spacing.
3. Design total assembly of generator set, enclosure, and subbase fuel tank (when used) to be lifted into place using spreader bars.
4. Housing:
  - a. Provide ample airflow for generator set operation at rated load in ambient temperature of 100 degrees F.
  - b. Doors:
    - 1) Hinged access doors as required to maintain easy access for operating and service functions.
    - 2) Lockable and include retainers to hold door open during service.
5. Roof: Cambered to prevent rainwater accumulation.
6. Openings: Screened to limit access of rodents into enclosure.
7. Electrical power and control interconnections shall be made within perimeter of enclosure.
8. Finishes:
  - a. Prime sheet metal for corrosion protection and finish painted with manufacturer's standard color using a two-step electrocoating paint process, or equal meeting performance requirements specified below.
  - b. Prime and paint surfaces of metal parts. Painting process shall result in coating that meets the following requirements:
    - 1) Primer: 0.5 mil to 2.0 mils thick.
    - 2) Top Coat: 0.8 mil to 1.2 mils thick.
    - 3) Gloss:
      - a) Per ASTM D523, 80 percent plus or minus 5 percent.
      - b) Gloss retention after 1 year shall exceed 50 percent.
    - 4) Crosshatch Adhesion: Per ASTM D3359, 4B-5B.
    - 5) Impact Resistance: Per ASTM D2794, 120-inch to 160-inch pounds.
    - 6) Salt Spray: Per ASTM B117, plus 1,000 hours.
    - 7) Humidity: Per ASTM D2247, plus 1,000 hours.
    - 8) Water Soak: Per ASTM D2247, plus 1,000 hours.

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- c. Painting of hoses, clamps, wiring harnesses, and other nonmetallic service parts shall not be acceptable.
  - d. Fasteners used shall be corrosion-resistant and designed to minimize marring of painted surface when removed for normal installation or service work.
9. Enclosure shall be constructed of minimum 12-gauge steel for framework and 14-gauge steel for panels.
10. Hardware and hinges shall be austenitic stainless steel.
11. Exhaust Silencer:
  - a. Install factory-mounted exhaust silencer inside enclosure.
  - b. Exhaust shall exit enclosure through a rain collar and terminate with a rain cap.
  - c. Exhaust connections to generator set shall be through seamless flexible connections.
12. Maintenance Provisions:
  - a. Flexible coolant and lubricating oil drain lines that extend to exterior of enclosure, with internal drain valves.
  - b. External radiator-fill provision.
  - c. External fuel fill provision (if equipped with a subbased fuel tank).
13. Provide motorized louvers to minimize air flow through enclosure when generator set is not operating. Louvers shall include provisions to prevent accumulation of ice or snow that might prevent operation.
14. Inlet ducts shall include rain hoods.
15. Provide external emergency stop switch that is protected from accidental actuation.
16. Provide factory mounted and wired electrical distribution panel to serve generator set and enclosure. Provisions required include:
  - a. 100-amp distribution panelboard connected to a 120/240V ac utility service.
  - b. Two duplex GFI receptacles, one inside enclosure, and one weatherproof receptacle on outside of enclosure.
  - c. Two three-way switches controlling three ac lamps mounted in vapor tight and gasketed fixtures.
  - d. Factory-wired normal ac service from panelboard to engine coolant and alternator heaters, and battery charger.
17. Sound Attenuation:
  - a. Provide with sound-attenuated housing which allows generator set to operate at full rated load in an ambient temperature of up to 100 degrees F.
  - b. Enclosure shall reduce sound level of generator set while operating at full rated load to a maximum of 74 dBA at any location 7 meters from generator set in a free field environment when tested in accordance with SAE J1074.

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- c. Insulate enclosure with nonhydroscopic materials.

### 2.12 FACTORY FINISHING

- A. Engine Generator Set and Instrument Panel: Factory-applied primer and two finish coats of manufacturer's standard heat-resistant engine paint.

### 2.13 FACTORY TESTS

- A. General: Conform to NFPA 110.
- B. Steady Load Test: Test engine generator set at steady load run of 60 minutes minimum duration at 100 percent full-rated load.
- C. Transient Load Test: Conduct transient load test to demonstrate ability to meet load pickup and load release requirements specified.
- D. Harmonic Test: Conduct at full load conditions.
- E. Record and Report:
  - 1. Strip chart recording and full harmonic analysis measuring up to 50th harmonic for both voltage and current and three phases simultaneously.
  - 2. Transient response.
  - 3. Load/speed stability.
  - 4. Engine fuel consumption.
  - 5. Power output.
  - 6. Harmonic analysis.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Level and securely mount engine generator set in accordance with manufacturer's recommendations.
- B. Install in accordance with NECA 404.
- C. Where applicable, mount engine generator set on vibration isolators in accordance with isolator manufacturer's recommendations.

### 3.02 FIELD FINISHING

- A. Touch up damaged coating with paint system compatible to existing.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.03 FIELD TESTS

- A. General: Conform to NFPA 110.
- B. Performance Test:
  - 1. Perform upon completion of installation.
  - 2. Operate 2 hours minimum.
  - 3. Manufacturer's representative shall make necessary adjustments.
  - 4. Demonstrate ability of engine generator set to carry specified loads.
  - 5. Demonstrate engine generator set safety shutdowns.
- C. Test Report: Record and report the following:
  - 1. Electric load on generator.
  - 2. Fuel consumption.
  - 3. Exhaust temperature.
  - 4. Ambient air temperature.
  - 5. Safety shutdown performance results.
  - 6. Noise levels at 7 meters. Property line.
- D. Post-test Requirements:
  - 1. Make final adjustments.
  - 2. Replace fuel and oil filters.
  - 3. Check belt drive tensions.
  - 4. Demonstrate proper operation of equipment, including automatic operation with control from automatic transfer switch, to Engineer and Owner.

### 3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
  - 1. One person-days for installation assistance and inspection.
  - 2. One person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
  - 3. One person-days for facility startup.
  - 4. One person-days for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner and Engineer.

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- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

**END OF SECTION**



**SECTION 26 33 53  
UNINTERRUPTABLE POWER SUPPLY (UPS)**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty three-phase, solid-state, scalable (field-upgradable) uninterruptible power system (UPS). The UPS shall provide high-quality AC power for the UV equipment loads.

**1.02 REFERENCES**

- A. The UPS shall be designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.

1. CSA 22.2, No. 107.1.
2. FCC Part 15, Class A.
3. IEC 61000-4-5.
4. ISO 9001.
5. National Electrical Code (NFPA-70).
6. NEMA PE-1.
7. UL Standard 1778.
8. ISTA\_1H.

- B. The UPS shall be UL listed per UL Standard 1778.

**1.03 SUBMITTALS**

- A. Action Submittals:

1. Descriptive product information.
2. Itemized Bill of Material.
3. Dimensional drawings.
4. Operational description.
5. One-line, three-line, and control schematic drawings.
6. Connection and interconnection drawings.
7. Conduit entrance locations.
8. Anchoring instructions and details.



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### B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Certified Factory Test Report.
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
4. Manufacturer's Certification of Proper Installation as specified in Section 01 43 33, Manufacturers' Field Services.

### 1.04 QUALITY ASSURANCE

#### A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

### 1.05 SYSTEM DESCRIPTION

1. Design Requirements: UPS Module System Input Voltage 480VAC (3 wire plus ground) System Output Voltage 480VAC (three or four-wire plus ground).
2. Intellislot Web Card LB Factory Installed
3. 1 Year of Free Remote Service Delivery included with UPS Startup.
4. Integrated Load Bus Sync.
5. Integrated paralleling capability: parallel up to 3 modules for capacity plus 1 for redundancy.
6. Field Configurable for dual input.
7. IGBT pulse-width modulated (PWM) rectifier providing 0.99 input power factor and 4% reflected input current distortion (THD).
8. Temperature compensated separate battery charger to allow use with valve-regulated lead acid (VRLA), wet cell lead acid.
9. IGBT pulse-width modulated (PWM) inverter.
10. Automatic continuous duty static transfer switch Internal maintenance bypass switch.
11. Digital Signal Processing (DSP) control system Back-lit LCD Graphic Display with multilingual support and user friendly navigation menu.
12. Alarm History Database Redundant Cooling Fans.
13. Local EPO with provision for Remote EPO.
14. Three (3) Intellislot™ Communication Ports.

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15. IP 20 enclosure Casters and leveling feet Casters and leveling feet Meets ISTA 1B transportation requirements.
  16. Meets FCC Part 15, Class A UL and cUL Listed to UL Standard 1778 1.
  17. (One) Intellislot™ Relay Contact Interface Kit - This hot-installable card provides relay contact signals for "On Battery", "Low Battery", "On Bypass", "UPS Fault", "Summary Alarm". Connections are to a DB25F connector.
  18. 1 (One) IS-WEBLB: IntelliSlot Web Card LB (Liebert NX and Liebert Hinet). This interface card delivers SNMP, Telnet and web-management capability for enhanced communications and control of Liebert UPS, Power Management or Precision Cooling systems. The card manages a wide range of operating parameters, alarms and notifications, transmitting data over the network.
- B. Provide an external battery system rated for 5 minutes at full load with the following features:
1. Stand-alone battery cabinets shall be shipped separately and include side panels and supply interconnecting cables.

### **PART 2 PRODUCTS**

#### 2.01 MANUFACTURERS

- A. Materials, equipment and accessories specified in this Section shall be products of:
1. Liebert:
    - a. UPS: Model 38SB060A0A00.
    - b. Batteries: Model 38BP080XHR1BNS.
  2. APC.
  3. MGE.
  4. Powerware.

#### 2.02 GENERAL

- A. Voltage: Input/output voltage specifications of the UPS shall be:
1. Rectifier Input: 480 volts, three-phase, 3-wire-plus-ground.
  2. Output: 480 volts, three-phase, 3-wire-plus-ground.
- B. Output Load Capacity: Specified output load capacity of the UPS shall be 60 kVA at 0.9 lagging power factor.

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- C. Scalable Output Capacity. UPS rated output capacity will be scalable by means of a software update which will require no hardware modifications to the UPS. The model will be available at a starting capacity of 40kVA and scale to 60kVA and 80kVA.
- D. Parallel Operation. Up to four (4) UPS module outputs may be connected together in parallel to provide up to 3X maximum output capacity with redundancy.
- E. Battery:
  - 1. Battery Cells: Sealed, lead-acid, valve-regulated.
  - 2. Reserve Time: 5 minutes at 0.9 power factor, with ambient temperature of 77°F (25°C). Unit shall provide terminal for connection of external batteries.
  - 3. Recharge Time: to 95% capacity within ten (10) times discharge time.
- F. Modes of Operation: The UPS shall be designed to operate as an on-line, double-conversion, reverse-transfer system in the following modes:
  - 1. Normal: The critical AC load is continuously supplied by the UPS inverter. The rectifier/charger derives power from a utility AC source and supplies DC power to the inverter while simultaneously float-charging the reserve battery.
  - 2. Emergency: Upon failure of utility AC power, the critical AC load is supplied by the inverter, which obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
  - 3. Recharge: Upon restoration of utility AC power after a utility AC power outage, the rectifier/charger shall automatically restart, gradually ramp up output voltage and assume the inverter and battery recharge loads.
  - 4. Bypass: If the UPS must be taken out of service for maintenance or repair or if the inverter overload capacity is exceeded, the static transfer switch shall perform a reverse transfer of the load from the inverter to the bypass source with no interruption in power to the critical AC load.

### 2.03 PERFORMANCE REQUIREMENTS

- A. AC Input to UPS:
  - 1. Voltage Configuration for Standard Units: 480V, three-phase, three-wire plus ground.
  - 2. Voltage Range: +15%, -20% of nominal without derating.
  - 3. Frequency: 57-66 Hz.

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4. Power Factor:
    - a. >0.99 at nominal input voltage and full-rated UPS output load.
    - b. >0.98 at nominal input voltage and half-rated UPS output load.
  5. Inrush Current: 600% of full load current maximum.
  6. Current Limit: 140% of nominal AC input current maximum.
  7. Current Distortion: <3% reflected THD maximum at full load.
  8. Surge Protection: Sustains input surges without damage per criteria listed in IEC 1000-4-5.
- B. AC Output, UPS Inverter:
1. Voltage Configuration: three-phase, 3-wire plus ground.
  2. Voltage Regulation:
    - a.  $\pm 1\%$  three-phase RMS average for a balanced three-phase load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature and load power factor.
    - b.  $\pm 2\%$  three-phase RMS average for a 100% unbalanced load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature and load power factor.
  3. Nominal Frequency:
    - a.  $\pm 0.05\%$  for single unit.
    - b.  $\pm 0.25\%$  for paralleled units.
  4. Frequency Slew Rate:
    - a. Selectable from 0.1Hz/sec to 3.0Hz/sec maximum for single unit.
    - b. Fixed maximum of 0.2Hz/sec for paralleled units.
  5. Phase Displacement:
    - a.  $\pm 0.5$  degree for balanced load.
    - b.  $\pm 1.0$  degrees for 100% unbalanced load.
  6. Bypass Line Sync Range:  $\pm 2.0$  Hz, field-selectable  $\pm 0.5$  to 5.0 Hz.
  7. Voltage Distortion:
    - a. 1% total harmonic distortion (THD) for linear loads.
    - b. <5% THD for 100% nonlinear loads (3:1 crest factor) without kVA/kW derating.
  8. Load Power Factor Range: 0.7 lagging to 1.0 leading without derating.
  9. Output Power Rating: Rated kVA at 0.9 lagging power factor
  10. Overload Capability:
    - a. 110% for 1 hour.
    - b. 125% for 10 minutes.
    - c. 150% for 1 minute.
  11. Voltage Transient Response:
    - a. 100% load step  $\pm 5.0\%$ .
    - b. Loss or return of AC input power  $\pm 1.0\%$ .
  12. Transient Recovery Time: to within 2% of output voltage within one cycle.
  13. Voltage Unbalance: 100% unbalanced load,  $\pm 2\%$ .

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## 2.04 ENVIRONMENTAL CONDITIONS

- A. The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:
1. Operating Ambient Temperature:
    - a. UPS Module: 32°F to 104°F (0°C to 40°C).
    - b. Battery: 77°F ±9°F (25°C ±5°C).
  2. Storage/Transport Ambient Temperature:
    - a. UPS Module: -13°F to 158°F (-25°C to 70°C)
    - b. Battery: -4°F to 92°F (-20°C to 33°C)
  3. Relative Humidity: 0 to 95%, non-condensing.
  4. Altitude:
    - a. Operating: to 6562 ft. (2000m) above Mean Sea Level without derating. Derated from 6562 ft. (2000m) to 9843 ft. (3000m) for higher altitude applications.
    - b. Storage/Transport: to 40,000 ft. (12,200m) above Mean Sea Level.
  5. Audible Noise:
    - a. Less than 63dB for 120kVA and 61dB for 80kVA typical (fan at low speed).
    - b. Less than 69dB for 120kVA and 67dB for 80kVA at worse case (fan at high speed).

## 2.05 FABRICATION

- A. Materials:
1. All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.
  2. The maximum working voltage, current and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. The operating temperature of solid-state component sub-assembly shall not be greater than 75% of their ratings. Electrolytic capacitors shall be computer grade and be operated at no more than 95% of their voltage rating at the maximum rectifier charging voltage.
- B. Wiring:
1. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70). All bolted connections of busbars, lugs and cables shall be in accordance with

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

requirements of the National Electrical Code and other applicable standards. All electrical power connections are to be torqued to the required value and marked with a visual indicator.

2. Provision shall be made for power cables to enter or leave from the top or bottom of the UPS cabinet.

### C. Construction and Mounting:

1. The UPS unit, comprised of an input circuit breaker, rectifier/charger, inverter, static transfer switch and maintenance bypass switch, shall be housed in a single free-standing NEMA type 1 enclosure. Cabinet doors/covers shall require a tool for gaining access. Casters and stops shall be provided for ease of installation. Front access only shall be required for expedient servicing and adjustments. The UPS cabinet shall be structurally adequate and have provisions for hoisting, jacking and forklift handling.
2. The UPS cabinet shall be cleaned, primed and painted with the manufacturer's standard color. The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug connections. Like assemblies and like components shall be interchangeable.

### D. Cooling:

1. Cooling of the UPS shall be by forced air using a redundant fan configuration. Fan power shall be provided by the UPS.
2. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.

### E. Grounding: The UPS chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.

## 2.06 COMPONENTS

### A. Rectifier/Charger:

1. General: The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a solid-state IGBT type with constant voltage/current limiting control circuitry.
2. AC Input Current Limiting: The rectifier/charger unit shall be provided with AC input current limiting whereby the maximum input current shall be limited to 140% of the full input current rating. The rectifier/charger shall operate at a reduced current limit mode whenever

the critical load is powered from the UPS static bypass circuit such that the maximum UPS input current will not exceed 125% of full load input current. In addition, the rectifier/charger shall have a battery current limit, adjustable from 0 to 25% of the full load input current.

