ATTACHMENT ONE

TRACTION POWER SUBSTATIONS REHABILITATION SPECIFICATIONS, PROJECT REQUIREMENTS AND DESIGN CRITERIA
SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY

CONTRACT SPECIFICATIONS
FOR
TRACTION POWER SUBSTATION REHABILITATION

CONTRACT 1
BETHAYRES · NESHAMINY · YARDLEY SUBSTATIONS

Volume 1 of 2

July 14, 2017
### SECTION 00010

**TABLE OF CONTENTS**

**VOLUME 1**

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIVISION 1 - GENERAL REQUIREMENTS</strong></td>
<td></td>
</tr>
<tr>
<td>01010</td>
<td>Summary of Work</td>
</tr>
<tr>
<td>01025</td>
<td>Measurement and Payment</td>
</tr>
<tr>
<td>01045</td>
<td>Cutting and Patching</td>
</tr>
<tr>
<td>01050</td>
<td>Field Engineering</td>
</tr>
<tr>
<td>01060</td>
<td>Regulatory Requirements and Safety</td>
</tr>
<tr>
<td>01065</td>
<td>Railroad Safety Requirements</td>
</tr>
<tr>
<td>01100</td>
<td>Special Project Procedures</td>
</tr>
<tr>
<td>01200</td>
<td>Project Progress Meetings</td>
</tr>
<tr>
<td>01300</td>
<td>Submittals</td>
</tr>
<tr>
<td>01305</td>
<td>Requests for Information</td>
</tr>
<tr>
<td>01380</td>
<td>Construction Photographs</td>
</tr>
<tr>
<td>01400</td>
<td>Quality Requirements</td>
</tr>
<tr>
<td>01410</td>
<td>Testing and Inspection Services</td>
</tr>
<tr>
<td>01452</td>
<td>Contractor Quality Control – Traction Power Equipment</td>
</tr>
<tr>
<td>01500</td>
<td>Construction Facilities and Temporary Controls</td>
</tr>
<tr>
<td>01505</td>
<td>Mobilization and Demobilization</td>
</tr>
<tr>
<td>01525</td>
<td>Project Vehicle</td>
</tr>
<tr>
<td>01580</td>
<td>Project Identification Signs</td>
</tr>
<tr>
<td>01590</td>
<td>SEPTA Field Office</td>
</tr>
<tr>
<td>01600</td>
<td>Materials and Equipment</td>
</tr>
<tr>
<td>01612</td>
<td>Delivery, Storage and Handling – Traction Power Equipment</td>
</tr>
<tr>
<td>01700</td>
<td>Contract Closeout</td>
</tr>
<tr>
<td>01710</td>
<td>Final Cleaning</td>
</tr>
<tr>
<td>01720</td>
<td>Project AS-Built Documents</td>
</tr>
<tr>
<td>01752</td>
<td>Spare Parts and Maintenance Materials – Traction Power Equipment</td>
</tr>
<tr>
<td>01820</td>
<td>Demonstration and Training</td>
</tr>
<tr>
<td>01822</td>
<td>Demonstration and Training – Traction Power Equipment</td>
</tr>
<tr>
<td>01830</td>
<td>Operation and Maintenance Data</td>
</tr>
<tr>
<td>01832</td>
<td>Operations and Maintenance Manuals – Traction Power Equipment</td>
</tr>
</tbody>
</table>

**DIVISION 2 – SITE CONSTRUCTION**

<p>| 02050 | Demolition |
| 02070 | Selective Demolition |
| 02080 | Hazardous Material Abatement |</p>
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>02082</td>
<td>PCB Abatement</td>
</tr>
<tr>
<td>02083</td>
<td>Heavy Metals Abatement</td>
</tr>
<tr>
<td>02084</td>
<td>Oil and Lubricants Abatement</td>
</tr>
<tr>
<td>02110</td>
<td>Clearing and Grubbing</td>
</tr>
<tr>
<td>02160</td>
<td>Excavation Support and Protection</td>
</tr>
<tr>
<td>02205</td>
<td>Impacted Soil Management</td>
</tr>
<tr>
<td>02209</td>
<td>Geotextile Fabric</td>
</tr>
<tr>
<td>02220</td>
<td>Excavation, Backfill and Compaction</td>
</tr>
<tr>
<td>02230</td>
<td>Subbase</td>
</tr>
<tr>
<td>02270</td>
<td>Erosion and Sedimentation Control</td>
</tr>
<tr>
<td>02450</td>
<td>Oil Containment System</td>
</tr>
<tr>
<td>02520</td>
<td>Bituminous Concrete Paving</td>
</tr>
<tr>
<td>02534</td>
<td>Cast-In-Place Concrete Curb</td>
</tr>
<tr>
<td>02821</td>
<td>Chain Link Fences and Gates</td>
</tr>
<tr>
<td>02850</td>
<td>Drilled Caissons</td>
</tr>
</tbody>
</table>

**DIVISION 3 - CONCRETE**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03100</td>
<td>Concrete Forms</td>
</tr>
<tr>
<td>03200</td>
<td>Concrete Reinforcement</td>
</tr>
<tr>
<td>03300</td>
<td>Cast-in-Place Concrete</td>
</tr>
<tr>
<td>03400</td>
<td>Precast Concrete</td>
</tr>
<tr>
<td>03600</td>
<td>Grout</td>
</tr>
<tr>
<td>03930</td>
<td>Concrete Repair</td>
</tr>
</tbody>
</table>

**DIVISION 4 - MASONRY**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>04011</td>
<td>Masonry Cleaning</td>
</tr>
<tr>
<td>04012</td>
<td>Brick Masonry Repair</td>
</tr>
<tr>
<td>04200</td>
<td>Unit Masonry</td>
</tr>
</tbody>
</table>

**DIVISION 5 - METALS**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>05090</td>
<td>Metal Fasteners, Joining and Welding</td>
</tr>
<tr>
<td>05120</td>
<td>Structural Steel</td>
</tr>
<tr>
<td>05210</td>
<td>Steel Joists</td>
</tr>
<tr>
<td>05310</td>
<td>Steel Decking</td>
</tr>
<tr>
<td>05500</td>
<td>Metal Fabrications</td>
</tr>
<tr>
<td>05520</td>
<td>Hand Rails and Railings</td>
</tr>
<tr>
<td>05530</td>
<td>Steel Gratings</td>
</tr>
<tr>
<td>05610</td>
<td>Miscellaneous Metals</td>
</tr>
<tr>
<td>05900</td>
<td>Metal Restoration and Cleaning</td>
</tr>
</tbody>
</table>
DIVISION 6 – WOOD AND PLASTICS

06100 Rough Carpentry

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

07190 Water Repellents
07210 Building Insulation
07500 Membrane Roofing
07620 Sheet Metal Flashing and Trim
07720 Roof Accessories
07900 Joint Sealers

DIVISION 8 – DOORS AND WINDOWS

08110 Metal Doors and Frames
08710 Door Hardware

DIVISION 9 – FINISHES

09662 Electrically Insulated Floor Covering
09705 Epoxy Resin Flooring
09910 Paints and Coatings
09960 High Performance Coatings
09965 Graffiti Resistant Coatings

DIVISION 10 – SPECIALITIES

10200 Louvers and Vents

VOLUME 2

DIVISION 13 – SPECIAL CONSTRUCTION

13280 Asbestos Abatement
13285 Lead Paint Abatement
13700 Intrusion Alarm System
13850 Fire Alarm and Detection System

DIVISION 15 - MECHANICAL

15010 Basic Mechanical Requirements
15050 Basic Mechanical Materials and Methods
15060 Hangers and Supports
15062 Hangers and Supports for Plumbing Piping and Equipment
15075 Mechanical Identification
15080  Mechanical Insulation
15160  Storm Drainage Piping
15165  Storm Drainage Piping Specialties
15183  Duct Installation
15184  Refrigerant Piping
15412  Emergency Plumbing Fixtures
15700  Heating, Ventilation and Air Conditioning Equipment
15890  HVAC Ductwork
15935  Building System Controls
15940  Sequence of Operation
15950  Testing, Adjusting and Balancing

DIVISION 16 - ELECTRICAL

16010  Basic Electrical Requirements
16050  Basic Electrical Materials and Methods
16052  General Electrical Requirements – Traction Power Equipment
16060  Grounding and Bonding
16070  Hangers, Anchors and Supports
16075  Electrical Identification
16120  Conductors and Cables
16121  Medium Voltage Cable
16123  Building Wire and Cable
16129  Fiber Optic Cable
16130  Raceways and Boxes
16138  Duct Work and Electrical Manholes and Handholes
16140  Wiring Devices
16150  Wiring Connections
16210  Electric Utility Services
16240  Battery Equipment
16270  Distribution Transformers
16275  Installation of Traction Power Autotransformers
16290  Protective Devices and Instrument Transformers
16310  Transmission and Distribution
16331  Installation of Circuit Breakers
16335  Surge Protection
16411  Enclosed Switches
16413  Enclosed Transfer Switches
16421  Enclosed Motor Controllers
16440  Panelboards
16460  Low-Voltage Transformers
16500  Lightning
16700  Communications
16760  Fiber Optic Network
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>16772</td>
<td>CCTV System</td>
</tr>
<tr>
<td>16791</td>
<td>Combined Relay and Control Switchboard</td>
</tr>
<tr>
<td>16826</td>
<td>Cable Trench System</td>
</tr>
<tr>
<td>16910</td>
<td>Electrical System Control SCADA, Remote Terminal Unit – Including HMI</td>
</tr>
<tr>
<td>16950</td>
<td>Testing</td>
</tr>
<tr>
<td>16952</td>
<td>Electrical Testing – Traction Power Equipment (RRD)</td>
</tr>
</tbody>
</table>

**END OF SECTION**
THIS PAGE LEFT BLANK
SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 Description
A. Design and Build Contract 1 consists of final design and rehabilitating and upgrading existing substations located at Bethayres, Neshaminy Falls and Yardley on the SEPTA West Trenton line. The Design-Build Contractor (Contractor) shall complete the final design and rehabilitate all equipment and installations at the facility, unless specifically noted otherwise.

The Design-Build Contractor (Contractor) shall be an electrical contractor with proven experience in the traction power systems of railroads. The Contractor shall have design capability on the team to advance the design from 50% level to 100% level and sign/seal the drawings besides subcontractors of other disciplines such as civil/structural, mechanical and other required trades.

B. Initiate the rehabilitation work in the following order, unless approved by SEPTA otherwise:
   1. Perform Bethayres first.

C. The work shall be performed in close coordination with SEPTA. All work shall be performed concurrently and carefully staged.

D. The Contractor shall be responsible for the following administrative activities:
   1. Creating and maintaining the Project schedule for all work.
   2. Provision of Project identification signs (Refer to Section 01580).
   3. Furnishing and maintaining SEPTA field office (Refer to Section 01590), including associated utilities.
   4. All snow removal, regular trash removal and cleaning from the Project sites.

E. Brief Description of SEPTA's Traction Electrification System:
   1. SEPTA operates a comprehensive transportation system in the Philadelphia metropolitan area and suburbs. The Regional Rail network of commuter lines is an important part of SEPTA's service. The Regional Rail operates on tracks and systems formerly owned by the Pennsylvania Railroad (PRR) and the Reading Railroad (RRR). The tracks of these two (2) systems were separate until the middle 1980's when the tracks were connected by the Center City Commuter Connection (CCCC) Project.
   2. The former Reading Railroad system is electrified at 12 kV/24 kV, 25 Hz, single-phase, autotransformer system. The 25 Hz traction power is supplied from SEPTA's three (3) static frequency converters located in Wayne Junction. Most of the original components at the substations are still being used, and are long past their useful life. If any of these over eighty (80) year old substations fails, service may be affected on the West Trenton Line, causing major disruptions throughout the regional transportation network.
3. All three (3) Substations (Bethayres, Neshaminy and Yardley) are situated along the West Trenton line. Each substation has a unique electrical and physical layout.

4. Bethayres currently comprises one (1) autotransformer and associated 46 kV 2-pole circuit breaker, feeder bus and four (4) 24 kV feeder circuit breakers, catenary bus and four (4) indoor 12 kV catenary feeder breakers. It has been decided to add a second autotransformer and utilize outdoor trolley circuit breakers.

5. Neshaminy currently comprises two (2) autotransformers, feeder bus and four (4) outdoor feeder circuit breakers, trolley bus and four (4) active indoor trolley circuit breakers. It has been decided to utilize 12 kV outdoor catenary circuit breakers. It has been decided not to replace the two (2) trolley breakers which are not in service.

6. Yardley currently comprises two (2) autotransformers, feeder bus and two (2) outdoor feeder circuit breakers, trolley bus and two (2) outdoor trolley circuit breakers. It has been decided to add two (2) additional catenary circuit breakers to supply West Trenton Yard.

7. Rehabilitation of the substations will allow SEPTA to ensure that the Regional Rail network continues to provide reliable, high quality transportation in the Philadelphia metropolitan area for many years to come.

8. The equipment described in this Section is intended for the part of SEPTA’s system formerly owned by the Reading Railroad.

F. The Contract is intended to rehabilitate the substations to a like new state. All equipment, components, installations, SCADA, lighting, auxiliary power systems, conductors, and cables, unless expressly stated otherwise, shall be replaced. The only exceptions are the control house building and the outdoor steel structure which shall be repaired, cleaned, primed and repainted to a like new state.

G. The work generally consists of, but is not necessarily limited to, the following:

1. Completion of the 50% design to 100 level
   a. Completing the 50% design supplied with the contract documents and specifications to 100% level
   b. Signing and sealing the drawings, reports and specifications

2. Site Demolition and Clearing for each Substation:
   a. Clearing and grubbing including removal and disposal of debris and abandoned rails and ties.
   b. Selective demolition of pipes, conduits, duct banks, manholes and metal cases (there will be no water access at any of these sites).
   c. Dispose of as hazardous and contaminated waste, scrap ties, treated utility poles and contaminated soil.
   d. Clear existing ballasted surface(s).

3. Excavation, Backfill and Compaction for each Substation:
   a. Excavate equipment pads, containment basin, site utilities, drainage structures, site fencing, system ductwork and catenary and other structure foundations.
   b. Removal and disposal of redundant and/or disused foundations, ballast and soil.
   c. Demolish existing concrete equipment pads. Remove debris and backfill as part of the substation facility.
d. Removal of existing backfill needed to construct the ground grid. The ground grid shall be covered and compacted with backfill (Refer to Section 16060).
e. Replace ballasted substation surface(s).
f. Testing, removal and disposal of excess excavated material.

4. Site Fencing for each Substation:
a. Construct new chain link perimeter fencing.
b. Construct new security fencing around building and equipment yard including double swinging gate.

5. Site Utilities for each Substation:
a. Protect in place site utilities.

6. Grading, Storm Water System and Sedimentation Control for each Substation:
a. Grade at site.
b. Provide sedimentation control to include filter fabric, filter bags for inlet protection; storm protection.
c. New oil containment system for the autotransformers.

7. Equipment Yard Pads for each Substation:
a. Construct new electrical and non-electrical equipment pads.

8. Cast-In-Place Concrete Foundations for each Substation:
a. Construct foundations for outdoor electrical equipment.
b. Construct catenary structure foundations.

9. Control Building for each Substation:
a. Demolish existing concrete equipment pads and refinish floor.
b. Relocate existing batteries and other auxiliary power supply equipment to facilitate the work.
c. New Protection and Control Panels:
   1) Installation of new protection and control panels.
   2) Decommission and remove existing control panels after commissioning of all new equipment.
   3) Installation of cable trays and cable ladder.

10. Structural Repairs to Existing Masonry Walls for each Substation:
a. Remove vegetation from wall joints.
b. Remove efflorescence from wall face.
c. Repair spalled areas.
d. Seal concrete.
e. Refinish/repair brick fence posts.

11. Work that will bring each substation into compliance with all relevant codes, regulations, standards:
a. Install fall protection system on gantries.
b. Caging of access ladders.
c. Signage.

12. Mechanical and HVAC System for each Substation:
a. Energy recovery ventilator units.
b. Electric unit heater.
c. Exhaust fan in battery room.
d. Air conditioning split system for control room.
e. Louvers with dampers.
f. Emergency eye wash in battery room.
g. Outdoor ground mounted HVAC unit.
h. Electrical controls and sensors.
i. Power connections, conductors in raceways and supports.

13. Auxiliary power system, to include all cabling and AC and DC power panel to receive power from existing PECO 240V/120V supply for each Substation.
   a. Substation Battery System (125 VDC System):
      1) Relocate, temporarily if required, existing batteries to facilitate the work in the control room.
      2) Install new batteries.
      3) Install new battery chargers (60 Hz and 25 Hz).
      4) Remove existing battery system and dispose per SEPTA instructions.
   b. New 125 VDC power panel.
   c. New or upgraded 60 Hz power supply from PECO, if required.
   d. AC power panel to provide power for yard lighting and new equipment
   e. Auxiliary power conduits, boxes, conduits and conductors.
   f. Disconnect switches.
   g. Receptacles inside control building and outdoor in the substation yard.
   h. Wall mounted dry type transformer 25 Hz, if required.
   i. Bonding and grounding.
   j. New outdoor cable raceway systems as required.

14. Lighting for each Substation:
   a. Site lighting mounted on vertical structural catenary members and walls. Site lighting to suit new equipment arrangement.
   b. Indoor lighting for existing control building.

15. Fire Alarm and Intrusion Detection for each Substation:
   a. Fire alarm system.
   b. Intrusion detection system.
   c. Controls in interface with HVAC for shut down.

16. Overhead Contact System (OCS) Support Structures for each Substation:
   a. Install new steelwork structure(s) to support the new electrical equipment.
   b. Cleaning, priming and painting of all existing and new steel structures, gantries and foundations.
   c. New steel structures necessary for the equipment and connections to the Overhead Contact System (OCS) Support Structures.
   d. Miscellaneous steelwork and structural members.

17. Communication and SCADA System for each Substation:
a. Provide Remote Terminal Unit (RTU) with integrated substation gateway computer.
b. SCADA conduits or cable trays and cables for indication and control circuits.
c. Substation controls and sensors.
d. Contractor is responsible for the design, execution and testing of the modifications to the master control station.
e. Replacing the communication cable from the substation termination cabinet to the nearest outdoor junction box.

18. Traction Power system equipment and/or installation, for each Substation to include outdoor autotransformers, outdoor circuit breakers, overhead high voltage feeders and busses, rail return bus, return cables including, but not limited to, the following:
   a. 12 kV, 25 Hz, single-pole circuit breakers (four (4) units at each substation) (installation only - Procured by SEPTA).
   b. 24 kV, 25 Hz, single-pole feeder circuit breakers (four (4) units each at Bethayres and Neshaminy, two (2) units at Yardley) ((installation only - Procured by SEPTA).
   c. 46 kV, 25 Hz, 2-pole circuit breakers (two (2) units at each substation) ((installation only - Procured by SEPTA).
   d. 5 MVA autotransformers (two (2) units at each substation) ((installation only - Procured by SEPTA - contractor is to keep the old autotransformers (ATs) at each site until the new AT arrives on-site and able to back up the new AT).
   e. 25 Hz potential and distribution transformers (PTs, DTs).
   f. 12 kV single-pole manual disconnect switches.
   g. 12 kV 2-pole manual disconnect switches.
   h. 12 kV single-pole manual disconnect horn gap switches.
   i. 24 kV single-pole manual disconnect switches.
   j. 24 kV 2-pole manual disconnect switches.
   k. 24 kV single-pole manual disconnect horn gap switches.
   l. 46 kV breaker 2-pole disconnect switches.
   m. Single-pole manual grounding disconnect switches.
   n. Surge arresters.
o. 12 kV and 24 kV potential and current transformers.
p. Combined relay and control board.
q. Remote Terminal Unit (RTU).
r. Renewal of all high voltage buses, wires, connections, insulators, conduit. This is to include all labor/materials to renew catenary trolley and/or feeder cables going to/from the TPSS, regardless of the work limits at each site.
s. Replace existing return rail/ground busses, install new return rail/ground busses and return rail cables from the substations to the existing track impedance bonds. Coordinate replacement with SEPTA.
t. Ground grid with ground buses and connections to the equipment and perimeter fencing. Install new ground grid and associated conductors to supplement and/or replace the existing ground grid and all equipment connections. This shall include return circuit connections in the areas affected by the new and existing equipment.

D/B Contractor will provide and install all equipment with the exception of specific equipment provided by SEPTA but installed by the D/B Contractor.

19. Recover redundant assets and return to SEPTA (spares/asset value) for each Substation:
a. Disconnect switches and horn gap switches.
b. Pedestal insulators.
c. Protection relays.
d. SCADA Remote Terminal Unit (RTU).
e. Wall bushings and associated Current Transformers (CTs) and connections.
f. 125 VDC battery chargers.

20. Demolition, Removal and Disposal of Equipment:
   a. 12 kV circuit breakers inside building. Coordinate with SEPTA for the details and schedule.
      SEPTA to remove parts from existing circuit breakers before removing existing circuit
      breakers from the Project site.
   b. 12 kV outdoor circuit breakers. SEPTA to remove parts from existing circuit breakers before
      removing existing circuit breakers from the Project site.
   c. 24 kV outdoor circuit breakers. SEPTA to remove parts from existing circuit breakers before
      removing existing circuit breakers from the Project site.
   d. 46 kV outdoor circuit breakers. SEPTA to remove parts from existing circuit breakers before
      removing existing circuit breakers from the Project site.
   e. Autotransformers. SEPTA to remove parts from existing autotransformers before removing
      existing autotransformers from the Project site.
   f. Current transformers and potential transformers.
   g. Auxiliary power transformers.
   h. Combined relay and control board after SEPTA has removed the relays and meters.
   i. Other equipment and components rendered non-functional.
   j. 125 VDC batteries.

21. Testing, commissioning, training and placing into revenue service of all components and
equipment to make a complete operating system; followed by post commissioning
   testing.

22. Final Design, procure materials, manufacture, test in the factory, deliver, install, test in
   the field, commission and bring into revenue service all components necessary for
   implementation of the substations.

23. Perform all work identified by the Contract Documents. The Contractor shall develop
   the final design drawings and specifications for review and approval by SEPTA.
   Construction work shall not be commenced until SEPTA has approved the final design
   drawings and specifications.

24. Verify and update all design requirements prior to commencement of detailed/final
   design.

25. The substation functionality will remain as it exists today, except for the changes as
    specified by the Contract Documents. Similarly, the substation will remain connected to
    the Overhead Contact System (OCS) support in a similar manner to what exists today
    except the two (2) additional trolley breakers at Yardley.

26. Abatement or remediation of contaminated or hazardous materials

27. Verification of existing conditions including utilities

28. As needed geotechnical reconnaissance and interpretation
29. Final construction plans for all Substation work including temporary structures, signed and sealed by an Engineer licensed in the Commonwealth of Pennsylvania

30. Final construction specifications for all Substation work including temporary structures, signed and sealed by an Engineer licensed in the Commonwealth of Pennsylvania

31. Permits including any work required by mandated permits

32. Work plans that are fully coordinated with the SEPTA Operations Manager

33. Support SEPTA public involvement initiative with technical information and presentation graphics

34. As-built drawings

H. Complexity of the Contract:

1. The traction power work included in this Contract is complex and requires a high degree of coordination between suppliers, Contractors and SEPTA. Therefore work shall be scheduled to minimize the requirement for outages. Also, repair and rehabilitation work shall be coordinated between all Contractors to ensure minimal requirement of outages.

2. Major components of traction power equipment, namely autotransformers, 24 kV outdoor feeder circuit breakers and 12 kV outdoor trolley circuit breakers have been procured by SEPTA. Final design shall be developed around this equipment. Coordinate with SEPTA for timely availability of the equipment. Coordinate the design of supporting structures and foundations with the equipment supplier. Coordinate the control scheme between circuit breakers, autotransformers and control board, and number and size of control cables.

3. It is expected that the other traction power equipment will be procured from multiple manufacturers. Special attention is required for the hand operated disconnect switches which have to be installed on the existing trusses and gantries. The Contractor is required to ensure that all components and equipment meet the requirements of the Contract and are compatible with each other for integration of the equipment into a single operable system. Services of an experienced and Electrical Engineer licensed in the Commonwealth of Pennsylvania are essential to accomplish this.

4. Control of the facility shall be by SEPTA's standard substation automation system using microprocessor based control relays and hard wired and/or fiber optic cable connection to SEPTA's SCADA system. The microprocessor relays shall be connected to a network gateway which shall communicate with the SCADA system. However, the substation shall remain functional via local control in the event of failure of any component or components of the automated control system. The network gateway shall be able to be interrogated via an integral Human Machine Interface (HMI) and keyboard provided within the combined relay and control board or integral to the SCADA Remote Terminal Unit (RTU).

5. Multiple levels of testing shall be required, including design and production tests at the manufacturer’s plants, and commissioning and post-energization testing at the site. Coordinate with SEPTA for factory testing of the equipment ordered directly by SEPTA.

I. Limit of Work:
1. The limit of the work shall generally be all the traction power electrical equipment within the boundary of the substation compound. In addition, all outgoing overhead conductors shall be replaced to the first structure outside the substation. It also includes replacement of rail return cables from the substation to the impedance bonds and the communication cable from the substation to the nearest outdoor junction box.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Provisions and other Division 1 Specification Sections, apply to this Section.

B. Agreement.

C. Section 01011 – Summary of Project Responsibilities

D. Section 01025 – Measurement and Payment

E. Section 01060 – Regulatory Requirements and Safety

F. Section 01065 – Railroad Safety Requirements

G. Section 01500 – Construction Facilities and Temporary Controls

H. Section 01580 – Project Identification Signs

I. Section 01590 – SEPTA Field Office

J. Section 16010 – Basic Electrical Requirements

K. Section 16060 – Grounding and Bonding

L. Design Criteria

1. The project design criteria shall be adhered to while preparing calculations, drawings, and specifications that are used to procure and construct each of the traction power substation facilities that make up the SEPTA Substation project. The project design criteria are arranged in a series of chapters that address various design disciplines, and each chapter includes the following sections:

a. Introduction – specifies the scope of design covered by a respective chapter.

b. Codes – list of applicable codes, standards, or other industry recognized best-practice publications that define minimum design requirements

c. Substation Criteria – special design requirements that are unique to the substation-related data relevant to the Substation project.

2. Variances to the project design criteria must be approved, in writing, by SEPTA.

M. Preliminary Drawings

1. Preliminary drawings demonstrate viability of proposed design solutions, and are provided to convey the scope of the SEPTA Substation project. The Contractor shall adopt the scope and solutions defined by the preliminary drawings as a basis for final design and construction.

N. Performance Specifications

1. Project performance specifications identify the general requirements, products, execution, and quality control measures that shall be adopted while constructing or procuring materials. These performance specifications must be integral to the final
design plans, and adhered to as the Contractor acquires manufactured products, materials, or construction services. The Contractor is encouraged to use and refine the project performance specifications to develop final technical specifications for construction, provided the final technical specifications preserve the fundamental framework and work result of each performance specification as approved by SEPTA.

O. Reference Documents

1. Reference documents that were obtained or developed in conjunction with these contract documents are provided as general background information. The reference documents have no contractual basis for design and construction. The Contractor must validate the accuracy of applicable reference documents before using this information to develop designs or construction plans. The following is a list of reference documents:
   a. ABB Circuit Breaker Drawing 1VSR630248C001
   b. ABB Drawing 1VSR724011E1334
   c. ABB Drawing No. 1VSR630253C001
   d. ABB Drawing No. 1VSR630254C001
   e. ABB Drawing No. 1VSR724011E1333
   f. ABB Drawing No. 1VSR724011E1534
   g. ABB Drawings of Transformers No. 1VSR630248C001
   h. ABB Drawings of Transformers No. 1VSR630252C0001
   i. Contract 1 Cadd Files
   j. Draft Environmental Investigation Report
   k. SADTEM Transformer Documentation
   l. Section 16275 Annex 1 SEPTA Purchase Specifications of 5 MVA Autotransformers
   m. Section 16275 Annex 2 Drawings of Autotransformers
   n. Section 16275 Annex 3 Test Reports of Current Transformers

P. Permit Matrix (attached to this Section)

1. The Permit Matrix summarizes the various permits that may be required for the Substation Rehabilitation project. This matrix identifies the type of permit, reviewing agency, municipality or city, and the entity responsible for obtaining each permit.

1.03 Contractor’s Responsibilities

A. Contractors shall furnish all materials, tools, equipment, supervision, administration and transportation, and perform all labor and services necessary to furnish, deliver, construct, install, connect and/or interconnect, test and commission as required to complete all work described in the Specifications and indicated in the Contract Drawings.

B. As necessary for proper execution and completion of work and as applicable at time of receipt of bids, secure and pay for:

1. Permits.
2. Temporary power.
3. Governmental fees.
4. Licenses.
5. Inspections.
6. Any local taxes.

C. Give written notices necessary for, and incidental to, the due and lawful prosecution of the work.

D. Notify the SEPTA Project Manager at least fourteen (14) days in advance of the date the individual construction stages or elements will be fully complete and ready for inspection.

E. Notify the SEPTA Project Manager at least fourteen (14) days in advance of the date the entire work will be substantially complete and ready for inspection.

F. Verify location of existing utilities prior to working in or adjacent to areas containing existing utilities.

G. Until final acceptance of the work by SEPTA, the Contractor shall have the charge and care thereof and shall take every reasonable precaution against injury or damage to any part thereof by the action of the elements, theft, vandalism, or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good, to the satisfaction of the SEPTA Project Manager, all damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof at no cost to SEPTA. One half of the substation will be in revenue service at all times, except for the brief outages if permitted by SEPTA.

H. Contractor's Staff:

1. Project Manager:
   a. The Contractor shall designate a Project Manager. The work of the Project Manager includes oversight and coordination of the entire Contract, including mobilization, final design, procurement, construction, testing & commissioning, quality assurance, and safety.
   b. The Project Manager shall serve as SEPTA's single point of contact for all contractual issues.
   c. The Project Manager shall coordinate prosecution of the work with each sub-contractor, public utilities, government bodies, PECO, PADOT, SEPTA Operations and other contractors. The Project Manager shall implement means and methods to eliminate or minimize, possible delays in the work caused by conflicts with utilities or other outside agencies or jurisdictions.

2. Design Manager:
   a. The Contractor shall designate a Design Manager. The Design Manager shall be responsible for completing all facets of final design including document research, surveys, field verification, final design, quality assurance, shop drawings, and as-buils.
   b. The Design Manager shall facilitate coordination between designers, subconsultants, utility companies, agencies having jurisdiction, suppliers, constructors, SEPTA, and any other entity that impacts the work.
   c. The Design Manager shall enforce quality standards and safety procedures.
   d. The Design Manager should have a direct line of communication with the Project Manager and the Superintendent.
   e. The Design Manager shall be a licensed Engineer in the Commonwealth of Pennsylvania.
3. **Environmental Engineer:**
   a. The Contractor shall designate an Environmental Engineer. The work of the Environmental Engineer shall include site investigations, sampling, administration of laboratory analyses, data interpretation, and developing remediation recommendations for construction.
   b. The Environmental Engineer shall coordinate with designers, agencies having jurisdiction, SEPTA, and any other entities that have authority over environmental practice.
   c. The Environmental Engineer shall monitor construction activities for compliance with specified remediation plans.
   d. The Environmental Engineer shall be licensed Engineer in the Commonwealth of Pennsylvania.

4. **Traction Power Lead Engineer:**
   a. The Contractor shall designate a Traction Power Lead Engineer. The Traction Power Lead Engineer shall be responsible for completing final design of all substation power equipment and supply systems. Duties include comprehensive design coordination with interfacing disciplines.
   b. The Traction Power Lead Engineer will coordinate with Contractor vendors, PECO, SEPTA, and providers of SEPTA supplied equipment.
   c. The Traction Power Lead Engineer shall perform or supervise checking of shop drawings and prepare of as-built drawings.
   d. The Traction Power Lead Engineer shall inspect delivered equipment for conformance to procurement specifications.
   e. The Traction Power Lead Engineer shall monitor construction for conformance to final construction plans.
   f. The Traction Power Lead Engineer shall monitor and coordinate testing & commissioning activities.
   g. The Traction Power Lead Engineer shall be a licensed Engineer in the Commonwealth of Pennsylvania.

5. **Communications Specialist:**
   a. The Contractor shall provide the services of a Registered Communication Distribution Designer (RCDD). Proof of RCDD certification shall be provided to SEPTA's Project Manager for approval. SEPTA reserves the right to reject the qualifications of the proposed RCDD based upon their lack of certification or credentials.
   b. The RCDD shall oversee the entire fiber optic cable equipment selection, procurement, installation, testing, and training of SEPTA maintenance and operating personnel.
   c. The RCDD shall oversee all work that is performed at the Regional Rail Operations Control Center.

6. **Superintendent:**
   a. The Contractor shall designate a Superintendent. The Superintendent shall be responsible for all aspects of construction including coordination with the final designer, suppliers, permitting agencies, agencies having jurisdiction, SEPTA, and any other entity that has legitimate activity within the limits of work.
   b. The Superintendent shall be a full time employee and shall be assigned exclusively to this Contract. Contract employees are not permitted.
   c. The Superintendent shall coordinate the substation outages, either half or full, with subcontractors and SEPTA.
d. The Superintendent shall maintain a detailed critical path method construction schedule, and a comprehensive activity log. The Superintendent shall attend recurring progress meetings with SEPTA and SEPTA’s representatives.

e. The Superintendent should have a direct line of communication with the Project Manager and the Design Manager.

f. The Superintendent shall enforce construction quality standards and safety procedures.

7. Traction Power Integrator/Designer:

a. The Contractor shall provide the services of a Traction Power Integrator (TPI) who shall be responsible for complete traction power system integration. He shall coordinate the shop drawings and supplies from the suppliers of autotransformers, transformers, 12 kV/24 kV/46 kV outdoor circuit breakers, disconnect switches, cables, bay module control circuits, and surge arresters to ensure full compatibility with each other, proper location of the conduits to suit the equipment, relay selection and setting of the relays.

b. The TPI shall be a registered Professional Engineer in the Commonwealth of Pennsylvania.

c. The TPI shall be responsible for:
   1) Coordinating and integrating the design of all disciplines into a single system
   2) Ensuring that there are no conflicts between the various equipment and subsystems especially in regard to functionality and layout
   3) Coordination of various studies, selection of protective relays and their settings
   4) Review and signing of the shop drawings before submitting to SEPTA for review
   5) Coordinating the construction activities in each stage of construction to minimize the requirement of power outage
   6) Coordinating matching of equipment various suppliers and with PECO for working on the low voltage supply
   7) Coordinating the testing of various subsystems and complete system
   8) The TPI shall be a registered Engineer in the Commonwealth of Pennsylvania.

8. Quality Control Manager:

a. Contractor shall assign a Quality Control Manager for the duration of the work.

b. The Quality Control Manager is responsible for developing, implementing, and enforcing project-wide quality control procedures for all design and construction activities.

9. Safety Officer:

a. Contractor shall assign a designated on-site Safety Officer.

b. The presence of the Safety Officer at the site is mandatory while work is being performed.


a. The Contractor shall provide the services of a Power System Integrator (PSI), who is responsible for the complete power system, including equipment and system integration, traction power system equipment, its related control systems and protective relay selection, relay selection coordination studies and relay settings, integration with site/civil, fencing, lighting, painting and structural elements of the Contract up to and including testing, and the training of SEPTA personnel as further detailed in Section 16010.

b. The PSI shall review, prior to submission to SEPTA, the shop drawings to ensure that the selected equipment is fit for the intended application and does not conflict with the equipment of other Contractors.

c. The PSI shall be a registered Professional Engineer in the Commonwealth of Pennsylvania. The Electrical Contractor shall submit the PSI resume prior to award of Contract.
d. Design Team: Contractor shall have a full-fledged design firm on its team to advance the 50% level design to 100% and sign/seal the drawings. The design team shall have architects and design engineers, licensed in Commonwealth of Pennsylvania, of all disciplines. The Design team shall also have specialty designers for the studies specified in Section 16052.

11. Traction Power Integrator/Designer:
   a. The Contractor shall provide the services of a Traction Power Integrator (TPI) who shall be responsible for complete traction power system integration and design. He shall coordinate the shop drawings and supplies from the suppliers of autotransformers, transformers, 12 kV/24 kV/46 kV outdoor circuit breakers, disconnect switches, cables, bay module control circuits, and surge arresters to ensure full compatibility with each other, proper location of the conduits to suit the equipment, relay selection and setting of the relays.
   b. The TPI shall be a registered Professional Engineer in the Commonwealth of Pennsylvania. With the approval of SEPTA Project Manager, the TPI and PSI could be the same person.
   c. Power Systems Integrator
      The Contractor shall provide the services of a Power Systems Integrator for integration of various subsystems into a complete substation power system. The PSI shall be responsible for:
      1) Coordinating and integrating the design of all disciplines into a single system
      2) Ensuring that there are no conflicts between the various equipment and subsystems especially in regard to functionality and layout
      3) Coordination of various studies, selection of protective relays and their settings
      4) Review and signing of the shop drawings before submitting to SEPTA for review
      5) Coordinating the construction activities in each stage of construction to minimize the requirement of power outage
      6) Coordinating matching of equipment various suppliers and with PECO for working on the low voltage supply
      7) Coordinating the testing of various subsystems and complete system
      The PSI shall be a registered engineer in the Commonwealth of Pennsylvania.

I. The Contractor shall provide the services of a Registered Communication Distribution Designer (RCDD). Proof of RCDD certification shall be provided to SEPTA’s Project Manager for approval. SEPTA reserves the right to reject the qualifications of the proposed RCDD based upon their lack of certification.
   1. The RCDD shall oversee the entire fiber optic cable equipment selection, procurement, installation, testing, and training of SEPTA maintenance and operating personnel.

J. Staff Qualifications:
   1. The work on this Contract requires the specified experience as described in the description of the specialized work of the Contract. The positions referenced in Article 1.03/H in this Section are considered key personnel and the review of their resumes and experience is a responsibility requirement under the Instructions to Bidders. The Contractor shall furnish SEPTA with the resumes of the staff proposed to hold the above positions as part of the bid documents.
   2. If, in the course of the work, these individuals are proposed to be replaced by the Contractor and/or SEPTA deems that their work is no longer satisfactory, the terms of
the Paragraph VIII K of the Agreement will be invoked. SEPTA has the right to require any or all of these individuals be replaced upon notifying the Contractor in writing.

3. D/B Contractor shall provide a Project Team organizational chart and resumes of all identified key staff.

K. Notification

1. Provide advance notification to SEPTA’s Project Manager prior to important design, manufacture, and testing and construction events, as shown in Table 01010-1.

2. Notify the SEPTA Project Manager of any delays, field activity or factory test cancellations both verbally and with written confirmation.

TABLE 01010-1 NOTIFICATION SCHEDULE

<table>
<thead>
<tr>
<th>Event</th>
<th>Activity</th>
<th>Minimum Advance Notification Requirement (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Review Meetings</td>
<td>-</td>
<td>Fifteen (15)</td>
</tr>
<tr>
<td>Field Inspections</td>
<td>-</td>
<td>Seven (7)</td>
</tr>
<tr>
<td>Testing</td>
<td>Factory</td>
<td>Thirty-Five (35)</td>
</tr>
<tr>
<td>Testing</td>
<td>Field</td>
<td>Fifteen (15)</td>
</tr>
<tr>
<td>Ground Grid Construction</td>
<td>Construction Commencement</td>
<td>Fifteen (15)</td>
</tr>
<tr>
<td>Ground Grid Construction</td>
<td>Backfilling</td>
<td>Seven (7)</td>
</tr>
<tr>
<td>Equipment Delivery</td>
<td>-</td>
<td>Fifteen (15)</td>
</tr>
</tbody>
</table>

L. Project Milestones

1. Prepare a critical path method project schedule that meets or accelerates the milestone durations specified by Table 01010-2 - Project Milestones.

2. Allow one (1) month for each SEPTA review cycle.

TABLE 01010-2 PROJECT MILESTONES

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion (months after NTP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice to Proceed</td>
<td>0</td>
</tr>
<tr>
<td>Final Design</td>
<td>6</td>
</tr>
<tr>
<td>Permits</td>
<td>8</td>
</tr>
<tr>
<td>Procurement of Power Equipment</td>
<td>35</td>
</tr>
<tr>
<td>Bethayres Substation Complete</td>
<td>14</td>
</tr>
<tr>
<td>Second Substation Complete</td>
<td>29</td>
</tr>
<tr>
<td>Third Substation Complete</td>
<td>43</td>
</tr>
</tbody>
</table>

1.04 SEPTA Responsibilities

A. SEPTA shall furnish free of charge to the Contractor three (3) complete half size sets of the Contract Documents including one (1) set of full size Contract Drawings, Specifications and
Addenda. Additional copies are available from the SEPTA Project Manager at cost of reproduction. One (1) Electronic copy (CD) will also be provided.

B. SEPTA Force Account:
   1. Because these are operating substations, SEPTA’s Substation Operations personnel must be on site at all times any Contractor work is being done for protection of the Contractor’s personnel and for continuity and reliability of revenue service.
   2. Electric Traction (ET) personnel also will be used for the protection of the Contractor's personnel when equipment or personnel must work near energized circuits.
   3. Flagman when the Contractor's personnel are working close to the tracks.
   4. Flagman to take track(s) out of service when construction work fouls the tracks.
   5. SEPTA will perform the necessary relocation work to modify the existing aerial cable routing for the communications and low voltage power cables that enter the substation control building across the substation site.
   6. Communications and Signal (C&S) employees providing interface support, cutting of active circuits, and final connections on the SEPTA end for the new installation and termination of copper and fiber optic signal and communication lines.
   7. Operations personnel to inspect any Contractor high rail vehicles that will operate on SEPTA track.
   8. ET and C&S personnel to identify and tag cables uncovered or pointed out by a Contractor.

1.05 Contractor's Use of Worksite
   A. Contractor shall confine operations at the site to areas permitted by law, ordinances, and permits, according to the schedule and the Contract Documents and shall not unreasonably encumber the site with any materials or equipment.
   B. Keep existing driveways and entrances serving the site clear and available at all times, except as otherwise specified in Section 01500.
   C. Entrance to all three (3) substations sites is via station parking lots. Minimize inconvenience to commuters by not blocking the driveways and parking spaces.
   D. Access to Neshaminy substation requires crossing SEPTA active rail tracks. Avoid making frequent crossings. Cross only when allowed by SEPTA personnel. Move equipment via temporary grade crossing which shall be provided by SEPTA.
   E. Keep the worksite available for SEPTA's operations during the construction period, unless otherwise noted in the construction staging.
   F. Consider the safety of the work, and that of people and property on and adjacent to worksite, when determining amount, location, movement, installation, and use of materials and equipment on worksite.
   G. Do not load finished work with equipment and products that would endanger the integrity of the finished work.
H. Move stored products as often as necessary to avoid interference with foreseeable operations of SEPTA, public and private utilities, and other Contractors at no additional expense to SEPTA. Security of stored materials shall be the Contractor's responsibility. Secure additional storage and work areas needed for construction operations at no additional expense to SEPTA.

I. Protect the general public and SEPTA operations from construction related activities. Conduct work in and on streets in a manner, which will ensure that pedestrian and vehicular traffic will either not be obstructed or obstructed to the least possible degree.

J. Should any temporary disruption of SEPTA's operations and/or use of the electric, water or telephone utilities at such site be necessary, it will be undertaken only pursuant to reasonable notices (not less than seven (7) days) given to the SEPTA Project Manager, and must be approved by SEPTA in writing in advance and shall not continue beyond the previously agreed upon period, without further written concurrence from SEPTA.

1.06 Work Sequence or Construction Staging

A. The contract includes rehabilitation of three substations, all on West Trenton line. Contractor shall plan the work so as to minimize the overall duration of work as well as requirement of power outage. Contractor can work at all the substations simultaneously subject to the limitations of the power outage.

B. Each substation must remain in operation during construction for normal service. It is expected that only one half of a substation can be out of service at one substation at a time for a limited duration, approved by SEPTA. A full outage may be allowed for brief periods for critical activities. A full outage can be allowed only in the night time at one (1) substation at a time. The proposed sequence of construction replaces limited amounts of equipment at a time and requires multiple cutovers as the new equipment is placed into service. The Contractor shall develop a staging plan for approval by SEPTA's Project Manager. Refer section 1.11 for details of the outages that can be permitted.

C. Each outage involves some switching operations on the catenary for continuity of power supply. These switching operations consume part of the outage. Contractor may propose to procure additional line disconnect switches, not shown on the design drawings, for installation by SEPTA forces. Contractor shall develop details of the switches to be procured and anticipated saving in the time in the detail design phase.

D. Do not remove any existing structures or remove any equipment from service which would affect the on-going SEPTA operations until such temporary provisions have been made, or permanent construction work has been completed and equipment is operable. The SEPTA Project Manager shall be the sole judge of when the Contractor's operations are causing interference with operations, and his orders and instructions shall be carried out without delay.

E. Ensure that all men are at site and that all necessary material and equipment have been delivered prior to commencing work.

F. The work at each substation will be performed by the Contractor in two (2) stages, Stage 1 and Stage 2. The following staging plan describes one (1) possible way to stage the work. The Contractor shall develop the final staging plan, as a part of the final design, to introduce appropriate work modifications and changes, to perform the work more efficiently and to
minimize the duration of any outage. The suggested construction sequence is shown in the Contract Drawings and as follows. The Contractor shall develop the final detailed staging and construction sequence and submit to SEPTA for review and approval.

1. Bethayres Substation
   a. Stage 1:
      1) Temporary 12 kV Potential Transformer:
         a) Request stage 1 power outage from SEPTA.
         b) Provide new temporary 12 kV potential transformer on bus 2 to provide voltage signal to the relays during outage of bus 1.
         c) Connect the potential transformer output to the existing control board in place of the existing potential transformer.
         d) Test the functioning of the protective relays, SCADA and indicating instruments with the new potential transformer output to verify the polarity.
      2) New Auxiliary Power Room:
         a) Build the Concrete Masonry Unit (CMU) wall to segregate the area from the switchgear room.
         b) Provide new doors and access.
         c) Provide new 60 Hz supply from PECO, if required. Otherwise, new cables and panel board at its new location. Coordinate with PECO as required. (SEPTA will apply for all relevant PECO services at these sites.)
         d) Install new battery, battery chargers, transfer switch, 60 Hz and 25 Hz panels.
         e) Power up new equipment in the new auxiliary power room.
         f) Connect existing control board and lights to the new power supply.
      3) Dismantle Existing Auxiliary Power Supply Equipment from the Existing Control Room:
         a) Remove battery, battery chargers, transfer switch, eye wash and AC panels from the existing control room. This will free up space near south wall.
         b) Carry out civil and architectural repairs on the south wall.
         c) Carry out civil and architectural repairs near north wall.
      4) Install New Control Board and New RTU:
         a) Connect AC and DC power to the new equipment; test the board.
         b) Connect the new RTU to the existing communication cable.
         c) Make necessary changes at control center for the new and existing RTU to work simultaneously.
         d) Test the new RTU for end-to-end functioning.
      5) Start Stage 1 Outage:
         a) Coordinate with SEPTA to jumper the section switch on track 1 to maintain continuity of catenary power during outage.
         b) Under full outage, remove cross feeders and horngap switch numbers HB1J, HB1N, HFB1J, and HFB1N. Also, remove BB1 and BFB1.
         c) Remove vertical drops of the four (4) de-energized circuits.
         d) Replace the feeders and horngap switches under full outage
   6) Disconnect all Wiring of Existing Circuit Breakers B1J, B1N, HFB1J and HFB1N and their isolating switches:
      a) Remove existing circuit breakers FB1J and FB1N from the site.
b) Demolish foundation pads of FB1N and FB1J.

7) Clean, repair, prime and repaint the existing steel. Provide New Truss for circuit breakers B1J, B1N, FB1J, FB1N and B1 and provide and install the following equipment:
   a) Provide new equipment.
   b) Install new 12 kV and 24 kV circuit breakers.
   c) Install new autotransformer circuit breaker B1.
   d) Install associated disconnect switches.
   e) Provide oil containment system and new foundation for autotransformer AT1.
   f) Install new autotransformer AT1.
   g) Connect control wires. Do not make high voltage connections.

8) Test new circuit breakers and protective relays from local and remote operation.

9) Test SCADA system.

10) Under full outage, install vertical drops and energize the new equipment to commission bus 1 with new equipment.

11) The communicable cable may be replaced in Stage 1 or 2, as approved by SEPTA.

b. Stage 2:
   1) Coordinate with SEPTA to jumper the section break switch on track 2 to maintain the continuity of catenary power supply.

2) New Auxiliary Power Room:
   a) Complete any work left over from stage 1. Commence work on stage 2 after successful completion of stage 1.

3) Start Stage 2 Outage:
   a) Jumper the insulated overlap on the track 2 to maintain continuity of catenary power during outage.
   b) Open and lock HB2J, HB2N, HFB2J, HFB2N, BB2 and BFB2.
   c) Remove vertical drops of the four (4) de-energized circuits.

4) Disconnect all Wiring of Existing Circuit Breakers B2J, B2N, HFB2J and HFB2N:
   a) Remove existing circuit breakers FB2J and FB2N from the site.
   b) Demolish foundation pads of FB2N and FB2J.
   c) Demolish and remove the existing autotransformer to make room for new 2-pole circuit breaker B2. Demolish the foundation of the existing autotransformer.

5) Provide New Circuit Breakers for Bus 2:
   a) Provide new steel work.
   b) Install new 12 kV, 24 kV circuit breakers and autotransformer breaker.
   c) Install new autotransformer AT2 and oil containment.
   d) Connect control wires. Do not make high voltage connections.

6) Test new circuit breakers and protective relays from local and remote operation.

7) Test SCADA system.

8) Under full outage, install vertical drops and energize the new equipment to commission bus 1 with new equipment.

2. Neshaminy Substation
   a. Stage 1:
      1) Temporary 12 kV Potential Transformer:
a) Request stage 1 power outage from SEPTA.
b) Provide new temporary 12 kV potential transformer on Bus 1 to provide voltage signal to the relays during outage of Bus 2.
c) Connect the potential transformer output to the existing control board in place of the existing potential transformer.
d) Test the functioning of the protective relays, SCADA and indicating instruments with the new potential transformer output to verify the polarity.

2) Auxiliary Power Equipment:
   a) Replace the 480V120V step-down transformer.
   b) Install new battery, battery chargers, transfer switch, 60 Hz and 25 Hz panels after carrying architectural and civil repairs.
   c) Power up new equipment.
   d) Connect existing control board and lights to the new power supply. Provide temporary power supply for the transition period. Obtain outage as required.

3) Demolish Existing Auxiliary Power Supply Equipment from the Existing Control Room:
   a) Remove battery, battery chargers, transfer switch, eye wash and AC panels from the existing control room.
   b) Carry out civil and architectural repairs.

4) Install New Control Board and New RTU:
   a) Install the new Control Board and the new RTU. Do not disturb the working of existing Control Board and the existing Connect AC and DC power to the new equipment; test the board.
   b) Connect the new RTU to the existing communication cable.
   c) Make necessary changes at the Control Center for the new and existing RTU to work simultaneously.
   d) Test the new RTU for end-to-end functioning.

5) Start Stage 1 Outage:
   a) Coordinate with SEPTA to jumper the insulated overlap on track 2 to maintain continuity of catenary power during outage in Phase 1 of construction.
   b) Under full outage, remove cross feeders and horngap switch numbers HN2B, HN2Y, HFN2B and HFN2Y. Also, remove BN1 and BFN1.
   c) Remove vertical drops of the four (4) de-energized circuits.
   d) Replace the feeders and horngap switches under full outage.

6) Disconnect all Wiring of Existing Circuit Breakers N2B, N2Y, FN2B, and FN2Y:
   a) Remove existing circuit breakers FN2B AND FN2J and their isolating switches from the site.
   b) Remove isolating switches of N2B and N2Y.
   c) Verify operation of in-service circuit breakers and their differential bus protection.
   d) Demolish foundation pads of FN2B and FN2Y.

7) Clean, repair, prime and repaint the existing steel. Provide New Truss for circuit breakers N2B, N2Y, FN2B, FN2Y and N2 and provide and install the following equipment:
   a) Provide new equipment.
   b) Install new 12 kV and 24 kV circuit breakers.
   c) Install new autotransformer circuit breaker N2.
   d) Install associated disconnect switches.
e) Provide oil containment system and new foundation for autotransformer AT2.
f) Install new autotransformer AT2.
g) Connect control wires. Do not make high voltage connections.

8) Install new ground grid over Bus 2 area.
9) Test new circuit breakers and protective relays from local and remote operation.
10) Test SCADA system.
11) Under full outage, install vertical drops and energize the new equipment to commission Bus 2 with new equipment.
12) Ensure adequate working clearance of the newly energized buses from the work area of Phase 2 of construction.
13) Communication cable may be replaced in Stage 1 or 2, as approved by SEPTA.

b. Stage 2:

1) Start Stage 2 Outage:
   h) Jumper the insulated overlap on the track 1 to maintain continuity of catenary power during outage.
   i) Under full outage, remove cross feeders and horngap switch numbers HN1J, HN1Y, HF1J and HF1Y and associated surge arresters. Also remove equipment which is not in use.
   j) Remove vertical drops of the four (4) de-energized circuits.
   k) Replace the horngap switches and surge arresters of Bus 1 circuits.

2) Disconnect all Wiring of Existing Circuit Breakers N1B, N1Y, FN1B, FN1Y, and N1.
   a) Remove existing circuit breakers FN1B, FN1Y, and N1 from the site promptly.
   b) Remove the autotransformer N1 from the site promptly.
   c) Demolish foundation pads.
   d) Install foundations for the new circuit breakers and new autotransformer.

3) Provide New Circuit Breakers for Bus 1:
   a) Provide new steel work.
   b) Install new 12 kV, 24 kV circuit breakers and autotransformer breaker.
   c) Install oil containment and new foundation for the new autotransformer. Install new autotransformer AT2.
   d) Connect control wires. Do not make high voltage connections.

4) Test new circuit breakers and protective relays from local and remote operation.

5) Test SCADA system.

6) Under full outage, install cross feeders, vertical drops and energize the new equipment to commission bus 1 with new equipment.

3. Yardley Substation
   a. Stage 1:

   1) Temporary 24 kV Potential Transformer:
      a) Request Bus 1 power outage from SEPTA.
      b) Provide new temporary 24 kV potential transformer on Bus 1 to provide voltage signal to the relays during Phase 1 outage of Bus 2.
      c) Connect the potential transformer output to the existing control board in place of the existing potential transformer.
d) Test the functioning of the protective relays, SCADA and indicating instruments with the new potential transformer output to verify the polarity.

2) Auxiliary Power Equipment:
   a) Provide temporary battery outside with associated battery chargers. Ensure continuity of dc and ac control power.
   b) Provide new 60 Hz power supply from PECO, if required.
   c) Install new battery, battery chargers, transfer switch, 60 Hz and 25 Hz panels after carrying architectural and civil repairs.
   d) Power up new equipment.
   e) Connect existing control board and lights to the new power supply. Provide temporary power supply for the transition period. Obtain outage as required.

3) Demolish Existing Auxiliary Power Supply Equipment from the Existing Control Room:
   a) Remove battery, battery chargers, transfer switch, eye wash and AC panels from the existing control room.
   b) Carry out civil and architectural repairs.

4) Install New Control Board and New RTU:
   a) Install the new Control Board and the new RTU. Do not disturb the working of existing Control Board and the existing Connect AC and DC power to the new equipment; test the board.
   b) Connect the new RTU to the existing communication cable.
   c) Make necessary changes at the Control Center for the new and existing RTU to work simultaneously.
   d) Test the new RTU for end-to-end functioning.

5) Start Stage 1 Outage:
   a) Coordinate with SEPTA to jumper the section switches as required to maintain continuity of catenary power to Trenton during outage in Phase 1 of construction.
   b) Under full outage, remove cross feeders and horngap switch numbers HY1N, HY1T, HFY2N, associated surge arresters and cross feeders.
   c) Remove vertical drops of the de-energized circuits.
   d) Replace the feeders, horngap switches, and surge arresters at their new locations under full outage.

6) Disconnect all Wiring of Existing Circuit Breakers Y1N, FY2N, and Y2:
   a) Remove the circuit breakers and their isolating switches from the site.
   b) Verify operation of in-service circuit breakers and their differential bus protection.
   c) Demolish the foundation pads.

7) Clean, repair, prime and repaint the existing steel. Provide foundations, coil containment and steel for the proposed circuit breakers and provide and install the following equipment.
   a) Install new ground grid over Bus 2 area. Do not disturb the existing ground grid.
   b) Install new 12 kV and 24 kV circuit breakers.
   c) Install new autotransformer circuit breaker Y2.
   d) Install associated disconnect switches.
   e) Install oil containment and new foundation for the new autotransformer. Install new autotransformer AT2.
   f) Connect control wires. Do not make high voltage connections.
8) Test new circuit breakers and protective relays from local and remote operation.

9) Test SCADA system.

10) Under full outage, install vertical drops and energize the new equipment to commission Bus 2 with new equipment.

11) Ensure adequate working clearance of the newly energized buses from the work area of Phase 2 of construction.