3. DC Filter: The rectifier/charger shall have a filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1% RMS. The filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.
4. Automatic Rectifier Restart: Upon restoration of utility AC power, after a utility AC power outage and prior to a UPS automatic end-of-discharge shutdown, the rectifier/charger shall automatically restart, walk-in and gradually assume the inverter and battery recharge loads.
5. Battery Recharge: In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery charging current sufficient to replace 95% of the battery discharge power within ten (10) times the discharge time. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.
6. Overvoltage Protection: There shall be DC overvoltage protection so that if the DC voltage rises to the preset limit, the UPS will shut down automatically and initiate an uninterrupted load transfer to the static bypass line.

B. Inverter:

1. General: The term inverter shall denote the solid-state equipment and controls to convert DC power from the rectifier/charger or battery to regulated AC power for supporting the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse-width-modulated (PWM) design capable of providing the specified AC output.
2. Overload Capability: The inverter shall be capable of supplying current and voltage for overloads exceeding 100%. The inverter is to provide 150% of full load for 1 minute, 125% of full load for 10 minutes and 110% of full load for 1 hour. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.
3. Fault Clearing and Current Limit: The inverter shall be capable of supplying an overload current of 150% of its full-load rating for one minute. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The critical load will be transferred to the static bypass automatically and uninterrupted. The inverter shall be self-protecting

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against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.

4. Voltage Distortion: For linear loads, the output voltage total harmonic distortion (THD) shall not be greater than 1%. For 100% rated load of 3:1 crest factor nonlinear loads, the output voltage total harmonic distortion shall not be greater than 4%. The output rating is not to be derated in kVA nor kW due to the 100% nonlinear load with 3:1 crest factor.
5. Phase Balance: Electronic controls shall be provided to regulate each phase so that an unbalanced loading will not cause the output voltage to go outside the specified voltage unbalance or phase displacement. With 100% load on one phase (and 0% load on the other two phases) or 100% load on two phases (and 0% load on the other phase), the voltage balance is to be within 2% and the phase displacement is to be 120 degrees within  $\pm 1$  degree.
6. Inverter Shutdown: For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.
7. Inverter DC Protection: The inverter shall be protected by the following disconnect levels:
  - a. DC Overvoltage Shutdown.
  - b. DC Undervoltage Warning (Low Battery Reserve)—pre-warning time is adjustable.
  - c. DC Undervoltage Shutdown (End of Discharge).
8. Output Frequency: The output frequency of the inverter shall be controlled by a high-speed DSP microcontroller capable of holding the inverter output frequency to within  $\pm 0.05\%$  during steady state and transient conditions. Total deviation from the rated frequency, including short time fluctuations and drift, shall not exceed 0.05%.

### C. Display and Controls:

1. Monitoring and Control: The UPS shall be provided with a microprocessor-based unit status display and controls section designed for convenient and reliable user operation. A graphical liquid crystal display (LCD) shall be used to show a single-line diagram of the UPS and shall be provided as part of the monitoring and controls sections of the UPS. All operator controls and monitors shall be located on the front of the UPS cabinet. Monitoring functions such as metering, status and alarms shall be displayed on the graphical LCD. Additional features of the monitoring system shall include:
  - a. Menu-driven display with pushbutton navigation.
  - b. Real-time clock (time and date).



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- c. Alarm history with time and date stamp.
- d. Memory with battery backup.
- 2. Metering: The following parameters shall be displayed:
  - a. Input AC voltage line-to-line.
  - b. Input AC current for each phase.
  - c. Input frequency.
  - d. Battery voltage.
  - e. Battery charge/discharge current.
  - f. Output AC voltage line-to-line.
  - g. Output AC current for each phase.
  - h. Output frequency.
  - i. Apparent power.
  - j. Active power.
  - k. Battery time left during battery operation.
- 3. Alarm Messages: The following alarm messages shall be displayed:
  - a. Mains Voltage Abnormal.
  - b. Mains Undervoltage.
  - c. Mains Freq. Abnormal.
  - d. Mains Phase Reversed.
  - e. Charger Fault.
  - f. Battery Reversed.
  - g. No Battery.
  - h. Control Power 1 Fail.
  - i. Parallel Comm. Fail.
  - j. Bypass Unable To Track.
  - k. Bypass Abnormal.
  - l. Inverter Asynchronous.
  - m. Fan Fault.
  - n. Control Power 2 Fail.
  - o. Unit Over Load.
  - p. System Over Load.
  - q. Bypass Phase Reversed.
  - r. Transfer Time-Out.
  - s. Load Sharing Fault.
  - t. Parallel Connect Fault.
  - u. Bypass Over Current.
  - v. Output Ground Fault.
- 4. Status Messages: The following UPS status messages shall be displayed:
  - a. Rectifier (Off / Soft Start / Main Input On / Battery Input On).
  - b. Input Supply (Normal Mode / Battery Mode / All Off).
  - c. Battery Self Test (True / False).
  - d. Input Disconnect (Open / Closed).
  - e. Epo (True / False).
  - f. Charger (On / Off).

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- g. Output Disconnect (Open / Closed).
  - h. Maint. Disconnect (Open / Closed).
  - i. Bypass Disconnect (Open / Closed).
  - j. Inverter (Off / Soft Start / On).
  - k. Bypass (Normal / Unable To Trace / Abnormal).
  - l. Output Supply (All Off / Bypass Mode / Inverter Mode / Output Disable).
  - m. Inverter On (Enable / Disable).
5. Controls: UPS startup, shutdown and maintenance bypass operations shall be accomplished through pushbutton controls on the front panel. Menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms. A mimic screen shall be available on the LCD to depict a single-line diagram of the UPS with switch positions and power flow.
  6. On-Line Battery Test: The UPS shall be provided with a menu-driven On-Line Battery Test feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode.

### D. Static Transfer Switch:

1. General:
  - a. A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously. The switch shall have an overload rating to clear a 20-ampere load branch circuit breaker.
  - b. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS or to bypass the UPS for maintenance.
2. Uninterrupted Transfer:
  - a. The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:
    - 1) Inverter overload capacity exceeded.
    - 2) Critical AC load overvoltage or undervoltage.
    - 3) UPS fault condition.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:
  - 1) Bypass frequency out of limits.
  - 2) Bypass out-of-synchronization range with inverter output.
- 3. Uninterrupted Retransfer:
  - a. Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:
    - 1) Bypass out of synchronization range with inverter output.
    - 2) Inverter/bypass voltage difference exceeding preset limits.
    - 3) Overload condition exists in excess of inverter full load rating.
    - 4) UPS fault condition present.
- E. Maintenance Bypass Switch:
  - 1. General: A manually operated maintenance bypass switch shall be incorporated into the UPS cabinet to directly connect the critical load to the bypass AC input power source, bypassing the rectifier/charger, inverter and static transfer switch.
  - 2. Isolation: All energized terminals shall be shielded to ensure that maintenance personnel do not inadvertently come in contact with energized parts or terminals. A means to de-energize the static switch shall be provided when the UPS is in the maintenance bypass mode of operation.
- F. Battery Power Pack: The battery power pack shall include sealed, lead-acid, valve-regulated battery cells housed in a separate cabinet that matches the UPS cabinet styling to form an integral system lineup. Battery cells shall be mounted on slide-out trays for ease of maintenance. A battery disconnect circuit breaker shall be included for isolation of the battery pack from the UPS module. The UPS shall be automatically disconnected from the battery when the battery reaches the minimum discharge voltage level. Casters and leveling feet shall also be provided with the battery power pack cabinet for ease of installation. The battery cabinet shall be bolted to the UPS cabinet with an interconnecting cable kit, pre-cut and pre-lugged.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions and recommendations.

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- B. Install plumb and in longitudinal alignment with pad or wall.

### 3.02 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services, for the following services at Site, for minimum person-days listed below, travel time excluded:
  - 1. One person-days for installation assistance, final adjustment, and initial energization of equipment.
  - 2. One person-days for functional and performance testing.

### 3.03 FIELD QUALITY CONTROL

- A. The following inspections and test procedures shall be performed by factory-trained field service personnel during the UPS startup.
  - 1. Visual Inspection:
    - a. Inspect equipment for signs of damage.
    - b. Verify installation per drawings.
    - c. Inspect cabinets for foreign objects.
    - d. Verify neutral and ground conductors are properly sized and configured.
    - e. Inspect battery cases.
    - f. Inspect battery for proper polarity.
    - g. Verify all printed circuit boards are configured properly.
  - 2. Mechanical Inspection:
    - a. Check all control wiring connections for tightness.
    - b. Check all power wiring connections for tightness.
    - c. Check all terminal screws, nuts and/or spade lugs for tightness.
  - 3. Electrical Inspection:
    - a. Check all fuses for continuity.
    - b. Confirm input voltage and phase rotation is correct.
    - c. Assure connection and voltage of the battery string(s).

### 3.04 MANUFACTURER'S FIELD SERVICE

- A. Service Personnel:
  - 1. The UPS manufacturer shall directly employ a nationwide service organization consisting of factory-trained field service personnel dedicated to the startup, maintenance and repair of UPS and power equipment. The organization shall consist of regional and local offices.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

2. The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week, 365 days/year. If emergency service is required, response time shall be 20 minutes or less.
  3. An automated procedure shall be in place to ensure that the manufacturer is dedicating the appropriate technical support resources to match escalating customer needs.
- B. Replacement Parts Stocking:
1. Parts shall be available through an extensive network to ensure round-the-clock parts availability throughout the country.
  2. Recommended spare parts shall be fully stocked by local field service personnel with backup available from national parts center and the manufacturing location. The national parts center Customer Support Parts Coordinators shall be on-call 24 hours/day, 7 days/week, 365 days/year for immediate parts availability. Parts from the national parts center shall be shipped within 4 hours on the next available flight out and delivered to the customer's site within 24 hours.
- C. Maintenance Contracts: A complete offering of preventive and full-service maintenance contracts for both the UPS system and battery system shall be available. An extended warranty and preventive maintenance package shall be available. Warranty and preventive maintenance service shall be performed by factory-trained service personnel.

**END OF SECTION**

**SECTION 26 36 23**  
**AUTOMATIC TRANSFER SWITCHES**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Institute of Electrical and Electronics Engineers (IEEE): C37.90.1, Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
  2. National Electrical Manufacturers Association (NEMA):
    - a. ICS 1, General Standards for Industrial Control and Systems: General Requirements.
    - b. ICS 2, Industrial Control and Systems Controllers, Contactors, and Overload Relays not more than 2000 volts ac or 750 volts ac.
    - c. ICS 6, Industrial Control And Systems: Enclosures 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  4. Underwriters Laboratories, Inc. (UL): 1008, Transfer Switch Equipment.

1.02 SUBMITTALS

- A. Action Submittals:
1. Descriptive product information.
  2. Dimensional drawings.
  3. Control diagrams.
  4. Conduit entrance locations.
  5. Equipment ratings.
- B. Informational Submittals:
1. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
  2. Factory test reports.
  3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

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## 1.03 QUALITY ASSURANCE

### A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

## **PART 2 PRODUCTS**

### 2.01 MANUFACTURERS

- A. Lakeshore Electric.
- B. Russelectric.

### 2.02 GENERAL

- A. Transfer switch to be product of a single manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.
- B. In accordance with applicable standards of NFPA 70, NEMA ICS 1, NEMA ICS 2, NEMA ICS 6, IEEE C37.90.1, and UL 1008.
- C. Transfer switch consisting of inherently double-throw power switch unit with interconnected control module.
- D. Rated 100 percent, in amperes, for total system transfer of motor, electric heating, discharge lamp loads, and tungsten-filament lamp loads.
  1. Switches rated 400 amperes and below suitable for 100 percent tungsten-filament lamp loads.
  2. Switches rated above 400 amperes suitable for 30 percent tungsten-filament lamp loads.
- E. Main and arcing contacts visible for inspection with cabinet door and barrier covers removed.
- F. Neutral transfer contacts for switched. Terminal plate with pressure contacts for solidly connected neutral conductors.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- G. Suitable for 7200/12470 volts, three-phase, three-wire, grounded-wye electrical service having an available short circuit current at line terminals of 65,000 amperes rms symmetrical.
- H. Switch Rating 400 continuous amperes in nonventilated enclosure.
- I. Current carrying capacity of arcing contacts shall not be used to determine the transfer switch rating.
- J. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- K. Operating Conditions:
  - 1. Ambient Temperature: Maximum 40 degrees C.
  - 2. Equipment to be fully rated without any derating for operating conditions listed above.

### 2.03 ENCLOSURE

- A. Type: Nonventilated NEMA 250, 3R with enclosure grounding terminal.
- B. Dead front, front accessible floor mounted cabinet with 14-gauge welded steel construction.
- C. Continuously hinged single door, with handle and lock cylinder.
- D. Finish: Baked enamel applied over rust-inhibiting, phosphated base coating.
  - 1. Exterior and Interior Color: Provide gray finish as approved by Owner.
  - 2. Unpainted Metal Parts: Plated for corrosion resistance.

### 2.04 TRANSFER SWITCH

- A. Type: Electrically operated, mechanically held, double-throw.
- B. Momentarily energized, single-electrically operated mechanism energized from source to which load is to be transferred.
- C. Locking mechanism to maintain constant contact pressure.
- D. Mechanical interlock switch to ensure only one of two possible switch positions.
- E. Silver alloy contacts protected by arcing contacts.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- F. Main and arcing contacts visible when door is open and barrier covers removed.
- G. Manual operating handle for transfer in either direction under either loaded or unloaded conditions.
- H. Internal control wire connections made with ring or spade type terminals, lock washers, and sleeve type marking labels.

### 2.05 CONTROL MODULE

- A. Completely enclosed and mounted separately from the transfer switch unit.
- B. Microprocessor for sensing and logic control with inherent digital communications capability.
- C. Plug-in, industrial grade interfacing relays with dust covers.
- D. Connected to transfer switch by wiring harness having keyed disconnect plug.
- E. Plug-in printed circuit boards for sensing and control logic.
- F. Adjustable solid state undervoltage sensors for all three phases of normal and for one phase of standby source:
  - 1. Pickup 85 to 100 percent nominal.
  - 2. Dropout 75 to 98 percent of pickup setting.
- G. Adjustable frequency sensors for standby source:
  - 1. Pickup 90 to 100 percent nominal.
  - 2. Dropout 87 to 89 percent of pickup setting.
- H. Control module with adjustable time delays:
  - 1. 0.5- to 6-second engine start delay.
  - 2. 0- to 5-minute load transfer to emergency delay.
  - 3. 0- to 30-minute retransfer to normal delay.
  - 4. 0- to 30-minute unload running time delay.
  - 5. Switch to bypass any of the above time delays during testing.
- I. Form-C start contacts, rated 10 amperes, 32-volt dc, for two-wire engine control, wired to terminal block.
- J. Exerciser, adjustable in 15-minute increments, 7-day dial clock to complete with door mounted NO LOAD and LOAD selector switch.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- K. In-phase monitor to control transfer when both sources are within acceptable phase angle limits, or adjustable pneumatic type time delay relay for time-delay-in neutral position.
- L. Adjustable 0 to 5 minutes time delay relay for engine starting signal.

### 2.06 METERING INSTRUMENTS

- A. Meters to be connected to load side of transfer switch.
- B. Ammeter: 3-1/2-inch, 2 percent accuracy, panel type with current transformers, three-phase, line-to-line, OFF, four-position selector switch.
- C. Voltmeter: 3-1/2-inch, 2 percent accuracy, panel type with three-phase, line-to-line, line-to-neutral, OFF, seven-position selector switch and 12470|volt scale.

### 2.07 INDICATORS

- A. Type: Manufacturer's standard.
- B. Green lens to indicate switch position for normal power source.
- C. Red lens to indicate switch position for standby power source.
- D. White lens to indicate normal power source is available within parameters established by pickup and dropout settings.
- E. Amber lens to indicate standby power source is available within parameters established by pickup and dropout settings.
- F. Provide one normally open and one normally closed, 5 amperes, 120-volt contact for remote indication when transfer switch is in either position.

### 2.08 FACTORY TESTS

- A. Test to Ensure Correct:
  - 1. Operation of individual components.
  - 2. Sequence of operation.
  - 3. Transfer time, voltage, frequency, and time delay settings.
- B. Dielectric strength test per NEMA ICS 1.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

**PART 3 EXECUTION**

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure enclosure to floor using anchor bolts.

**END OF SECTION**

**SECTION 26 41 00**  
**FACILITY LIGHTNING PROTECTION**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Lightning Protection Institute (LPI): 175, Standard of Practice.
  2. National Fire Protection Association (NFPA):
    - a. 70, National Electrical Code (NEC).
    - b. 780, Standard for the Installation of Lightning Protection Systems.
  3. Underwriters Laboratories, Inc. (UL):
    - a. 96, Standard for Lightning Protection Components.
    - b. 96A, Standard for Installation Requirements for Lightning Protection Systems.

1.02 DESIGN REQUIREMENTS

- A. Provide lightning protection system design for all structures of the Project.
- B. Design lightning protection system to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

1.03 SUBMITTALS

- A. Action Submittals:
1. Reproducible Mylar Drawings:
    - a. Lightning protection system layout.
    - b. Component locations.
    - c. Detailed plans.
  2. Down conductor.
  3. Connecting conductor.
  4. Bond strap.
  5. Air terminals.
  6. Fittings.
  7. Connectors.
  8. Ground rods.
- B. Informational Submittals:
1. Field test report.
  2. Ground Witness Certification-Form LPI-175A.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

3. Post-Installation Certification-Form LPI-175B.
4. UL 96 Master Label "C" Certification.

### 1.04 QUALITY ASSURANCE

- A. Designer: Lightning protection system design shall be prepared by an LPI-certified designer or recognized lightning protection manufacturer.
- B. System components shall be the product of a manufacturer regularly engaged in the manufacturing of lightning protection components in accordance with UL 96.
- C. Lightning protection system shall be installed under direct supervision of an LPI 175 Certified Master Installer.
- D. Inspection of final installation and grounding connection shall be performed by an LPI-certified inspector.
- E. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
- F. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
  1. Thompson Lightning.
  2. IPC Protection.
  3. Erico Eritech Lightning Protection Systems.
  4. VFC, Inc.

### 2.02 GENERAL

- A. Complete system shall bear UL 96 Master Label C.
- B. System Material: Copper or high copper content, heavy-duty bronze castings unless otherwise specified.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Material shall comply in weight, size, and composition for the class of structure to be protected as established by NFPA 780.

### 2.03 COMPONENTS

#### A. Air Terminal:

1. Material: Solid copper rods with tapered or blunt points as required for application.
2. Diameter: 1/2.
3. Length: Sufficient to extend minimum 10 inches above object being protected.
4. UL 96 Label B applied to each terminal.

#### B. Conductors:

1. Lightning System Conductors: Bare medium hard-drawn stranded copper, or stranded aluminum as required for the application.
2. Main Down Conductor: Smooth twist stranding, Class I
3. Connecting Conductor: Concentric stranding, Class I.
4. Bonding Conductor: Flexible strap, minimum 3/4-inch wide by 1/8-inch thick.
5. Main down and connecting conductors shall bear the UL 96 Label A, applied every 10 feet.
6. Grounding Conductors: Stranded bare copper.

- C. Cable Fastener And Accessories: Capable of withstanding minimum pull of 100 pounds.

#### D. Fittings:

1. Heavy-duty.
2. Bolts, Screws, and Related Hardware: Stainless steel.

#### E. Ground Rods:

1. Material: Copper-clad.
2. Diameter: 3/4 inch.
3. Length: 10 feet.

#### F. Grounding Connections:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Hardware: Silicone bronze.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- G. Cable Connections and Splicers:
  - 1. Welds: Exothermic process.
  - 2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
  - 3. Through-Roof Connectors: Straight or right angle with bronze and lead seal flashing washer.
- H. Conduit: Schedule 40 PVC, as specified in Section 26 05 33, Raceway and Boxes.

### **PART 3 EXECUTION**

#### 3.01 GENERAL

- A. Workmanship to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.
- B. Aluminum materials shall be used where required to meet the galvanic corrosion requirements of UL 96A.
- C. Provide pitchpockets or method compatible with roofing to waterproof roof penetrations.
- D. Install system in inconspicuous manner so components blend with building aesthetics.

#### 3.02 EXAMINATION

- A. Verify conditions prior to installation. Actual conditions may require adjustments in air terminal and ground rod locations.

#### 3.03 INSTALLATION

- A. Air Terminals:
  - 1. Supports: Brackets or braces.
  - 2. Parapet Bracket Attachment: Lag or expansion bolts.
  - 3. Secure base to roof surface with adhesive or pitch compatible with roofing bond.
  - 4. Provide terminal flashing at roof penetrations.
  - 5. Perimeter Terminals:
    - a. Maximum Spacing: 20 feet.
    - b. Maximum Distance From Outside Edge of Building: 2 feet.
  - 6. Roof Ridge Terminals: Maximum spacing 20 feet.
  - 7. Mid-Roof Terminals: Maximum spacing 50 feet.
  - 8. Provide blunt point air terminals for applications exposed to personnel.

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### B. Conductors:

1. Conceal whenever practical.
2. Provide 1-inch PVC conduit in building walls or columns for main downleads and roof risers.
3. Support: Maximum spacing for exposed conductors.
  - a. Vertical: 3 foot.
  - b. Horizontal: 4 foot.
4. Maintain horizontal and vertical conductor courses free from dips or pockets.
5. Bends: Maximum 90 degrees, with minimum 8-inch radius.
6. Install air terminal conductors on the structural roof surface before roofing composition is applied.

### C. Bonding:

1. Bond to Main Conductor System:
  - a. Roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
  - b. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
2. Bond each steel column or major framing members to grounding system.
3. Bond each main down conductor to grounding system.

### D. Grounding System:

1. Grounding Conductor:
  - a. Completely encircle building structure.
  - b. Bury minimum 1 foot below finished grade.
  - c. Minimum 2 feet from foundation walls.
2. Interconnect ground rods by direct-buried copper cables.
3. Maximum Resistance: 5 ohms when connected to ground rods.
4. Connections:
  - a. Install ground cables continuous between connections.
  - b. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
  - c. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
  - d. Use bolted offset parapet bases or through-roof concealed base assemblies for air terminal connections.
  - e. Provide interconnections with electrical and telephone systems and all underground water, gas, sewer, and metal pipes.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- f. Provide electric service arrestor ground wire to building water main.

### 3.04 FIELD QUALITY CONTROL

#### A. Field Testing:

1. Isolate lightning protection system from other ground conditions while performing tests.
2. Resistance: Test ground resistance of grounding system by the fall-of-potential method.
  - a. Test Resistance to Ground: Maximum 1 ohms.
  - b. Install additional ground rods as required to obtain maximum allowable resistance.
3. Test Report:
  - a. Description of equipment tested.
  - b. Description of test.
  - c. Test results.
  - d. Conclusions and recommendations.
  - e. Appendix, including appropriate test forms.
  - f. Identification of test equipment used.
  - g. Signature of responsible test organization authority.

**END OF SECTION**

**SECTION 26 43 00  
TRANSIENT VOLTAGE SUPPRESSION**

**PART 1 GENERAL**

**1.01 SUBMITTALS**

- A. Submit product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
- B. Submit manufacturer's UL certified test data and nameplate data for each TVSS.
- C. Submit electrical single-line diagram showing location of each TVSS.

**1.02 QUALITY ASSURANCE**

- A. UL Compliance and Labeling:
  - 1. For power and signal circuits, TVSS devices shall comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units that are listed and labeled by UL.
  - 2. For telephone circuit protection, TVSS devices shall comply with UL 497A.
- B. ANSI Compliance: Use TVSS devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

**PART 2 PRODUCTS**

**2.01 GENERAL**

- A. All TVSS devices for power circuits, provided under this section, shall be the product of a single manufacturer.
- B. TVSS devices shall be capable of performance at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.
- C. TVSS devices shall be fused to disconnect the suppressor from the electrical source should the suppressor fail. The fusing shall allow full surge handling capabilities and to afford safety protection from thermal overloads and short circuits.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Design TVSS devices for the specific type and voltage of the electrical service. Single-phase and three-phase wye-configured systems shall have L-N, L-G, and N-G protection. Grounded delta-configured systems shall have L-L and L-G protection.
- E. Power Filter: The TVSS shall include a high frequency extended range power filter complimentary listed to UL 1283 as an electromagnetic interference filter.

2.02 MANUFACTURER

- A. Innovative Technology, VanGuard Series.
- B. Advanced Protection Technologies, Inc.
- C. General Electric.

2.03 MAIN DISTRIBUTION TVSS

- A. Provide TVSS meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.
- B. Surge current capacity shall be not less than the following:
  - 1. L-N Capacity: 200 kA.
  - 2. L-G Capacity: 120 kA.
  - 3. N-G Capacity: 120 kA.
- C. Suppressor housing shall be in an enclosure that has the same NEMA rating as the equipment it protects and painted to match.
- D. UL 1449 maximum suppression voltage shall not be more than:

System Voltage	Phase	L-L or L-N Suppression Voltage
120	1	400
208Y/120	3	400
240	3	800
480Y/277	3	800

2.04 PANELBOARD TVSS

- A. Provide TVSS meeting IEEE C62.41.1 and IEEE C62.41.2 Location Category B.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Surge current capacity shall be not less than the following:
  - 1. L-L Capacity: 80 kA.
  - 2. L-N Capacity: 80 kA.
  - 3. L-G Capacity: 80 kA.
  - 4. N-G Capacity: 80 kA.
- C. Suppressor shall be in an enclosure that has the same NEMA rating as the panel it protects or the TVSS may be integral to a panelboard.
- D. UL 1449 maximum clamp voltage shall not be more than:

System Voltage	Phase	L-L or L-N Clamp Voltage
120	1	400
208Y/120	3	400
240	3	800
480Y/277	3	800

2.05 ANNUNCIATION

- A. Provide unit or separately mounted LED-type indication lights to show the normal and failed status of each module. Provide one normally open and one normally closed contacts which operate when the unit fails.

2.06 SURGE COUNTER

- A. Provide each TVSS rated above 100 kA with a counter displaying the number of voltage transients that have occurred on the unit input. The counter shall be battery backed and retain the count through system power outages.

2.07 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

- A. Provide units meeting IEEE C62.41, Location Category A.
- B. Use bi-polar 1,500-watt silicon avalanche diodes between the protected conductor and earth ground.
- C. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).
- D. Breakdown voltage shall not exceed 36 volts.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 2.08 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

- A. Provide units meeting IEEE C62.41, Location Category A.
- B. Suppressors shall be a hybrid design with a minimum of three stages, utilizing solid-state components and operating bi-directionally.
- C. Suppressors shall meet or exceed the following criteria:
  - 1. Maximum single impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
  - 2. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform): 2,000 occurrences.
  - 3. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of the normal applied signal voltage by 200 percent.

## **PART 3 EXECUTION**

### 3.01 APPLICATION REQUIREMENTS

- A. Install TVSS when indicated on the Drawings and:
  - 1. Main Distribution TVSS in or near each low-voltage switchgear (load center).
  - 2. Main Distribution TVSS in or near each motor control center.
  - 3. Panelboard TVSS In or near each distribution panelboard unless otherwise indicated.
- B. Electronic Equipment Paired Cable Conductors: Install data line suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.
  - 1. Use secondary protectors on lines that do not exit the structure.
  - 2. Use primary protectors on lines that exit and enter the structure.

### 3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install suppressors according to manufacturer's recommendations.
- B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with all conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- C. Connecting wires shall be as short as possible with gently twisted conductors, tied together, to prevent separation. Connecting wires shall not exceed 24 inches in length at any point.
- D. Field installed conductors shall be the same as specified for building wire, not smaller than No. 8 AWG and not larger than No. 4 AWG. Device leads shall not be longer than the length recommended by the manufacturer, unless specifically reviewed and approved by the manufacturer.
- E. Provide dedicated disconnecting means for TVSS devices installed at main service entrance location, switchgear, and motor control centers. Provide dedicated 30-60-ampere circuit breakers (size dependent upon wire size used) with number of poles as required, as disconnecting means for TVSS devices installed at panelboards. The interrupting capacity of the circuit breakers shall be that specified for the other breakers at that location.

**END OF SECTION**



**SECTION 26 50 00  
LIGHTING**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Canadian Standards Association (CSA).
  2. Certified Ballast Manufacturer (CBM).
  3. Federal Communications Commission (FCC).
  4. Illuminating Engineering Society of North America (IESNA).
  5. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
  6. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC) – Softbound Version.
  8. Underwriters Laboratories, Inc. (UL):
    - a. 595, Marine-Type Electric Lighting Fixtures.
    - b. 844, Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
    - c. 924, Emergency Lighting and Power Equipment.

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
    - a. Interior Luminaires:
      - 1) Catalog data sheets and pictures.
      - 2) Luminaire finish and metal gauge.
      - 3) Lens material, pattern, and thickness.
      - 4) Candle power distribution curves in two or more planes.
      - 5) Candle power chart 0 degree to 90 degrees.
      - 6) Lumen output chart.
      - 7) Average maximum brightness data in foot lamberts.
      - 8) Coefficients of utilization for zonal cavity calculations.
      - 9) Mounting or suspension details.
    - b. Exterior Luminaires:
      - 1) Catalog data sheets and pictures.
      - 2) Luminaire finish and metal gauge.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- 3) Lens material, pattern, and thickness.
  - 4) IESNA lighting classification and isolux diagram.
  - 5) Fastening details to wall or pole.
  - 6) Ballast type, location, and method of fastening.
  - 7) For light poles, submit wind loading, complete dimensions, and finish.
- c. Lamps:
- 1) Voltages.
  - 2) Colors.
  - 3) Approximate life (in hours).
  - 4) Approximate initial lumens.
  - 5) Lumen maintenance curve.
  - 6) Lamp type and base.
  - 7) Copy of lamp order, including individual quantities, for Project.
- d. Ballasts:
- 1) Type.
  - 2) Wiring diagram.
  - 3) Nominal watts and input watts.
  - 4) Input voltage and power factor.
  - 5) Starting current, line current, and restrike current values.
  - 6) Sound rating.
  - 7) Temperature rating.
  - 8) Efficiency ratings.
  - 9) Low temperature characteristics.
  - 10) Emergency ballasts rating and capacity data.
- e. Photo-Time Control:
- 1) Wiring diagram.
  - 2) Contact ratings.
- f. Photocells:
- 1) Voltage, and power consumption.
  - 2) Capacity.
  - 3) Contacts and time delay.
  - 4) Operating levels.
  - 5) Enclosure type and dimensions.
  - 6) Temperature range.
- g. Occupancy Sensors:
- 1) Type.
  - 2) Switching capacity.
  - 3) Coverage.
  - 4) Time delay AUTO/OFF adjustment.
- h. Low Voltage Remote Control Wiring System:
- 1) Type.
  - 2) Switching capacity.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- 3) Voltage rating.
- 4) Wiring diagrams.
- 2. Samples: Submit Samples of each substituted luminaire if requested by Engineer.

1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
  - 1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
  - 2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.
  - 3. Assembled fixture, complete with lamps, shall be in accordance with California Code of Regulations Title 24 requirements.
- B. Preinstallation Meeting: Occupancy Sensors: Arrange preinstallation meeting with manufacturer's factory authorized representative at Owner's facility, to verify placement of sensors and installation criteria.

1.04 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts:

<u>Item</u>	<u>Quantity</u>
Spare ballast of each type	One complete set per unit.
Spare lamps of each type	One complete set per unit.

**PART 2 PRODUCTS**

2.01 LUMINAIRES

- A. Specific requirements relative to execution of the Work of this section are located in Luminaire Schedule on Drawings.
- B. Feed-through type, or separate junction box.
- C. Ballasts: Two-lamp when possible.
- D. Tandem wired for three-lamp, fluorescent fixtures.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- E. Wire Leads: Minimum 18 AWG.
- F. Component Access: Accessible and replaceable without removing luminaire from ceiling.
- G. Exterior Installations:
  - 1. UL Labeled: SUITABLE FOR WET LOCATIONS.
  - 2. Ballast: Removable, prewired.
  - 3. When factory-installed photocells are provided, entire assembly shall have UL label.
- H. Emergency Lighting:
  - 1. Power Pack: Self-contained, 120/277-volt dual voltage selectable input transformer, inverter/charger, sealed nickel cadmium lead acid lead calcium battery, and indicator switch in accordance with UL 924.
  - 2. Lighted, push-to-test indicator.
  - 3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
  - 4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
  - 5. Capable of protecting against excess charging and discharging.

### 2.02 LAMPS

- A. Fluorescent:
  - 1. Type Efficiency: Energy.
  - 2. Color: Cool white.
- B. High Intensity Discharge:
  - 1. Type: High pressure sodium and metal halide.
  - 2. Color: Color corrected.
- C. Incandescent:
  - 1. Type Efficiency: Energy.
  - 2. Color: Inside frosted.
- D. Incandescent Quartz: Translucent.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- E. Tungsten Halogen:
  - 1. Type Efficiency: Energy.
  - 2. Color: Clear.
- F. Manufacturers:
  - 1. General Electric Co.
  - 2. Osram Sylvania.
  - 3. Phillips Lighting Company.