12) Communication cable may be replaced in Stage 1 or 2, as approved by SEPTA.

b. Stage 2:

13) Start Stage 2 Outage:
   a) Coordinate with SEPTA to jumper the section switches, as required, to maintain continuity of catenary power to Trenton during outage.
   b) Under full outage, remove cross feeders, horngap switch and surge arresters of Bus 1 circuits Y2N, FY1N. Also remove equipment which is not in use.
   c) Remove vertical drops of the de-energized circuits.
   d) Replace the feeders, horngap switches and surge arresters of Bus 1 circuits.

14) Disconnect all Wiring of Existing Circuit Breakers Y2N, FY1N and other not in use equipment.
   a) Remove the disconnected and not in use circuit breakers from the site promptly.
   b) Remove the autotransformer AT1 from the site promptly.
   c) Demolish foundation pads.
   d) Install foundations for the new circuit breakers and new autotransformer.

15) Provide New Circuit Breakers for Bus 1:
   a) Provide new foundations, oil containment and new steel work.
   b) Clean, repair, prime and repaint the existing steel.
   c) Install new 12 kV, 24 kV circuit breakers and autotransformer breaker.
   d) Install new autotransformer AT1 and oil containment.
   e) Connect control wires. Do not make high voltage connections.

16) Test new circuit breakers and protective relays from local and remote operation.

17) Test SCADA system.

18) Under full outage, install cross feeders, vertical drops and energize the new equipment to commission bus 1 with new equipment.

G. Holiday Service:

1. SEPTA will prohibit service shut downs and diversions on certain Holidays and Holiday weekends. Holidays include Memorial Day weekend, the Welcome America Celebration one (1) week before the Fourth of July weekend, the Fourth of July (and the Fourth of July weekend, if applicable) and Labor Day weekend.

2. Outages, shutdowns and diversions shall not be permitted during the "Holiday Season" which is defined as the period starting 5:01 am on the Wednesday before Thanksgiving Day until January 2, inclusive.

H. Operational Constraints:

1. All track and power outages, as requested by the Electrical Contractor, are restricted to the window between 1:30 am and 4:30 am, (including switching and grounding). In
addition, normally one (1) of two (2), 24 kV feeders on a line can be taken out of service after 8:00 pm. Grounding would add another half hour, to 8:30 pm.

2. If approved by SEPTA, the substation may be removed from service at non-rush hour periods on weekends.

3. Half of the substation (one (1) feeder bus and associated catenary bus) may be removed from service for extended periods up to two (2) months.

4. Refer to the requirements in Section 01065.

I. Construction Constraints:

1. Any actual construction activities with the potential to interfere with SEPTA operations and passenger service shall not begin until:
   a. The Contractor provides a written plan to SEPTA indicating impact to passenger service and SEPTA operations. Such plan shall include remedial solutions acceptable to SEPTA.
   b. The plan is approved in writing by SEPTA. The Contractor shall be responsible for revision and resubmittal of the plan until it is approved by SEPTA.
   c. Before starting work on a construction stage, the Contractor may submit a written request to SEPTA to amend or adjust the staging plan.

1.07 SEPTA Occupancy and Use

A. Portions of the work will be placed in operation by SEPTA in advance of the completion of all work, following an inspection to determine completion of these portions of the work and completion of appropriate field tests. Operation of these portions of work by SEPTA will not relieve the Contractor of any responsibility for proper integrated operation of all parts of the work, nor shall it act to relieve the Contractor of any responsibilities under the Contract Documents for warranty of the work.

B. SEPTA reserves the right to use, or cause to be used, any portion of the work as soon as it is made ready for use. Such use shall not be construed as acceptance of the work by SEPTA. The Contractor shall be responsible for maintenance and up-keep of all newly installed work and the site until final acceptance of the work.

1.08 Existing Conditions

A. The existing conditions represented in the Contract Drawings are based on the best available information obtained from one (1) or any combination of the following sources. Every effort has been made to present as much information as possible.
   1. Field survey.
   2. As-built documents.
   3. Reference drawings.
   4. Visual investigation.

B. On the basis of the information presented on the Contract Drawings, visual and physical verifications shall confirm the conditions presented. If verified conditions are close to those represented on the Contract Drawings, the Contractor shall, in addition to reporting the verification to the SEPTA Project Manager, proceed with the work at no additional cost to SEPTA. If conditions are significantly different to those presented on the Contract Drawings,
the Contractor shall, in addition to reporting the verification to the SEPTA Project Manager, submit a detailed scheme and associated cost for completing the required work for review and comment. The Contractor shall allow twenty-one (21) days for review and comment.

C. The Contract Documents establish specific criteria and standards of performance. The Contractor shall use its discretion to determine means of compliance and is responsible for coordinating with other sub-contractors at the site in order to achieve compliance.

1.09 License and Permits

A. The D/B Contractor is responsible for applying for, paying for, and obtaining all licenses and permits for the Contract. See Permit Matrix attached to this Section.

1.10 Final Design

A. The Contract Drawings are incomplete and identify the scope of work that must be performed while meeting the objectives listed in this Section. The D/B Contractor shall complete their portion of the final design of the substation rehabilitation and utilize a Design capable entity on their Project Team who will carry the present 50% design through to 100% completion.

B. The final design shall be prepared around autotransformers and circuit breakers which have been ordered by SEPTA. SEPTA will furnish drawings and data of this equipment to the Contractor.

C. Final design documentation shall include, but not limited to, confirming the preliminary design as necessary, and developing all necessary final details related to equipment layouts, staging, functional schematics, sectionalizing, site layouts, equipment detail and arrangements, relay and protection diagrams, equipment interconnection, cable and conduit routing and schedules, specifications and construction schedule.

D. The Contractor may propose alternative construction staging as necessary for review and acceptance by SEPTA. In such cases the Contractor shall provide all design aspects as deemed necessary by SEPTA. It is required that the Contractor develop a CPM sequence of work for submission to SEPTA.

E. Final design shall also include all required studies and calculations, including but not limited to short circuit study, ground grid design and calculation of step and touch potentials, relay and protection setting coordination study, lighting calculations and ground grid calculations.

F. The D/B Contractor shall provide, at a minimum, 60 percent, 90 percent and 100 percent design submittals, for SEPTA review, in completion of the design.

1.11 Substation Rehabilitation

A. The approach adopted is to replace one half of the substation at a time, keeping the other half in revenue service. Note that replacement of some equipment, such as horn gap disconnect switches and bus-tie disconnect switches will require full substation outage periods. Also, some of the equipment, such as the existing 24 kV feeder breakers, the existing two pole autotransformer circuit breakers and the existing 2 MVA autotransformers, have to be dismantled and removed during the construction stage while the remaining equipment can be dismantled and removed after completion of the work.
B. The Contractor shall review the staging approach presented in the Contract Drawings and Specifications to develop detailed staging plans for final design and associated work. Detailed staging plans shall be submitted to SEPTA for approval, clearly identifying the number and duration of half substation and full substation outages. Note that outage can be allowed only at one (1) substation at a time.

C. Following are the types of power outages which can be permitted. The Contractor shall request each outage one week, minimum, in advance for review and approval by SEPTA. Contractor shall indicate the details of the outage required, duration, start time, finish time and the details of the work proposed to be performed in the request. Contractor shall develop the format of the request with SEPTA soon after NTP.

1. Half substation outage: Horngap switches will be open; North-South cross feeders of the de-energized circuits would be dead, and the vertical drops would be removed. Horngap switches of the other bus would be closed and the circuits would be energized. Line switches of the catenary would be closed, as required, for continuity of the power supply. This outage will be available for extended duration, possibly 6 to 8 weeks at one TPSS at a time.

2. Full substation outage: All horngap switches at the substation will be open. Line disconnect switches will be closed to maintain continuity of the power supply. It could be allowed over the weekends from Friday 10:00 PM to Monday 4:00 AM at one TPSS at a time, and

3. Branch outage: Breakers J1B, J2B, FJ1B and FJ2B at Jenkintown will be opened to de-energize the entire West Trenton line from Jenkintown. The contractor can access the horngap switch gantry and the cross feeders. It will be allowed only during the night hours between 01:30 AM and 04:30 AM which includes time for switching and applying/removing the grounds. Thus, the effective working time will be approximately 2:30 hours or less.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
### SEPTA SUBSTATIONS REHABILITATION PROJECT

**Permits Matrix**

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Permit</th>
<th>Reviewing Agency</th>
<th>Contract 1</th>
<th>Contract 2</th>
<th>Contract 3</th>
<th>Contract 4</th>
<th>Contract 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Civil</td>
<td>Site Plan Approval</td>
<td>Township/Borough</td>
<td>D</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Building (See Architectural)</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stormwater Plan Review</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PennDOT Highway Occupancy Permit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Street Closure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Street Opening (excavation in ROW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Record of Disturbance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Site Civil</td>
<td>Site Plan Approval</td>
<td>Township/Borough</td>
<td>D</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Building (See Architectural)</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stormwater Plan Review</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PennDOT Highway Occupancy Permit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Street Closure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Street Opening (excavation in ROW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Record of Disturbance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>Building</td>
<td>Philadelphia Licenses &amp; Inspect.</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Plumbing</td>
<td>Philadelphia Licenses &amp; Inspect.</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Mechanical</td>
<td>Philadelphia Licenses &amp; Inspect.</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Environmental</td>
<td>Remediation (Spill &amp; Release)</td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSX Right of Entry</td>
<td></td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
<td>D &amp; C</td>
</tr>
</tbody>
</table>

**Updated:** SEG  
**Date:** 12/23/2016  
**D** Designer to obtain  
**C** Contractor to obtain
SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 Description
   A. This specification covers general requirements for measurement of quantities and schedule of values required to process payment applications according to the provisions set forth in the Agreement.
   B. Provide a detailed breakdown of the agreed contract sum (Schedule of Values) showing values allocated to each of the various parts of the work, as specified herein, and as required by other provisions of the Contract Documents.

1.02 Related Sections
   A. Documents affecting work of this section include, but are not necessarily limited to the Agreement, pertinent Sections in Division 1 and technical Divisions 2 through 16.

1.03 Measurement of Quantities
   A. The work performed under the Contract will not be measured, except to establish percentage of completion for each value line payment item.
   B. Contract Specifications require factory (design and production) tests to be performed on the traction power equipment (autotransformers, distribution transformers, disconnect switches, circuit breakers, battery equipment, SCADA/RTU and instrument transformers). Include in the bid the amount of credit to be given to SEPTA for each individual factory test if it is waived by SEPTA upon review of the reports of the tests performed on similar or essentially similar equipment in the past (Sections 16240, 16270, 16275, 16290, 16310, 16330, and 16791).

1.04 Scope of Payment
   A. Payment for work performed under the Contract will be paid in accordance with the Agreement.

1.05 Quality Assurance
   A. Prior to applying for first application of payment, secure SEPTA’s approval of the Schedule of Values.
   B. During progress of the work, including any change order work, modify the Schedule of Values, as required, and as approved by SEPTA.
   C. Provide data, including detailed bid preparation documents to substantiate each value line.

1.06 Schedule of Payments
   A. Submit a schedule of values in accordance with the requirements specified in the Agreement.
PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
SECTION 01045

CUTTING AND PATCHING

PART 1 - GENERAL

1.01 Description

A. This Section covers general requirements pertaining to cutting (including excavating), fitting, and patching of the work required to:

1. Make the installation fit properly with each existing and new structure.
2. Uncover work to provide for installing, inspecting, or both, of ultimate work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove and replace defective work.
5. Repair holes and cracks caused by removal of accessories and equipment.
6. Coordinate the work of all trades.

1.02 Related Sections

A. Section 01010 – Summary of Work
B. Section 01060 – Regulatory Requirements and Safety
C. Section 01300 – Submittals
D. Section 01305 – Requests for Information
E. Section 01400 – Quality Requirements
F. Section 01600 – Materials and Equipment
G. Section 02050 – Demolition
H. Section 02070 – Selective Demolition

1.03 Submittals

A. Request for Approval:

1. Prior to cutting any element, submit written request to the SEPTA Project Manager for permission to proceed with cutting. Request should include structural design calculations that have been sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania for temporary structural supports.

2. Should conditions of the work, or schedule, indicate a required change of materials or methods for cutting and patching, so notify the SEPTA Project Manager and secure his written permission prior to proceeding.
1.04 Quality Assurance
   A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
   B. Do not cut or patch structural elements in a manner that would reduce the load carrying capacity of load deflection ratio.
   C. Do not cut or patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance or decreased operational life or safety.
   D. Do not cut or patch, construction exposed on the exterior or in occupied spaces, in a manner that would, in the opinion of SEPTA's Project Manager, reduce the building's elements; aesthetic qualities, or result in visual evidence of cutting and patching. The Contractor shall remove and replace work cut and patched in a manner deemed to be visually unsatisfactory by any of the above parties.

PART 2 - PRODUCTS

2.01 Materials
   A. Except as otherwise indicated or approved by SEPTA, provide materials for cutting and patching which will result in equal or better work than work being cut and patched, in terms of performance characteristics and including visual effect where applicable. Use materials identical with original materials where feasible and where recognized that satisfactory results can be produced thereby.

PART 3 - EXECUTION

3.01 Inspections
   A. Inspect existing conditions, including elements subject to movement or damage during cutting, excavating, patching and backfilling.
   B. After uncovering the work, inspect conditions affecting installation of new work.

3.02 Discrepancies
   A. If uncovered conditions are not as anticipated, immediately notify the SEPTA Project Manager and request direction.
   B. Do not proceed until unsatisfactory conditions are corrected.

3.03 Temporary Support and Protection
   A. Provide adequate temporary support to prevent failure of work to be cut. Do not endanger other work. Provide adequate protection of other work during cutting and patching, to prevent damage; and to provide protection of the work from adverse weather exposure. If safety of structure appears to be endangered, take immediate precautions to support structure until determination is made for continuing operations.
3.04 Performance

A. Cut work so as not to damage work to be retained and adjoining work. Where physical cutting is required, cut work using means and methods that minimize the spread of debris. Use water and adequate ventilation to control dust.

B. Patch seams which are durable and as invisible as possible. Restore exposed finished or patched areas in a manner to eliminate evidence of patching.

C. Do not cut and patch operational elements or safety related components in a manner that would result in a reduction of their capacity to perform in the manner intended, or that would result in increased maintenance, or decreased operational life or decreased safety.

D. If existing utilities, pipes, and/or conduits are affecting the Contractor's work and it is necessary to relocate the existing services it shall be relocated by the Contractor and the Contractor shall install by-pass services of quality equal to the existing system prior to beginning the work.

3.05 Cleaning

A. Thoroughly clean areas and spaces where work is performed or used as access to work. Thoroughly clean piping, conduit and similar fixtures before painting or other finishing is applied. Restore damaged pipe covering to its original condition.

END OF SECTION
THIS PAGE NOT USED
SECTION 01050

FIELD ENGINEERING

PART 1 - GENERAL

1.01 Description

A. This Section covers field engineering services as are required for proper completion of the work including, but not limited to:

1. Establishing and maintaining lines and levels and other survey controls as dictated by the specific Contract parameters.

2. Structural design of sheeting, shoring, forms, and similar temporary work provided by the Contractor as part of the means and methods of construction.

3. The Contractor is responsible to perform its own field engineering/survey work. The Contractor is also responsible to perform the site survey and stakeout markers for others to use per Article 1.05, Part C in this Section.

1.02 Related Sections

A. Section 01300 – Submittals
B. Section 01305 – Requests for Information
C. Section 01400 – Quality Requirements
D. Section 01700 – Contract Closeout
E. Section 01720 – Project As-Built Documents

1.03 Submittals

A. Meet pertinent provisions of Section 01300.

B. Upon request of SEPTA submit:

1. Data demonstrating qualifications of persons proposed to be engaged for field engineering services.

2. Documentation verifying accuracy of field engineering work.

3. Certification, signed by the Contractor’s retained field engineer, that elevations and locations of improvements are in conformance or nonconformance with requirements of the Contract Documents.

1.04 Quality Assurance

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. A Professional Land Surveyor (PLS) Licensed to Practice in the Commonwealth of Pennsylvania shall be directly responsible for survey work performed by the Contractor. The PLS shall be on the work site whenever survey activities are taking place.
C. Temporary support and excavation support shop drawings shall be prepared. The shop drawings shall be signed and sealed by a Professional Engineer Licensed in the Commonwealth of Pennsylvania.

1.05 Procedures

A. In addition to procedures directed by the Contractor for proper performance of the work, the Contractor shall:

1. Locate and protect control points before starting work on the site.
2. Preserve permanent reference points during progress of the work.
3. Do not change or relocate reference points or items of the work without specific approval from SEPTA.
4. Promptly advise SEPTA when a reference point is lost or destroyed, or requires relocation because of other changes in the work.
   a. Upon direction of SEPTA, require the field engineer to replace reference stakes or markers.
   b. Locate such replacements according to the original survey control.
5. Log elevation of critical points of the Project such as slab on grades and takeoff structures.
6. Log elevations at finish grades and sidewalks.

B. Before proceeding with the layout of actual work, the Contractor shall verify the layout information shown on the drawings, in relation to the property survey and existing benchmarks. As the work proceeds, the surveyor shall check every major element for line, level and plumb. Maintain a surveyor’s log or record book of such checks. Make this log or record book available for SEPTA’s reference. The surveyor shall record deviations from the required lines and levels, and shall, upon detection, promptly advise SEPTA of deviations exceeding indicated or recognized tolerances. The Contractor shall update final survey information on record drawings.

C. The Contractor shall be responsible for the stakeout of all construction boundary lines, building lines, sidewalk-cut, wall-cut, access roads, and corners required to establish the location of fences and other items of work, of which location is referenced thereto.

D. The Contractor shall assume full responsibility for dimensions and elevations taken from benchmarks and baselines and for the setting of lines and grades.

E. The Contractor shall provide the SEPTA Project Manager with any assistance required for checking lines, grades and measurements as may be requested by the SEPTA Project Manager.

1.06 Preservation of Field Books

A. The Contractor shall preserve field books and stakeout data until final acceptance of the work at which time they will be signed and sealed by a Land Surveyor licensed in the Commonwealth of Pennsylvania and turned over to SEPTA. The Contractor shall meet the requests by the SEPTA Project Manager for field books and stakeout data upon request during the course of work. Transmit field books and stakeout data to the SEPTA Project Manager.
Manager as part of the project closeout submittal. The field books and stakeout data will become the property of SEPTA.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
THIS PAGE NOT USED
SECTION 01060

REGULATORY REQUIREMENTS AND SAFETY

PART 1 - GENERAL

1.01 Description

A. This Section specifies the regulatory and safety requirements for prosecution of the work and supplements the requirements specified in the Agreement. The Contractor is required to assure that all employees, subcontractors, and suppliers/vendors, while on the work site and/or in the conduct of the Contract, meet the provisions of this Section.

B. The Contractor shall take every precaution necessary to assure the safe access and egress of all SEPTA patrons and employees, the safe and continuous operation of all SEPTA vehicles, ensure the appropriate protection of the environment as well as the safety and general welfare of the public at large.

1.02 Related Sections

A. Agreement.

B. Section 01010 – Summary of Work

C. Section 01065 – Railroad Safety Requirements

D. Section 01100 – Special Project Procedures

E. Section 01300 – Submittals

F. Section 01305 – Requests for Information

G. Section 01400 – Quality Requirements

H. Section 01500 – Construction Facilities and Temporary Controls

1.03 Submittals

A. The Contractor shall furnish a copy of the Contractor’s employee safety program to the SEPTA Project Manager within thirty (30) days from receipt of the Notice to Proceed (NTP).

1.04 Quality Assurance

A. The Contractor shall daily monitor and document the compliance and performance of the requirements set forth in this Section consistent with appropriate SEPTA work rules and local, Commonwealth of Pennsylvania, and federal rules and regulations. The Contractor shall document the Contractor’s compliance with all of the referenced codes.

B. The Contractor’s employee safety program, as a minimum, shall include but not be limited to the following:

1. Construction orientation.

2. OSHA inspection and compliance.

3. General and site specific safety.
4. Workmen’s compensation reporting.
5. Fall protection/personal protective equipment.
6. Confined space.
8. Trenching and excavation.
9. Cranes.
10. Electrical protection.
11. Drug and alcohol.

C. The Contractor shall provide a qualified safety officer who shall be responsible for all safety-related activities until the completion of the work. The safety officer shall report all on the job injuries at once to the SEPTA Project Manager and submit all paperwork pertaining to such injuries, as required.

D. The Contractor’s superintendent or safety officer shall as a minimum hold weekly (tool box) safety meetings with all of the Contractor’s personnel. Subjects, time and location may be set at the Contractor’s convenience. SEPTA requires at least three (3) days prior notice of location and time of each meeting, and an agenda shall be submitted to the SEPTA Project Manager. Minutes of each safety meeting shall be provided to the SEPTA Project Manager at each regularly scheduled project coordination meeting.

E. The Contractor is required, by Agreement, to maintain an alcohol and drug free environment. The Contractor shall describe in their employee safety program on how this contract stipulation is to be accomplished and maintained. Please note that SEPTA reserves the right to restrict access to its property, because of the inherent safety hazard to its employees and general public. Any person shall be removed and barred from SEPTA property if in the opinion of SEPTA’s Project Manager, and/or other appropriate SEPTA representative that person constitutes a safety risk.

F. Meet the applicable provisions of the most recent issues of the following references:
   1. ANSI 107, High Visibility Safety Apparel and Accessories.
   2. ANSI S1.4, Specifications for Sound Level Meters.
   3. ANSI Z87.1, American National Standard for Occupational and Educational Personal Eye and Face Protection Devices.
   4. ANSI Z89.1, Personal Protection - Protective Headwear for Industrial Workers.
   5. IEC 179, Precision Sound Level Meters.
   8. NFPA 70E, Standard for Electrical Safety in the Workplace.


13. Pennsylvania Department of Environmental Protection.

1.05 General Safety Requirements

A. All work shall be performed in accordance with rules, regulations, procedures, and safe practices of SEPTA, the Commonwealth of Pennsylvania, OSHA and all other governmental agencies having jurisdiction over the work. The following safety rules are highlighted from the aforementioned documents and are considered especially applicable to all of the Contractor’s employees in regard to conduct while on SEPTA property.

1. The Contractor’s employees shall wear hard hats, suitable work shoes or boots (as required), vests and full body cover clothing, at all times, and safety glasses if required.
   a. Hard hats shall be ANSI Z89.1, Class E.
   b. Work shoes shall have nonslip soles. Permanent metal plates or cleats on the sole or heel of shoes are prohibited. Shoelaces are to be kept short so they do not pose a tripping hazard. Athletic shoes, sandals, open-toed shoes, moccasins and/or shoes with heels higher than 1 inch are not permitted.
   c. The Contractor personnel shall wear eye protection for all structural track and specialized work activities and any other protective equipment in accordance with the applicable OSHA regulations. Eye protection shall be safety glasses with rigid side shields that meet ANSI Z87.1. Prescription eyewear shall also meet the same requirements as described above, or the individual shall wear equivalent eye protection over their prescription glasses or contact lenses.
   d. The safety vest shall be ANSI 107, Class 2 high visibility with a yellow green background and 2 inch retroreflective striping for work on SEPTA owned track. Amtrak track requires the use of an orange vest subject to approval by Amtrak.
   e. The Contractor’s personnel shall wear long pants (without cuffs) and, at a minimum, short sleeve shirts.
   f. All employees and workers shall wear SEPTA specified Personal Protective Equipment (PPE) in accordance with NFPA 70E. Note that the work sites are active substations.

B. The Contractor and his employees shall cross the railroad tracks under supervision of SEPTA personnel. Obtain guidance from SEPTA for crossing the tracks owned by other agencies.

C. The Contractor shall take all necessary precautions and provide protective measures to prevent injury to the public and damage to property of others. Before commencing operations, the Contractor shall furnish and erect construction fencing or barricades and signage, as specified, for the safeguarding of the public against accident or damage resulting from Contractor's operations, and as required to prevent unauthorized access to the work and to the storage areas. Contractor shall maintain the protective measures and/or construction fencing until removal.

D. The Contractor shall dismantle and remove construction fencing when required or when directed by the SEPTA Project Manager.
1.06  Emergency Procedures
A. The Contractor shall set up emergency procedures and prepare written guidelines discussing such procedures for the following categories:
   1. Fire.
   2. Injury to employees.
   3. Injury to general public.
   4. Property damage, including property of utilities, i.e., gas, water, sewage, electrical, telephone or pedestrian and vehicle routes.
   5. Hazardous/toxic material spill discharges.
   6. Site evacuation.
B. Copies of all guidelines for emergency procedures shall be written and posted prior to the initiation of actual construction. Posting shall include emergency telephone numbers and directions to and from the nearest hospital. The Contractor shall have standing arrangements for the transportation and hospital treatment of any employees who may be injured or who may become ill. These guidelines shall be included in the Contractor's written safety program and shall be submitted to SEPTA.
C. The Contractor shall provide and fully equip a first aid station at the site, for first aid service to any that may be injured in the progress of the work.
D. SEPTA operational emergencies will be handled by the senior SEPTA Operations personnel present. This individual “The Incident Commander” is responsible for summoning the number of persons required by the situation and assignment of all recommended procedures.

1.07  Protection of SEPTA Facilities
A. The Contractors shall be cognizant of and bound by SEPTA’s safety rules and regulations specified herein and conduct operations in strict accordance with same.
B. SEPTA shall be the sole judge of protection necessary for the safe operation of its facilities.
C. SEPTA’s facilities and/or structures shall not be utilized by the Contractor for temporary scaffolding and/or support for the construction effort. The Contractor may however, request SEPTA’s consideration for such action. The Contractor shall provide a detailed plan to utilize SEPTA’s facilities and/or structures. The plans will be submitted for SEPTA’s review and approval prior to the initiation of any work. SEPTA also reserves the right to have the drawings and supporting calculations sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania if deemed appropriate.

1.08  Storage and Handling of Materials
A. The Contractor shall store equipment and materials at the job site in accordance with instructions of the SEPTA Project Manager and in conformance with applicable regulatory provisions. The Contractor shall not store unnecessary items at the job site. Flammable materials shall not be stored in confined spaces, or other areas such as subways, tunnels and building basements. Flammable materials shall be stored in accordance with applicable
NFPA 30 guidelines. The Contractor shall enforce the instructions of the SEPTA Project Manager regarding such items as fires and smoking.

B. The Contractor shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.

C. Where it is permitted to store materials on streets, the Contractor shall place such materials in a secured place in accordance with local jurisdictions so as to cause minimum obstruction to traffic and the public safety. The Contractor shall not place materials within 15 feet of fire hydrants nor obstruct drainage gutters or inlets. The Contractor shall obtain and pay for all required permits relative to storage of materials.

D. The Contractor shall submit for review by the SEPTA Project Manager, sketches defining the operations of all cranes used in support of construction during periods of train operations. The Contractor shall submit, at the SEPTA Project Manager's request, similar information for cranes or other equipment in use and capable of encroachment.

1. These sketches shall include planned locations and movements of the equipment, calculations demonstrating the adequacy of the capacity of the crane for the loads, the interface between the footprint of the equipment the movement of the boom and loads relative to the existing structure and surrounding buildings, the support grillages and the protection of existing utilities and facilities, and any other pertinent details required by the SEPTA Project Manager.

2. The following data shall be required for all hoisting operations adjacent to active SEPTA operations and facilities and shall be prepared by and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

   a. Plans and sections showing locations of cranes, horizontally and vertically, operating radii, with delivery of disposal locations shown. The location of the SEPTA Right of Way and all active facilities shall also be shown.

   b. Crane rating sheets showing cranes to be adequate for 150 percent of the actual weight being lifted. A complete set of crane charts, including crane, counterweight and boom nomenclature is to be submitted.

   c. A location plan showing all obstructions such as wires, poles, adjacent structures, etc., and that the proposed lifts are clear of these obstructions.

   d. A data sheet shall be prepared listing the type, size, and arrangements of slings, shackles, or other connecting equipment, all to be designed for 150 percent of the actual weight being lifted. Copies of a catalog or information sheets for specialized equipment shall be included.

   e. A complete procedure is to be included, indicating the location and order of lifts and any repositioning or rehitching of the crane or cranes.

   f. Temporary support of any components or intermediate stages is to be shown and detailed.

   g. A time schedule of the various stages must be shown as well as a schedule for the entire lifting procedure.

E. Materials Handling:

1. Reinforcing steel shall not be used as a lifting ("pick") point on any load nor as a guyline anchor.

2. All scrap material of any kind, type, or nature shall be placed daily into designated confined areas or containers specifically supplied for this purpose. Containers shall be removed from the job site when full.
3. All loose material on platforms or other exposed locations shall be removed or secured at the end of each day to prevent dislodgment by train movement, wind, vandalism or other causes.