### 2.03 BALLASTS

- A. General:
  - 1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
  - 2. Certified by electrical testing laboratory to conform to CBM specifications.
- B. Fluorescent (Electromagnetic):
  - 1. Type: High power factor, energy efficient, rapid-start and instant-start type ballast, compatible with lamps specified.
  - 2. Sound Rating: Minimum A, maximum allowable noise level of 30 decibels measured 2 feet from installed fixture.
  - 3. Class: P.
  - 4. Automatic resetting, thermo-protector to prevent case temperature from exceeding 110 degrees C in event of short circuit.
  - 5. For use in exterior located ballasts to produce reliable starting of lamps at minus 20 degrees F at 90 percent of normal line voltage.
- C. Fluorescent (Electronic):
  - 1. Provide in 1 lamp, 2 lamp, or 3 lamp models.
  - 2. High frequency ballast of 20k Hz or greater; rapid-start instant-start
  - 3. Meets FCC Part 18.
  - 4. UL listed, Class P, sound rating A.
  - 5. Power factor of: 90 percent or greater.
  - 6. Total harmonic distortion THD shall be less than: 10 percent.
  - 7. Shall withstand line transients per IEEE C62.41, Cat A.
  - 8. Shall not contain PCB's and shall carry a minimum 3-year manufacturer's warranty.
  - 9. Ballast shall start lamp at a minimum temperature of 50 degrees F.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

10. Shall meet Canadian Standards Association (CSA) where applicable.

### D. Metal Halide:

1. High power factor, normal ambient, 180 degrees C insulation class.
2. Types:
  - a. Autotransformer with capacitor and ignitor for lamps 150 watts and less.
  - b. Constant wattage autotransformer with capacitor for lamps above 150 watts.

### E. High Pressure Sodium:

1. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and ignitor.
2. Type:
  - a. Autotransformer for 50-watt lamps.
  - b. Constant wattage autotransformer for lamps 70 watts and above.

### F. Manufacturers:

1. MagneTek Lighting Products.
2. Advance Transformer Co.
3. Motorola Lighting Inc.
4. SLI Inc.
5. General Electric.

## 2.04 LIGHTING CONTROL

### A. Time Switch:

1. Provide digital electronic time switches with number of channels indicated on Drawings. Each channel shall be independently programmable and shall have a Form C dry contact, output rated for 10 amps at 120V ac. Time switches shall have, as a minimum, the following features:
  - a. Selectable am/pm or 24-hour format.
  - b. 1-minute time resolution.
  - c. Programmable up to 48 events per channel.
  - d. Weekly or 365-day capability.
  - e. Holiday capability.
  - f. User-programmable daylight savings time adjustment option.
  - g. Automatic leap year compensation.
  - h. Battery backup with rechargeable batteries and 72-hour capacity.
  - i. Individual manual ON/OFF override control for each channel.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- j. Manufacturers:
  - 1) Tork.
  - 2) Paragon Electric Company.

### B. Photocell:

- 1. Automatic ON/OFF switching photo control.
- 2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
- 3. Setting: ON at dusk and OFF at dawn.
- 4. Time delay feature to prevent false switching.
- 5. Field adjustable to control operating levels.
- 6. Manufacturers:
  - a. Tork.
  - b. Paragon Electric Company.

### C. Low Voltage Remote Control Wiring System:

- 1. Provide a complete low-voltage, remote control wiring system for control of lighting fixtures as indicated on Drawings and Schedules. System shall be complete with transformers, rectifiers, relays, switches, master switches, electronic controls, enclosures, wall plates, and wiring. System and components shall be of same manufacturer.
- 2. Remote control wiring shall be in accordance with Article 725, Class 2 of NFPA 70.
- 3. Provide for direct-wired connection of:
  - a. Standard of pilot light switches for individual control of relays.
  - b. Two independent master override inputs which allow ON/OFF control of all relays while still supporting individual control of each relay.
- 4. Relay panels shall be configured to allow future addition of up to two master controls of programmable control of all relays.

### D. Occupancy Sensors:

- 1. Passive Infrared:
  - a. Wall switch sensors shall be capable of detection of motion at desk top level up to 300 square feet and gross motion up to 1,000 square feet.
  - b. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1,200 watts at 277 volts and shall have 180-degree coverage capability.
  - c. Bi-level wall switch sensors shall accommodate up to two loads from 0 to 800 watts at 120 volts; 0 to 1,200 at 277 volts, for each load.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- d. Passive infrared sensors shall have a multiple segmented lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.
- e. Wall switches shall be compatible with electronic ballasts.
- 2. Dual Technology Units:
  - a. Unit to be ceiling mounted for 360-degree coverage.
  - b. Unit shall utilize both passive infrared and ultrasonic technologies and be easily programmed to accommodate different environmental and architectural conditions.
  - c. Unit must detect up to 2,000 square feet with no blind spots.
  - d. No audio dual technology units will be accepted.
- 3. Circuit Control Hardware—CU Power Packs:
  - a. Control Units: Able to mount through a 1/2-inch knock-out in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of two sensors.
  - b. Relay contacts shall have ratings of:
    - 1) 13A, 120V ac tungsten.
    - 2) 20A, 120V ac ballast.
- 4. Wiring: Control wiring between sensors and control units shall be Class II, 14-AWG, stranded, UL Classified, PVC insulated or Teflon jacketed cable approved for use in plenums, where applicable.
- 5. General:
  - a. Sensors shall be capable of operating normally with any electronic ballast and PL lamp systems.
  - b. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to cycling of air conditioner or heating fans.
  - c. Sensors shall have readily accessible, user adjustable controls for time delay and sensitivity.
  - d. In event of failure, bypass manual OVERRIDE ON key shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
  - e. Units shall have an extra Form C (1-NO-1-NC) contact for interface with building system. Units shall be designed to be mountable in standard electrical box.
  - f. Units shall have capability of being ordered with integral power pack.
  - g. Manufacturers:
    - 1) Unenco, Inc.
    - 2) The Watt Stopper, Inc.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 2.05 EMERGENCY BALLAST

- A. In accordance with UL 924.
- B. Nickel cadmium battery, charger, and electronic circuitry in metal case plus ac ballast.
- C. Solid state charging indicator monitoring light and double-pole test switch.
- D. Capable of operating: two fluorescent lamps for a period of 90 minutes with output of 1,100 to 1,200 lumens.
- E. Manufacturers:
  - 1. MagneTek Lighting Products.
  - 2. The Bodine Co., Inc.
  - 3. Lithonia.

### 2.06 IN-LINE FUSE HOLDER AND FUSE

- A. Fuse Holder:
  - 1. General: Waterproof, of corrosion-resistant material.
  - 2. Rating: 600 volts.
- B. Fuse:
  - 1. General: Midget, dual element.
  - 2. Rating: 5-amp, voltage as required by application.
- C. Manufacturer: Methods Electronics Inc. Network, Buss Div.

## **PART 3 EXECUTION**

### 3.01 LUMINAIRES

- A. General:
  - 1. Install in accordance with manufacturer's recommendations.
  - 2. Provide proper hangers, pendants, and canopies as necessary for complete installation and meeting specified seismic requirements.
  - 3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
  - 4. Install plumb and level.
  - 5. Install each luminaire outlet box with galvanized stud.



## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- B. Mounting:
  - 1. General:
    - a. Mounting, fastening, and environmental conditions shall be coordinated with Section 26 05 02, Basic Electrical Requirements.
    - b. Refer to Fastener Schedule in Section 05 50 00, Metal Fabrications.
  - 2. Wall Mounted: Measure mounting heights from center of mounting plate to finished floor or finished grade, whichever is applicable.
  - 3. Pendant Mounted:
    - a. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
    - b. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
    - c. Provide twin-stem hangers on single luminaires.
    - d. Measure mounting heights from bottom of luminaire to finished floor or finished grade, whichever is applicable.
- C. Swinging Type: Provide, at each support, safety cable capable of supporting four times vertical load from structure to luminaire.
- D. Finished Areas:
  - 1. Install symmetrically with tile pattern.
  - 2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
  - 3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
  - 4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
  - 5. Junction Boxes:
    - a. Flush and Recessed Luminaires: Locate minimum 1-foot from luminaire.
    - b. In concealed locations, install junction boxes to be accessible by removing luminaire.
  - 6. Wiring and Conduit:
    - a. Provide wiring of temperature rating required by luminaire.
    - b. Provide flexible steel conduit.
  - 7. Provide plaster frames when required by ceiling construction.
  - 8. Independent Supports:
    - a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
    - c. Fasten chain or wire to each end of luminaire.
  - E. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.
    - 1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
    - 2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.
  - F. Building Exterior: Flush-mounted back box and concealed conduit, unless otherwise indicated.
- 3.02 LAMPS
- A. Provide in each fixture, number and type for which fixture is designed, unless otherwise noted.
- 3.03 BALLASTS
- A. Install in accordance with manufacturer's recommendations.
  - B. Utilize all ballast mounting holes to fasten securely within luminaire.
  - C. Replace noisy or defective ballasts.
- 3.04 LIGHTING CONTROL
- A. Outdoor Luminaires: Photocells switch time clock ON at dusk with time clock switching lights OFF at preset time.
  - B. Occupancy Sensors: Locate and aim sensors in correct location required for complete and proper volumetric coverage within range of coverage(s) of controlled areas per manufacturer's recommendations. Rooms shall have 90 to 100 percent coverage to completely cover controlled area to accommodate all occupancy habits of single or multiple occupants at any location within room(s). Locations and quantities of sensors shown on Drawings are diagrammatic and indicate only rooms which are to be provided with sensors. Provide additional sensors if required to properly and completely cover respective room.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.05 EMERGENCY BALLAST

- A. Install battery, charger, and electronic circuitry metal case inside fluorescent fixture housing.
- B. Install monitoring light and double-pole switch adjacent to light fixture.
- C. Wire in accordance with manufacturer's wiring diagrams.

### 3.06 EMERGENCY LIGHTING UNIT

- A. Install in accordance with manufacturer's recommendations.
- B. Provide permanent circuit connections with conduit and wire.
- C. Connect to branch circuit feeding normal lighting in area ahead of all local switches.
- D. Provide separate circuit wiring to luminaire.

### 3.07 STANDBY LIGHTING UNIT

- A. Install in accordance with manufacturer's recommendations.
- B. Provide separate circuit wiring to luminaire.
- C. Provide permanent circuit connections with conduit and wire.

### 3.08 MANUFACTURER'S SERVICES

- A. Occupancy Sensors:
  - 1. Furnish manufacturer's representative at Job Site in accordance with Section 01 43 33, Manufacturers' Field Services, to inspect installation, test unit, and put into service.
  - 2. Provide, at Owner's facility, training necessary to familiarize Owner's personnel with operation, use, adjustment, and problem solving diagnosis of occupancy sensing devices and systems.

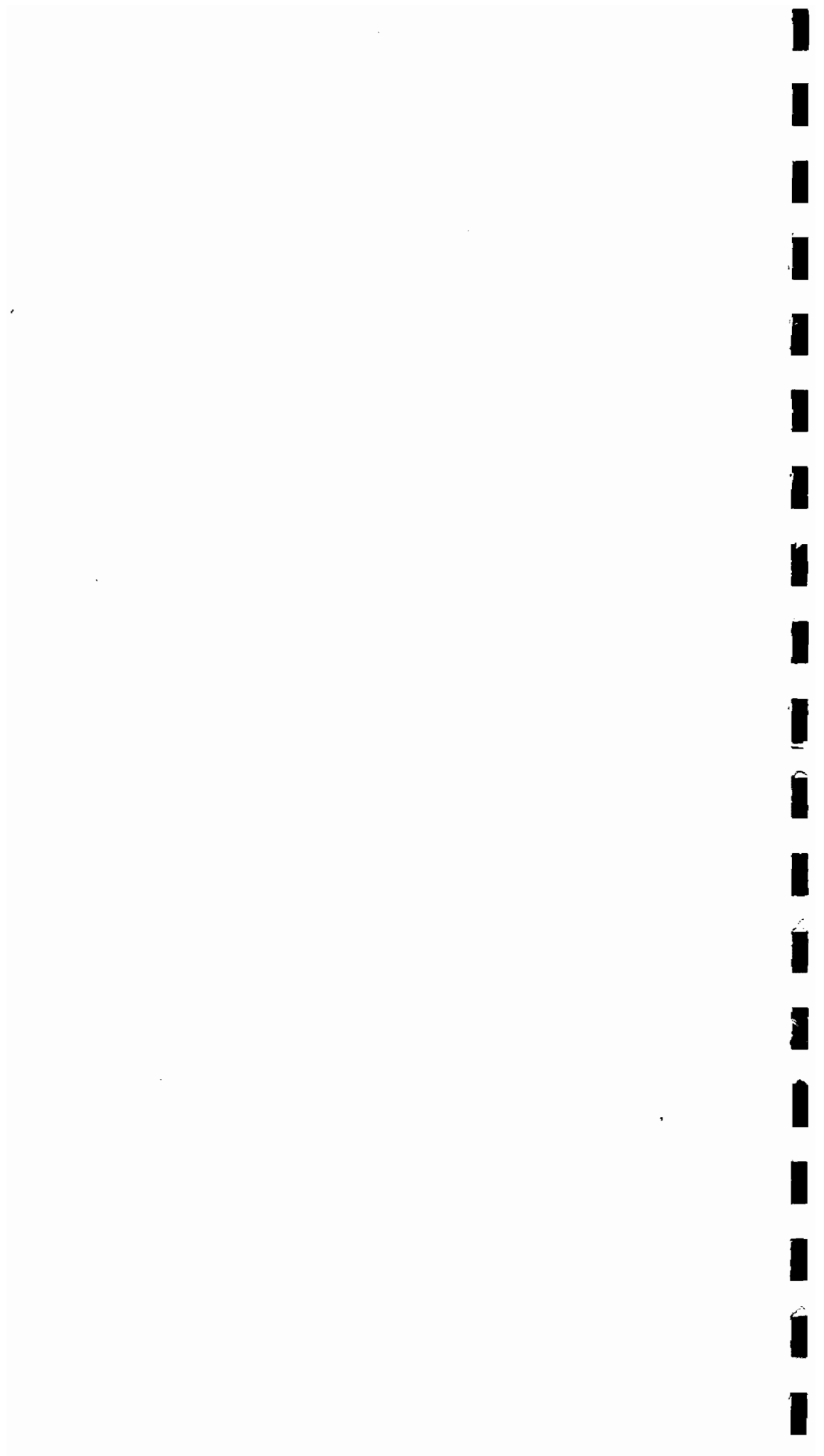
### 3.09 CLEANING

- A. Remove labels and markings, except UL listing mark.
- B. Wipe luminaires inside and out to remove construction dust.
- C. Clean luminaire plastic lenses with antistatic cleaners only.

MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- D. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
- E. Replace defective lamps at time of Substantial Completion.

**END OF SECTION**



**SECTION 26 56 00  
EXTERIOR LIGHTING**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
    - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    - b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    - c. A572/A572A, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
    - d. A588/A588M, Standard Specification for High-Strength Low-Alloy Structural Steel, with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick.
    - e. A595/A595M, Standard Specification for Steel Tubes, Low-Carbon or High-Strength Low-Alloy, Tapered for Structural Use.
    - f. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
    - g. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
    - h. D6576, Standard Specification for Flexible Cellular Rubber Chemically Blown.
    - i. G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
  2. American Wood Protection Association (AWPA): M6, Brands Used on Forest Products.
  3. Illuminating Engineering Society of North America (IESNA): HB-9, Lighting Handbook.
  4. The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C2, National Electrical Safety Code.
  5. Military Specification (MIL): DTL-83420M, Wire Rope, Flexible, for Aircraft Control, General Specification for.
  6. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    - b. ICS 6, Industrial Control and Systems: Enclosures.
  7. National Energy Policy Act.

# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

8. National Fire Protection Association (NFPA): 70, National Electrical Code.
9. Rural Utilities Service (RUS): 1728F-700, Specification for Wood Poles, Stubs and Anchor Logs.
10. Underwriters Laboratories, Inc. (UL):
  - a. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.
  - b. 844, Standard for Luminaires for Use in Hazardous (Classified) Locations.
11. U.S. Environmental Protection Agency and U.S. Department of Energy: Energy Star.