4. All Contractors shall assure that all chemicals, paints, solvents and cleaners are maintained per OSHA's hazard standards. Discarded chemicals shall be disposed of in accordance with Pennsylvania DEP requirements. Copies of all Material Safety Data Sheets (MSDS), OSHA Form 20, and the product use sheets shall be sent to SEPTA's Project Manager. All training shall be done in accordance with OSHA's Hazard Communication Standard.

1.09 Snow Removal

A. The Contractor shall remove all snow and ice within the Project site as required for the proper protection and prosecution of the work.

B. The Contractor shall at all times provide and maintain adequate protection against weather so as to preserve all work, materials, equipment, apparatus and fixtures free from damage.

C. The Contractor shall not use sodium chloride on any facilities adjacent to SEPTA electric rail lines where the possibility exists that melting mixture may leach onto the Railroad Right of Way.

1.10 Welding

A. Gas or electric cutting, burning or welding shall be done in accordance with the guidelines of NFPA 51B, the International Fire Code or the provisions below, whichever is more restrictive.

1. If hot work is to be executed at the job site, the Contractor’s safety office must have a copy of the current version of NFPA 51B at the job site.

2. The Contractor’s safety officer shall act as a Permit Authorizing Individual (PAI) and complete the checklist to fulfill the requirements of NFPA 51B for all torch work. The Contractor shall obtain the current copy of SEPTA’s “Hot Work/Source of Ignition" checklist for this purpose.

3. The SEPTA Project Manager shall be notified at least forty-eight (48) hours in advance of any hot work on site. A copy of each checklist completed for that period shall be delivered to the SEPTA Project Manager at the next job progress meeting.

4. Spark shields and a fire watch must be posted when executing hot work for a period of at least four (4) hours after all activity has been completed but the SEPTA Project Manager reserves the right to extend the duration of the fire watch in special circumstances. A supply of water and an approved fire extinguisher shall be readily available to the location where the work was done.

5. All oxygen/acetylene bottles must be removed and stored outside of all tunnels, underground stations and other confined spaces at the end of the workday. While in use in a tunnel, underground station or confined space, they shall be attended at all times. At no times when not in use shall oxygen and acetylene bottles are stored together.
1.11 Utilities

A. As per 73 P.S., § 176, et seq., the Contractor is required to notify utilities prior to all excavations. The Contractor shall be held responsible for any damage done to any utility in the prosecution of the work. The Contractor shall exercise any precautions necessary to prevent damage in working underneath or adjacent to any underground structure. If it becomes necessary for a utility company, through emergency procedures or because of unforeseen conditions, to repair, reconstruct, relay or relocate utilities within the Contract area, after work has commenced by the Contractor, then the said utility company and the Contractor shall make suitable arrangements to overcome such interference. No compensation shall be allowed to the Contractor for the disruption to his work. A no-cost time extension may be granted in accordance with the Contract to the Contractor by SEPTA for the delay that has occurred.

B. All of the above shall be accomplished at no extra cost or charge to SEPTA.

1.12 Environmental Protection

A. Environmental protection considerations consist of, but are not limited to, the following factors:

1. Natural resources, including air, water and land.
2. Solid waste disposal.
4. Control of toxic substances, hazardous materials and radiation.
5. The presence of chemical, physical, and biological elements and agents that adversely affect and alter ecological balances.
6. Degradation of the aesthetic use of the environment.
7. Historical, archaeological and cultural resources.

B. General Requirements:

1. The Contractor shall provide and maintain environmental protection as defined herein.
2. The Contractor's operation shall meet all applicable federal, commonwealth and local laws, ordinances and regulations pertaining to environmental protection.
3. Compliance of subcontractors with the provisions of this and various other Sections of these Specifications shall be the responsibility of the Contractor.
4. The Contractor shall not use equipment from which factory installed antipollution and noise control devices have been removed or rendered ineffective through lack of proper maintenance.
5. The Contractor shall provide adequate pollution controls for painting and surface preparation in compliance with the State Department of Environmental Resources Regulations.

C. Protection of Natural Resources:

1. General:
a. It is intended that the natural resources within the Project boundaries and outside the limits of permanent work performed shall be preserved in their existing condition or be restored to an equivalent of the existing condition, as approved by the SEPTA Project Manager upon completion of the work. The Contractor shall confine its on-site construction activities to areas defined by the Contract Drawings and Specifications or directed by the SEPTA Project Manager.

2. Protection of Project Site and Existing Roadways:
   a. Debris or rubbish of any kind shall not be dumped onto the site or roadways. This shall include paint splatters and spillage during painting operations. Care shall be taken to prevent damage and injury to personnel, vessels, and vehicles using roadways, or areas accessible to pedestrians. Devices shall be provided and maintained by the Contractor as required to prevent such occurrences. Material or items falling onto roadways shall be promptly removed at the Contractor’s expense.

3. Land Resources:
   a. Except in areas indicated to be cleared or excavated, the Contractors shall not remove, cut, deface, injure, or destroy trees, shrubs or vegetation. No ropes, cables or guys shall be fastened or attached to any existing nearby trees for anchorage unless otherwise permitted by the SEPTA Project Manager. Where such use is permitted, the Contractor shall be responsible for any resulting damage.
   b. The use of herbicides is not permitted unless otherwise specified.
   c. The Contractor shall submit a plan for protecting existing trees and vegetation that are to remain and that may be injured, bruised, defaced or otherwise damaged by construction operations. Rocks that are displaced into uncleared areas shall be removed. Monuments, markers and works of art shall be protected prior to the start of the operations. A preconstruction survey, including photographs, shall be performed by the Contractor, and a written report of the survey shall be furnished to SEPTA within five (5) days of its request by the SEPTA Project Manager.
   d. All trees, vegetation and other landscape features that are to remain and become scarred or damaged by the Contractor’s equipment or operations shall be repaired and restored to their original condition at the Contractor’s expense. The SEPTA Project Manager shall approve the repair and restoration program prior to its initiation and after completion.

4. At all times, measures shall be taken to prevent oil, gasoline and other hazardous substances from entering the ground, drainage areas, sewers, streams and other local bodies of water.

5. The Contractor shall not disturb native habitat adjacent to the Project construction area.

D. Erosion and Sediment Controls:
   1. Burning of ground cover shall not be permitted.
   2. The Contractor shall meet all applicable requirements of the Department of Environmental Resources of the Commonwealth of Pennsylvania with respect to erosion and sediment control measures to prevent discharge into storm water discharge systems and active waterways.

E. Toxic Substances:
   1. The Contractor shall meet the Toxic Substance Control Act, P.L. 94-469 (TSCA).
a. No toxic chemical substance, mixture, equipment, container, sealant, coating or dust control agent shall be used except in accordance with all provisions of the TSCA as interpreted by the rules and regulations of 40 CFR 761.

b. Any toxic chemical substance, mixture, equipment, container, sealant, coating, or dust control agent found stored within the Project area shall be immediately reported to the SEPTA Project Manager in writing and work shall be stopped in the area. The SEPTA Project Manager shall make arrangements for the removal of the toxic materials, after which the Contractor may continue work in the area.

F. Control and Disposal of Chemical and Sanitary Wastes:

1. Trash shall be picked up and placed in containers that shall be emptied on a regular schedule. Handling and disposal shall be so conducted as to prevent contamination of the site and other areas, and shall not be disposed of in wetlands or burned on the Right-of-Way. On completion, the area shall be left clean and in natural condition.

2. Disposal of rubbish and debris shall be as follows:
   a. The Contractor shall transport all waste, including excess excavated material, off the site and dispose of it in a manner that meets the federal, commonwealth and local requirements.
   b. The Contractor shall secure a permit or license prior to transporting any material off the site.
   c. Waste materials shall not be burned on the site.

3. The Contractor shall transport the garbage to a pickup point or disposal area.

4. Chemical waste shall be stored in corrosion resistant containers, removed from the Project site, and disposed of as necessary, but not less frequently than monthly. Disposal of chemical waste shall be in accordance with standard established practices as approved by the SEPTA Project Manager. Fueling and lubricating of equipment and motor vehicles on the site shall be conducted in a manner that affords the maximum protection against spills and evaporation. Lubricants to be discarded, including burned oil, shall be disposed of in accordance with approved procedures meeting federal, commonwealth and local regulations. For oil and hazardous material spills that may be large enough to violate federal, commonwealth or local regulations, the SEPTA Project Manager shall be notified immediately.

G. Dust Control:

1. Dust shall be kept down at all times, including non-working hours, weekends and holidays. Soil at the site, station platforms, haul roads, and other areas disturbed by the Contractor’s operations and materials stockpiled for the Project shall be treated with dust suppressors or covered to control dust. Dry power brooming shall not be permitted. Vacuuming, wet mopping, wet sweeping or wet power brooming shall be used instead. Air blowing shall be permitted only for cleaning off non-particle debris, such as that from reinforcing bars. Sandblasting shall not be permitted except as otherwise specified elsewhere. Only wet cutting of concrete block, concrete and asphalt shall be permitted.

2. The Contractor shall meet all applicable provisions of the National Emission Standards for Asbestos (40 CFR 61 Subpart B) and regulations of the City of Philadelphia Air Management services department.
3. The Contractor shall inspect all vehicles for dirt prior to their leaving the construction site. Dirt, soil, and rubble likely to be dislodged during transit shall be removed from the trucks and other vehicles prior to leaving the site.

4. The Contractor shall ensure that equipment transporting material to and from the site that may become airborne is covered.

5. The Contractor shall not cause or permit fugitive particulate matter to be emitted into the outdoor atmosphere from any source such that emissions are visible beyond the project property line.

1.13 Protection of Existing Water and Sewer Lines

A. When the equipment axle load exceeds 15 tons, the Contractor shall provide and work from timber mats placed over existing underground water lines and sewer lines.

1.14 Noise Control

A. General:

1. It is mandatory that noise generated as a result of the construction equipment be at an absolute minimum level. Provide working machinery and equipment with efficient noise suppression devices, and employ other noise abatement measures necessary for protection of both employees and the public.

2. The Contractor shall protect employees and the public against noise exposure in accordance with the requirements of this section, and requirements of 29 CFR 1910.95 and 29 CFR 1926.52.

3. The Contractor is responsible to check all federal, state, and local noise regulations and meeting the applicable governing regulation. SEPTA may impose stricter noise regulations at their discretion.

B. Special Requirements:

1. The Contractor shall meet the requirements of this Section and which will require the use of machines with effective mufflers or enclosures and selection of quieter alternative procedures. Compliance will also require the use of completely closed enclosures around work sites or a combination of closed enclosures and effective mufflers.

C. Measurement Procedures:

1. Except where otherwise indicated, perform all noise measurements using A-weighting and "slow" response of an instrument meeting the Type 2 requirements of American National Standard (ANSI) S1.4, "Specification for Sound Level Meter", or equivalent. All noise levels are A-weighted sound levels, per ANSI S1.4, in decibels referenced to 20 x 10^-6 Pa.

2. Construction Noise Measurements:
   a. Measure impulsive or impact noises with an impulsive sound level meter meeting the criteria of IEC 179 for impulse sound level meters. As an alternative procedure, a Type 2 general purpose sound level meter on C-weighting and "fast" response may be used to estimate peak values of impulsive or impact noises.
b. Measure noise levels at buildings affected acoustically by the Contractor’s operation at points between 3 feet and 6 feet from the building face or building line or a distance of 200 feet from the construction limits, whichever is closer.

3. Monitor noise levels of work operations to assure compliance with the noise limitations contained herein and retain records of noise measurements for inspection by SEPTA. Promptly inform SEPTA of any complaints received from the public regarding noise. Describe the action proposed and the schedule for implementation and subsequently inform SEPTA of the results of the action.

D. Noise Level Restrictions:

1. Noise Level Restrictions at Affected:
   a. Structures:
      1) Conduct construction activities in such a manner that the noise levels at the nearest affected building do not exceed the levels in Table 01060-1.

<table>
<thead>
<tr>
<th>Time</th>
<th>Maximum Allowable Noise Level, dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day (6:00 A.M. to 9:00 P.M.)</td>
<td>65</td>
</tr>
<tr>
<td>Night</td>
<td>55</td>
</tr>
</tbody>
</table>

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
SECTION 01065

RAILROAD SAFETY REQUIREMENTS

PART 1 - GENERAL

1.01 Description

A. This Section specifies the general requirements and safety regulations governing all Contractor’s activities when working in the vicinity of substation and active SEPTA railroad right of way.

1.02 Related Sections

A. Section 01010 - Summary of Work
B. Section 01060 – Regulatory Requirements and Safety
C. Section 01100 – Special Project Procedures
D. Section 01400 – Quality Requirements
E. Section 01500 – Construction Facilities and Temporary Controls

1.03 Submittals

A. Submit Contractor safety plans.
B. Submit Contractor lists of personnel to receive SEPTA roadway worker training.
C. Submit Contractor protection assurance representative credentials.
D. Submit safety incident reports.
E. Submit site specific work plans.
F. Submit excavation drawings and calculations.

1.04 Quality Assurance

A. Refer to Section 01060.

1.05 Safety Requirements

A. General:

1. The substations or switching stations covered by this Contract are located, to a varying degree, near active tracks of SEPTA Regional Railroad. All the substations or switching stations are active electrical substations or switching stations with live bare medium voltage electrical conductors.

2. The information contained in this Section is intended to provide guidance and safety precautions to all Contractors when working on a live SEPTA right of way and in substation. All Contractors are advised that SEPTA will operate trains over the right of way during the performance of work under the Contract, unless otherwise specified. All Contractors shall meet all parts of this Section and all parts of SEPTA's Roadway Worker Protection manual.
3. The substations or switching stations shall be assumed to be live at all times unless a written clearance is provided by an authorized SEPTA electrical employee.

B. Responsibility:

1. The work covered by the Contract involves safety of persons and property on a live electrified rail line and substation. Therefore, relevant skill and experience is required of all Contractors and their employees to do its work safely. The Contractor shall be responsible for the safety of its construction operations. The Contractor shall be required to post adequate watchperson and/or protective devices to protect its work crews, equipment and the work site as directed by the Employee-in-Charge (EIC) of railroad safety. Pertinent safety rules that shall be followed are listed in, but not limited to, Paragraphs F, G & H of this subsection. All Contractors shall exercise proper care at all times.

2. All workers working at the sites are required to have completed SEPTA safety training and wear the SEPTA issued photo ID badges while on site.

C. Operations:

1. When work is being performed in the vicinity of active train operations, the safety and continuity of operation of the trains by SEPTA shall be of the first importance. They shall, at all times, be protected and all Contractors shall arrange the work accordingly. Whenever the work may affect the safety or movement of trains, the method of doing such work, together with the proposed sequence of operations and time schedules for same, shall be submitted to the SEPTA Project Manager for prior approval.

2. No work shall be started or prosecuted until such approval has been obtained. However, such approval of the SEPTA Project Manager, or duly authorized representative shall not be considered as a release of any Contractor from responsibility for any damage to SEPTA by the acts of any Contractor, its employees, and/or its subcontractor’s employees.

3. In the event of an unplanned discontinuation of train service due to any Contractor's operations, all Contractors shall be liable not only for any injury or damage that might occur, but also for the full cost of any detour of train traffic, shuttle bus service and any associated costs.

D. SEPTA Personnel:

1. Employee-in-Charge (EIC):
   a. SEPTA will designate an employee to be responsible for providing a safe operation and on-track protection. The EIC may be a senior foreman, track supervisor, flag person and/or any other qualified individual. The SEPTA Project Manager will coordinate the activities of the EIC with the Contractor's safety officer and/or the Contractor's designated on-track protection assurance representative.
      1) The EIC will determine the method of providing protection to be used according to the SEPTA operating rules.
      2) The EIC will conduct a job briefing as prescribed by the operating rules before any track is fouled. The job briefing is not complete until all of the Contractor's employees acknowledge understanding the on-track protection procedures being used.
3) The EIC will not release the working limits until all affected Contractor’s workers have been notified and are either clear or are protected by train approach warning equipment/devices.

2. Flag Person:
   a. SEPTA Flag Persons are responsible for the safety and continuity of train operations. The SEPTA Flag Persons shall have authority to direct the stoppage of trains. Any sharing of protective duties between SEPTA and any Contractor within the work site can be considered coincidental.

3. Electric Traction Protection Personnel:
   a. SEPTA’s electric traction Class A employees are responsible for the coordination and de-energization of catenary and power circuits. Wires and attachments of wires shall be treated as live (energized), unless noted by SEPTA that the wires have been de-energized and grounded. If any Contractor requires to de-energize part of the substation or switching station, the Contractor must make the request to the SEPTA Class A employees. The Contractor shall not allow his employees to perform any work in the vicinity of energized equipment unless permitted by the SEPTA Class A employee. The Contractor’s employees shall obey all directions and safety requirements prescribed by SEPTA and its employees.

4. Pilots:
   a. If any Contractor needs to occupy live or operating tracks with on-track equipment, the Contractor shall request a SEPTA pilot who will obtain exclusive track occupancy on the live track.

5. SEPTA Project Manager:
   a. The SEPTA Project Manager, or a duly authorized representative, has complete authority in matters related to the safety of SEPTA’s operations and facilities. The SEPTA Project Manager, or a duly authorized representative, is also responsible to all Contractor’s planning and coordination of their safety effort related to SEPTA’s operations and facilities.

6. The Contractor is responsible for submitting an outage or fouling request in a timely fashion in order to avoid delays to the work. SEPTA requires as a minimum two (2) week notice to assign personnel once a fouling or outage request is approved.

E. Contractor’s Personnel:

1. Protection Assurance Representative:
   a. The Contractor’s Protection Assurance Representative (Representative) may be the superintendent, safety officer or responsible foreperson. The Representative shall be present at all times when any Contractor’s employees are working within the SEPTA operating envelope. The Representative must ensure that the requisite on-track protection job briefings are held and all employees engaged in work requiring on-track protection attend. In general, the Representative shall be responsible for day to day oversight of any Contractor’s gang watchperson and employees so that they are working safely according to all parts of this Section and to coordinate construction activities with the EIC.

2. Gang Watchperson:
   a. The role of the Contractor’s gang watchperson is solely for the purpose of safety for all Contractor’s employees when external circumstances, i.e., rail traffic or highway traffic, may expose the workers to a safety hazard. One (1) or more gang watchperson shall be on site with each work crew at all times. If it becomes necessary for a watchperson to leave the site, work shall be suspended until he/she returns or is replaced by another qualified gang watchperson.
F. Right of Way Restrictions:

1. **Fouling:**
   a. An operating track is fouled for operating safety purposes when any individual and/or object is closer than 10 feet from the near rail of the track. Equipment shall be considered as fouling the tracks when working in such a position that any movement whether intentional or unintentional or failure of the equipment, with or without load, will foul the track. All Contractors are advised that the use of equipment which has the potential to foul live or operating tracks shall be restricted to weekday non-peak hours and/or weekends.

2. The Contractor is advised that certain types of equipment shall not be permitted to work under live wires. No extras shall be allowed because of equipment restrictions. Refer to Paragraph H in this subsection.

3. The Contractor shall ensure that the Contractor's equipment will not foul any track until proper protection has been afforded. While trains or cars are passing on an adjacent track, any work that has the potential to foul shall be stopped.

4. The SEPTA Project Manager shall have the right to restrict the operations of fouling or on-track equipment when, in the SEPTA Project Manager's opinion, the equipment is not in satisfactory condition to be safely operated or where operation will adversely affect the track structure. The SEPTA Project Manager shall also have the right to prohibit the operation of any fouling or on-track equipment by the Contractor-employed operator who is, in the SEPTA Project Manager's opinion, not qualified or able to operate said equipment in a safe manner.

5. When any excavation extends below the bottom of the crossties, or where the stability of the railroad embankment and/or structure may be affected by excavation, such excavation shall be adequately braced by the Contractor. Prior to starting any such excavation, detailed drawings of the proposed bracing method shall be prepared and submitted to the SEPTA Project Manager for his approval. When deemed appropriate by SEPTA's Project Manager, the shop drawings shall be accompanied by structural calculations sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

G. General Safety Rules:

1. The following safety rules are considered especially applicable to all of the Contractor's employees with regard to conduct while on SEPTA property. The Contractor's foreperson or gang watchperson will be responsible to ensure the safety of all the Contractor's personnel. The Contractor shall furnish and equip its foreperson and/or gang watchperson with the equipment as specified in the Roadway Worker Protection Manual (SRW) to warn all Contractor's personnel of the approach of trains.
   a. All Contractor employees prior to working in any capacity that has the potential to foul, and/or working within 10 feet of railroad tracks shall attend a SEPTA safety seminar full day class on safety rules and operating procedures (SRW Course). All Contractor's employees must demonstrate an understanding of and proficiency in the SRW manual. All Contractor's employees who are added during the course of the Contract shall also be required to attend this seminar and demonstrate an understanding of and proficiency in the SRW manual before being able to work. The attendance certification (current date) from this seminar shall be logged into the SEPTA Database. Re-certification is required on an annual basis.
b. The Contractor-employed supervisors, forepersons, and gang watchpersons shall be responsible for the safety, safety instructions and safe performance of all employees under their immediate supervision. They must see that all employees working under their supervision receive warnings of approaching trains and other equipment in time to reach a safe place as per the SRW. Inexperienced employees must be instructed by immediate supervisors of the safe methods of performing their duties.

c. All Contractor employees working on or near an active track must attend an on-track protection job briefing. This briefing shall be held, prior to performing any work that has the potential to foul track, or at a minimum, would require the individual to be within 10 feet of any active track or any time the job conditions change such that on-track protection procedures differ from those covered in the initial job briefing. An active track is any track that has the potential for train or on-track equipment operations.

1) The EIC will conduct the job briefing to explain the on-track safety procedures being utilized.

2) The Contractor’s Protection Assurance Representative responsible for the overall supervision of all Contractor employees shall ensure that the requisite job briefings are held, that all employees attend, and sign the job briefing form. At a minimum, the job briefings must cover the following information, if applicable:
   a) The identification of the EIC.
   b) A review of operational and safety conditions.
   c) The means by which on-track safety is to be provided.
   d) The positioning of any individuals responsible for providing warning to roadway workers.
   e) The type of signals that will be used to convey the warning of an approaching train.
   f) The location where roadway workers will be required to go to clear for trains.
   g) The identification of the SEPTA employee responsible for communicating with trains.
   h) The type of signals that will be used to signal it is safe to resume work.

3) SEPTA will maintain a written record of all individuals who attend the job briefing.

d. The Contractor shall not perform any work that has the potential to foul an active track, or at a minimum, would come within 10 feet of an active track, without the approval and/or presence of a qualified and authorized SEPTA representative.

e. The Contractor shall require employees to carry hand held lights when working from dusk to dawn, in tunnels or when visibility is restricted.

f. The Contractor’s employees shall consider all tracks as operating tracks and be on the alert for trains operating in either direction at all times, and walk facing the direction from which trains in regular operations will approach. In the event that track area visibility remains poor after institution of remedial measures (as described in Paragraph e of this subsection), work in the track area may be restricted.

g. The Contractor’s employees shall STOP before crossing any tracks and look for trains approaching in either direction. All Contractors shall instruct employees not to cross tracks unless there is time to walk slowly, not to take chances and not to step on the head of the rail.

h. The Contractor’s employees shall ensure that clothing cannot catch onto any part of a moving car.

i. The Contractor’s employees shall not step on track behind stopped rail cars, particularly those arriving at stations, due to the possibility of rail cars being moved in reverse directions.
j. The Contractor’s employees shall not attempt to carry heavy materials across tracks without permission of proper SEPTA authorities.

k. The Contractor’s employees shall keep hands and feet clear of power switches, switches, switch equipment and frogs.

H. Catenary and Overhead Electrical Lines:

1. When handling work near overhead wires, all Contractor’s employees shall observe the following:
   a. All overhead wires, including catenary, transmission and signal lines in electrified zones, shall be considered energized at all times.
   b. Insulating covering of wire shall not be depended upon for protection against shock.
   c. No employee of any Contractor shall do any work near electrical wires or apparatus where it is possible for any part of the employee’s body or tools and material with which the employee is working to come within 10 feet of such wires, unless a SEPTA Overhead Maintenance employee (Class A employee) is assigned to observe the safety of the operation. Use of metal ladders is forbidden.
   d. When equipment is used in electrified territory or in the vicinity of Verizon Telephone, PECO, as well as SEPTA overhead wires, all Contractors must exercise special care to safeguard all persons in the area. Special attention must be given in the vicinity of overhead bridges and other structures where the wires may be depressed. If, in the opinion of the SEPTA Project Manager, the required clearances cannot be maintained or any hazards are involved, a SEPTA Overhead Maintenance employee (Class A Employee) must be requested. All required protection personnel shall be SEPTA employees.

2. If a safety situation arises requiring an immediate power shutdown, notify the SEPTA Railroad Operation Center (RROC) - Superintendent at 215-580-8668, and the SEPTA Project Manager.

3. In a case of electrical contact, personal judgment and initiative has to be used, bearing in mind that the rescuer’s safety should not be imperiled. Contact with a live overhead wire may prove fatal in a matter of seconds. The most important thing is to stop the flow of electricity through the victim’s body and then resuscitation (or CPR when necessary and if qualified to do so) until he or she recovers consciousness or trained help arrives. Once a victim is freed from the overhead wire, do not move him or her unless they can do so under their own power. Except for qualified rescuers, moving an injured person may result in further injury.

I. Work Inside the Substations or Switching Stations:

1. All substations or switching stations are active electrical substations or switching stations of SEPTA Regional Railroad.

2. All equipment in the substation or switching station shall be considered live and energized at all times by all Contractors and his employees.

3. Work shall be performed only when permitted by SEPTA Class A employees. The work shall be confined to the areas identified by the Class A employee as safe.

4. All Contractor’s employees shall maintain safe working distance from the energized equipment at all times. Personal protective equipment including FR (ANSI rated) clothing shall be worn when inside a substation.
5. The Contractor shall request outage of entire substation or switching station if warranted for working on some equipment. Such work may have to be performed during night time or over the weekend.

J. Work Inside Vaults and Manholes:
   1. Work within vaults and manholes is considered work within confined space and shall follow a SEPTA approved Contractor developed written safety plan. The plan shall be compliant with OSHA regulations.

1.06 Compliance with Roadway Worker Protection Manual (SRW)
   A. In addition to the above, the Contractor must follow all requirements of the Roadway Worker Protection Manual (SRW). If there is doubt as to the meaning of any procedures specified, the EIC shall be consulted prior to the commencement of work, which requires fouling of any track.

PART 2 - PRODUCTS
2.01 Not Used

PART 3 - EXECUTION
3.01 Not Used

END OF SECTION
SECTION 01100

SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.01 Description

A. This Section provides for the procedural requirements to enable the Contractor to plan and be granted concurrence for power outages, track outages and service disruptions specified under this Contract.

1.02 Related Sections

A. Section 01010 – Summary of Work
B. Section 01060 – Regulatory Requirements and Safety
C. Section 01065 – Railroad Safety Requirements
D. Section 01300 – Submittals
E. Section 01305 – Requests for Information
F. Section 01400 – Quality Requirements

1.03 Submittals

A. Requests for service disruptions and Site Specific Work Plans (SSWP) shall be submitted to the SEPTA Project Manager by the Contractor for concurrence twenty-eight (28) calendar days prior to the need for the service disruption. The SEPTA Project Manager will respond within seven (7) calendar days of receipt of the submittal. Changes to the submittal, once reviewed by SEPTA, are also subject to a subsequent review by SEPTA. These submittals must be annotated and re-issued weekly to reflect changes in the scope or schedule created during the twenty-eight (28) day period between the original issue and the date of operation. Not later than twenty-eight (28) days before a planned service disruption, a new revision of the submittal incorporating all changes and reflecting the final work plan must be submitted to the SEPTA Project Manager.

B. Should the Contractor desire to cancel an approved service disruption, the written cancellation request shall be received by the SEPTA Project Manager a minimum of seven (7) calendar days prior to the service disruption date, so that affected SEPTA operations can be rescheduled. Late cancellation requests shall result in the outage costs being assessed against the Contractor.

1.04 Request for Track Outage (Outages and Shutdowns)

A. In addition to the requirements for a SSWP as described in these Specifications, all construction operations that interfere with the normal operations or that require track and power outages or track occupancy shall be a time-scaled logic network. This network is to fully detail the extent of work proposed and the Contractor's plan and means for its accomplishment. Specific separate operations and planned service disruptions should be highlighted in these submittals.
1. The SSWP shall provide a description of work; time scaled hourly logic network, breakdown of labor force and the type of equipment that will be utilized. The SSWP shall include the Contractor’s watchperson (if required), required SEPTA flagging and assistance, construction methods, arrangements for emergency clearing and restoration of service, and sketches for defining the configuration of rail service and other operational elements at the end of the Contractor’s outage.

2. All work by SEPTA Force Account Track, Power, Signals, etc. or other Contracts that are defined in Section 01010 and subsequent reviews that has the potential of delaying either the work by the Contractor, or the restoration of service, must be identified clearly in terms of scope and schedule for coordination with others.

3. The proposed work of this Contract will require track and power outages consisting of communication lines, cutovers for circuit breakers, replacement of OCS feeder connections, disconnect switches, insulators and conductors/taps and catenary and trolley feeder modifications.

4. All track and power outages as requested by the Contractor are restricted to the window between 12:00 am and 4:30 am (this window includes the necessary switching and grounding required by SEPTA forces).

5. Additional outages may be requested by the Contractor. These times do not include the time for the necessary switching and grounding required by SEPTA forces.

6. The Contractor shall minimize the amount of work that affects or requires overhead catenary outages or track access.

B. SEPTA will not grant outages or shutdowns until the Contractor's SSWP has been reviewed and approved by SEPTA in writing.

C. The Contractor shall not perform any of the work requiring outages or shutdowns until written approval has been received from SEPTA.

1.05 Request for Surface Diversion

A. Not Used.

1.06 Request for SEPTA Support

A. Flagging:

1. The Contractor shall communicate with the SEPTA Project Manager, in a manner acceptable to SEPTA, regarding flagging protection to complete the work associated with making new connections to the catenary system.

B. Signal:

1. Not Used.

C. Power:

1. The Contractor shall communicate with the SEPTA Project Manager, in a manner acceptable to SEPTA, regarding the de-energizing and re-energizing of the catenary system.
1.07 Request for Area Relocations
   A. Not Used.

1.08 Request for SEPTA Services
   A. Not Used.

1.09 Track Car/High Rail Vehicle (TC/HRV)
   A. The Contractor shall formally request by submittal, all track or TC/HRV equipment proposed to be utilized for the work of this Contract. The submittal shall be directed to the SEPTA Project Manager for review and approval. This submittal shall include the equipment’s physical characteristics which include, but not limited to the following:

   1. Manufacturer’s catalog cuts by showing all dimensions.
   2. Any subsequent modifications noted and dimensioned.
   3. Vehicle Identification Number (VIN).
   4. Must have a current Pennsylvania vehicle safety inspection sticker, if rubber tired.
   5. If subway operation is in work plan, it must be diesel powered and equipped with either a catalytic converter or exhaust scrubber meeting U.S. Bureau of Mines Schedule 24.
   6. The SEPTA Project Manager will provide a clearance diagram and attach to their section if available. The Contractor shall also provide the following on-board equipment:

      a. All vehicles will be equipped with a steering wheel lock.
      b. Hydraulic outriggers will be equipped with locking pins.
      c. Guards will be installed at all wheel pinch points.
      d. All vehicles will have an ABC type fire extinguisher.
      e. A tow bar and coupler adapter.
      f. A clearance placard in the cab using the correct print.
      g. Boom tie-down if applicable.
      h. Wheel chocks to secure on rail if left unattended.

   7. Each vehicle shall have a unit number clearly marked on its exterior.

   B. SEPTA will inspect the equipment and grant approval if it meets safety standards or refuse operation of the equipment if it is not in safe condition, before any equipment may be placed on the rail. Any repairs or modifications found to be required will be done at no cost to SEPTA and a yard retest will be held. SEPTA will yard test equipment to determine actual performance in curves and crossover before granting permission for use. If the equipment is utilized to deliver materials the loading shall also be reviewed for clearance.

      1. If any modifications are made after the initial yard test, the Contractor will notify the SEPTA Project Manager in writing with details and receive approval before using it again on track.
      2. If the approved vehicle is taken off the Contract for another job and then returned, the Contractor must certify in writing that it is still in its original condition. If there is any question, a yard test and inspection will be scheduled at no additional cost to SEPTA.

   C. Operation:
1. A qualified SEPTA employee will assist the Contractor to place the equipment on the track. The SEPTA pilot must be on board when such equipment enters a siding or a point of access to the main rail. The SEPTA pilot as a minimum will ride the vehicle to and from the work zone.

2. The Contractor shall operate this equipment within the work zone specified in the Bulletin Order issued for that work. In addition, the following rules apply to all Contractor’s personnel when placing equipment on the rail after receiving authorization from a qualified SEPTA Employee:
   a. The TC/HRV driver shall perform a visual inspection to see that the track car is in a safe operating condition before being operated. Track cars shall not be operated if found in an unsafe condition.
   b. The TC/HRV shall display a white light to the front and red light to the rear when visibility is restricted and at night. High rail vehicles shall have headlights on high beam when moving.
   c. The TC/HRV shall not trail through spring switches or semi-automatic switches unless switches are properly lined.
   d. The maximum speed for the movement of any TC/HRV is governed by the appropriate operating rule book.
   e. The TC/HRV shall be operated at a speed, which will permit them to stop short of any obstruction, improperly lined switch or broken rail.

3. The Contractor shall include training of TC/HRV drivers in the appropriate part of their safety plan, and develop and maintain an updated log of these personnel.

1.10 Damages for Failure to Return to Service
   A. All costs, such as protection or operating costs, if the Contractor fails to properly utilize a track outage or service diversion at no fault to SEPTA and additional outage hours are required to return the track(s), facility and/or services within an allotted time, shall be assessed against the Contractor.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
SECTION 01200

PROJECT PROGRESS MEETINGS

PART 1 - GENERAL

1.01 Description

A. This Section enables orderly review during progress of the work and to provide for systematic discussion of problems. The SEPTA Project Manager or a designee will conduct Project meetings on a bi-weekly basis throughout the construction period. The progress meetings are in addition to the coordination, pre-construction and scheduling meetings noted elsewhere in the Contract Documents.

B. The Contractor’s relations with its subcontractors, and discussions relative thereto, are the Contractor’s responsibility and are not agenda items in the Project progress meetings.

C. The discussions and minutes of meetings shall exclude any claims related issues not directly impacting the progress of the work, and other items for which SEPTA has provided clarifications/directives/change order(s), but remain disputed by the Contractor.

1.02 Related Sections

A. Agreement.

B. Section 01300 – Submittals

C. Section 01305 – Requests for Information

D. Section 01400 – Quality Requirements

1.03 Submittals

A. Agenda items:

1. To the maximum extent practicable, the Contractor shall advise the SEPTA Project Manager at least forty-eight (48) hours in advance of Project meetings regarding items to be discussed during the meeting.

2. Technical questions requiring SEPTA’s response shall be submitted in writing at least three (3) days prior to the Project meeting.

B. Minutes:

1. The SEPTA Project Manager or his designee will compile minutes of each Project meeting and will furnish one (1) copy to the Contractor.

2. The Contractor may copy and distribute other copies as required.

1.04 Quality Assurance

A. The Contractor’s Superintendent shall attend and participate in each Project meeting and shall represent the Contractor consistent with Contract and commit the Contractor to solutions agreed upon during the Project meetings.
PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Meeting Schedule
A. Project meetings will be held every two (2) weeks as arranged and organized by the SEPTA Project Manager.

B. The SEPTA Project Manager will coordinate as required to establish a mutually acceptable meeting schedule.

3.02 Meeting Location
A. The SEPTA Project Manager will determine meeting location. To the maximum extent practicable, meetings will be held at the job site.

3.03 Project Meetings
A. Attendance:
   1. Subcontractors and others may be invited to attend those Project meetings in which their aspect of the work is involved.

B. Minimum Agenda for Each Project Meeting:
   1. Review and revise the minutes of previous Project meetings.
   2. Safety.
   3. Review progress of the work since last Project meeting, including status of submittals for approval.
   4. The Contractor is to provide progress and status of coordination and installation meetings with subcontractors engaged in the work of the Contract.
   5. Identify problems which impede planned progress.
   6. Develop corrective measures and procedures to regain planned schedule, if applicable.
   7. The status of Requests for Information (RFI) and all Potential Change Orders (PCO) shall be discussed and updated. The Contractor’s PCO listing shall meet SEPTA’s listing.
   8. The Contractor shall provide and discuss "thirty (30) day look ahead" activity schedule if the work is not progressing per the early start/finish activity dates as noted in the latest update of the approved schedule.
   10. Complete other current business.

C. Revisions to Minutes:
   1. Unless published minutes are challenged in writing, within five (5) working days of the distribution date, they will be accepted as properly stating the activities and decisions made at the meeting.
2. Any individual challenging published minutes shall provide proper supporting documentation acceptable to the SEPTA Project Manager to verify that the challenged item was truly discussed during the subject meeting.

3. Challenge to minutes shall be settled as priority portion of "Review and Revise the minutes of previous Project meeting" at the next regularly scheduled Project meeting. The SEPTA Project Manager’s decision(s) concerning challenged item(s) shall be binding on the Contractor.

END OF SECTION
THIS PAGE NOT USED
SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 Description

A. This Section covers all submittals including shop drawing submission and concurrence requirements, and further complements the requirements of Paragraph VIII.N. of the Agreement. Make submittals required by the Contract Documents, and revise and resubmit as necessary to establish compliance with the specified requirements.

B. Requirements relating to traction power equipment are included in Section 01452. In case of conflict, the more stringent requirement shall prevail.

C. The following products require only the submittal, and no further review is required except for interface with work. However, it is not applicable to the traction power equipment.

1. Products specified by reference to standard Specifications such as ASTM and similar standards.

2. Products specified by manufacturer’s name and catalog model number.
   a. Product lists.
   b. Test selection.
   c. Manufacturer’s installation instructions.
   d. Manufacturer’s certificates.
   e. Shop drawing.
   f. Manufacturer’s samples.
   g. Certifications.
   h. Testing.
   i. Warranties.
   j. Equipment.

D. Submittals that are not required will not be reviewed.

E. The Contractor may require subcontractors to provide drawings, installation diagrams and similar information to help coordinate the work, but such data shall remain between the Contractor and the subcontractors and will not be reviewed unless it is required by other pertinent Sections of the Specifications.

F. The Contractor is required to submit all information in an electronic format as approved by the SEPTA Project Manager.

G. In addition to any other documentation responsibility, the Contractor shall provide copies of all approved and/or incorporated submittals in an electronic format as defined by the SEPTA Project Manager to fulfill the Contract closeout requirements.

1.02 Related Sections

A. Section 01010 – Summary of Work
B. Section 01305 – Requests for Information
C. Section 01400 – Quality Requirements
D. Section 01410 – Testing and Inspection Services
E. Section 01452 – Contract Quality Control – Traction Power Equipment
F. Section 01700 – Contract Closeout
G. Section 01720 – Project As-Built Documents
H. Section 01830 – Operations and Maintenance Data

1.03 Submittals

A. The Contractor, within two (2) weeks of the receipt of SEPTA’s computerized listing of the Contractor(s) submittals, shall review, revise and/or amend, if applicable, and resubmit the revised listing of submittals. Long lead items shall be identified.

B. After checking and verifying all field measurements and after meeting the applicable procedures of the Contract, the Contractor shall submit shop drawings, catalog cuts, samples and substitution(s) for review and action.

C. The Contractor shall coordinate between the Contractor/Fabricator/Detailer and SEPTA for each complex submittal requiring detailed coordination, including all structural items.

D. This coordination may be conducted by a meeting. The purpose of the meeting shall be to establish guidelines for details and information necessary to prepare the shop drawings. The Contractor is responsible for determining the need for such a meeting.

E. Submittals will be reviewed by SEPTA.

F. The results of review of submittals will be a status as follows:
   1. NO EXCEPTIONS TAKEN.
   2. PROCEED AS NOTED.
   3. PROCEED AS NOTED; REVISE AND RESUBMIT FOR RECORD.
   4. DO NOT PROCEED; REVISE AND RESUBMIT.
   5. REJECTED.
   6. NOT APPLICABLE.

G. Submittals not in compliance with the Contract will be returned to the Contractor for revision. Any losses of time and additional costs associated with resubmittals are the Contractor’s responsibility.

H. Each submission and re-submission shall give specific written notice on the transmittal of each variation that the shop drawings or samples may have from the requirements of the Contract Documents and, in addition, shall cause a specific notation to be made on each shop drawing submitted for review and approval of each such variation.

I. Each resubmission shall clearly identify and make specific notation(s) on each shop drawing concerning the:
   1. Changes that are made as a result of comments on the previous submittal(s).
2. Changes that are not made, but commented on the previous submittal(s). The Contractor shall provide detailed explanations and justifications as to why the comments are not addressed.

3. Changes that are solely made by the Contractor, but were not commented on the previous submittal(s). The Contractor shall provide a detailed explanation and justification for such changes.

J. Submittals that are "Proceed as Noted" are for the purpose of expediting procurement/fabrication/installation of the intended work. The Contractor shall incorporate all corrections and resubmit to SEPTA original sepias and required copies of drawings within thirty (30) days of the "Proceed as Noted" action. If a resubmittal is not required then it is understood that the Contractor will proceed in accordance with the comments.

K. Payment for completed work that is related to "Proceed as Noted" submittal will not be made until the corrected and final resubmittal is accepted in writing by SEPTA.

L. Design submittal drawings to meet SEPTA’s CAD drafting standards including use of the standard border. A copy of the standards and drawing border are available upon request.

1.04 Quality Assurance

A. SEPTA reserves the right to require mock-ups of any material and/or assembly, at any time during the construction process. Once approved, the mock-ups will set a minimum standard of performance and/or appearance for the work. Mock-ups will be provided at no cost to SEPTA. The approved mock-up may, at the discretion of the SEPTA Project Manager, become part of the work.

B. Electronic Submittals:

1. SEPTA uses software to track submittals. The Contractor’s forms, e.g. transmittal etc., will be submitted in a form compatible with this software.

2. For its record, SEPTA requires that all approved submittals be converted to electronic format; at no additional cost to SEPTA; for SEPTA’s document retention purposes.

C. Coordination of Submittals:

1. Prior to making each submittal, the Contractor shall carefully review and coordinate all aspects of each item being submitted. Shop drawings of systems containing closely related items and components must be submitted, as a single submission showing the interrelationship of the components required for that system.

2. The Contractor shall verify prior to submission that each shop drawing is well prepared and that the submittal meets all the specified requirements. The drawings shall provide complete information regarding proper fabrication and installation.

3. The Contractor shall sign each submittal or shop drawing original and copies and affix a stamp with specific written indication that the Contractor has satisfied all responsibilities under the Contract Documents with respect to review of the submission. Refer to Article 1.05 in this Section for submittals that are substitutions.

4. Shop drawings shall be tailored to the specific Contract need including coordination of various trades and should include material descriptions, quantities, dimensions, design criteria and similar data to enable review information as required. The shop drawings
must show clear and complete information for the fabrication and installation of materials.

5. Orient the plan(s) on the shop drawing(s) in the same manner as the plans on the Contract Drawings.

6. Shop drawings with reproduction(s) of the Contract Drawings will not be accepted.

7. Structural fabrication and erection drawings shall be prepared, checked, signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania with proven qualifications and similar experience.

8. Unless the Contract Documents indicate specific steel connections, the Contractor shall design steel connections, signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania and provide sufficient details for SEPTA’s review and approval.

D. Responsibility:

1. The Contractor is solely responsible and accountable for:
   a. Means, methods, techniques, sequences and procedures of construction including fabrication, assembly, installation/erection, safety precautions and programs incidental to any submittal.
   b. Accuracy of all submittals and shop drawings and final installation.
   c. Arranging submittals and shop drawing standards review meetings with SEPTA.
   d. Converting all approved submittals to an agreed on electronic format (PDF unless otherwise noted) and providing these files to SEPTA at no cost to SEPTA.

1.05 Substitutions

A. "Or Equals" Substitutions:

1. Restricted Items:
   a. Where items of equipment and/or materials are specifically identified in the Specifications or on the Contract Drawings by a manufacturer’s name, model or catalog number, only such specific items may be used.

2. When several materials are specified by name for one (1) use, the Contractor may select any of those specified. Materials specified by manufacturer’s trade name shall meet the manufacturers printed Specifications and data.

3. Equals Considered:
   a. Whenever a material or article required is specified or shown on the plans by using the name of the proprietary product or of a particular manufacturer or vendor, any material or article which will perform adequately the duties imposed by the general design, will be considered equal and satisfactory provided material or article so proposed is of equal properties and function in the opinion of SEPTA’s Project Manager. It shall not be purchased or installed without the SEPTA Project Manager’s written approval. SEPTA’s decision shall be final in this regard.

4. The Contractor shall document each request with complete data substantiating compliance of the proposed substitution with the Contract Documents. "Or equal" requests will be considered only when substantiated by the Contractor's submittal of data documenting the "or equal" nature of material or article within thirty-five (35)
calendar days after the date of receipt of Notice to Proceed. A request constitutes a representation that the Contractor:

a. Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.

b. Shall provide the same warranty for the substitution as for the specified product.

c. Shall coordinate installation and make changes to other work, which may be required for the work to be complete with no additional cost to SEPTA.

d. Shall waive claims for additional costs or time extension, which may subsequently become apparent.

e. Shall reimburse SEPTA (if applicable) for review or redesign services associated with review and approval by SEPTA, if the substitution is rejected as not being equivalent.

B. Substitutions for Unavailability

1. Substitutions will be considered when a specified product becomes unavailable through no fault of the Contractor. The Contractor shall document each request with complete data substantiating compliance of proposed Substitution with Contract Documents. A request constitutes a representation that the Contractor:

a. Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.

b. Shall provide the same warranty for the substitution as for the specified product.

c. Shall coordinate installation and make changes to other work, which may be required for the work to be complete with no additional cost to SEPTA.

d. Shall waive claims for additional costs or time extension, which may subsequently become apparent.

2. The Contractor shall provide substitutions in a timely manner and in accordance with the construction Contract, so as to not have a negative impact on the construction schedule.

PART 2 - PRODUCTS

2.01 Shop and Design Drawings

A. The term “shop drawings” and “design drawings’ includes calculations, drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials furnished by the Contractor to explain in detail specific portions of the work required by the Contract.

B. The Contractor shall coordinate all shop drawings and review them for accuracy, completeness, and compliance with Contract requirements, and shall indicate its approval thereon as evidence of such coordination and review. Shop drawings submitted to SEPTA without evidence of the Contractor’s approval may be returned for resubmission. SEPTA will indicate its approval or disapproval of the shop drawings, and if not approved as submitted shall indicate his reasons thereof. Shop drawings shall be submitted to SEPTA in time to allow at least twenty-one (21) calendar days for checking and processing, unless otherwise specified elsewhere in this Contract. Any work done prior to such approval shall be at the Contractor’s risk. Approval by SEPTA shall not relieve the Contractor from responsibility for any errors or omissions in such drawings, nor from responsibility for meeting the
requirements of this Contract, except with respect to variations described and approved in accordance with Article 2.01/D in this Section.

C. The Contractor shall submit a schedule, showing dates for submission, review and approval of its shop drawings.

D. If shop drawings show variations from the Contract requirements, the Contractor shall describe such variations in writing, separate from the drawings, at the time of submission. If SEPTA approves any such variation(s), it shall issue an appropriate Contract modification, except that, if the variation is minor and does not involve a change in price or in time of performance, a modification need not be issued.

E. All details on shop drawings submitted for approval shall clearly show the relation of the various parts, and where the work depends upon field measurements, such measurement shall be obtained by the Contractor and noted on the shop drawings being submitted for approval.

F. All submittals shall be properly referenced to indicate clearly the location, service and function of each particular item, and shall include proper reference to the appropriate section, drawing numbers and details. Where manufacturer’s publications in the form of catalogues, pamphlets or other data sheets are submitted in lieu of prepared shop drawings, such submissions shall specifically indicate the item for which such approval is requested. Identification of items shall be made in ink and submissions showing only general information will not be acceptable.

G. Design drawings for the 60 percent, 90 percent and 100 percent submittals shall be submitted to SEPTA for its review in accordance with the following:

1. One (1) reproducible copy and five (5) prints of each design document or plan for the intermediate design stages.

2. One (1) reproducible copy and five (5) prints of each design document or plan for the final submittal and as-builts. All documentation shall be provided in CAD and PDF. One (1) full size set of original stamped and sealed plans shall be provided.

H. Shop drawings for construction means drawings, submitted to SEPTA by the Contractor, subcontractor or any lower tier subcontractor pursuant to a construction subcontract, showing in detail the proposed fabrication and the installation (i.e. form, fit and attachment details) of materials or equipment. SEPTA may duplicate, use and disclose in any manner, and for any purpose, shop drawings delivered under this Contract.

I. Shop drawings are defined as original drawings, prepared by the Contractor, subcontractor, supplier or distributor, which illustrate some portion of the work; showing fabrication, layout, setting or erection details. They shall:

1. Be prepared by a qualified detailer.

2. Identify details by definitive title and by reference to sheet and detail numbers shown on the Contract Drawings.

J. Unless otherwise stated elsewhere in the Contract Documents, shop drawings shall be furnished to SEPTA for its use in accordance with the following sequence of operation:
1. Initially, one (1) reproducible copy and ten (10) prints of each shop drawing shall be submitted to SEPTA for review, in a media acceptable to the SEPTA Project Manager. After review, the reproducible copy will be returned to the Contractor.

2. When shop drawings are returned for correction, they shall be corrected and resubmitted for approval as described above, and such procedure will not be considered as grounds for delay in completing work.

3. When shop drawings are approved, three (3) additional prints of the approved shop drawings shall be immediately sent to SEPTA.

4. Blueprints and sepias will not be acceptable

K. Review comments will be shown on two (2) sets which will be returned to the Contractor. The Contractor may make and distribute such copies as are required for its purposes.

L. Each standard drawing, brochure, catalogue cut, etc., to be submitted for approval for the Contract shall be furnished to SEPTA for its use in accordance with the following sequence of operation:

1. Initially, two (2) copies shall be submitted to SEPTA for review. After review, one (1) copy will be returned to the Contractor.

2. When submittals are returned for correction, they shall be corrected and resubmitted for approval as described above, and such procedure will not be considered as grounds for delay in completing work.

3. When approved, three (3) additional copies of the approved submissions shall be immediately returned to SEPTA. All copies of approved submissions will be identified by SEPTA as having received such approval by being stamped and dated.

M. Failure of the Contractor to supply the required number of approved shop drawings for field use can constitute reason to reject work or material at the job site.

N. Before the final payment is made, the Contractor shall deliver to SEPTA for SEPTA’s permanent file, two (2) complete bound sets of the final approved shop drawings applicable to the Contract.

O. The Contractor shall standardize size of shop drawings as far as practicable for all submittals.

P. Submittals not meeting the requirements of Article 3.03 of this Section shall be summarily rejected.

Q. Submittals which are marked “approved as noted” shall be resubmitted for final approval after compliance with the comments relating to the qualified part of the approval.

R. Submittals involving design and calculations by the Contractor or supplier should be signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania if appropriate.

2.02 Manufacturer’s Literature (Including Catalog Cuts)

A. The term “product data” includes manufacturer’s specifications, catalog cuts, performance and test data, applicable standards such as AASHTO, ANSI, ASTM, IEEE, AREMA and other industry standards of compliance, assembly and erection diagrams, parts lists, and where
applicable, certificates of compliance verifying compliance with the specified and referenced standards as specified herein and in Section 01400.

B. Product data submittals shall indicate all modifications made to the manufacturer’s standard product, including deletions of descriptive information not applicable to the Contract. The product data shall include dimensions, clearances, performance characteristics, capacities, and any other information or diagrams, as applicable. All product data submittals shall include the following:

1. Contract title and number.
3. Applicable Specification Section numbers.
4. Applicable standards, such as ASTM or Federal Specification number, AREMA, AASHTO and pertinent railroad authority Specifications or standards.
5. Identification of deviations from the Contract Drawings and Specifications.
6. The Contractor’s stamp, initialed or signed, certifying:
   a. Dimensional compatibility of the product with the space in which it is intended to be used.
   b. Review of submittals for compliance with Contract requirements.
   c. Compatibility of the work shown thereon with that of affected trades.

C. Certificates of compliance shall be submitted for those products for which no samples and test results are specified. A copy of the certificate shall also accompany the product for which the certificate is prepared. The certificates shall:

1. State that the product meet the respective Specification and Contract Drawing requirements.
2. Be accompanied by a certified copy of test results pertaining to the product.
3. Show the submittal date, subcontractor’s name and address, Contract title and number, product represented and its location in the Contract, producer’s name, product trade name and catalogue number, place of product origin, test date, testing organization’s name and address, quantity of the product to be furnished, and related Contract Drawing and Specification Section numbers.
4. Be signed by an officer or another authorized representative of the producer.

D. Procedures for submittal and approval of product data shall follow the procedures for shop drawings as specified in Article 3.03 of this Section.

E. Product submitted for approval shall be highlighted from product data sheet.

F. The Contractor shall submit the original printed literature and product data sheets available from the manufacturers and as many copies as are required. SEPTA will keep the original copy of all items submitted.

G. Where contents of submitted literature from manufacturers includes data not pertinent to the submittal, the Contractor shall clearly show on all copies which portions of the contents are being submitted for review.

H. The Contractor shall submit the number of copies which are required to be returned, plus six (6) copies for SEPTA's use and distribution.
2.03 **Software for System Components**

A. Contractor shall provide to SEPTA all software, with required documentation, used for system components, regardless of all proprietary rights, from all vendors and suppliers. The software and documentation shall be in sufficient detail to allow SEPTA to make minor changes in the system configuration during the operational life of the system. Contractor shall provide required training to SEPTA personnel for using the software.

2.04 **Samples**

A. The Contractor shall provide sample(s) identical to the precise article proposed to be provided. Identify as described in Article 3.03 of this Section.

B. Number of Samples Required:
   1. Unless otherwise specified, the Contractor shall submit samples in the quantity, which is required to be returned, plus one (1), which will be retained.
   2. By prearrangement in specific cases, a single sample may be submitted for review and, when approved, be installed in the work at a location agreed upon by SEPTA.

2.05 **Colors and Patterns**

A. Unless the precise color and pattern is specifically called out in the Contract Documents, and whenever a choice of color or pattern is available in the specified products, the Contractor shall submit accurate color and pattern charts for selection.

B. SEPTA reserves the right to require samples and/or mock-ups of any material to determine final appearance.

**PART 3 - EXECUTION**

3.01 **General Submittal Procedures**

A. Design drawings, shop drawings, product data and samples shall be submitted for work or materials as indicated in each technical Specification Section.

B. SEPTA recognizes the benefits of expedited construction, and will review submittals for various portions of the work as they are received, provided that each portion submitted for review is a clearly identifiable element of the construction work, and adequate consideration has been given to coordination between trades and with other portions of the overall Contract. SEPTA shall assume no responsibility or liability for additional costs resulting from the Contractor’s failure to properly coordinate all portions of the work.

C. The Contractor shall review, stamp with its approval and submit to SEPTA for review all shop drawings, samples, and product data required by the Contract Documents, or subsequently by SEPTA as covered by modifications. Shop drawings, samples and product data shall be properly identified as specified, or as SEPTA may require.

D. By approving and submitting design drawings, shop drawings, samples, and product data, the Contractor thereby represents that it has determined and verified all field measurements, field construction criteria, materials, catalogue numbers, and similar data, or will do so, and that it has checked and coordinated each shop drawing and sample with the requirements of the work and of the Contract Documents. The Contractor is responsible
for the accuracy of all shop drawing submittals that are prepared by the Contractor’s subcontractors and the Contractor’s approval of such shop drawings shall indicate that it has reviewed them for accuracy and adherence to the design criteria.

E. The Contractor shall submit design drawings, specifications, shop drawings, samples and product data in reasonable time to permit SEPTA’s review. The Contractor shall plan on SEPTA’s review of each submittal twenty-one (21) calendar days from the date of receipt by SEPTA.

F. SEPTA will review design drawings, specifications, shop drawings, samples, and product data only for conformance with the design concept of the Contract and with the requirements stated in the Contract Documents. SEPTA’s acceptance of a separate item shall not indicate acceptance of an assembly in which the item functions. Shop drawings and other acceptances necessary from SEPTA should be submitted sufficiently in advance of anticipated purchase or delivery to the site to allow for review by SEPTA.

G. Where work requires submittals to SEPTA for approval, the Contractor shall wait for the approvals or it performs the work at its own risk. If SEPTA subsequently disapproves such items or work, the Contractor shall, at its own expense, promptly remove these items or work, and replace them with items or work meeting the SEPTA approved submittals.

H. The Contractor shall make any correction required by SEPTA, and shall resubmit the required number of corrected copies of shop drawings, new samples or product data. The Contractor shall direct specific attention, in writing or on resubmitted shop drawings, to new revisions.

I. SEPTA’s acceptance of shop drawings, samples, and product data will not relieve the Contractor of its responsibility for deviation from the requirements of the Contract Documents, unless the Contractor has informed SEPTA in writing of the deviation at the time of submission, and SEPTA has given written approval to relieve the Contractor of its responsibility for errors or omissions in the shop drawings or samples.

J. Drawings and schematics for all system components not limited to: RTU, relays, network communication devices, I/O Bay Modules control panels are the property of SEPTA.