## 1.02 SUBMITTALS

### A. Action Submittals:

#### 1. Shop Drawings:

- a. Exterior Luminaires:
  - 1) Catalog data sheets and pictures.
  - 2) Luminaire material, finish, metal gauge, and dimensions.
  - 3) IESNA classification and isolux diagram.
  - 4) Distribution data according to classification type as defined in IESNA HB-9. Computerized horizontal illumination levels in footcandles at ground level, taken every 10 feet. Include average maintained foot candle level and maximum and minimum ratio.
  - 5) Fastening details.
  - 6) For light poles, submit wind loading, complete dimensions, pole deflection with fixture attached, finish, and catalog sheet.
  - 7) Lens material, pattern, and thickness.
  - 8) Data indicating lumens per watt efficiency and color rendition index of light source.
- b. Lamps:
  - 1) Voltage.
  - 2) Approximate life (in hours).
  - 3) Approximate initial lumens.
  - 4) Lamp type and base.
  - 5) Color.
- c. Ballasts:
  - 1) Type.
  - 2) Wiring diagram.
  - 3) Nominal watts and input watts.
  - 4) Input voltage and power factor.
  - 5) Starting current, line current, and restrike current values.
  - 6) Sound rating.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- 7) Temperature rating.
- 8) Efficiency ratings.
- 9) Low temperature characteristics.
- d. Photocells:
  - 1) Voltage, and power consumption.
  - 2) Capacity.
  - 3) Contacts and time delay.
  - 4) Operating levels.
  - 5) Enclosure type and dimensions.
  - 6) Temperature range.

### B. Informational Submittals:

1. Manufacturer's printed installation instructions.
2. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

## 1.03 QUALITY ASSURANCE

### A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

### B. Standard Products:

1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship.
2. Products shall have been in satisfactory commercial or industrial use for 2 years prior to Bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
3. Material and Equipment Manufacturing Date: Products manufactured more than 3 years prior to date of delivery to Site shall not be used.



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## 1.04 DELIVERY, STORAGE, AND HANDLING

### A. Aluminum Poles:

1. Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.
2. Do not store poles on ground.
3. Support poles so they are at least 1 foot above ground level and growing vegetation.
4. Do not remove factory-applied pole wrappings until just before installing pole.
5. Ship poles with bolt circle template, base cover, handhold cover, and shaft cap or tenon.

## PART 2 PRODUCTS

### 2.01 LUMINAIRES

#### A. General:

1. Specific requirements relative to the Work of this section are located in Luminaire Schedule on Drawings.
2. Component Access: Accessible and replaceable without removing luminaire from its mounting.

#### B. Soffit Installations:

1. UL Labeled: "SUITABLE FOR DAMP LOCATIONS."
2. Ballast: Removable, prewired.

#### C. Exterior Installations:

1. UL Labeled: "SUITABLE FOR WET LOCATIONS."
2. Ballast: Removable, prewired.
3. When factory-installed photo cells are provided, entire assembly shall have UL label.

#### D. Lamps:

1. High-Intensity Discharge:
  - a. Type: High-pressure sodium and metal halide.
  - b. Color: Color corrected.
2. Incandescent Quartz: Translucent.
3. Tungsten Halogen:

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

- a. Type Efficiency: Energy.
  - b. Color: Clear.
  4. LED lamps, color as indicated in Luminaire Schedule.
  5. Auxiliary Instant-On Quartz System:
    - a. Features:
      - 1) UL listed, automatically switched instant-on 150-watt quartz lamp.
      - 2) Quartz lamp shall come on when luminaire is initially energized and immediately after a momentary power outage, and remain on until HID lamp reaches approximately 60 percent light output.
      - 3) Wiring for quartz lamp shall be internal to ballast and independent of incoming line voltage to the ballast.
      - 4) Provide instant-on quartz system as indicated in Luminaire Schedule.
  6. Manufacturers:
    - a. General Electric Company.
    - b. Osram Sylvania.
    - c. Phillips Lighting Company.
- E. Ballasts for High-Intensity-Discharge (HID) Luminaires:
1. Constant wattage autotransformer (CWA) or regulator, high power factor type (minimum 90 percent) type.
  2. Provide single-lamp ballasts which shall have a minimum starting temperature of minus 30 degrees C. Ballasts shall be:
    - a. Designed to operate on voltage system to which they are connected.
    - b. Constructed so open circuit operation will not reduce the average life.
  3. Solid-state igniter/starter with an average life in the pulsing mode of 10,000 hours at intended ambient temperature. Igniter case temperature shall not exceed 90 degrees C.
  4. Manufacturers:
    - a. MagneTek Lighting Products.
    - b. Advance Transformer Company.
    - c. Motorola Lighting Inc.
    - d. SLI Inc.
    - e. General Electric Company.

### 2.02 LIGHTING CONTACTOR

- A. Features:
1. Electrically held contactor.

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2. Contacts shall be rated as called for on the Drawings
3. Silver alloy double-break contacts
4. Coils shall be rated 120volts.
5. Rate contactor as indicated in Luminaire Schedule.
6. Enclosure: NEMA 12conforming to NEMA ICS 6.
7. Provide contactor with hand-off-automatic selector switch.
8. Contactor shall be hermetically sealed.

### 2.03 PHOTOCCELL SWITCH

#### A. Features:

1. Automatic ON/OFF switching photo control.
2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
3. Setting: ON at dusk and OFF at dawn.
4. Time delay feature to prevent false switching.
5. Field adjustable to control operating levels.
6. Manufacturers:
  - a. Tork.
  - b. Paragon Electric Company.

### 2.04 POLES

#### A. General:

1. Design for wind load as specified in Section 01 61 00, Common Product Requirements, while supporting luminaires and other appurtenances. The effective projected areas (EPA) of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole.
2. Poles 40 feet and shorter shall be one piece construction.
3. Pole Height: As indicated on Luminaire Schedule.
4. Handhole:
  - a. Poles shall have oval-shaped handhole having a minimum clear opening of 2.5 inches by 5 inches.
  - b. Cover shall be secured by stainless steel captive screws.
  - c. Metal poles shall have internal grounding connection accessible from handhole near bottom of each pole.
5. Scratched, stained, chipped, or dented poles shall not be installed.

#### B. Aluminum Poles:

1. Manufactured of corrosion-resistant aluminum alloys. Seamless extruded or spun seamless type with minimum 0.188-inch wall thickness.

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2. Shape: Round or square as called for in the Schedule
3. Provide pole grounding connection designed to prevent electrolysis when used with copper ground wire.
4. Shaft Top: Fitted with cap.
5. Base:
  - a. Anchor bolt mounted and machined to receive lower end of shaft.
  - b. Joint between shaft and base shall be welded.
  - c. Base cover shall be cast aluminum alloy.
  - d. Hardware, except anchor bolts, shall be either anodized aluminum alloy or stainless steel.
  - e. Handhole.
6. Provide pole cast-in-place foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end.
7. Provide base covers to match pole and galvanized nuts and washers for anchor bolts.
8. Finish: Pole and brackets shall have dark anodic bronze finish to match fixture.

### 2.05 POLE FOUNDATIONS

- A. Anchor Bolts: Steel rod having a minimum yield strength of 50,000 psi; the top 12 inches of the rod shall be galvanized.
- B. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

### 2.06 EQUIPMENT IDENTIFICATION

- A. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; nameplate of distributing agent will not be acceptable.
- B. Markings shall be clear and located to be readily visible to service personnel.

### 2.07 FACTORY FINISH

- A. Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Electrical installations shall conform to IEEE C2 and requirements specified herein.

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- B. Pole Setting:
  - 1. Depth shall be as indicated on Drawings or footing detail.
  - 2. Poles in straight runs shall be in a straight line.
- C. Aluminum Poles: Install according to pole manufacturer's instructions.
  - 1. Provide cast-in-place concrete base.
  - 2. Provide branch circuit in-line fuses in pole base handhole.
- D. High Mast Lighting: Install according to manufacturer's instructions.
- E. Photocell Switch Aiming: Mount and aim switch according to manufacturer's recommendations.
- F. Grounding: Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 26 05 26, Grounding. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

### 3.02 FIELD FINISHES

- A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00, Painting and Coating.

### 3.03 FIELD QUALITY CONTROL

- A. Upon completion of installation, verify equipment is properly installed, connected, and adjusted. Conduct an operating test to show equipment operates in accordance with the requirements of this section.
- B. Coordinate lighting and controls installation and testing with commissioning as specified in Section 01 91 14, Equipment Testing and Facility Startup.

### 3.04 CLEANING

- A. Remove labels and markings, except UL listing mark.
- B. Wipe luminaires inside and out to remove construction dust.
- C. Clean luminaire plastic lenses with antistatic cleaners only.
- D. Touchup painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

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- E. Replace defective lamps at time of Substantial Completion.

**END OF SECTION**



# MEMORIAL PARKWAY WTP ADVANCED TREATMENT

## SECTION 27 24 23 VIDEO EQUIPMENT

### PART 1 GENERAL

#### 1.01 WORK INCLUDED

- A. Provide video equipment as shown on the Drawings.
- B. The new system at the AT Building shall be compatible with the existing head-in equipment in the Filter Building.

#### 1.02 SUBMITTALS

- A. Product data.
- B. Block Diagram: Provide system diagram noting major system components and interrelationship of each component.
- C. Interconnection Diagram: Provide detailed drawing noting interconnecting cable and labeled connections for all closed circuit television (CCTV) equipment.

#### 1.03 REFERENCES

- A. CE and FCC Class A.
- B. UL/cUL Listed.

### PART 2 PRODUCTS

#### 2.01 CAMERAS

- A. The cameras shall be pan-tilt-zoom (PTZ) and must be suitable for outdoor installation. Key features shall include:
  - 1. Autofocus, high resolution.
  - 2. Day/night, 540 TVL, 128X wide dynamic range.
  - 3. Motion detection.
  - 4. Electronic image stabilization.
  - 5. On-screen compass and tilt display.
  - 6. Built-in surge and lightning protection.
  - 7. Internal clock.



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- B. Camera to be provided complete with mounting hardware including:
  - 1. Wall mount bracket, Pelco Model IWM-G4 or equivalent.
  - 2. Pole adapter, Pelco Model PA402 or equivalent.
- C. Camera to be Pelco Spectra series, Model SD435-PG-E1 or equivalent.

### 2.02 DIGITAL VIDEO RECORDER (DVR)

- A. Provide one (1) DVR mounted inside the AT Building electrical room. Key features of the recorder include:
  - 1. 16 channels.
  - 2. 250 GB of storage.
  - 3. Input voltage: 120VAC.
  - 4. Signal system: NTSC/PAL
  - 5. Video connectors: BNC
  - 6. Rack Mount.
- B. DVR to be Pelco Model DX8116-250 or equivalent.

### 2.03 POWER SUPPLY

- A. Each camera shall be provided with a 120 VAC - 24 VDC power supply mounted inside a weatherproof box. The power supply shall be Pelco Model WCSI-4 or equivalent.

### 2.04 CABLING

- A. Cabling from each camera to the DVR shall be coax cable RG59/U.
- B. Surge protection shall be provided on both ends of the coax cable.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install CCTV system in accordance with manufacturer's recommendations and reviewed shop drawings.
- B. Contractor to be responsible for complete programming of CCTV system to include system application programming, camera presets, camera and sequencing..
- C. Grounding: Ground all CCTV components and power supplies in accordance with NEC requirements.

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

### 3.02 TRAINING

- A. Provide training to ensure Owner's operational and maintenance staff are capable of operating, configuring and maintaining all system components.

### 3.03 TESTING AND INSPECTION

- A. Conduct system acceptance test upon completion of installation using pre-approved procedures.
- B. Perform tests and provide test equipment, tools, and personnel required to conduct system test and inspection.

**END OF SECTION**



**SECTION 28 13 53  
ACCESS CONTROL SYSTEM**

**PART 1 GENERAL**

**1.01 WORK INCLUDED**

- A. Scope: This section covers the furnishing and installation of an access control system and accessories, that must interface with the existing access control system.
- B. The installation shall include programming the existing server to accept the new access control system. The new system shall be programmed similar to the other buildings at the plant.
- C. General:
  - 1. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Owner.
  - 2. The specifications describe the minimum requirements for hardware. Where Contractor's standard configuration includes additional items of equipment features not specifically described herein, such equipment or features shall be furnished as a part of the system. The Contractor shall provide all material, equipment, and labor necessary to complete the work properly.

**1.02 INSTALLATION AND MATERIALS**

- A. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective installation or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions. Equipment shall not have been in service at any time prior to delivery, except for testing.

**1.03 FACTORY ASSEMBLY**

- A. Equipment shall be shipped completely factory assembled, except where its physical size, arrangement, configuration, or shipping and handling limitations make the shipment of completely assembled units impractical.

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## 1.04 EXPANDABILITY

- A. The system shall be capable of expansion as required.

## 1.05 AMBIENT TEMPERATURES

- A. Unless otherwise specified, equipment shall be suitable for the conditions described in this paragraph. All system equipment located in air conditioned areas shall be suitable for operation in ambient temperatures from 50°F to 95°F and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non-air conditioned indoor areas shall be suitable for an ambient temperature range of 32°F to 120°F and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range of minus 30°F to 120°F and a relative humidity of 5 to 100 percent.

## 1.06 SUBMITTALS

- A. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with the submittals section.

## 1.07 REFERENCE TO STANDARDS

- A. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gage
EIA	Electronic Industries Association
FCC	Federal Communications Commission
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

## 1.08 PREPARATION FOR SHIPMENT

- A. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements; shall be kept dry at all times, and shall not be exposed to adverse weather conditions.

- B. Painted surfaces shall be protected against damage by impact, abrasion, discoloration, or other conditions. Painted surfaces that are damaged prior to acceptance of the system shall be repainted to the satisfaction of the Owner.

### 1.09 SPARE PARTS

- A. Spare parts and consumable items shall be provided as specified. All spare parts shall be delivered to the Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Electronic parts shall be enclosed in anti-static material. All spare parts shall be clearly marked with the manufacturer's name, part number, date of manufacture, and approximate shelf life. Contractor may utilize spare parts and supplies during system installation and testing but shall restore or replace all such materials and supplies to the specified quantities before final acceptance of the system.
- B. Contractor shall provide the following spare parts:
  - 1. Power Supplies: Provide at least one (1) of each type, minimum of two (2).
  - 2. Card Reader: Provide at least one (1) of each type.
  - 3. Two (2) door contacts with relays.
  - 4. Two (2) hatch limit switches.

### 1.10 POWER SUPPLY

- A. Unless otherwise specified, power supply to all equipment will be 120 volts, 60 Hz, single phase. Contractor shall be responsible for supplying power to all access control system panels. Contractor shall be responsible for distribution of power among enclosures, consoles, peripherals, and other components of the system. Power distribution hardware shall include cables and branch circuit overcurrent protection.

### 1.11 SYSTEM OVERVIEW

- A. The system shall be a PC-based access control system used to control and monitor personnel and alarm activity. Contractor shall coordinate with the Owner for connection to existing hardware and network systems as required. The existing software used by the Owner is WinDSX and shall be used by the Contractor to operate the access control system.

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## B. Access Control:

1. A card reader at the building will open the primary door and allow access into the building. The card reader will function properly by using the proximity card or by entering the code on the keypad. Operating the card reader a second time will reset the system and reactivate the door alarms. If an employee fails to reset the system, it will automatically reset at 5:00 p.m. and the system will identify the last person of entry.
2. Contact switches on access hatches will activate an alarm to SCADA only.

## 1.12 OPERATING AND MAINTENANCE MANUALS

### A. Two (2) copies of a manual fully describing all procedures and instructions for operation of the system shall be provided, including but not limited to the following:

1. Hardware and peripherals.
2. Definition of terms and functions.
3. System start-up and shutdown procedures.
4. Use of system and applications software.
5. Recovery and restart procedures.
6. Graphic alarm presentation.
7. Alarm reports and printing formats.
8. Use of report generator and generation of reports.
9. Date entry.
10. Operator commands.

### B. Maintenance information shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

## PART 2 PRODUCTS

### 2.01 ACCESS CONTROLLER

#### A. The controller shall be "Model DSX-1048PKG", as manufactured by DSX Access Systems, Inc, without exception to match Owner's existing system. The controller shall meet the following minimum requirements:

#### B. Basic Features:

1. UL 294.
2. Complete distributed processing: Never any reliance on host PC for any decision-making.
3. Access verifications for all cards performed at controller.

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4. Linking: Input to Input, Input to Output, Output to Input, Output to Output, Code to Input and Code to Output Linking. Done locally at controller AND/OR controller to controller.
5. Status LED for each Input.
6. Status LED for each Output
7. Controller Polled LED.
8. Separate communication received and transmitted LEDs.
9. Processor functioning properly LED.
10. Dynamic Battery load test: Programmable using a spare open collector output to trip the Battery Test Input. Battery test may also be manually initiated through PC at any time.
11. Battery Load shed circuit: Once the system is running on battery power the batteries must be disconnected at approximately 9VDC. The batteries must stay disconnected until AC power is restored.
12. Controller can report to PC; loss of DC power, and low battery as separate alarms.
13. Status LED for DC power to Controller.
14. Real time on board clock/calendar generation that is synchronized with host PC clock/calendar.
15. Dynamic memory allocation.
16. Change to/from auto buffering of all transactions based on communications status.
17. Point to point RS-485 4 wire controller communications allowing up to 4000 feet between each 1048PKG.
18. Wiring Management System that includes wire chases, cable ties and mounting clips.
19. Silkscreen detailing displays wiring termination and function of all terminals on controller.
20. Controller operating system resides in Flash ROM that is upgradeable thru the Host PC. Upgrades in controller operating system shall NOT require PROM changes.

C. Power Supplies: DSX-1040PDP (power distribution panel) and DSX-1040CDM (communications distribution module), Included in 1042PKG.

1. 2VDC 8A power for controllers. (Battery backed up).
2. 12VDC 8.5A / 24VDC 4.25A power for locks (provide four (4) batteries "12V-BATT" for each controller package furnished and provide "Controller Power Source" AS-150" in power distribution panel).
3. 5VDC .375 amp for 5 volt devices.
4. UL294
5. AC loss and low battery supervisory outputs.
6. Battery load test control input.
7. Lock power override input.
8. Provides individual fused output for 8 locks.



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9. Provides for 8 individual sets of termination of Lock wiring and control relay wiring with removable terminals.
- D. Controller Architecture: AM186 20 MHz processor, RAM, ROM, and removable field wiring terminals.
- E. Compatibility: Controller is compatible with any identification device that transmits data using Wiegand, clock/data, or RS-232 ACSII at 1200-baud, 8N1. This includes but is not limited to proximity, barium ferrite, bar code, magnetic stripe, Wiegand, keypads, and biometric readers.
- F. Memory: RAM: 512K and ROM: 512K Flash
- G. Communications:
  1. Via direct serial port, dial-up modem, or TCP/IP. TCP/IP communications require additional hardware.
  2. Communication Ports: PC to controller 1 - RS-232 in; 50 feet max. 50ft - 4000 feet requires two MCI modules.
  3. Controller to controller in the same enclosure; RS232 via the 1040CDM. 1042 PKG to 1048 PKG to 1022 regenerative RS485 4000 feet max via the 1040CDM.
  4. 1040CDM (communications distribution module) handles RS232 between controllers in the same enclosure, and serves as RS485 connection point for other 1040 series PKG units or 1022 controllers in controller network.
- H. Operating Temperature: 32 to 131 degrees F. Operating Humidity: 0-95% RD.
- I. Battery Changing Output: Trickle Charge: 13.5 VDC. 500ma, fused. Standby Time: 11 hours under minimum load and 3.25 hours under maximum load w/ 2-12VDC 7AH battery.
- J. Model DSX-1048PKG Intelligent 8 Door I/O Controller. The controller shall be designed for eight-door reader/key pad application. Inputs shall include 32 EOL supervised inputs; each capable of 2, 3, or 4 state point monitoring with trouble reports. Outputs shall include 8 relay, 8-Open collector outputs, 8 pre-warn, 24 LED drivers as follows:
  1. 8 - Form C, 5 amp rated relay outputs.
  2. {tc \13 "8 - Form C, 5 amp rated relay outputs. 2. }8 - Open collector outputs 100ma. {tc \13 "8 - Open collector outputs 100ma. }
  3. 8 - pre-warn outputs for door being held open sounders.
  4. 24 - LED output Drivers to show lock status and or valid card read status at the reader or keypad.

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- K. The controller shall include trouble LEDs to show low battery, battery fuse, auxiliary power fuse, 12 VDC fuse, 5 VDC fuse, low AC, and High AC. Power supply shall be 12 VDC 1 amp and 5 VDC 300 milliamp.

### 2.02 ACCESS CONTROL READER

- A. The access control readers shall be "Proxpoint Plus Model Number 6005" as manufactured by HID corporation, without exception. The card reader shall read the encoded data from the access card and transmit the data back to the host panel, giving audible and visual indication of a properly read card. The card reader shall be listed under UL 294 as an access control system unit accessory. The reader shall have a lifetime warranty.
- B. The card reader shall have a typical read range of 2 inches to 3 inches when used with an HID Corporation "IsoProx II" proximity card. The card reader shall be no larger than 3.135 inches by 1.720 inches. The card reader shall be a single unit with a two-piece housing, with an epoxy-potted enclosure and a snap-on cover, and with properly sized mounting holes that allow it to be attached to a standard mullion. The card reader shall be fully weatherized and shall have an operating temperature of -22 degrees Fahrenheit to 150 degrees Fahrenheit and shall have an operating humidity of 5 to 95 percent noncondensing. The card reader shall be made from polycarbonate material, and shall be white, gray, beige or black.
- C. The card reader shall have separate terminal control points for the green LED, the red LED, and the audible indicator. The card reader shall have a hold line that will buffer a card read until the panel has asserted that the information can be sent up line. The card reader shall have a card present line that will indicate that card data is ready to send for clock and data applications. The card reader shall have a re-present mode in which the card must be taken from the reader for one second before being read again.
- D. The card reader shall communicate in a Wiegand protocol interface and be compatible with all standard access control systems. The voltage requirements of the card reader shall be 5 to 16 VDC. The card reader shall transmit at a 125 kHz frequency. Cable requirements of the card reader shall be 22 AWG twisted pair, shielded, stranded cable. The card reader shall be provided with a 10 wire pigtail connector.
- E. The card reader shall have the following reader configuration options:
  - 1. Reader beeps and flashes green on a card read, LED normally red, single line control of LED.
  - 2. Reader flashes green on a card read, LED normally red, single line controls of LED.

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3. Reader beeps on a card read, LED normally red, single line control of LED.
4. Beeper and LED are controlled by host only, LED normally red, single line control of LED.
5. Reader beeps and flashes green on a card read, LED normally off, red and green LED's controlled individually.
6. Reader flashes green on a card read, LED normally off, red and green LED's controlled individually.
7. Reader beeps on a card read, LED normally off, red and green LED's controlled individually.
8. Beeper and LED are controlled by host only, LED normally off, red and green LED controlled individually.

### 2.03 TAMPER SWITCHES

- A. Enclosures, cabinets, housings, and boxes having hinged doors or removable covers and which contain connections of the system or power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. The enclosure and the tamper switch shall function together and shall not allow direct line of sight to any internal components before the switch activates. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door or cover; and shall be wired so that they break the circuit when the door or cover is disturbed.

### 2.04 SYSTEM OPERATION AND CONTROL

- A. Each controller shall operate as an autonomous intelligent processing unit. It shall be part of a fully distributed processing control network. Each controller shall maintain its own database, in its entirety, necessary for independent operation in its own RAM. It shall make all decisions about access control, alarm monitoring, linking functions and door locking schedules for its operation independent of any other system components.
- B. When controller is brought on-line all database parameters shall be automatically downloaded to it. After initial download is completed only database changes shall be downloaded to each controller. This shall be referred to as "Incremental downloads" or "Downloading of Changes Only."

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- C. I/O Linking shall operate globally between all controllers within the same location without any Host PC intervention. Linking shall not depend on any decision-making process or macros from the Host PC and shall occur even with the Host PC off line.
- D. Controller operating system resides in Flash ROM that is upgradeable through a download from the Host PC. Upgrades in controller operating system shall NOT require PROM changes.
- E. A location shall be defined as a loop of up to 64 controllers (128 readers).
- F. The first controller of every location shall be designated as the "Master." All subsequent controllers at the same location shall be designated as "Slaves." Any controller may be selected by dipswitch settings to work as a Master controller. A Master controller shall perform all the same functions as a Slave controller, but it shall also be responsible for polling all Slave controllers and reporting the history transactions to the host PC. The Master controller shall not make any access decisions for the Slave controllers. The Master controller shall be the messenger for information from the controllers to the PC, and from the PC to the controllers.
- G. Each card reader port of a controller shall be custom configurable for over 120 different card reader or keypad formats. Multiple card reader/keypad formats may be used simultaneously at different controllers and even within the same controller.
- H. The Controller shall provide a response to all Card Read or Keypad entries in less than .25 seconds regardless of System size.
- I. All valid codes for a location shall be downloaded and reside in the controllers. The controllers shall not depend on querying the Host PC database or any other controller or system component for code authorizations.
- J. All communication between the Host PC & Master controller (Direct, Dial-up or TCP/IP), and between the Master & Slave controllers use a polled communication protocol that checksum and acknowledges (ACK) each message. All communication is verified and will automatically be buffered and retransmitted if it fails to be acknowledged.
- K. There shall be NO degradation of System performance in the event of a communication loss between the Host PC and the Master controller. The Master controller shall automatically switch to buffer mode storing up to 10,000 events. There shall be NO loss of transactions in System history files until the controller buffer overflows.

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- L. A missing or failed controller shall not degrade the performance of the communicating controllers in the controller communication network. Missing controllers shall be ignored and sampled less often by the Master controller. Any functioning Slave controller not communicating with the Master will automatically switch to buffer mode storing up to 10,000 events.
- M. Buffered events shall be handled in a FIFO (First in First Out) mode of operation.
- N. All controllers shall have a built in dead man reset timer (watchdog circuit) that automatically reboots the controller in the event the processor is interrupted for any reason.
- O. Any controller that is reset, or powered up from a non-powered state shall automatically request a parameter download and reboot to its proper working state. This shall happen without any operator intervention.
- P. The System shall provide a means for viewing the Communications Status of the intelligent controllers RS485 Communications loop.
- Q. The Communication Status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which intelligent controller last missed a poll. Missed polls reflect that messages had to be retransmitted and are an indication to the soundness or quality of the controller-to-controller network.
- R. The Communication Status window shall show what type of CPU, what type of Input/Output board, and how much RAM Memory each controller has.

### 2.05 CONTROLLER TO CONTROLLER COMMUNICATIONS

- A. The Controller to Controller Communications shall be a true RS-485, 4-wire, point to point, regenerative (repeater) communications network methodology.
- B. The RS-485 communications signal shall be re-generated at each controller without any additional modules or hardware.
- C. The controller-to-controller communications shall be performed without the use of external modules or devices.
- D. The Master Controller shall supervise the communications to each Slave controller. Communication Loss shall be reported immediately for direct serial port connected locations. Controller communications loss shall be configurable to initiate a call to the PC for dial-up modem locations

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### 2.06 CABLE

- A. Cable used in the access control system shall be multi-conductor cable, at least 18 AWG size for electric strikes and electromagnetic locks and 22 AWG size for contacts and signal, or as recommended by the manufacturer of the access control system equipment, specifically designed for industrial systems and UL listed for indoor/outdoor installations. All cable required for the system shall be installed in conduits.
  
- B. Except as otherwise specified or indicated on the drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage.
  - 1. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.
  - 2. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may be used for splicing solid cable and for terminations at lighting fixtures.
  - 3. Splices may be made only at readily accessible locations.
  - 4. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions. All shielded cable stress cone terminations shall be IEEE Class 1 molded rubber type. Shielded cable splices shall be tape or molded rubber type as required. Shielded cable splices and stress cone terminations shall be made by qualified splicers. Materials shall be by 3M Company or Raychem Electric Power Products.
  - 5. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.
  - 6. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J", Quote #1823.
  - 7. Spare cable ends shall be taped, coiled, and identified.
  - 8. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.
  - 9. All cables in one conduit, over 1 foot long, or with any bends, shall be pulled in or out simultaneously.

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### 2.07 DOORS AND HARDWARE

- A. Contractor shall install new steel door and frame at the locations indicated on the drawings. Door and frame shall be as manufactured by Kawneer or approved equivalent. Install door in accordance with manufacturer's instructions. Set items straight, level, square, plumb, and in alignment.
- B. Door Hardware:
  - 1. Contractor shall furnish and install hardware on new doors to make the access control system operational. All door hardware to be made from cast brass, bronze, or stainless steel. Door hardware shall be manufactured by Russwin, Schlage, Folger Adam, LCN, or approved equivalent.
  - 2. Door contacts shall be magnetic type, double pole double throw, as manufactured by Sentrol, Locknectics, or approved equivalent.
  - 3. Door hardware items shall be installed in accordance with the manufacturer's instructions.
  - 4. Care shall be taken to protect finished surfaces of hardware during installation. Hardware on which the finish has been damaged prior to final acceptance of the work shall be replaced with new hardware at no additional cost to the Owner.
  - 5. All cylinder locks shall be keyed to match the existing keying system or re-keyed in groups. Contractor shall meet with the Owner to determine the keying groups.
- C. Crash Bar Exit: Steel doors having new card readers shall include crash bar exit hardware. Crash bar shall be Von Duprin "Series 99 Rim Device" or approved equivalent. Doors furnished with a card reader and crash bar exit hardware shall not provide alarm communications to the portal's local processor. The crash bar, except for local alarm annunciation and alarm communications, shall depend upon a mechanical connection only and shall not depend upon electric power for operation. The crash bar shall be provided with a double pole micro switch. The micro switch shall be connected to the door reader processor and to the door lock power circuit. The micro switch shall be UL listed for egress. The crash bar shall be compatible with rim mount door hardware and shall operate by retracting the bolt. The external surface of the push pad on the crash bar shall have a grooved mechanism case. Finish shall be stainless steel satis.
- D. Touch Bar Exit: Aluminum doors having new card readers shall include a touch bar for exit. Touch bar shall be Locknectics "Series 671" or approved equivalent. The touch bar shall be provided with a single pole double throw

## MEMORIAL PARKWAY WTP ADVANCED TREATMENT

switch and shall be compatible with the door's electromagnetic lock. Doors furnished with a card reader and touch bar exit hardware shall not provide alarm communications to the portal's local processor.

- E. Electric Strike: Electric strikes for steel doors shall be compatible for use with rim exit devices (crash bar) and shall be Von Duprin "6111" or approved equivalent. Electric strikes for aluminum doors shall be compatible for use with touch bar exit device and shall be Von Duprin "6211" or approved equivalent. Electric strikes shall be provided with fail secure feature. Lock power supply shall be provided for all electric strikes.
- F. Electromagnetic Lock:
  - 1. Electromagnetic locks shall contain no moving parts and shall depend solely upon electromagnetism to secure a portal by generating at least 1200 pounds of holding force. The electromagnetic lock shall be provided with a battery for emergency backup power supply for a minimum of 4 hours. The lock shall interface with the local processors without external, internal or functional alteration of the local processor. The electromagnetic lock shall incorporate an end of line resistor to facilitate line supervision by the system.
    - a. Armature: The electromagnetic lock shall contain internal circuitry to eliminate residual magnetism and inductive kickback. The actuating armature shall operate on 24 Volts dc and shall not dissipate more than 12 Watts. The holding current shall be not greater than 500 milliamperes. The actuating armature shall take not more than 300 milliseconds to change the status of the lock from fully secure to fully open or fully open to fully secure.
    - b. Tamper Resistance: The electromagnetic lock mechanism shall be encased in hardened guard barriers to deter forced entry.
    - c. Mounting Method: The door electromagnetic lock shall be suitable for use with single and double door with mortise or rim type hardware and shall be compatible with right or left hand mounting.
  - 2. Contractor shall remove latch and cylinders on existing doors receiving electromagnetic locks and replace with blank plates.
- G. Magnetic Door Contacts:
  - 1. Provide hermetically sealed magnetic door contacts with normally opened and normally closed contacts.
  - 2. Initiate an alarm whenever portal is opened up to 1-1/4" in secure mode.



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### 2.08 HATCH CONTACTS

- A. Contractor shall install limit switches on access and ladder hatches at the locations indicated on the Drawings.
- B. Limit switches shall be Allen Bradley Model BUL802M-AY5, or approved equivalent, with level arm and wheel (AD2-66). Conduit shall be continuous to the limit switch or the Contractor shall install heavy-duty, moisture-proof cable Type ST00W-A16 AWG 4C by AIW Corp. or equivalent from the limits switch to the conduit grip end.