K. Contractor shall provide SEPTA with all software for all system components regardless of any proprietary rights from any subcontractor and/or vendor.

3.02 Submittal Requirements

A. Submit the number of copies of shop drawings, product data and samples required by the Contractor for distribution plus three (3) copies to be retained by SEPTA.

B. Submittals shall include:
   1. Date and revision dates.
   2. Project title and number.
   3. The names of:
      a. SEPTA (Office of the Chief Engineer).
      b. Contractor.
      c. Subcontractor, supplier and/or manufacturer, as applicable.
4. Identification of product or material and whether item is domestic construction material or foreign construction material as approved by SEPTA.

5. Relationship and method of attachment to adjacent structure or material.

6. Field dimensions, clearly identified as such.

7. Specification Section number.

8. Applicable standards, such as ASTM or Federal Specification number.


10. The Contractor’s stamp, initialed or signed, certifying to the review of submittal, verification of field measurements and compliance with Contract Documents.

3.03 Identification of Submittals

A. The Contractor shall assign a number and date to each submittal and shall number, date and sign each submittal original and copy acknowledging that the Contractor has reviewed the submittal for conformance to the Contract Documents.

1. Each submittal subject to approval must receive a separate number not shared by any other component, information or process. Only one (1) approval/rejection will be given per submittal number.

2. Each submittal number must include the Specification Section that the submittal most applies to.

3. When a resubmittal is made for any reason, the Contractor shall transmit under a new letter of transmittal with a new transmittal number in the form of the original number plus the letters a, b, c and so on for each subsequent resubmittal.

B. The Contractor shall maintain an accurate submittal log for the duration of the work, showing current status of all submittals at all times. The Contractor shall make the submittal log available for review upon request.

3.04 Grouping of Submittals

A. Unless otherwise specified, the Contractor shall make submittals in groups (with separate numbers) containing all associated items to assure that information is available for checking of each item when it is received.

B. Each grouping shall be accompanied by a dated transmittal letter which lists each transmittal by number and the number of copies submitted.

C. Partial, confusing and poorly prepared submittals will be rejected as not meeting the requirements of the Contract. The Contractor will be liable for delays so occasioned.

3.05 Timing of Submittals

A. The Contractor shall make submittals consistent with early start dates shown on the approved baseline schedule, but sufficiently in advance of early scheduled dates for installation to provide the necessary time required for reviews, for securing necessary approvals, for possible revisions and resubmittals, and for placing orders and securing delivery.
B. In scheduling, the Contractor shall allow twenty-one (21) calendar days for review and processing by SEPTA following its receipt of the submittal.

C. This review time will be increased for the submittal(s) that are so extensive that twenty-one (21) calendar days of turnaround period is unreasonable as determined by the SEPTA. This determination shall be binding on the Contractor.

D. Continued submission of material and repetitious submittals which clearly fail to meet the requirements of the Contract Documents which may cause delays in the completion of the Contract and any such delays shall be the sole responsibility of the Contractor.

3.06 SEPTA’s Review

A. Review and processing shall not relieve the Contractor from responsibility for errors, which may exist in the submitted data.

B. SEPTA does not confirm dimensions or make any representation that parts will fit together properly if fabricated in the sizes shown on the shop drawings. SEPTA requires that the Contractor take all necessary site measurements and that the shop drawings represent an accurate documentation of these dimensions.

C. The Contractor assumes responsibility to exercise control over all construction tolerances and ensure that these tolerances do not result in construction which violates regulations, codes or clearances.

D. Revisions:

1. The Contractor shall make required revisions as noted on the initial submittal.

2. If the Contractor considers any required revision to be a change, it shall so notify SEPTA as provided for in the Agreement. Such notification shall be made no later than ten (10) calendar days from the date of return of such submittals by SEPTA to the Contractor.

3. The review of the shop drawings waives the original contract requirements of the Contract Documents only if the Contractor submits this data as a substitution as specified in Article 1.05 in this Section. Other deviations from the Contract Documents will be understood to be Contractor errors and have no effect on the Contract.

3.07 Final Electronic Submission

A. As part of the Contractor’s closeout documentation requirements, the Contractor shall submit to the SEPTA Project Manager all approved submittals and other documentation in an electronic format (PDF files unless otherwise approved by the SEPTA Project Manager).

3.08 Interface Coordination System by the Contractor

A. The Contractor shall setup a control system to track all areas requiring interface between and with the Contractor. Use the control system for the following activities:

1. Tracking of all interface requirements.

2. Any potential conflicts with other parties.

3.09 Design Submittals, Special Requirements for Traction Power

A. The Contractor shall submit all traction power design submittals at the following levels of design completion:

1. Within thirty (30) days of the award of the Contract, submit the details of the major traction power equipment (switchgear, circuit breakers, autotransformers, current transformers, potential transformers and disconnect switches) proposed to be used to enable proper interface.

2. Include control schematic drawings of the switchgear and circuit breakers, details of the protective relays, current transformers and potential transformers and calculations necessary to permit understanding of the direction of the design (note: drawings & schematics for all system components NOT limited to RTU, relays, network connection devices and I/O Bay Modules control panels are to be the property of SEPTA once submitted).

3. In-progress design submission at 60 percent design completion level. Provide essentially completed design, although some special designs may not have been finalized. Include documentation, drawings, data and calculations necessary to permit full understanding of the design. Submit studies related to the prefabricated building and switchgear, as necessary. All studies specified in Section 16052 would have been completed by this time.

4. Pre-final design submission at 90 percent design completion level. Provide all design documentation.

5. Final design submission at 100 percent design completion level. Provide all design documentation sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania as a Professional Engineer in the disciplines applicable to the work.

3.10 Distribution of Approved Submittals

A. Distribute copies of approved submittals bearing SEPTA’s stamp and signature to relevant subcontractors, suppliers and manufacturers and to members of the Contractor’s force.

B. Ensure that all holders of approved submittal receive updated copies to ensure the availability of the latest approved data.

3.11 Notification

A. Provide advance notification to SEPTA prior to important design, manufacture, testing and construction events, as shown in Table 01010-1.

END OF SECTION
SECTION 01305
REQUESTS FOR INFORMATION

PART 1 - GENERAL

1.01 Description
A. This Section stipulates procedural requirements for processing of Contractor Request(s) for Information (RFI) and complements the requirements of the Contract Agreement, Paragraphs V.B and VIII.B.
B. An RFI is a written communication originated by a construction Contractor to request clarification of the intent of the Construction Documents.

1.02 Related Sections
A. Agreement.
B. Section 01010 – Summary of Work
C. Section 01300 – Submittals
D. Section 01400 – Quality Requirements
E. Section 01700 – Contract Closeout
F. Section 01720 – Project As-Built Documents
G. Attachment – Request for Information (RFI) Form

1.03 Submittals
A. Meet the provisions of Section 01300.
B. Submit RFIs using the attached RFI form and provide specific reference to the section of the Construction Documents to which the RFI refers. RFIs that are incomplete, unsigned or otherwise not submitted in compliance with the Contract, will be returned to the Contractor.
C. Any losses of time and/or additional costs associated with frivolous RFI submittals are the responsibility of the Contractor.

1.04 Quality Assurance
A. All RFIs will be signed by the Contractor's representative and submitted to SEPTA in "hard" copy.
B. The primary purpose of an RFI is to clarify the Contract Documents.
   1. The Contractor has the responsibility to be familiar with the Contract Documents. RFIs that request clarification of items that in the judgment of the SEPTA Project Manager, are clearly evident in the Contract Documents, shall be rejected by SEPTA.
   2. The Contractor shall not use RFIs for the following:
a. To facilitate construction coordination between the Contractors and subcontractors/vendors.
b. To initiate substitutions in material, methods and/or systems.
c. To transfer their responsibility for reviewing Contract Documents to SEPTA.

3. RFIs, which fail to reference the specific Contract Documents in question, will be rejected. If the Contractor uses an RFI for the purposes described Article 1.04, subsection B/2 in this Section, it will also be rejected. In these cases, the Contractor will be directed to meet the requirements specified in Section 01300 by the SEPTA Project Manager.

PART 2 - PRODUCTS

2.01 RFI Form
A. SEPTA will provide an electronic version of the RFI form for use by each Contractor.

PART 3 - EXECUTION

3.01 Identification of Request(s) for Information
A. Consecutively number all RFIs. Submit RFIs using the attached form. When an RFI must be resubmitted for any reason it shall be sent using a new RFI number with reference provided to the previous RFI.

3.02 Timing of Request(s) for Information
A. Submit RFIs sufficiently in advance of early construction schedule "Start" dates for fabrication and/or installation activities in order to provide the necessary time required for reviews, possible revisions and subsequent resubmittals.
B. For scheduling purposes, allow seven (7) working days for review and response by SEPTA following their receipt of the RFI, as determined in the Agreement.
   1. This review time will be increased for RFIs that are sufficiently extensive or complex that the above turnaround period is unreasonable as determined by SEPTA. This determination shall be binding on the Contractor.
C. The Contractor shall be solely responsible for delays in the completion of the Contract that result from the submission of RFIs which clearly fail to meet the requirements of this Section.

3.03 SEPTA's Review
A. SEPTA is responsible to review Contractors' RFIs and provide clarifications and/or interpretations as they relate to design documents. SEPTA is responsible to provide clarifications and/or interpretations to RFIs that are related to the Agreement or SEPTA operational issues and service. A clarification will not result in a change to the Construction Contract cost. SEPTA is responsible for coordinating all RFI clarifications with the Contractor.
B. If the Contractor considers any clarifications to an RFI to be a change; it shall so notify SEPTA in the manner provided for in the agreement.
1. Such notification shall be made no later than fourteen (14) calendar days from the date of the return of such clarifications by SEPTA to the Contractor.
# ATTACHMENT

## REQUEST FOR INFORMATION (RFI)

**PROJECT:**

<table>
<thead>
<tr>
<th></th>
<th>RFI Number</th>
<th>Contractor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Requested By (Signature): | Due Date

<table>
<thead>
<tr>
<th></th>
<th>SEPTA Response:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEPTA (Signature):</td>
<td>Date</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Transmitted to Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>PCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.PCO</td>
<td>No Impact</td>
</tr>
</tbody>
</table>

CD&C PM (Signature): | Date

PCO Number:
RFI FORM

Key Points

1. This section is to be completed by the Contractor. The SEPTA Project Manager shall provide RFI forms to the Contractor at the pre-construction meeting.

2. This section is to be completed by SEPTA. All technical inquiries are to be responded to by SEPTA. The section must be signed and dated within the contractual time frame.

3. This section is to be completed by SEPTA Project staff to return the RFI to Contractor. The distribution must include the Project file.

4. This section is to be completed by SEPTA Project staff. The RFI response will be reviewed for its potential to result in a change order. This box should be appropriately completed as a result of this review.
SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 Description

A. Contractor shall employ a professional photographer to take construction record photographs periodically during course of the work as specified and as determined by the SEPTA Project Manager.

B. In addition to photographs generally describing the progress of the work, the SEPTA Project Manager will require specific components and processes be documented.

C. SEPTA reserves the right to require that an approved professional photographer be used if, in the opinion of the SEPTA Project Manager, the photographs submitted at any time are inadequate in quality or coverage.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01300 – Submittals

C. Section 01305 – Requests for Information

D. Section 01400 – Quality Requirements

E. Section 01720 – Project As-Built Documents

1.03 Submittals

A. Provide SEPTA with photographs taken bi-weekly. Photographs shall not be used for any purposes other than fulfilling the requirements of this Section. Other uses without the written permission from SEPTA's Project Manager is prohibited.

B. Additionally, provide photographs of important events relating to the traction power switchgear, autotransformers, circuit breakers, control board, RTU and other major structures. Such events include, but are not limited to, factory test set ups, unloading at site, placement on the foundation etc. to highlight the site specific difficulties for future guidance.

C. Also, provide at least twenty external and twenty internal views of each substation before and after rehabilitation taken from similar angles.

D. Views and Quantities Required:

1. At each specified time, photograph the equipment from ten (10) different views, as directed by SEPTA.

2. Provide two (2) sets of prints of each view, enclosed in two (2) separate binders with double-faced plastic sleeves.

3. The prints and digital files shall be furnished to SEPTA at the Contractor's expense and shall become the exclusive property of SEPTA.
E. Ownership of Electronic Files:
   1. The prints and electronic files shall be furnished to SEPTA at Contractor’s expense and all images collected during the course of the Contract shall become the sole property of SEPTA. The Contractor shall turn over all copyright rights to SEPTA in a written document to be approved by SEPTA.

F. Prints:
   1. The prints shall be furnished to SEPTA at Contractor’s expense and shall become the property of SEPTA.
   2. Contractor shall obtain the photographer’s agreement, prior to employment, to furnish additional prints to SEPTA at commercial rates applicable at time of purchase.

PART 2 - PRODUCTS

2.01 Digital Files (JPEG Format)
   A. Digital files from a 16.1 megapixels or higher resolution camera.
   B. Color prints to be 8.5 inches x 11 inches of each digital photograph at a resolution of 300 dpi.
   C. Provide a digital photo log in Word or Excel format listing the information contained in Article 2.01/D of this Section for each photograph submitted.
   D. Identify each print on back, listing:
      1. Southeastern Pennsylvania Transportation Authority (SEPTA).
      2. FTA Project number.
      3. SEPTA Contract number.
      5. Bi-weekly progress photographs (if applicable).
      6. Date that construction photographs are submitted.
      7. Description/Key Plan:
         a. Photo identification code.
         b. Orientation of view.
         c. Date and time of exposure.
         d. Key plan in lower right hand corner permanently affixed.
   E. Name, firm name and address of photographer.

PART 3 - EXECUTION

3.01 Technique
   A. Factual presentation is required.
B. Paramount importance shall be given to factual detailed presentation with maximum depth of field, proper exposure with adequate shadow and highlight detail and minimum distortion.

C. The photographer will be required to use fill in electronic flash technique to adequately light high contrast scenes and assemblies. Electronic flash shall also be used at all interior locations and other locations where the available light is not adequate for recording appropriate detail.

D. Camera capture (non-enhanced) must provide a minimum image size of 3500 x 2500 pixels unless otherwise determined by the SEPTA Project Manager.

E. Correct exposure and focus.
   1. High resolution and sharpness.
   3. Minimum distortion.

F. Take views as directed, and in the presence of SEPTA’s Project Manager when so requested.

G. Photographs of Traction Power Equipment:
   1. Provide professional quality, digital, color photographs to document manufacturing, installation and completed installation of traction power equipment.
   2. The photographs shall show the layout of internal equipment in clear detail.
   3. Provide at least fifty (50) views at key stages of manufacture for each type of equipment. Views shall be primarily internal.
   4. Provide at least twenty-five (25) views of various stages of installation for each type of equipment. For all equipment (except the grounding system), include views of crane setting/rigging, unconnected in place on pad and final installation with all hookups.
   5. Identify each print on back with the following information:
      a. Owner’s name:
         1) Southeastern Pennsylvania Transportation Authority (SEPTA).
      b. SEPTA Contract number.
      c. Contract name and location.
      d. Date and time taken.
      e. Brief description of the photograph view.

H. SEPTA reserve the right to photograph, without restriction and at its own expense, all stages of equipment manufacture and construction.

3.02 Delivery of Prints

A. Deliver two (2) sets of prints and the digital files with each application for payment.

B. The SEPTA Project Manager will determine the appropriate delivery of digital files.

C. At the conclusion of the Contract, Contractor will provide a complete set of all electronic files delivered in a medium as directed by the SEPTA Project Manager.
END OF SECTION
SECTION 01400

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 Description

A. The Contractor(s) shall establish and maintain a Contract specific Quality Assurance/Quality Control (QA/QC) system in the form of an Inspection and Test Plan (ITPs) for the work executed under the Contract Documents.

B. The Contractor shall have the "primary" responsibility for the quality of all of its work as well as the work of its subcontractors and fabricators. The program shall include organization, personnel, procedures, instructions and records/documentation to properly maintain the quality of the work.

C. ITPs shall be based on the requirements of each technical Specification and shall include reference to the attribute(s) of the item(s) to be tested and/or inspected, the frequency (as applicable), the person or organization responsible for the activity and the method of documentation, if required. The Contractor(s) shall monitor implementation of ITPs to the extent necessary to control the quality of the work.

D. The ITP may be based on the QA/QC plan submitted by the inspection and testing service hired by the Contractor (Refer to Section 01410) but augmented by the Contractor to include activities beyond the scope of that service.

E. The primary responsibility for quality during construction remains with the Contractor and he must take all steps necessary to control the quality of the completed Contract.

F. The Contractor will cooperate fully with SEPTA’s QA/QC efforts including, but not limited to, providing requested information in a timely fashion when SEPTA executes quality audits of the Contract.

G. The Contractor will be responsible for completing the checklists and activities called for in SEPTA’s construction inspection/ monitoring program as part of their QA/QC program.

H. In view of the critical and developmental nature, additional requirements for traction power equipment are included in Section 01452. In case of conflict, more stringent requirement shall prevail.

1.02 Related Sections

A. Requirements of the Agreement.

B. Section 01300 – Submittals

C. Section 03105 – Requests for Information

D. Section 01410 – Testing and Inspection Services

E. Section 01452 – Contractor Quality Control — Traction Power Equipment

F. Section 01700 – Contract Closeout
1.03 Submittals

A. The Contractor shall develop and explain a Quality Assurance Program (QAP) which includes surveillance methods to verify that reviewed inspection, testing and documentation activities have been performed to assure that shop manufactured/fabricated and site construction/installation activities the meet the highest quality standards. The Contractor’s QAP shall be submitted within fifteen (15) working days of the Notice to Proceed (NTP) and shall address the following quality assurance functions as a minimum:

1. Document control.
2. Procurement.
3. Receiving inspections.
4. Handling and storage.
5. Packaging and shipping.
6. Factory and field inspections.
7. Control of in process activities.
8. Factory and field testing.
9. Quality records.
10. Non-conformance/corrective actions.
11. QA audits.

B. The Contractor shall develop and document ITPs and procedures for all elements of the work. ITPs shall be based on the requirements of each Section of the technical Specifications and demonstrate how the quality of materials and workmanship required by the Contract Documents will be verified by the Contractor.

C. ITPs shall address inspection and test activities at the both the source of manufacture, at receipt at the Project site and during installation. The complete set of ITPs for the Contract and any additional material required by the SEPTA Project Manager to demonstrate the Contractor’s QA/QC activities will constitute the Contractor’s Quality Control Plan (QCP) for the work. This QCP shall be submitted within fifteen (15) working days of the Notice to Proceed (NTP).

D. SEPTA's review of a Contractor's QA/QC plan shall not relieve the Contractor from adding subsequent testing as needed to meet its primary responsibility for the quality of the work.

E. SEPTA reserves the right to require mock-ups of any material and/or assembly, at any time during the construction process of a size proscribed by the SEPTA Project Manager. Once approved, the mock-up will set a minimum standard of performance and/or appearance for the work. Mock-ups will be provided at no cost to SEPTA. The approved mock-up may, at the discretion of the SEPTA Project Manager, become part of the work.

1.04 Source Quality Assurance

A. SEPTA shall monitor the Contractor’s quality control during design, manufacturing, installation, and by conducting reviews of submittals, design review meetings, observing manufacturing process, inspecting installation, and witnessing tests at the factory and site.
B. Use the following standards for the preparation of drawings:
      (Including Reference Designation Class Designation Letters).
   3. IEEE 315A, Supplement to Graphic Symbols for Electrical and Electronics Diagrams.
   4. ANSI Y14.38, Abbreviations and Acronyms for Use on Drawings and Related Documents.
   5. SEPTA drawing standards.

C. Engage an adequate number of skilled professionals who are thoroughly trained,
experienced and familiar with the specific requirements and methods needed for the proper
performance of the work.

D. Take steps to investigate the authenticity of manufactured components and ensure that
counterfeit components are not being used in the work.

E. Establish technical and administrative surveillance methods to ensure the highest degree of
quality and to correct potential problems so as not to affect the Contract schedule.

F. Verify that the required QC inspection, testing and documentation activities have been
performed to assure that the equipment, materials and construction meet all the
requirements of the Contract Documents.

G. Monitor QC over suppliers, manufacturers, fabricators, products, services, site conditions,
workmanship and installation to produce work of the highest quality.

H. Take corrective action in a timely manner to identify and resolve undesirable conditions
affecting the quality of work.

I. Use only appropriately scaled and calibrated measuring and test equipment to perform
inspection and tests. Calibration records shall be traceable to National Standards and shall
reflect the as-found condition of the equipment at the point of calibration. Verify that all
equipment has been calibrated at a frequency acceptable to SEPTA and inspect logs of these
calibration efforts.

J. All test results shall clearly include a statement that the item tested or analyzed meets or
fails to meet the Contract requirements. Each report shall be conspicuously stamped on the
cover sheet in large red letters a minimum of 1/2 inch high “CONFORMS” or “DOES NOT
CONFORM” as the case may be.

K. All test reports shall be signed by a testing laboratory’s authorized person and counter
signed by the Contractor. The Contractor shall provide all tests, reports, certifications and
other documentation to the SEPTA Project Manager at the same time the results are made
available to the Contractor.

L. Promptly reject work which does not meet the requirements of the Contract Documents.

M. Develop quality assurance forms in a format acceptable to SEPTA for all major elements of
the work including additional elements as determined by SEPTA during the progress of the
work.
1.05 **Source Quality Control**

A. The Contractor shall provide required documentation that each material, manufactured product and/or fabricated items are produced and tested to meet the highest quality standards.

B. Items will not be considered as accepted until associated quality assurance documents are received and reviewed by SEPTA.

C. Do not schedule any factory tests/inspections by SEPTA until required prerequisites are received and reviewed by SEPTA. Twenty-one (21) day's prior written notice is mandatory for (re) scheduling any factory tests/inspections by SEPTA.

D. SEPTA reserves the right to source inspect all materials and equipment that are part of the Contract Documents. Any and all costs related to re-inspection of items found to be initially unsatisfactory shall be borne by of the Contractor.

E. Quality assurance documentation shall identify and include any changes made to the material, manufactured product or fabricated item as compared to the Contract requirements and approved shop drawings. The Contractor shall describe as to how each change will affect the installation, space and subsequent operations.

F. SEPTA's review of certified quality assurance documents and inspections shall not relieve the Contractor from its responsibility for the quality of work.

1.06 **Site Quality Control**

A. The Contractor shall identify an individual within its organization at the site of the work, who shall be responsible for overall management of Contract Quality Control (CQC) matters. The CQC shall be experienced in the performance and supervision of the inspections and tests required in the Specification. The CQC shall be on the work site at all times with complete authority to take any action necessary to ensure conformance with the Contract. The CQC shall be appointed by a letter.

B. The CQC shall inspect and document material arriving at site to ensure conformance to Contract requirements. Segregate and remove from the site, non-conforming and damaged material.

C. All materials and equipment shall be protected from rust, corrosion and similar damages by either factory applied or field applied protective coatings. Clean and touch-up such protected surfaces that become scratched, marred or otherwise damaged and make surfaces ready for field painting.

D. Unless specifically allowed elsewhere in the Contract, do not deliver reconditioned material at site. Protect all stenciled markings, labels and any other type of identification(s) to clearly identify the originality of the material.

E. As soon as the material arrives at site, (but before beginning installation) provide to SEPTA the original bill of lading and certification that the material meets the requirements of the Contract Documents.

F. Do not begin installation until all installation related shop drawings have been reviewed by SEPTA. Installation shall meet the conformed shop drawings. If installation cannot proceed as described in the shop drawings, notify the SEPTA Project Manager immediately for
direction. Do not install material or equipment using supplies or techniques not in compliance with the shop drawings.

G. Perform necessary and specified tests upon receipt and document the results. Replace material that fails the tests.

H. Remove and replace new or existing material that is damaged in storage or in the performance of work unless specifically accepted in writing by SEPTA's Project Manager.

I. No work shall be performed at the site if the Contractor's superintendent or his authorized representative, as approved by SEPTA, is not present at the location where work is being performed.

J. Install field samples at the site as required by individual Specification Sections for SEPTA approval.

K. Submit final reports and test(s) data to SEPTA as required by Section 01300.

1.07 Definitions

A. The following definitions pertain to requirements of this Section.

1. Quality Assurance (QA) is a program of policies, procedures and outline of detailed responsibilities to provide adequate confidence through approved surveillance and audit requirements that the Contractor will meet the required quality standards.

2. Quality Control (QC) is the act of examining, witnessing, inspecting, checking and testing of in-process or completed work to determine conformity with specified requirements and documenting the results.

3. Calibration is the comparison of two (2) instruments or measuring devices, one (1) of which is of known accuracy traceable to National Standards, to detect, correlate, report or eliminate by adjustment any discrepancy in the accuracy of the instrument or measuring device being compared with the standard.

4. Inspection is a stage of QC, which by means of examination, observation or measurement, determines the conformance of materials, supplies, components, parts, appurtenances, systems, processes, installation or structures to predetermined quality requirements.

5. Source Inspection consists of review, monitoring, observation, and/or inspection, random or consistent, or at selected stages of manufacturer or construction, of manufacturer or sub-manufacturer's personnel, material, equipment, process or tests.

6. Site Inspection consists of reviewing, monitoring, observing and inspecting the work at the Project site.

7. Quality Manager:
   a. The Contractor shall identify a Quality Manager (QM) within its organization at the site of the work, who shall be responsible for overall management of contract Quality Control matters. The QM shall be experienced in the performance and supervision of the inspections and tests required by the specification.
   b. The responsibilities of the QM may be executed by the superintendent. SEPTA reserves the right to demand a separate full time QM who reports directly to the construction company director, at any time during the duration of the Contract without cause.
c. The QM shall be on the work site at all times with complete authority to take any action necessary to ensure conformance with the Contract and obtain the level of quality defined by code and the Contract Documents. The QM shall be appointed and substituted by letter.

1.08 Non-Conformance Reports
A. A Non-Conformance Report (NCR) shall be issued when any material or component does not meet the requirements of the Contract Documents in the opinion of the SEPTA Project Manager or other approved SEPTA personnel.
B. Once issued, the Contractor has ten (10) days to challenge the NCR in a written response to the SEPTA Project Manager.
C. Any NCR not withdrawn in writing by the SEPTA Project Manager or other approved SEPTA personnel, must be corrected in a timely manner.
D. The Contractor is obliged not to proceed with any work which would cover or reduce access to the non-conforming work.

1.09 Contents of an ITP
A. The Contractor’s ITP must be specific and not generic; tailored to the actual requirements of the Contract. ITPs shall include the following items:
   1. Organization and responsibilities.
   2. An organizational chart showing who has responsibility for QC functions and how they interact with the rest of the Project team.
   3. Brief resumes of key personnel.
   4. Document how the QA/QC personnel will oversee the QA/QC activities of subcontractors and fabricators.
B. Procedures and Documentation:
   1. Samples of logs and checklists to be used in QA/QC activities.
   2. A schedule of tests, inspections and mock-ups required by the Contract Documents and governmental authorities.
   3. Procedures which guarantee that any material which must meet a specific test or other definition of quality is delivered to the job site accompanied by written verification that the material does meet these requirements. Included in this procedure is the process of gathering this information and retaining it by the Contractor.
   4. Procedures which insure that handling and storage instructions are obtained and followed for all material.
   5. Procedures that insure that the Contractor effectively controls documents at the Project site. Included in this responsibility is a requirement that a copy of the most current construction documents is present at the job site at all times; including but not limited to drawings, specifications, addendum items, change orders and RFI’s.
C. Inspection and Testing Activities:
   1. List of inspection devices to be used by the Contractor or a subcontractor which must be calibrated, the proposed frequency of calibration and who will calibrate them.
2. Procedures to insure that testing and inspections will be done in a timely manner and will not negatively impact the progress of the work.

3. Procedures to insure that mock-ups and preinstallation conferences are done in a timely manner and give the SEPTA Project Manager sufficient time to participate and review them without negatively impacting the schedule.

4. Procedures that insure that material which fail tests or inspections is identified and segregated.

D. Audit Activities:
   1. Define how the QA/QC efforts for key construction activities will be audited and how the results of this audit will be presented to the job superintendent.
   2. Define when anticipated audits may be implemented.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
THIS PAGE NOT USED
SECTION 01410

TESTING AND INSPECTION SERVICES

PART 1 - GENERAL

1.01 Description
   A. The Contractor shall employ a testing and inspection agency fully licensed and competent in the field of testing specific elements of the Contract. Submit such testing agencies and their qualifications for SEPTA’s prior written approval.
   B. Refer to Division 16 Sections for additional requirements of testing pertaining to the traction power equipment.
   C. The Contractor shall pay for all necessary testing and inspection services.