## **PART 3 EXECUTION**

### 3.01 INSTALLATION

- A. The Electrical Contractor shall be responsible for providing and installing all conduit, wire cables, and all signal lines required to complete the installation of the access control systems. All on-site signal lines shall be in conduit.
- B. Most of the conduit and wire for the access control system is shown on the drawings. The omission from the Drawings of any wire, conduit, cable or other signal lines does not relieve the Electrical Contractor from the responsibility of installing a complete and operable system.
- C. The access control system and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as defined by the Engineer during construction. Obtain in the field all information relevant to the placing of equipment, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an acceptable manner.
- D. Installation shall be in strict compliance with manufacture's standard detail, wiring diagrams and written instruction.
- E. All work shall be executed in full accordance with applicable codes. Should any work be performed contrary to said codes and/or regulations, the Contractor shall be responsible for such violations and assume all costs arising as a result.
- F. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

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- G. The shields on instrumentation signal wires shall be continuous from source to destination. In no case shall more than one ground point be employed for each shield.
- H. Do not splice or tap wiring except at device terminals or terminal blocks.

### 3.02 CLEANING

- A. All instruments and equipment shall be left free from shipping stickers, paint, splatter, dirt, grease, etc., and shall be clean and in working condition at final acceptance. Touch-up paint shall be furnished as needed to repair blemishes and scratches in finish pain on panels and enclosures, which shall be corrected by the Contractor.

### 3.03 TESTING

- A. The Contractor shall perform pre-delivery testing, site testing, and adjustment of the completed access control system. The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Written notification of planned testing shall be given to the Owner at least 14 days prior to the test; notice shall not be given until after the Contractor has received written approval of the specific test procedures.
- B. Test procedures shall explain in detail, step-by-step actions and expected results, demonstrating compliance with the requirements specified. Test reports shall be used to document results of the tests. Reports shall be delivered to the NKWD within 7 days after completion of each test.
- C. Communications tests shall include:
  - 1. Controllers to manager server.
  - 2. Manager server to client.
  - 3. Remote dial-up support.
- D. Contractor shall provide on-site inspection as needed by a factory-trained technician who will assist and advise the Contractor on the system installation.

**END OF SECTION**



**SECTION 28 31 00  
FIRE DETECTION AND ALARM**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Surge Voltages in Low-Voltage AC Power Circuits.
  2. International Fire Code (IFC).
  3. International Building Code (IBC).
  4. National Fire Protection Association (NFPA):
    - a. 70, National Electrical Code (NEC).
    - b. 72, National Fire Alarm Code.
    - c. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
    - d. 101, Code for Safety to Life from Fire in Buildings and Structures.
    - e. 820, Fire Protection in Wastewater Treatment and Collection Facilities.
    - f. 1221 Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems.
  5. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  6. National Institute for Certification in Engineering Technologies (NICET).
  7. Telecommunications Industry Association (TIA):
    - a. 232, Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange.
    - b. 485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.
  8. Underwriters Laboratories, Inc. (UL):
    - a. 217, Single and Multiple Station Smoke Alarms.
    - b. 228, Door Closures-Holders, With or Without Integral Smoke Detectors.
    - c. 268, Smoke Detectors for Fire Protective Signaling Systems.
    - d. 286A, Smoke Detectors for Duct Application.
    - e. 464, Audible Signal Appliances.
    - f. 497B, Protectors for Data Communication and Fire Alarm Circuits.
    - g. 864, Control Units for Fire-Protective Signaling Systems.

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- h. 1449, Standard for Transient Voltage Surge Suppressors.
- i. 1480, Speakers for Fire-Protective Signaling Systems.
- j. 1604, Electrical Equipment for Use in Class I and Class II, Division 2, and Class III Hazardous (Classified) Locations.
- k. 1638, Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling.
- l. 1971, Signaling Devices for the Hearing Impaired.

### 1.02 DEFINITIONS

- A. Addressable: A fire alarm system component with a unique identification that can have its status individually identified or that is used to individually control other functions.
- B. AHJ: Authority Having Jurisdiction.
- C. CAD: Computer Aided Design.
- D. Coded: Audible or visible signal that conveys information about alarm event. Examples are, number of rings of a bell or flashes of a strobe. This could be used to convey location or type of alarm.
- E. dB: Decibels.
- F. DXF: Drawing Interchange Format.
- G. ECP: Environmental Control Panel.

### 1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
  - 1. Contract Drawings show location of fire alarm system components.
  - 2. Design, coordinate, and provide system in accordance with building codes indicated in Section 01 61 00, Common Product Requirements.
  - 3. Design conduit layout and wiring interconnection of devices specified herein
  - 4. Coordinate, and include in design, requirements for interfacing with HVAC system.
  - 5. Coordinate design and installation with elevator installation.
  - 6. Equipment suitable for addressable fire alarm system.

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### B. Performance Requirements:

1. Actuation of alarm (smoke or heat detector, flow switch, or other normally open initiating device contact) or trouble (trouble or supervisory switch) shall cause the following operations:
  - a. Audible and visual indications of alarmed devices on fire alarm control panel display, and on remote annunciator.
  - b. Closure of doors held open by electromagnetic devices.
  - c. For remote buildings with subpanels, transmit common alarm or trouble signal to light appropriate zone lamp at master fire alarm control panel.
  - d. Master fire alarm control panel shall transmit common alarm or trouble signal to plant control panel.
2. Actuation of duct smoke detectors shall, send signal (contact closure) to environmental control panel (ECP) to shut off HVAC equipment and send a Supervisory Alarm to the fire control panel. Fan equipment shall shutdown in accordance with Section 23 09 00, Instrumentation and Control Devices for HVAC. Contact output to ECP shall be rated for no less than 5A, 250V ac.
3. Actuation of sprinkler flow switch shall alarm at panel.
4. Discharge of sprinklers in elevator shaft or machine room shall send supervised trip signal to elevator controller/circuit breaker to trip on actuation of temperature detector installed adjacent to sprinkler head and with lower setting.

### 1.04 SUBMITTALS

#### A. Action Submittals:

1. Descriptive product information for each individual system component.
2. Dimensional drawings of panels and associated equipment.
3. Itemized bill of material.
4. Operating and programming instructions.
5. Control panel configuration and module data.
6. Complete point to point wiring diagrams of system and device interconnection. Identify spare connection points.
7. Alarm initiating, indicating, and supervisory device electrical data.
8. Annunciator configuration and module data.
9. Plans showing device and panel locations as well as conduit and cable sizes. Prepare drawings and diagrams on drawing sheets of uniform size without extraneous information. Marked up electrical, HVAC, lighting or similar drawings or copies of catalog data sheets are not acceptable in lieu of required drawings or diagrams.
10. Battery sizing calculations.
11. Supervisory power requirements for equipment.

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12. Alarm power requirements for equipment.
13. Power supply rating justification showing power requirements for system power supplies.
14. Voltage drop calculations for wiring runs, demonstrating worst case condition.
15. Conduit fill calculations.
16. Sample warranty.
17. Recommended types and quantities for spare parts.
18. For each system's control panel, provide written schedule of active and spare addresses provided on each addressable circuit.

### B. Informational Submittals:

1. Experience and qualifications of firm(s) proposed to design and install system.
2. Certifications documenting service technician's training. Certification shall indicate name of individual, training, dates, systems qualified, and current status.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
4. Copy of design documents, Shop Drawings, and calculations submitted to code-enforcement authorities.
5. Code-enforcement authority approval letter.
6. Factory test reports.
7. Detailed program and schedule for testing, inspection, and maintenance of fire alarm system that satisfies requirements of NFPA 72, manufacturer's recommendations, and local authority having jurisdiction.
8. Documentation of system voltage, current, and resistance readings taken during installation, testing, and ATP phases of system installation.
9. System record drawings and wiring details including one set of reproducible masters and drawings on CD-ROM in a DXF format suitable for use in a CAD drafting program.
10. NFPA 72, Record of Completion: Submit to Owner and code-enforcement authorities.
11. NFPA 72, Inspection and Testing Form: Submit to Owner and code enforcement authorities.
12. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

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## 1.05 QUALITY ASSURANCE

### A. Qualifications:

1. Provide names of projects, locations, and telephone numbers of persons to contact for at least two installations where Contractor or Subcontractor has installed detection and alarm systems that are similar in size and scope as this.
2. System design, installation and testing shall be performed by licensed firm(s) with established reputation in fire alarm system industry having 5 years' experience in design, installation, and testing of fire alarm systems.
3. Technician with minimum of NICET Level II Certification for fire alarm systems or professional engineer registered in State of Kentucky shall be available onsite.
4. Service technician shall be formally trained by manufacturer.

## 1.06 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of one year after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

## 1.07 MAINTENANCE

- A. Maintenance Service: For 2 years after Correction Period, provide maximum of 2 service calls, at Owner's request, to make adjustments or repairs required to keep system in satisfactory, full operation.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
1. Silent Knight.
  2. Siemens Building Technologies.
  3. FCI.
  4. Notifier Fire Systems.
  5. Edwards Systems Technology.



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## 2.02 GENERAL

- A. Material and equipment shall be standard products of their respective manufacturers, and shall be of a model that has been in production for not less than 3 years. Equipment shall be supported by a service organization that is, in the opinion of Owner, reasonably convenient to Site.
- B. Contractor shall become familiar with details of Project, verify dimensions in field, and revise conduit and equipment locations to avoid obstructions and allow installation of new equipment.
- C. Contractor shall not begin system installation prior to receiving written approval of Shop Drawings from Engineer.

## 2.03 UL COMPLIANCE

- A. Products manufactured within scope of Underwriters Laboratories, Inc. shall conform to UL Standards and have an applied UL listing mark.
- B. Equipment shall be UL listed in accordance with requirements of NFPA.

## 2.04 SERVICE CONDITIONS

- A. Altitude: Not greater than 3,300 feet above sea level.
- B. Ambient Temperature:
  - 1. Maximum 40 degrees C.
  - 2. Minimum 0 degrees C.
- C. Equipment shall be fully rated without derating for these conditions.

## 2.05 FIRE ALARM CONTROL PANELS

- A. General:
  - 1. Control panel circuit for 24V dc, power limited, initiating circuits per NFPA 70, Article 760.
  - 2. Assembled panel UL 864 listed Product Category UOJ2, as an integrated control system.
  - 3. Enclosure:
    - a. NEMA 250 Type suitable for location installed.
    - b. Color: Red.
  - 4. Internally Mounted Module with:
    - a. Transformer with 120V ac input and 21.5V ac output.

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- b. Solid state rectifier for 21.5V ac input and fuse protected, filtered, and regulated 26V dc no-load output.
  - c. Solid state transfer switch, minimum 8 amp-hours.
  - d. Standby sealed, gelled electrolyte (lead acid) batteries sized for system operating period of 24 hours of standby mode operation.
  - e. Solid state battery charger.
  - f. Over/under voltage monitor supervisory circuit.
  - g. LEDs for status of normal power, battery trouble, and power supply module trouble.
  - h. Alarm mode of 5 minutes after standby operation.
  5. Local differentiating audible sound device for alarm, trouble, and supervisory conditions.
  6. Full digital transmission protocol.
  7. Addressable signal transmission protocol to be either digital pole/response protocol or proprietary communication protocol, with all antilog sensing device signals digitally transmitted to control panel.
  8. Form C output circuitry for remote alarm control panel.
  9. MOV gas discharge transient protection for power supply module.
  10. For addressable systems provide additional 20 percent capacity for future indicating and initiating devices.
  11. EMI/RF Protection:
    - a. Protect control equipment, devices, and wiring against unwanted radiated electro-magnetic interference (EMI) and from affects of audio and radio frequencies (RF) that can cause transmission of spurious alarms.
    - b. System shall be designed and installed so as to be unaffected (with control cabinet faceplates installed) by operation of handheld, portable radios of up to 5 watts, or portable cellular telephones up to 1 watt, within 12 inches of system components.
- B. Addressable Control Panel:
1. Modular construction with solid state, microprocessor-based components, programmable central processor unit, back lighted display of primary control status and essential alarm operating conditions, and concealed, maintenance, purpose operator's keypad.
  2. With Signaling Line Circuit Class A and Class A, Style Z Notification Appliance Circuits.
  3. Main control module consisting of operator's keyboard/keypad, local and remote communications and supervision capabilities, system control memory, and programming interface.
    - a. Two-line, back lighted, 80 alphanumeric LCD characters with:
      - 1) Visible cursor for entering data information.
      - 2) Displayable when cabinet door is open.

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- b. Primary operators keypad with:
    - 1) Acknowledge keys and LEDs for system alarm, supervisory service, and system trouble conditions.
    - 2) Power on LED.
    - 3) Alarm silence reset keys.
    - 4) Displayable when cabinet door is closed.
  - c. Pass code protected action display keypad for:
    - 1) Circuit/device enable or disable.
    - 2) Control on/off.
    - 3) Test/status.
    - 4) Auto or manual.
    - 5) Activate/reset.
    - 6) Display historical logs/real time.
    - 7) Function/menu.
    - 8) Program.
    - 9) Delete.
    - 10) Displayable when cabinet door is open.
  - d. Numerical entry and selection keypad, used in conjunction with action display keypad, to perform control function on system zones, initiating circuits, or auxiliary relays, and to gain access to system information. Displayable when cabinet door is closed.
  - e. Programmable control keypad with five pass code keys, associated LEDs, and identification labels for:
    - 1) Elevator bypass.
    - 2) Manual evacuation.
    - 3) HVAC shutdown disable.
    - 4) Displayable when door is open.
  - f. Four function keys for control of variable functions related to primary operations keypad, displayable when door is open.
- 4. TIA 485, NFPA 72, Style 4, Style 6, or Style 7 data circuit capability for remote annunciators.
  - 5. Form C relay contacts rated 2 amperes, 24V dc.
  - 6. Down loader port for connection to microprocessor-based transponder.
  - 7. Power supply interface module generating digital voltage and current data to LCD with:
    - a. dc power conversion and output terminals.
    - b. Supervision and control of power supply.
  - 8. Modules with coded input on first alarm, local trouble LED, and in/out capabilities for:
    - a. 120 addressable initiating alarm sensors consisting of analog/addressable or traditional detector methods.

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- b. Four hardwired I/O points, field selectable in any combination to be either NFPA 72, Style B or Style D, initiating device circuits or NFPA 72, Style Y or Style Z, indicating appliance circuits or auxiliary control circuits.
  - c. Auxiliary control circuit contacts shall be single-pole, double-throw, rated 2 amperes at 24V dc and 0.5 amperes at 120V ac.
  - 9. Auxiliary control circuit contacts shall be single-pole, double-throw rated, 2 amperes at 24V dc and 0.5 ampere at 120V ac.
  - 10. Two isolated TIA 232 communication port modules.
- C. Eight-inch flame retardant and moisture repellent cone speakers, 24-volt.

### 2.06 ADDRESSABLE DETECTOR BASE

- A. Solid state circuitry with integral dip switch or program selectable addressing, and common base receptacle for ionization, photoelectric, and heat detectors. Device address shall be located in base.
- B. Constantly monitors detector status and status changes.
- C. Suitable for mounting on standard outlet box.
- D. Normally open, single pole contacts rated 3 amperes, 30V dc.

### 2.07 INDIVIDUAL ADDRESSABLE MODULE

- A. Solid state circuitry with selectable latch/nonlatch operating conditions and mounting plate.
- B. Monitors single and multiple devices with dry contacts.
- C. Suitable for installing inside 4-inch by 4-inch by 2-1/2-inch electrical box.

### 2.08 ZONE ADDRESSABLE MODULE

- A. Monitor module with solid state circuitry for Class A circuits serving dry contact initiating devices.
- B. Signal module with solid state circuitry for supervising and operating Class A circuits serving 24V dc signals, speakers, and telephone devices.
- C. Control module with solid state circuitry for supervised control functions.
- D. Module complete with mounting plate, suitable for installation in 4-inch by 4-inch by 2-1/2-inch electrical box having 1-1/2-inch deep extension ring.

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## 2.09 INITIATING DEVICE

### A. Pull Station, Fire:

1. Single action station for general alarm.
2. Constructed of red molded polycarbonate material and raised white letters stating "FIRE."
3. Surface mounted with hinged front cover having keyed or allen-wrench reset lock.
4. Where required, rated for use in hazardous environments.
5. Recessed pull handle for single action lift door and pull handle for double action operating station with plastic break rod.
6. Activated station pull handle, latched in protruding position until reset by key.
7. Stations keyed alike with fire alarm control panel.
8. Screw terminal for field connections.
9. Manual Pull Station: Microprocessor-based communication circuit address, and compatible with fire alarm control panel.

### B. Heat Detector:

1. Fixed temperature elements with 57 degrees C trip setting, complete with addressable mounting base.
2. Nonrestorable fixed temperature elements |
3. Dangling disk indicator for activated fix temperature element
4. Attach detector bases on surface mounted octagon boxes.
5. Double-screw terminals for supervised connection.