1.02 Related Sections
   A. Requirements of the Agreement and Division 1.
   B. Section 01300 – Submittals
   C. Section 01305 – Requests for Information
   D. Section 01400 – Quality Requirements
   E. Section 01452 – Contract Quality Control – Traction Power Equipment
   F. Section 01600 – Materials and Equipment
   G. Division 16 for Electrical Testing of Traction Power Equipment.

1.03 Submittals
   A. Prior to start of work, submit testing laboratory name, address, and telephone number, and names of Professional Engineer licensed in the Commonwealth of Pennsylvania and responsible laboratory officer.
   B. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
   C. Provide schedule of laboratory activities commitment with the Contractor(s) schedule and work to be provided.
   D. Laboratory Reports:
      1. After each inspection and test, promptly submit two (2) copies of laboratory report to SEPTA and to the Contractor.
      2. Include:
         a. Date issued.
         b. Contract title and number.
         c. Name of inspector.
         d. Date and time of sampling or inspection.
e. Identification of product and Specification Section.

f. Location in the Contract.

g. Type of inspection or test.

h. Date of test or inspection.

i. Results of tests or inspection.

j. Conformance with Contract Documents.

E. When requested by SEPTA, provide interpretation of test results.

1.04 Quality Assurance

A. The testing and inspection agency shall be approved by SEPTA.

B. Where no testing requirements are described and not required or suggested by any applicable codes and standards, but SEPTA decides that testing is necessary, SEPTA may require such testing to be performed at SEPTA's expense.

C. Testing performed to investigate the failure of a system, equipment or component shall be at no cost to SEPTA.

D. The testing laboratory shall be approved in advance by SEPTA. To be qualified the laboratory shall:

1. Meet "Recommended Requirements for Independent Laboratory Qualifications", published by the American Council of Independent Laboratories.


3. Be authorized to operate in the Commonwealth of Pennsylvania.

4. Maintain a Professional Engineer licensed in the Commonwealth of Pennsylvania on staff to review services.

5. Have testing equipment that meet the following requirements:
   a. Calibrated at maximum twelve (12) month intervals by devices of accuracy traceable to either:
      1) National Bureau of Standards.
      2) Accepted values of natural physical constants.
   b. Submit a copy of certificate of calibration.

E. Testing, when required, shall be the strictest of all pertinent codes and regulations, including selected standards of the American Society for Testing and Materials.

F. All site testing and taking of the specimens and samples shall be performed in the presence of the Contractor's superintendent. SEPTA, at its discretion, may elect to be present at any or all testing.

G. Provide adequate notice to SEPTA Project Manager for all testing.

1.05 Product Handling

A. The Contractor shall meet the requirements of Section 01600.
B. The Contractor shall promptly process and submit required copies of test reports and related instructions to assure necessary retesting and replacement of materials without any possible delay in the progress of the work.

1.06 Contractor’s Responsibilities

A. The Contractor shall provide all required time within the approved construction schedule.

B. Notify SEPTA and agency forty-eight (48) hours prior to expected time for operations requiring inspecting and testing services.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Retesting

A. When initial tests indicate non-compliance with the Contract Documents, subsequent retesting occasioned by the non-compliance shall be performed by the same testing agency, at no additional cost to SEPTA.

B. Deliver to laboratory at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.

C. Provide incidental labor and facilities:
   1. To provide access to work to be tested or inspected.
   2. To obtain samples at the site or at source of products to be tested.
   3. To facilitate tests and inspections.
   4. To provide storage and curing of test samples.

3.02 Contractor’s Convenience Testing

A. Inspecting and testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

3.03 Cooperation with Testing Laboratory

A. Representatives of the testing laboratory shall have access to the work at all times and at all locations where the work is in progress. The Contractor shall provide facilities for such access to enable the laboratory to perform its functions properly.

B. Deliver to laboratory at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.

C. Provide incidental labor and facilities:
   1. To provide access to work to be tested or inspected.
   2. To obtain samples at the site or at source of products to be tested.
3. To facilitate tests and inspections.
4. To provide storage and curing of test samples.

3.04 Schedules for Testing

A. Establishing Schedule:

1. By advance discussion with the testing laboratory, the Contractor shall determine the time required for the laboratory to perform its tests and to issue each of its findings.
2. Notify SEPTA and laboratory seventy-two (72) hours prior to expected time for operations requiring inspecting and testing service.
3. Provide required time for sampling, testing and reporting within the approved construction schedule.

END OF SECTION
SECTION 01452

CONTRACTOR QUALITY CONTROL – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Traction power equipment required for the Contract is unique in terms of rating (frequency, voltage and single phase) and will be supplied by multiple manufacturers. Quality Control (QC) by the Contractor is therefore of paramount importance.

B. SEPTA shall monitor the Contractor's QC of the traction power equipment during design, manufacturing, installation, and by conducting reviews of submittals, design review meetings, observing manufacturing process, inspecting installation, and witnessing tests at the factory and site.

C. In case of conflict with other Sections, provisions that are more stringent shall apply.

1.02 Related Sections

A. All Sections of Division 1.
B. Section 01300 – Submittals
C. Section 01380 – Construction Photographs
D. Section 01041 – Project Coordination
E. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment
F. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment
G. Section 01822 – Demonstration and Training – Traction Power Equipment
H. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment
I. Section 05090 – Metal Fasteners, Joining and Welding
J. Section 09910 – Paints and Coatings
K. Section 16052 – General Electrical Requirements – Traction Power Equipment
L. Section 16060 – Grounding and Bonding
M. Section 16075 – Electrical Identification
N. Section 16270 – Distribution Transformers
O. Section 16272 – Traction Power Autotransformers
P. Section 16290 – Protective Devices and Instrument Transformers
Q. Section 16330 – Trolley, Feeder and Autotransformer Circuit Breakers (ABB)
R. Section 16335 – Surge Protection
S. Section 16791 – Combined Relay and Control Switchboard
T. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI
U. Section 16952 – Electrical Testing – Traction Power Equipment (RRD)

1.03 Submittals

A. Design Documentation:
   1. Studies and Reports:
      a. Submit studies and reports for each component design requiring calculations. This is specifically applicable for the components which have not been previously used on similar traction power equipment. As a minimum, include in each report the following sections:
         1) General description.
         2) Design parameters.
         3) Design procedures.
         4) Calculation procedures.
         5) References to standards and technical literature.
         6) Design of the equipment based on the calculations.
         7) Statement of compliance with the Contract Documents, specified standards and codes to which each item of equipment is designed.
         8) Conclusions.
         9) Seal and signature of a Professional Engineer licensed in the Commonwealth of Pennsylvania.
   2. Product Data:
      a. Provide technical product data for all items of equipment used.
      b. Identify materials, dimensions, weights, manufacturing and fabrication procedures, factory and field tests, and installation procedures.
      c. Make use of standard equipment product data and specifications where practical and describe functional, design, electrical characteristics and performance requirements. Identify materials, fabrication procedures, factory tests, field tests and installation procedures.
      d. Modify the manufacturer’s standard schematics, drawings, brochures, diagrams, details, procedures, instructions, schedules, illustrations, calculations and other descriptive data as follows:
         1) Delete information which is not applicable to this Contract.
         2) Highlight pertinent information related to this Contract.
         3) Show dimensions, clearances, performance characteristics, interfaces, wiring diagrams, inputs, outputs and controls, as appropriate.
      e. Submit certificates of compliance for those products for which no product samples or tests are specified. Demonstrate that the product meets the Contract Document requirements. The certificates of compliance shall be signed by an authorized representative of the product manufacturer.
   3. Design and Shop Drawings:
      a. The Contract includes design and manufacture of traction power equipment rated at frequency and voltage that are not commonly used in other traction distribution systems. Submit detailed design drawings including control schematics and layouts for SEPTA review.
      b. Prepare all design and shop drawings using SEPTA approved border and title block. Include in the title block the drawing number, title, date, Contract number, reference to next higher assembly and signature of the Contractor’s responsible engineer.
      c. All drawings shall be prepared to SEPTA AutoCAD standards as specified elsewhere.
d. Reserve a blank area, 2 inches x 4 inches in the lower right corner just above the title block, for SEPTA's review stamp.

e. Include a complete list of materials and parts with the Contractor's part number. Provide room for including SEPTA's part number.

f. Fully dimension each assembly.

g. Provide weight of each assembly.

h. Identify commercial equivalent of components, where possible.

i. Changes in products for which drawings have been reviewed and approved will not be permitted, unless those changes have been submitted to and approved in writing by SEPTA.

j. Include seal and signature of a Professional Engineer licensed in the Commonwealth of Pennsylvania on all drawings.

4. Manufacturers Internal Quality Control Tests and Control Points:
   a. Submit details of the internal factory tests that will be performed by the manufacturer as part of his quality control.
   b. Submit list of control points where the manufacturer's internal quality department will perform a pass/fail check.
   c. SEPTA may elect to witness any or all control point tests at the manufacturer's factory.

5. Bill of Materials:
   a. Provide a complete list of all equipment and materials used.
   b. For each item of equipment on the list include the following information:
      1) Item identification.
      2) Major characteristics.
      3) Name and address of the manufacturer.
      4) Catalog number.
      5) Complete ordering data.
      6) Alternate manufacturers.

B. Product Samples:
   1. Submit product samples to SEPTA as specified in other Sections of this Specification.
   2. Prepay all shipping charges to SEPTA's offices or construction site.
   3. Provide samples and quantity to clearly illustrate full color, range, and functional characteristics of products and materials. Provide complete accessories or attachment devices. After review and written approval by SEPTA, samples may be used in construction, if not damaged and if allowed by SEPTA.
   4. Changes in products for which samples have been approved will not be permitted, unless those changes have been reviewed and approved in writing by SEPTA.

C. Software Code and Documentation:
   1. Provide all software source code and software documentation developed under the Contract to insure that should the need arise after expiration of the warranty and the Contractor is unable or unwilling to provide technical support, SEPTA or a software consultant, will have the capability to perform any needed software modifications. At this time, SEPTA has no plans to modify supplied software without the Contractor's knowledge and consent.
2. Include all application and diagnostic software and any software developed for embedded microprocessors that are integrated into the equipment modules.

3. Software documentation shall include the following:
   a. General description and operation.
   b. Software architecture and program functions.
   c. Data flow information.
   d. Annotated source code listing, with comments and descriptions pertaining to each module in sufficient detail to allow an experienced programmer to understand the program.
   e. Detailed memory map and listing.
   f. Input/output port map.

4. In addition to the software source code and documentation described above, submit the following:
   a. A licensed copy of all software tools such as debuggers, assemblers and compilers needed to convert the supplied source code into executable form used by the target processors.
   b. Hardware devices, such as EPROM programmers, with their accompanying software tools, necessary to transfer the executable programs onto the storage devices used by any embedded microprocessors.
   c. Documentation that describes the procedures necessary to convert the supplied source code into an executable format.

D. Photographs:
   1. Refer to Section 01380 for photograph requirements.

E. Record Documents:
   1. Maintain one (1) record copy of all design documents and change orders at the work site. The design documents shall be continuously annotated to indicate the following:
      a. All design changes in the field.
      b. Substitutions of items of equipment as changes occur.
      c. Additional details not provided on the original design documents.
      d. All other changes, as required, to show a complete "as-built" condition.
   2. Periodically update the drawings electronically. Upon completion of the construction, when the design documents include all design and field changes, designate and stamp the documents as record documents.
   3. At completion of all work ensure the record documents are sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania and submit to SEPTA. All record documents will become the property of SEPTA.
   4. Retain all system design and record documents for a minimum of five (5) years from the final acceptance date of each element of work. The documents shall be accessible to SEPTA during this period.

1.04 Quality Assurance
   A. Use the following standards for the preparation of drawings:
3. IEEE 315A, Supplement to Graphic Symbols for Electrical and Electronics Diagrams.
4. ANSI Y14.38, Abbreviations and Acronyms for Use on Drawings and Related Documents.
5. SEPTA drawing standards.

PART 2 - PRODUCTS

2.01 SEPTA’s Review

A. All submissions shall be subject to review and approval by SEPTA in accordance with Section 01300 or as amended herein. Approval does not relieve the Contractor of its obligation to meet the requirements of the Contract.

B. One (1) copy of each submittal will be returned to the Contractor. Submittals bearing exception and submittals not approved will indicate the review comments and instruction relative to correction of the resubmittal.

C. Review and approval of a separate item will not constitute approval of the assembly in which the item functions.

D. Allow twenty-one (21) calendar days for all SEPTA reviews for submittals relating to traction power equipment.

2.02 Design Review Meetings

A. Design review meetings shall be conducted to discuss and evaluate design progress, technical adequacy of the design and the compliance with the performance requirements of the Contract. Each review shall also evaluate compatibility of the functional interfaces between the system components and between other facilities.

B. Hold design review meetings monthly and at special design milestones as required by SEPTA. The special design milestones shall include, but not be limited to:

1. In-progress (60 Percent) design review meeting following the in-progress design submission.
2. Pre-final (90 Percent) design review meeting following the pre-final design submission.
3. Final design (100 Percent) review meeting following the final design submission.

C. The location of the review meetings shall be, at the option of SEPTA, either at the Contractor's offices or at SEPTA's office. Prepare written record of each meeting in the form of meeting minutes. The meeting minutes shall be included in the Project correspondence and shall be distributed to SEPTA.

D. SEPTA reserves the right to review any and all design drawings, design data, studies and analyses.

E. SEPTA reserves the right to audio tape all meetings with the knowledge of all participants.
2.03 Manufacture Observation and Construction Inspection

A. SEPTA and its representatives will visit the Contractor's facilities and the construction site from time to time to monitor manufacturing and construction progress.

B. For this purpose, provide SEPTA thirty-five (35) days' notice of upcoming control points in the manufacture of traction power equipment, and arrange for design staff, manufacturing personnel, and construction personnel to be available for formal meetings, shop floor discussions and site inspections.

2.04 Test Witnessing

A. SEPTA and its representatives will visit the construction sites from time to time and be present at important stages of equipment testing.

B. For this purpose, provide SEPTA fourteen (14) days' notice of all important installation events, such as delivery of major equipment, and arrange for required field staff to be available for meetings and discussions at site.

PART 3 - EXECUTION

3.01 Interface Coordination System

A. Setup a control system to track all areas requiring interface with other Contractors. Use the control system for the following activities:

1. Tracking of all interface requirements.
2. Any potential conflicts with other Contractors.

3.02 Design Submittals

A. Refer to Section 01300 for design submittal requirements.

3.03 Distribution of Approved Submittals

A. Refer to Section 01300 for distribution of approved submittal requirements.

3.04 Resubmission Requirements

A. Refer to Section 01300 for submittal resubmission requirements.

3.05 Notification

A. Provide advance notification to SEPTA prior to important design, manufacture, testing, and construction events, as shown in Table 01010-11.
### 3.06 Submission Schedule

A. Provide submittals as shown in Table 01452-1.

**Table 01452-1 Design Documentation Submission Schedule**

<table>
<thead>
<tr>
<th>Deliverable Item</th>
<th>Level of Submission</th>
<th>Submission Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studies and Reports</td>
<td>In-Progress</td>
<td>At least fifteen (15) days prior to preliminary design meeting</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>At least fifteen (15) days prior to in-progress design meeting</td>
</tr>
<tr>
<td>Product Data</td>
<td>In-Progress</td>
<td>At least fifteen (15) days prior to preliminary design meeting</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>At least fifteen (15) days prior to in-progress design meeting</td>
</tr>
<tr>
<td>Design and Shop Drawings</td>
<td>In-Progress</td>
<td>At least fifteen (15) days prior to in-progress design meeting</td>
</tr>
<tr>
<td></td>
<td>Pre-Final</td>
<td>At least fifteen (15) days prior to pre-final design meeting</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>At least fifteen (15) days prior to final design meeting</td>
</tr>
<tr>
<td>Plans and Procedures</td>
<td>In-Progress</td>
<td>At least fifteen (15) days prior to preliminary design meeting</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>At least fifteen (15) days prior to in-progress design meeting</td>
</tr>
<tr>
<td>Test Documentation</td>
<td>Test Plan, In-Progress</td>
<td>At least fifteen (15) days prior to preliminary design meeting</td>
</tr>
<tr>
<td></td>
<td>Test Plan, Final</td>
<td>At least fifteen (15) days prior to in-progress design meeting</td>
</tr>
<tr>
<td></td>
<td>Test Procedures, In-Progress</td>
<td>At least fifteen (15) days prior to in-progress design meeting</td>
</tr>
<tr>
<td></td>
<td>Test Procedures, Final</td>
<td>At least fifteen (15) days prior to pre-final design meeting</td>
</tr>
<tr>
<td></td>
<td>Test Reports</td>
<td>Within thirty (30) days of test completion</td>
</tr>
<tr>
<td>Bill of Material</td>
<td>In-Progress</td>
<td>At least fifteen (15) days prior to pre-final design meeting</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>At least fifteen (15) days prior to final design meeting</td>
</tr>
<tr>
<td>Deliverable Item</td>
<td>Level of Submission</td>
<td>Submission Requirement</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Spare Parts, Special Tools and Test Equipment</td>
<td>Pre-Final List</td>
<td>At least fifteen (15) days prior to pre-final design meeting</td>
</tr>
<tr>
<td></td>
<td>Final List</td>
<td>At least fifteen (15) days prior to final design meeting</td>
</tr>
<tr>
<td></td>
<td>Parts, Tools and Equipment</td>
<td>With delivery of the last item of equipment</td>
</tr>
<tr>
<td></td>
<td>Catalogs</td>
<td>With delivery of the last item of equipment</td>
</tr>
<tr>
<td>Product Samples</td>
<td>Final</td>
<td>At least fifteen (15) days prior to in-progress design meeting</td>
</tr>
<tr>
<td>Software Code and Documentation</td>
<td>Final</td>
<td>Within thirty (30) days of final system acceptance</td>
</tr>
<tr>
<td>Photographs</td>
<td>Final</td>
<td>Within thirty (30) days of final system acceptance</td>
</tr>
<tr>
<td>Operations and Maintenance Manuals</td>
<td>Manuals, Pre-Final</td>
<td>Include in pre-final design submission</td>
</tr>
<tr>
<td></td>
<td>Manuals, Final</td>
<td>With delivery of the last item of equipment</td>
</tr>
<tr>
<td>Personnel Resumes</td>
<td></td>
<td>At least one hundred and twenty (120) days prior to commencement of training</td>
</tr>
<tr>
<td>Training Plan</td>
<td></td>
<td>At least one hundred and twenty (120) days prior to commencement of training</td>
</tr>
<tr>
<td>Training Program</td>
<td></td>
<td>At least ninety (90) days prior to commencement of training</td>
</tr>
<tr>
<td>Training Manuals, Final</td>
<td></td>
<td>At least thirty (30) days prior to commencement of training</td>
</tr>
<tr>
<td>Training Materials</td>
<td></td>
<td>At least thirty (30) days prior to commencement of training</td>
</tr>
<tr>
<td>Program Demonstration</td>
<td></td>
<td>At least thirty (30) days prior to commencement of training</td>
</tr>
<tr>
<td>Record Documents</td>
<td>Final</td>
<td>Within thirty (30) days of final system acceptance</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 Description

A. The Contractor shall provide temporary facilities and controls (except otherwise as indicated below) needed for the performance of their work including, but not necessarily limited to:

1. Temporary utilities such as heat, water, electricity and telephone to be provided by the Contractor for SEPTA and by the Contractor for themselves.
2. Field office for the Contractor's personnel to be provided by the Contractor, except the Mechanical Contractor may opt to not provide and occupy a field office due to the limited scope of Mechanical Contractor work.
3. Field office for SEPTA personnel to be provided and maintained by the Contractor.
4. Sanitary facilities to be provided by the Contractor.
5. Enclosures such as tarpaulins, barricades and canopies to be provided by the Contractor.
6. First-aid facilities to be provided by each the Contractor.
7. Temporary fencing and other safety devices for pedestrian and vehicular traffic as well as isolating the construction area to be provided by the Contractor.
8. Entry control to be provided by the Contractor.
9. Personnel identification to be provided by the Contractor.
10. SEPTA operations staff must have unrestricted access to any area that contains in-service equipment.

1.02 Related Sections

A. Agreement.
B. Section 01010 – Summary of Work
C. Section 01060 – Regulatory Requirements and Safety
D. Section 01065 – Railroad Safety Requirements
E. Section 01300 – Submittals
F. Section 01305 – Requests for Information
G. Section 01400 – Quality Requirements
H. Section 01580 – Project Identification Signs
I. Section 01590 – SEPTA Field Office

1.03 Submittals

A. The Contractor shall meet the pertinent provisions of Section 01300.
B. The Contractor shall provide shop drawings including means, methods and procedures related to all temporary facilities.

1.04 Product Handling

A. The Contractor shall maintain and protect all temporary facilities and controls in proper and safe condition throughout progress of the work.

1.05 Temporary Utilities and Services

A. Water:

1. The Contractor shall provide drinking water from an approved source, so piped or transported as to keep it safe and fresh and served from single service containers or satisfactory drinking stands or fountain. All such facilities shall be furnished in strict accordance with existing governing health regulations.

2. The Contractor shall protect pipes from freezing during inclement weather and any vandalism. Refer to the Agreement, Paragraph VIII E.

B. Sanitary Facilities:

1. The Contractor shall furnish for the work force on this Contract, the necessary toilet conveniences, secluded from public observation. The conveniences shall be kept in a clean, sanitary condition and shall meet the requirements and regulations of the agencies having jurisdiction. Refer to the Agreement, Paragraph VIII E.

C. Temporary Power and Lighting:

1. The Contractor shall provide, maintain and pay for all costs of temporary electrical and lighting services required at the site for the proper performance and inspection of work. The level of lighting shall not be less than the existing, at a minimum, or greater as required to perform the required tasks. Remove services and lighting after completion of work and repair of all damages.

2. The Contractor shall provide area distribution boxes so located that the individual trades may furnish and use 100 feet maximum length extension cords to obtain power and lighting at points where needed for work, inspection and safety.

3. The Contractor shall provide all necessary items such as breakers, transformers, panelboards and cable required for the service. Provide a complete distribution system expanded as required during the construction including wiring devices, outlets, distribution panels, transformers, cable and other related work necessary to provide a temporary power system for use during construction.

4. The Contractor shall pay all costs associated with the utility tie-ins, physical plant, maintenance of system throughout construction, removal of same at Contract completion and any other items necessary in providing temporary power and light.

5. The temporary power and lighting system shall at all times meet the applicable codes and regulations of OSHA, NEMA, UL and the local municipality.

D. Telephone:
1. The Contractor shall make necessary arrangements and pay costs for installation, maintenance and operation of direct line (non-pay type) telephone services (voice and data) in SEPTA's field office at the site.

E. Heating:
   1. The Contractor shall provide and maintain heat necessary for proper conduct of operations.
   2. The Contractor shall provide electric power to the heaters in the control cabinets of the electrical power equipment (including traction power) to prevent condensation during storage.

1.06 Access, Storage and Parking Areas

A. The Contractor shall establish a construction compound in which the Contractor provided SEPTA office trailer will be located adjacent to the Contractor's office trailer. The physical location of the compound will require written approval of SEPTA's Project Manager.

B. The Contractor shall provide a minimum of three (3) parking spaces adjacent to the SEPTA trailers within the compound for SEPTA vehicles.

C. The Contractor shall provide all necessary security for this compound area. The Contractor shall provide all necessary keys to the SEPTA Project Manager so as to provide access to the compound at any time.

D. The Contractor shall submit to the SEPTA Project Manager a plan layout of the compound within ten (10) working days after Notice to Proceed (NTP).

E. The Contractor shall coordinate the provisions of utility services for all trailers and be responsible for all installation charges, removal costs at Contract completion, and any periodic or other charges incidental to the provision of those utility services.

F. Upon final acceptance of the work, clean up the work areas and leave them in a neat and orderly condition. Dismantle and remove all temporary fencing and barricades and other temporary items installed, unless otherwise directed by the SEPTA Project Manager. Repair damaged areas to their original condition.

1.07 Field Offices and Sheds

A. Contractor's Field Office:
   1. Contractor shall furnish and maintain a field office with a telephone at the site during the entire period of construction. Contractor or superintendent shall be present at said office, at all times while its work is in progress. Keep readily accessible, at the field office, copies of both the Contract Documents and the latest approved shop and working drawings.
   2. Submit for SEPTA's written approval, working drawings showing proposed locations and size of offices and shops.

B. SEPTA's Field Office:
   1. The Contractor shall provide one (1) SEPTA field office and facilities complete and in place to the satisfaction of the SEPTA Project Manager prior to the initiation of any construction work. Refer to Section 01590 for details.
C. Field Office Security:
   1. The Contractor shall guard against unauthorized or illegal entry and protect the field
      office against vandalism, theft and mischief. The Contractor shall be responsible for the
      replacement and/or compensation for any items owned by SEPTA or SEPTA employees,
      which are related to the subject work, which are removed or damaged as the result of
      vandalism, theft, mischief or illegal entry to the field office.

D. Upon Contract completion, assume ownership of and remove temporary field offices and
   appurtenances from the job site.

1.08 Temporary Barricades, Enclosures and Fencing

A. The Contractor shall provide all temporary barricades required by the staging plans,
   including barricades for the designated the Contractor work areas, the Contractor laydown
   areas and public access for areas that must remain open during a stage. Where barricades
   are required outside a designated work area for the exclusive use of the Contractor, they
   shall be provided by the Contractor.

B. The Contractor shall submit drawings of the proposed temporary barricades for SEPTA’s
   review. Do not install barricades until the drawings for them have been reviewed by SEPTA.

C. The Contractor shall provide barricades as follows:
   1. Barricades shall enclose and prevent entry into the work area and shall be full height
      and dustproof.
   2. Barricades shall be constructed of materials suitable for location. Wood construction
      shall meet the AFPA “National Design Specification for Wood Construction”, the latest
      edition. As a minimum, the barricades shall be constructed of 5/8 inch thick APA rated
      exterior grade plywood. Framing members shall be Spruce-Pine-Fir No.2 or better, a
      minimum of 2 inches x 4 inches and larger sizes as necessary, spaced at a maximum 16
      inches on center to provide a rigid temporary structure to resist all applicable loads.
   3. Barricades shall be painted on all solid surfaces exposed to public view.

D. The temporary barricades shall have a reasonable number of hollow metal doors and
   frames, with locksets, at locations acceptable to SEPTA. The locksets on the doors requiring
   SEPTA access for operational and safety reasons shall be keyed to SEPTA’s Standard Lock
   System.

E. All open excavations must be properly barricaded and shall be lighted at the end of each
   work day and be operating from sunset to sunrise.

F. On a daily basis, the Contractor shall maintain the temporary barricades in a “like new”
   condition. The Contractor shall remove graffiti and restore surfaces on a continual
   maintenance basis. Maintenance shall continue until the barricades are removed.

1.09 Temporary Signs (Construction)

A. The Contractor shall provide necessary operations, directional and safety signs whenever
   the new construction disrupts the normal passenger traffic pattern, train operations or
   necessitates closing of stairway, entrances, etc.
B. All signs shall be of commercial quality and must meet SEPTA's graphic standards. All signs shall be approved by SEPTA at least fifteen (15) working days in advance of any work that necessitates interruption of operations and passengers. Do not interrupt any service or public flow until signs are in place.

C. Signs of personal nature, such as business advertisement, shall not be installed without the express written permission of SEPTA.

D. Operational and directional signs shall be maintained throughout the Contract in "like-new" condition and free of all unrelated signs, posters, painting, advertising and defacement of any kind. Replace signs as necessary to maintain it in a "like-new" condition.

E. Remove all signs from the site and repair all damages within five (5) days of the date of the notice from SEPTA.

1.10 Protection of New Work

A. Until final acceptance of the work by SEPTA, the Contractor shall have the charge and care, and shall take every reasonable precaution against injury or damage to any part, by the action of the elements, theft, vandalism, or from any other cause, whether arising from the execution or from the non-execution of the work. Rebuild, repair, restore, and make good, to the satisfaction of the SEPTA Project Manager, all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and bear the expense at no cost to SEPTA.

1.11 Dust Control

A. The Contractor shall meet the requirements specified in Section 01060.

1.12 Security

A. General:

1. The Contractor shall provide adequate security measures to protect material, equipment, and work from all incidental and intentional damage or theft at all Project site locations, staging areas and fabrication yards. The use of guard dogs and the possession of firearms on SEPTA property are prohibited. Security measures shall include, at a minimum, the following:

   a. Exterior lighting of 20 to 30 lux within the yard areas.
   b. 8 foot high chain link fence enclosure with gate(s) so the yard areas may be fully secured during non-work periods. Chain link fence fabric to have openings no greater than 25mm.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used
SECTION 01505
MOBILIZATION AND DEMOBILIZATION

PART 1 - GENERAL

1.01 Description
A. This Section specifies the general requirements for mobilization and demobilization on the Contract.
B. The work under this Section includes all labor, equipment, materials associated with setting up the Project work site and dismantling and removing such items at the end of the Contract.
C. The work includes but is not necessarily limited to:
   1. Project work signs.
   2. Initial Project setup.
   3. Final cleaning.
   4. Restoration of surfaces and repairs.
   5. Disposal of all debris and excess materials.
D. SEPTA will allocate an area for equipment storage, laydown areas and office space for use by the Contractor. All temporary facilities associated shall be at the Contractor’s expense.
E. Access to the worksite shall be arranged by the Contractor by co-ordination with SEPTA.