### C. Smoke Detector:

1. Ionization type with plug-in, twist-lock addressable base per UL 217 and UL 268.
2. Solid state circuitry, unipolar, single source, dual sensing chamber, suitable for device releasing service.
3. Concealed, field adjustable, sensitivity test switch.
4. LED; pulsed indication for power availability and steady indication for activated detectors.
5. Self-Compensating Circuitry:
  - a. Voltage Range: 15V dc to 30V dc, 24V dc nominal.
  - b. Temperature Range: 0 degrees C to 38 degrees C.
  - c. Operating Temperature Range: Minus 10 degrees C to 50 degrees C.
  - d. Humidity Range: 0 to 95 percent relative humidity.
6. Detectors equipped with insect screen.

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7. Photoelectric sensors adjusted to within 3 percent of UL 217 window obturation sensitivity value.

### D. Air Duct Smoke Detector:

1. Duct mounted housing with prealigned sampling and exhaust tubes, analog sensing, solid state circuitry, and plug-in, twist-lock addressable base for photoelectric detector in accordance with UL 286A, NFPA 72, NFPA 90A, and NFPA 101.
2. Sampling tubes to extend full width of branch air return duct.
3. Self-Compensating Circuitry:
  - a. Voltage Range: 15V dc to 30V dc, 24V dc nominal.
  - b. Temperature Range: 0 degrees C to 38 degrees C.
  - c. Humidity Range: 10 percent to 90 percent relative humidity.
  - d. Velocity Range: 400 feet to 4,000 feet per minute.
4. Front mounted LED with pulsed indication for alarm condition.

## 2.10 ALARMS

### A. Audible Alarm:

1. General:
  - a. Polarized, 24V dc device with sound power measured dB in accordance with UL 464.
  - b. Separate in/out wire leads for field connections.
  - c. Baked red enamel finish.
  - d. Audibility: In accordance with NFPA 72 and local requirements.
2. Modular Horn:
  - a. Surface basic unit, complete with single projector, designed for mounting on 4-inch square weatherproof electrical box.
  - b. Manufacturer supplied box with flush grille plate and basic surface unit for recessed horns.
3. Modular Bell: Vibrating basic unit complete with 4-inch gong and outdoor yard hood, designed for mounting on 4-inch weatherproof electrical box.
4. Single protection type bell with weatherproof housing, rated for 120V ac motor, adjustable mounting bracket, and audible output of 115 dB.

### B. Visual Alarm, Fire:

1. Polarized, 24V dc, multi-candela indicating output per UL 1638.
2. Solid state circuitry for high and low intensity control of xenon flashtube.

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3. Tamper-proof, translucent molded, polycarbonate, pyramidal shaped lens with "FIRE" in red lettering visible from 180-degree viewing field; red enclosure.
  4. Polarized in/out wiring.
  5. Designed for mounting on wall single-gauge electrical box, or as part of audible/visible base housing.
  6. Synchronized unit.
- C. Visual Alarm, Emergency Alarm:
1. Polarized, 24V dc, 100 candela indicating output per UL 1638.
  2. Solid state circuitry for high intensity control of xenon flashtube.
  3. Tamper-proof, translucent blue, molded polycarbonate, pyramidal shaped lens with "EMERGENCY" in lettering visible from 180-degree viewing field; blue enclosure.
  4. Polarized in/out wiring.
  5. Designed for mounting on wall single-gauge electrical box, or as part of audible/visible base housing.
  6. Synchronized unit.
- D. Visual Alarm in Outdoor or Hazardous Location:
1. Cast metal fixture with red glass globe and guard.
  2. Rating: 100 candela at 120V ac.
  3. UL Listed for wet locations when installed outdoors.
  4. Designed for wall mounting.
- E. Audio Visual Alarm:
1. Audible/visible base housing with visual alarm and front mounted horn as specified.
  2. Semi-flush mounting on recessed 4-gauge square electrical box or surface mounted on backbox with adapter.
  3. Audibility: In accordance with NFPA 72 and local requirements.
  4. Synchronous audible/visible output.

### 2.11 WIRING

- A. AC power wiring shall meet requirements of Section 26 05 05, Conductors.
- B. Low voltage wiring shall be solid copper or bunch tinned (bonded) stranded copper, minimum 14 AWG, and shall meet NEC Article 760 for nonpower limited service.

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- C. Network or addressable loop cables shall be as recommended by manufacturer for installation of their system and UL Listed for Fire Alarm Systems.

### 2.12 RACEWAYS

- A. Conduit used for installation of Fire Alarm system shall follow requirements as identified in Section 26 05 33, Raceway and Boxes.

### 2.13 END-OF-LINE RESISTORS

- A. Ohmic value and power rating as determined by manufacturer based upon number of circuit devices supplied and circuit configuration as installed.
- B. Single-gang, stainless steel plate mounted in recessed box.

### 2.14 SURGE SUPPRESSORS

- A. Transient Voltage Surge Suppressors (TVSS): In accordance with Section 26 43 00, Transient Voltage Suppression.
- B. Transient Voltage Surge Suppressors (TVSS):
  - 1. Provide to suppress voltage transients that might damage fire alarm panel/transmitter components. Unit shall wire in series to power supply of protected equipment with screw terminations.
  - 2. Unit shall be UL 1449 listed with a 330-volt suppression level and have a maximum response time of 5 nanoseconds.
  - 3. Unit shall meet IEEE C62.41 Category B tests for surge capacity.
  - 4. Features:
    - a. Multi-stage construction that includes inductors and silicon avalanche zener diodes.
    - b. Long life indicator lamp (LED or neon lamp) which extinguishes upon failure of protection components. Fusing shall be externally accessible when this feature is available.
  - 5. Manufacturer and Product: Edco of Florida, Ocala, FL; Model HSP-121BT2.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Coordinate with other trades for mounting and interfacing with fire alarm system related devices.
- B. Install control panels, initiating and alarm devices, conduit, and wiring for interconnection of devices specified herein for complete and operable system.



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### 3.02 INSTALLATION

- A. Install and connect fire detection and alarm equipment in accordance with manufacturer's instructions and recommendations, and in accordance with applicable codes and standards.
- B. Mount devices in accordance with manufacturer's instructions.
- C. Provide outlet and junction boxes that are compatible with raceway system.
- D. Mount detector LEDs so they are readily visible from floor.
- E. Arrange sampling tubes and duct detectors to monitor duct area and point of duct penetration sealed and reinsulated.
- F. Install conductors in accordance with Section 26 05 05, Conductors, and NFPA 70, Article 760.
- G. Install initiating alarm, signal, and communication conductors in separate and independent raceway system.
- H. Circuit wiring color-code, as established by installer, to be maintained throughout installation.
- I. Size conductors in accordance with device manufacturer's recommendations. Increase AWG size of alarm conductors, if necessary, to maintain terminal voltage drop within acceptable level required by NEC and NFPA.
- J. Detectors shall not be installed until after construction clean up of trades is complete, per requirements of NFPA. Exception, where required by AHJ for protection during construction, detectors installed prior to final clean-up by trades shall be cleaned or replaced.
- K. Duct Smoke Detector: Furnish, wire, and connect to fire alarm system in accordance with this Specification. Installed in accordance with NFPA and Manufacturer's requirements.
- L. HVAC Equipment: Wire and connect fire alarm system to air handling system, smoke exhaust fan and smoke damper control circuits, and fan status contacts. Coordinate work with Section 23 09 00, Instrumentation and Control Devices for HVAC.
- M. Wire and connect fire alarm system to elevator communications circuit and alarm.

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### 3.03 CONDUIT

- A. Requirements apply to fire alarm system conduits, electrical enclosures, terminal cabinets, junction boxes, pullboxes, and device backboxes.
- B. Conduit systems shall be dedicated to fire alarm system and shall contain no unrelated conductors.
- C. Fire alarm system conduits shall be of sizes and types specified under Section 26 05 33, Raceway and Boxes.
  1. Conduit shall be as identified under Section 26 05 33, Raceway and Boxes. Flexible metallic conduit may be used for whips to devices only, maximum length 6 feet, 3/4-inch diameter minimum. Set screw type couplings or connectors are specifically prohibited.
  2. Size conduits according to conductors contained therein. Cross sectional area percentage fill for fire alarm system conduits shall not exceed 40 percent.
- D. Route and install conduit to minimize potential for physical damage, either mechanical or by fire, and so as not to interfere with existing building systems, facilities or equipment, and to facilitate service and minimize maintenance. Coordinate installation between different trades to avoid conflicts.
  1. Conduit, except flexible conduit whips to devices, shall be solidly attached to building structural members or permanent walls. Conduit shall not be attached to existing conduit, ductwork, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, evacuation signaling or auxiliary function devices.
  2. Conduit shall be routed either parallel or perpendicular to building structural members.
  3. Conduit shall be installed at a height so as not to obstruct any portion of a window, doorway cable tray, stairway or a passageway, and shall not interfere with operation of existing mechanical or electrical equipment.
  4. Conduit, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device backboxes shall be readily accessible for inspection, testing, service and maintenance.
  5. Conduits shall be arranged to minimize the possibility of water in those conduits draining through control panels.
    - a. Conduit, except nipples between control panels shall be arranged to enter control cabinets from below.
    - b. Conduit shall be provided with three, 1/4-inch drain holes at horizontal low point beneath each control cabinet.

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6. Bushings shall be provided at termination of conduit, prior to installation of wire.
  7. Install junction boxes as necessary. Conductors shall be pulled through junction boxes, without splices.
  8. Pullboxes shall be installed in each conduit at intervals not to exceed 100 feet. Pullboxes shall be 4-inch square, minimum.
  9. Device backboxes and junction boxes shall be sized to accommodate number of conductors contained. Extension rings or extension boxes are prohibited.
  10. Junction boxes, pull boxes, terminal cabinets, device backboxes, and raceways shall be gasketed and weather-tight per requirements of Section 26 05 33, Raceway and Boxes.
- E. Conduit, junction boxes, panels, electrical enclosures, relays and device backboxes shall be exposed in unfinished areas. Conduit and device backboxes shall be concealed in walls, ceiling spaces, electrical shafts or closets, in finished areas, except as noted on Drawings. Exposed conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.
- F. Conduit penetrations of walls, floors and ceilings shall be sealed around conduit(s) in accordance with Section 07 92 00, Joint Sealants, restoring walls, floors and ceilings to their original condition, fire resistance and integrity.
- G. Pull boxes, junction boxes, conduit bodies, and terminal cabinets shall be painted "fire engine red" prior to installation. Provide touch-up painting, of normally visible pull boxes, junction boxes, and terminal cabinets prior to final acceptance testing.
- H. Conduit shall be grounded by approved ground clamps, and per NEC requirements.
- I. Mount end-of-line resistors on terminal blocks.
- J. Detection and alarm wire shall be installed in separate conduits. Outgoing and return conductors for each supervised circuit shall be routed in separately as required by NFPA 72. The minimum separation of outgoing and return conduits shall be 1 foot vertically and 4 feet horizontally.

### 3.04 IDENTIFICATION

- A. Junction, terminal, and pulling box covers shall be painted red and identified with engraved labels by loop number and circuit that it contains.

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- B. Detection and terminal devices shall have engraved alphanumeric identification that shall be keyed to posted operations and maintenance instructions.

### 3.05 CONDUCTORS

- A. Requirements apply to fire alarm system conductors, including all signaling line, initiating device, indicating appliance, releasing function, remote signaling, ac and dc power and grounding/shield drain circuits.
- B. Conductors shall be:
  - 1. New; wire that has scrapes, nicks, gouges or crushed insulation shall not be used.
  - 2. Installed in conduit.
  - 3. Continuous between devices and between devices and intermediary terminal cabinets.
  - 4. Low voltage conductors shall be minimum size No. 14 AWG. Smaller conductors shall only be permitted where part of a manufacturer's specific communications cable, i.e. addressable system.
  - 5. In accordance with requirements of NEC, Article 760 for nonpower limited service.
- C. Splices in conductors are specifically prohibited.
- D. Types:
  - 1. Conductors, except ac power conductors and grounding conductors, shall be solid copper or bunch tinned (bonded) stranded copper.
  - 2. Stranded copper conductors are acceptable for ac power conductors and grounding conductors only.
- E. Terminations, including field connections to supervisory resistors, diodes, relays or other devices shall be to numbered terminals or terminal strips and readily accessible for inspection, service, testing and maintenance.
  - 1. Terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other suitable metal enclosures.
  - 2. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.
  - 3. Each conductor termination shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on Contractor's Record Drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of conductor terminations.

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4. Wire nuts are prohibited.
5. Where pigtail devices are factory provided with wires too short to be connected to terminal strips (i.e., solenoids), such connections shall be soldered and taped.

### F. Control Panel Wiring:

1. Fully dressed and bundled with nylon tie wraps at 3-inch intervals.
2. Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90 degree angles to their associated terminal connections.
3. AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 2-inch separation shall be maintained between ac power conductors and low voltage conductors wherever possible.
4. Control cabinets shall be sized to accommodate the requirements of this Section.
5. Control panels shall not be used as raceways. Conductors that do not terminate within a control panel shall not be routed through that control panel.

### G. Conductors shall be separated into the following categories:

1. Low voltage circuits that serve devices.
2. ac power circuits.

### H. Each category of conductors shall be installed in physically separated, dedicated conduits, and shall not interface with one another, except at common associated control equipment. Conductors shall be further segregated as necessary to conform to fire alarm system manufacturer's recommendations and as necessary to prevent electrical crosstalk between conductors installed in common conduits.

## 3.06 OVERVOLTAGE AND SURGE PROTECTION

- A. Install TVSS for fire alarm control panel per manufacturer's requirements.

## 3.07 REPAIR/RESTORATION

- A. Touch up scratches, mars, and dents, incurred during shipment or installation of equipment.
- B. If required because of extensive damage, as determined by Engineer, refinish entire assembly.
- C. Keep covers on smoke detectors until areas have been thoroughly cleaned.

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### 3.08 TESTS AND INSPECTION

- A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup, and NFPA 72.
- B. Demonstrate entire system meets performance requirements specified in Article System Description.
- C. Perform tests in presence of code-enforcement authorities, Owner and Engineer.
- D. Each smoke detector shall be individually field tested prior to installing device at its designated location to ensure reliability after shipment and storage conditions. A dated log indicating system address, type of device, sensitivity and initials of technician performing test, using test equipment specifically designed for that purpose, shall be prepared and kept for final acceptance documentation. After testing detection devices, base shall be labeled with system address, date, and initials of installing technician. Labeling shall not be visible after installation is complete.
- E. Test wiring runs for continuity, short circuits, and grounds before system is energized. Resistance, current, and voltage readings shall be made as work progresses.
  - 1. Systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on logging form for readings, dates, and witnesses.
  - 2. Notify Fire Marshal and Owner before start of any required tests. Correct items found at variance with Drawings or Specification during testing or inspection.
  - 3. Deliver test reports to Fire Marshal and Owner as completed.
- F. Prepare final as-built Sequence of Operations Matrix (See Supplement at End of Section) referencing each alarm input to every output function affected as a result of an alarm, trouble, or supervisory condition on that. In case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; complete output equation shall be referenced in matrix.
- G. Prepare complete listing of device labels for alphanumeric annunciator displays and logging printers prior to acceptance test.
  - 1. Test system wiring to demonstrate correct system response and correct subsequent system operation in event of:

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- a. Open, shorted, and grounded intelligent analog signaling line circuit.
  - b. Open, shorted, and grounded network signaling line circuit.
  - c. Open, shorted, and grounded conventional initiating device circuits.
  - d. Primary power or battery disconnected.
  - e. Intelligent device removal.
  - f. Incorrect device address.
2. Secondary power capabilities shall be demonstrated as follows:
    - a. Disconnect system primary power for a period of time as specified herein; at end of period, alarm condition shall be created and system shall perform as specified for period as specified.
    - b. Restore system primary power for 48 hours and system-charging current shall be normal trickle charge for fully charged battery bank.
    - c. Check system battery voltages and charging currents at fire alarm control panel using test codes and LCD displays
- H. In the event system fails to perform as specified and programmed during acceptance test, test shall be terminated at discretion of acceptance inspector.
1. Retest system, correcting deficiencies and providing test documentation to acceptance inspector.
  2. In event that software changes are required during acceptance test, system manufacturer to compare edited program with original and shall furnish utility program. Utility shall yield printed list of changes and system functions, inputs and outputs affected by changes. Items listed by program shall be minimum acceptable to be retested before calling for resumption of acceptance test. Submit printed list and printer log of retesting before scheduling of acceptance test.
  3. Acceptance inspector may elect to require complete acceptance test to be performed again if, in their opinion, modifications to system hardware or software warrant complete retesting.
- I. Upon completion of tests, complete and provide the following:
1. NFPA 72, Record of Completion, and Inspection and Testing Form.

### 3.09 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services, for the following services at site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:

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1. One person-days for installation assistance and inspection.
2. One person-days for prestartup classroom or site training.

**END OF SECTION**