1.02 Related Sections
A. Section 01580 – Project Identification Signs
B. Section 01700 – Contract Closeout
C. Section 01710 – Final Cleaning

1.03 Submittals
A. Submit within sixty (60) days after the Notice to Proceed (NTP), a layout of the proposed construction site including fences, roads, buildings, trailers and storage areas.

PART 2 - PRODUCTS

2.01 Plant and Equipment
A. Construction plant and equipment shall be of the capacity, type, quality, function and in the quantity necessary for the timely prosecution of the work.

PART 3 - EXECUTION
3.01 General
   A. Construction plant, equipment, materials, supplies, temporary buildings, facilities and other items necessary for mobilization shall be available at the work site at the times they are to be built, used, installed or operated.
   B. Construction plant location shall be approved by SEPTA and shall be appropriately close to the portion of the work for which it will be used. The construction plant, including equipment and personnel, shall have sufficient capacity, in the opinion of the SEPTA Project Manager, to permit a rate of progress which will insure completion of the work within the Contract time required by the Agreement and shall also have sufficient excess capacity for emergencies and overloading.
   C. The SEPTA Project Manager shall have the right to reject construction plants and apparatus which, are in its opinion, unsafe, improper or inadequate. Rejected construction plants and apparatus shall be brought to acceptable condition or shall be removed from the jobsite by the Contractor.

3.02 Demobilization
   A. Upon completion of the work, the Contractor shall remove construction plant, equipment, materials, supplies, temporary building, facilities and other items that were necessary for mobilization. The Contractor shall return the area allocated for the construction plant to its condition prior to the start of the work.

END OF SECTION
SECTION 01525

PROJECT VEHICLE

PART 1 - GENERAL

1.01 Description

A. The Contractor shall provide at his sole cost and expense one (1) light duty SUV, such as Chevy Blazer, 6 cylinders, 4 wheel drive. The vehicle shall not be older than one (1) model year and less than 15,000 miles. The vehicle must be provided no later than thirty (30) days from Notice to Proceed (NTP) for the SEPTA Project personnel to perform their field inspection duties.

1. The Contractor shall be responsible for the insurance, state inspection, maintenance and repair, and an oil company credit card covering the cost of fuel and oil.

2. The vehicle shall be provided for the duration of the Contract. The SEPTA Project Manager will relinquish the use of the vehicle thirty (30) days after satisfactory completion of the testing.

PART 2 - PRODUCTS

2.01 Standard Equipment

A. Project Vehicle:

1. The SEPTA Project vehicle shall be equipped as follows:

   a. Air conditioning.
   b. Automatic transmission.
   c. AM/FM radio.

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
THIS PAGE NOT USED
SECTION 01580

PROJECT IDENTIFICATION SIGNS

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of furnishing and installing Project identification signs and temporary signs as described below and required by the Contract Documents.

1.02 Related Sections
A. Section 01010 – Summary of Work
B. Section 01300 – Submittals
C. Section 01305 – Requests for Information
D. Section 01400 – Quality Requirements
E. Section 01500 – Construction Facilities and Temporary Controls
F. Attachment – SEPTA Starburst Sign
G. Attachment – No Trespassing Sign

1.03 Submittals
A. In accordance with Section 01300, submit the following:
   1. Shop drawings of each sign scheduled to be utilized during construction.
      a. Indicate materials, size, location, fonts and colors proposed for use.
   2. After consultation with the SEPTA Project Manager, submit the following sign information for review and approval by SEPTA:
      a. Sketch and narrative description identifying the location, orientation and mounting height of each sign.
      b. Total quantity of each sign to be utilized.
      c. Name, address, telephone number and key contact person of the company responsible for the fabrication of the sign.
   3. Hardware and mounting details for erection of each sign.

1.04 Job Conditions
A. Signs shall be commercial quality and approved by SEPTA prior to fabrication.
   1. Install operational, directional and safety signs at least fifteen (15) working days in advance of any work that necessitates the interruption or detour of operations, the flow of passengers and/or the flow of the general public. Do not interrupt any service or public flow until signs are in place.
   2. Install Project identification signs within twenty-one (21) calendar days after the Notice to Proceed (NTP).
3. The "NO TRESPASSING" sign shall be installed within the Contractor's Project compound and other areas to be determined by the SEPTA Project Manager. SEPTA's graphics department will provide an electronic copy.

B. Prohibited Signs:
   1. Signs of personal nature, such as business advertisements or labor union notices, will not be permitted.

PART 2 - PRODUCTS

2.01 Project Identification Sign Material

A. Sign Material:
   1. Cut sign from a standard 48 inch x 96 inch x 3/4 inch thick, waterproof exterior, A-B grade plywood with a smooth, finished surface. Round all edges to a 1/8 inch radius. Joints will not be permitted.

B. Mounting Material:
   1. Provide mounting frames and hardware of such quality to be able to support the sign under all weather conditions for the duration of the Contract.
      a. Unless surface mounted, support signs with frames constructed with pressure treated dimension lumber, or other approved non-conductive material, of sufficient size to brace against weather conditions.
      b. Secure surface mounted signs using anchoring devices approved by SEPTA.

2. Hardware:
   a. Galvanized screws or bolts with nuts and washers.
   b. Paint all hardware, visible in the finished assembly, to match the adjoining surface of the sign or mounting.

3. Posts:
   a. Pressure treated dimensional lumber or other non-conductive material acceptable to SEPTA.

C. Paint:
   1. Paint sign surfaces, posts and mounting frames with one (1) coat of primer sealer and two (2) coats of white semi-gloss enamel on all sides and edges.
   2. Paint sign text and/or graphics on Project signs using "Warm Red" and "Reflex Blue", as indicated on the applicable sign sketches located at the end of this Section.
   3. Use paint manufactured for exterior use by a manufacturer acceptable to SEPTA.

D. Fabricator:
   1. A company specializing in and having documented experience in the fabrication of graphic signs. Available graphic sign companies include, but are not limited to, the following:
      c. Liberty Graphic Systems, Inc., Feasterville, PA.
d. Ridgeway’s, Inc., Philadelphia, PA  
e. Or Approved Equal.

E. SEPTA Project Sign:

1. Provide three (3) SEPTA Project signs. Sample SEPTA Project sign is shown on “Sketch # SEPTA-1” located at the end of this Section.

2. Size to be 4 feet x 6 feet.

3. SEPTA will provide the Contractor with a proof copy and a computer disk containing the actual Project sign information to be displayed on the SEPTA Project sign for the Contract at the pre-construction meeting.

4. Obtain the services of a graphic sign company to transfer the information contained on the SEPTA provided computer disk onto 0.1 mm pressure sensitive vinyl with weather-all fluorinated polyurethane coating, or approved equal film. The vinyl shall be mounted onto the sign surface.

5. Do not include information on the SEPTA Project signs except that contained on the computer disk provided by SEPTA.

6. The Contractor is responsible for advising the SEPTA Project Manager of any problems that occur during the production of the SEPTA Project sign.

2.02 Temporary Signs

A. Temporary signs are considered to be any sign not included in Article 2.01 in the Section that are required to be erected during the construction stage of the Contract and removed at the completion of the construction stage of the Contract. These signs include, but are not limited to, field office signs, safety, and instructional signs for workers, visitors and the public. This section does not include signs utilized and required for the purpose of identifying public street traffic closures and/or detours, and pedestrian control.

B. Field Office Signs:

1. Size to be 4 feet high x 5 feet wide.

2. Letter with black enamel paint using block letters at least 4 inches high, with the Contract name. Contract number and the words “CONTRACTOR’S FIELD OFFICE” or “SEPTA’S FIELD OFFICE” as appropriate with each word painted on a separate line.

3. Where the field offices to be identified are not readily visible from the work site entrance, paint a directional arrow on the sign and locate the sign near the entrance. In this case, provide additional signs of reduced size with the words “CONTRACTOR’S FIELD OFFICE” or “SEPTA’S FIELD OFFICE” as necessary to direct traffic to, and identify the field office location(s).

C. Operational, Directional and Safety Signs:

1. Keep dimensions of the signs to a minimum, but provide a sufficient size to include all pertinent information and/or directions in a concise and comprehensible manner.

2. Use block type lettering of sufficient size to be legible from 100 feet away.

D. No Trespassing Sign:
1. Sign base will be white baked enamel aluminum, 12 inches wide, 18 inches high and 0.062 inches thick. Additional prints of two (2) colors will be used; fire red and black. 1 inch border on the top and both sides and 1/2 inch border on the bottom.

2. Sign Information:
   a. 1 inch down from the top is a 10 inch wide x 2.75 inch high fire red block with reversed out white copy at 1.5 inch Helvt. Med. Acct. A. K. Rev. M to read “WARNING” centered in caps.
   b. 5 inches down from the top is the baseline for 0.75 inch Helvt. Med. Acct. A. K. Rev. M, black copy to read “NO TRESPASSING” centered in caps.
   c. 8.75 inches down from top is the center of a 6 inch fire red outlined circle 0.5 inches thick with a diagonal 45 degree slash from the upper left to the lower right of the circle. Behind the circle and slash is a 4.5 inch pictograph of a walking pedestrian.
   d. 13 inches down from the top is the baseline for 0.75 inch Helvt. Med. Acct. A. K. Rev. M, in black copy to read “AUTHORIZED” centered in caps.
   e. 14.125 inches down from the top is the baseline for 0.75 inch Helvt. Med. Acct. A. K. Rev. M, in black copy to read “PERSONNEL ONLY” centered in caps.
   f. 16.5 inches down from the top is the baseline for 0.375 inch Helvt. Med. Acct. A. K. Rev. M, broken down in four (4) lines of black copy to read
      
      “All Others Will Be Prosecuted In
      Accordance With
      Section 3503 of the Pennsylvania
      Crimes Code”

      Centered with initial caps.

   g. 17.5 inches down from the top, flush right, is the base line for 0.5 inch SEPTA logo in black.

3. Fasteners are not incorporated in the sign. The Contractor can drill holes in the signs to mount them on fencing, walls and barricades not to obstruct the message of the sign.

PART 3 - EXECUTION

3.01 Inspection
   A. Prior to erection, examine all signs to verify that the size, material and wording is in accordance with the approved shop drawings.

   B. Examine areas and conditions under which the signs are to be located. Prior to erection, notify the SEPTA Project Manager of any conditions that may differ from the information identified on the sign submission.

3.02 Erection
   A. Install signs in accordance with approved shop drawings and as directed by the SEPTA Project Manager. Support all non-surface mounted signs on a minimum of two (2) posts, anchored into the ground at a depth sufficient to provide rigid support of the sign during all weather conditions.

   B. Provide Project signs and SEPTA’s field office signs at places designated by SEPTA.

   C. No trespassing signs shall be posted on every side at 40 foot spacing on all temporary fences and walls, barricades and compound fencing.
D. Temporary Signs:
   1. Provide one (1) sign for each Contractor’s field office to indicate each location.
   2. Provide and install other temporary signs deemed necessary for the Contract by SEPTA.

E. Maintain all signs throughout the course of construction from installation until Contract completion, keeping them clean, free from graffiti, in good repair and free of obstruction. Provide and maintain adequate protection against weather so as to preserve all work, materials, equipment, apparatus, and fixtures free from injury or damage. Maintain all signs free of all unrelated signs, posters, painting, advertising and defacement of any kind. Within five (5) days of notice, the Contractor shall clean, repair or replace signs as necessary to maintain them in a "like-new" condition.

F. Within five (5) days of final acceptance of the Project by SEPTA, remove and dispose of all Project identification and temporary signs. All cost for the removal and disposal of signs shall be borne by the Contractor.

Sketch # SEPTA-1 SEPTA Starburst Sign
SEPTA Substation Rehabilitation

Overbrook Regional Rail Station
Historic Renovation

Another SEPTA Capital Improvement Project

The Capital Program
Text: Making long-term, strategic investments in vehicles, facilities, technology and infrastructure to ensure continued safe, reliable, modern railway service to our customers in Philadelphia, Bucks, Chester, Delaware, and Montgomery counties.

This Project Includes
Text: Installing new, air-conditioned waiting area.
Renewing the Victorian era architecture.
Renovating passenger tunnel, and other access.
Modernizing rest room facilities.
Providing fully accessible facilities for the disabled.

Cost
Text: 34.3 Million

Planned Completion
Text: Spring 1999

For further Project Information Call 215.580.7

Spec Sheet for Capital Improvement Projects
- This document is prepared in QuarkXPress v3.32
- The fonts used are Goudy
- The colors used are septa logo: reflex blue + warm red background color: pantone 120
- The art files used are PENNDOT/reflex blue+122 septa/logo/reflexblue/warmed SUN/122 USDOT/reflexblue
- This document is prepared 1/4 size. The document is 12" x 18" and needs to be enlarged to a final size of 48" x 72"
- ALL point sizes are specified @ the 12" x 18" scale.

H1 . . . . . . . . . . . . 102/76 Goudy bold; 100% reflex blue; space after p6
H2 . . . . . . . . . . . . 46/50 Goudy; 100% reflex blue; space after .5"
H3 . . . . . . . . . . . . 38/37 Goudy bold; 100% reflex blue,
4pt reflex blue rule above, offset .5" 4pt rule reflex blue rule below, offset .5"; space after .5"
H4 . . . . . . . . . . . . 30/39 Goudy bold; 100% reflex blue
Text . . . . . . . . . . . . 21/29 Goudy; 100% reflex blue; space after 1p6
Logo Credit: 17/21 Goudy, 100% reflex blue
No Trespassing Sign Samples

No Loitering-Dumping signs

**NO LOITERING**
Violators Subject to Penalties and Fines

18" x 12" PMS 186

**NO DUMPING**
Violators Subject to Penalties and Fines

No Smoking sign

**NO SMOKING**

8.5" x 11"/12" x 18"
PMS 186, black

 Courtesy sign

**PLEASE**

No Smoking
No Eating
No Drinking

15" x 5" PMS Reflex Blue

Revised 8-12-05

No Tresspassing

**WARNING**

NO TRESPASSING

AUTHORIZED PERSONNEL ONLY

All Others WILL Be Prosecuted in Accordance With Section 3560 of the Pennsylvania Crimes Code.

12" x 18"
PMS 186, black

Revised 5-12-06
SECTION 01590

SEPTA FIELD OFFICE

PART 1 - GENERAL

1.01 Description

A. At a location acceptable to the SEPTA Project Manager and within twenty-one (21) days after Notice to Proceed (NTP); the Contractor shall provide and maintain until completion of the work a temporary field office for the occupancy and use of SEPTA and its employees, with a minimum of 600 square feet of usable area divided into two (2) areas, and equipped as specified in this Section. At the completion of the work the Contractor shall provide for the removal of the temporary field office and its contents. The Contractor will consult the SEPTA Project Manager for the placement of the SEPTA field trailer.

1.02 Related Sections

A. Section 01010 – Summary of Work
B. Section 01300 – Submittals
C. Section 01305 – Requests for Information
D. Section 01400 – Quality Requirements
E. Section 01500 – Construction Facilities and Temporary Controls

1.03 Submittals

A. In accordance with Section 01300, submit within fourteen (14) days after receipt of the NTP a plan detailing SEPTA’s office and associated appurtenances including parking and a bill of materials of all required office equipment and supplies for the review of the SEPTA Project Manager.

PART 2 - PRODUCTS

2.01 Furnishing

A. Furnish field office with the following equipment and furniture. All must be in like-new condition except where indicated as new:

1. One (1) desk (60 inches x 30 inches) with one (1) file drawer and three (3) drawers, all lockable, and swivel chair for the desk.
2. One (1) desk lamp.
3. One (1) 4 foot x 8 foot drafting table and padded stool.
4. One (1) new all-in-one fax/printer/copier/scanner machine with letter, legal and 11 inch x 17 inch size capability. All-in-one machine shall be floor standing type (not desktop style).
5. One (1) new desktop Personal Computer (PC) Intel Core quad processor or most current Intel offering, 3GHz processor with 9 GB RAM, 1.5 TB hard drive, 23 inch LCD flat panel display with 1920 x 1080 resolution, videocard, Integrated 10/100 ethernet, 15 in 1 memory card reader. Minimum four (4) USB ports, dual optical drives consisting of 16x DVD-ROM drive and 16x DVD+/-RW, Norton Internet Security and anti-spyware and with antivirus subscription maintained, a ten (10) pack of DVD+R discs, fifty (50) pack CD-R, fifty (50) standard size CD cases, CD label kit with one hundred (100) laser compatible CD labels, Roxio Easy Media Creator, for all software, the original CD media and hard copy manuals, soundcard, speakers, 104+ keyboard, mouse and pad, Windows 7 or latest version, most current version of MS Office Professional.

6. One (1) new HP Color LaserJet Professional CP5225dn printer or equal. Must be able to print up to and including 11 inch x 17 inch sheets.

7. A continuous supply of new color and black toner supplies for all printers and all-in-one machines as needed throughout the Contract duration.

8. One (1) new rolling plan storage rack with six (6) sticks.

9. Two (2) new file cabinets with four (4) legal-sized drawers, fire resistant, with lock and two (2) keys.

10. Two (2) new bookcases (36 inches x 42 inches) with four (4) shelves.

11. One (1) new conference table (48 inches x 96 inches).

12. Twelve (12) new folding chairs.

13. Two (2) new swivel-type desk armchairs with arm rests.

14. One (1) coat rack and ten (10) plastic hangers.

15. One (1) new whiteboard (60 inches x 36 inches), wall mounted with multi-color pens (minimum of six (6) colors, in both thick and thin tip styles), eraser and supply of erasing wipes. Provide continuous supply of multi-color pens and erasing wipes throughout Contract duration.

16. One (1) fire extinguisher, 15 to 20 pound, ABC type.

17. Two (2) wastepaper baskets.

18. One (1) storage cabinet (36 inches x 18 inches x 72 inches) with lock.

19. One (1) new refrigerator with freezer. Minimum 3.3 cubic feet or larger size.

20. One (1) new automatic drip coffee machine (Ten (10) cup capacity).

21. One (1) complete first aid kit.

22. One (1) new combination water cooler/refrigerator (1 cubic foot minimum), Kelvinator Design Series with hot- and cold-water spigots. Provide bottled water as needed for duration of Contract.

23. One (1) drinking cup dispenser and continuous supply of drinking cups.

24. Three (3) telephones, one (1) with answering service provided through the telephone company.
25. One (1) new microwave oven, minimum 0.07 cubic meter in size. Minimum power output to be 1000 watts.

26. One (1) wall clock.

27. One (1) thermometer (ambient).

28. One (1) high resolution digital camera with larger internal storage and all associated leads for charging and transferring data via USB.

29. All furnishings and equipment are the property of the Contractor.

B. Office Supplies:
   1. One (1) stapler.
   2. Three (3) 2 inch, three (3) ring loose leaf binders.
   3. Two (2) 6 foot, wood folding rules.
   4. Two (2) 25 foot minimum, cloth tapes.
   5. Two (2) sets, heavy duty rain gear and slip on mud boots.
   6. All office supplies shall become the property of SEPTA upon completion of the work.

PART 3 - EXECUTION

3.01 Office
   A. Weather-tight, with barred windows and doors, each equipped with screens and adequate locking devices. Exterior doors shall be equipped with cylinder locks and dead bolts, both keyed alike with two (2) keys and also provided with burglarproof bars and locks across the doors.
   B. Exterior wall, ceilings and floors to be covered with insulation.
   C. Floor covered with resilient flooring material such as asphalt tile or linoleum.
   D. Restroom with lavatory, toilet, soap holder, toilet paper, holders, paper towel dispenser, wastepaper basket, mirror, and hot and cold water supply, or restroom facilities commensurate with the Contractor’s own on-site facilities.
   E. Sufficient lighting to provide a minimum of 100-foot candles at desk light uniformly in all areas.
   F. Grounded duplex electrical receptacles around interior walls at approximately 10 foot spacing.
   G. Automatically controlled heating and air-conditioning systems with thermostats, capable of maintaining the office at an ambient temperature ranging between 64°F and 78°F. The Contractor shall provide fuel and bear all costs in connection therewith.
   H. The Contractor shall provide water, sewer and electrical utility service as required.
   I. The Contractor shall provide continuous telephone service within the field office and bear all costs in connection therewith, including long distance telephone charges until final
completion and acceptance of the work. The Contractor shall coordinate with SEPTA for provision of the phone line to meet the requirements as follows:

1. One (1) separate unit with two (2) separate phone lines into the field engineer's area.
2. One (1) telephone answering machine.
3. Provide broad band internet service to the computer in SEPTA office.

3.02 Maintenance and Service

A. The Contractor shall provide all electrical and telephone tie-ins for the field office and provide continuous maintenance of utility tie-ins during the construction period.

B. The Contractor shall provide continuous maintenance during the construction period including daily janitorial service for offices and toilet facilities and provide toiletry supplies as necessary. The Contractor shall clean the windows biweekly.

C. The Contractor shall repair or refinish damaged areas as required.

D. The Contractor shall provide supplies for the copying machine for an average usage of approximately five hundred (500) copies per month.

E. The Contractor shall repair or replace the printer and/or all-in-one machine and related equipment within twenty-four (24) hours of becoming inoperable or defective.

F. The Contractor shall pay cost of all utilities including long distance telephone usage.

G. The Contractor shall be responsible for all maintenance, warranty, licensing, and replacement of the Desktop Personal Computer hardware, software and associated appurtenances during the construction Contract period.

3.03 SEPTA Parking

A. The Contractor shall provide a minimum of three (3) parking spaces at the trailer location for SEPTA's exclusive use during the entire Contract duration.

3.04 Security

A. The Contractor shall guard against unauthorized or illegal entry and protect the field office against vandalism, theft and mischief. The Contractor shall be responsible for the replacement and/or compensation for any item owned by SEPTA or its employees, which are related to the subject work, removed or damaged as the result of vandalism, theft, mischief or illegal entry to the field office.

3.05 Removal

A. Upon Contract completion, as determined by the SEPTA Project Manager, the Contractor shall remove the temporary field office and its contents (equipment and furnishings) from the worksite.

END OF SECTION
SECTION 01600

MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements regarding transportation, handling, storage and protection. This Section also identifies product options and substitution procedures, described to permit direct reference from individual product specification sections.

B. Work items included:
   1. Products.
   2. Transportation and handling.
   3. Storage and protection.
   4. Repair and replacement.
   5. Product options.

C. Pay all costs associated with equipment shipping including transportation costs, insurance and custom’s fees. Obtain all relevant shipping approvals and permits prior to shipping.

D. Additional requirements for traction power equipment are included in Section 01612. In case of conflict the more stringent requirement shall prevail.

1.02 Related Sections

A. SEPTA Agreement: Paragraph XII regarding substitution and payment of stored materials, and paragraph XIV regarding Value Engineering.

B. Section 01010 – Summary of Work

C. Section 01060 – Regulatory Requirements and Safety

D. Section 01300 – Submittals

E. Section 01305 – Requests for Information

F. Section 01400 – Quality Requirements

G. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

H. Products as specified in Divisions 2-16.

1.03 Submittals

A. Refer to Section 01300 for submittal requirements.

1.04 Quality Assurance

A. The Contractor shall include in its Quality Assurance Program (QAP) such procedures as are required to assure full protection of SEPTA property, new work and delivery of materials.
1.05 Manufacturer’s Recommendations
   A. The Contractor shall meet the manufacturer’s recommendations on product handling, storage, and protection except as noted in the Contract Documents or otherwise approved by SEPTA.

1.06 Products
   A. The Contractor shall not reuse materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
   B. The Contractor shall provide interchangeable components of the same manufacturer, for components being replaced.

1.07 Transportation and Handling
   A. The Contractor shall transport and handle products in accordance with the manufacturer’s instructions.
   B. The Contractor shall promptly inspect shipments to ensure that products meet the requirements, quantities are correct and products are undamaged. The shipments shall be unpackaged to inspect for compliance, quantities and damage and then re-stored.
   C. The Contractor shall provide equipment and personnel to handle products by methods to prevent soiling, disfigurement or damage.
   D. The Contractor shall deliver products to the job site in their manufacturer’s original container, with labels intact and legible.
      1. The Contractor shall maintain packaged materials with seals unbroken and labels intact until time of installation.
      2. The Contractor shall promptly remove damaged material and unsuitable items from the job site, and promptly replace with materials meeting the specified requirements, at no additional cost to SEPTA.
   E. SEPTA may reject, as non-complying, such material and products that do not bear satisfactory identification as to manufacturer, grade, quality and other pertinent information.

1.08 Storage and Protection
   A. The Contractor shall store and protect products in accordance with the manufacturer’s instructions, with seals and labels intact and legible.
   B. The Contractor shall store sensitive products in weather tight, climate controlled enclosures.
   C. For exterior storage of fabricated products, place on sloped supports, above ground.
   D. The space available for storage of material is limited. The Contractor shall make off-site arrangements for storage and staging. Deliver material to the site as required, so as not to affect work progress of other Contractors and create unsafe conditions.
   E. The Contractor shall protect all finished surfaces and equipment.
   F. The Contractor shall provide protection for finished floor surfaces prior to allowing equipment or materials to be moved over such surfaces.
G. The Contractor shall maintain finished surfaces and equipment clean, unmarred and suitably protected until final acceptance by SEPTA.

H. The Contractor shall not store fuel, explosives, or other volatile or hazardous materials within the limits of the site.

I. The Contractor shall assure that on-site storage of material and conditions are legally provided and maintained, and all waste materials are disposed of in a legal way, including the requirements of Pennsylvania Department of Environmental Protection and the Township Department of Health having jurisdiction.

1.09 Repairs and Replacement

A. In event of damage, the Contractor shall promptly make replacements and repairs at no additional cost to SEPTA.

B. Additional time required to secure replacements and to make repairs will not be considered by SEPTA as legitimate justification for a Contract extension.

1.10 Product Options

A. Products specified by reference standards or by description may be used regardless of manufacturer.

B. Products of manufacturers named and meeting specifications, no options or substitutions, except as otherwise provided in the Contract Documents.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
THIS PAGE NOT USED
SECTION 01612

DELIVERY, STORAGE AND HANDLING – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Deliver, store and handle of all equipment from manufacturing plants to the construction site or Contractor provided storage facility. Pack, load, transport and unload all equipment. Access to the sites is by public roads, except Neshaminy where active SEPTA railroad tracks have to be crossed.

B. Accept the delivered equipment and immediately check for any damage that may have occurred during shipment before storing. Arrange inspection by the manufacturer where required. Replace any damaged equipment.

C. Pay all costs associated with equipment shipping including transportation costs, insurance and custom’s fees. Obtain all relevant shipping approvals and permits prior to shipping.

1.02 Related Sections

A. All requirements that are described in Division 1.
B. Section 01452 – Contractor Quality Control – Traction Power Equipment
C. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment
D. Section 01822 – Demonstration and Training – Traction Power Equipment
E. Section 01832 – Operations and Maintenance Manuals -Traction Power Equipment
F. Section 05090 – Metal Fasteners, Joining and Welding
G. Section 09910 – Paints and Coatings
H. Section 16050 – Basic Electrical Materials and Methods
I. Section 16052 – General Electrical Requirements – Traction Power Equipment
J. Section 16060 – Grounding and Bonding
K. Section 16075 – Electrical Identification
L. Section 16270 – Distribution Transformers
M. Section 16275 – Installation of Traction Power Autotransformers
N. Section 16290 – Protective Devices and Instrument Transformers
O. Section 16331 – Installation of Circuit Breakers (ABB)
P. Section 16335 – Surge Protection
Q. Section 16791 – Combined Relay and Control Switchboard
R. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI
S. Section 16952 – Electrical Testing – Traction Power Equipment (RRD)
PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Preparation

A. General:

1. Pack all equipment into crates or containers in accordance with the manufacturer’s recommendations. Pack in a dry and clean area. Wrap all equipment in weatherproof coverings to protect the equipment from moisture and dust. Pad all equipment for protection against mechanical damage.

2. Provide adequate quantity of desiccants to keep the moisture out of the equipment crates and containers. Provide additional quantity of desiccants for travel over oceans and waterways and provide packing which shall prevent damage from water spray.

3. Brace all crates or containers to protect the equipment against damage due to vibration.

4. Provide tilt and shock indicators prior to shipping on the autotransformers and circuit breaker assemblies. The indicators shall record tilts of more than 20 degrees and shocks of more than 0.5 g in any direction. The indicators shall not be removed until the equipment is in its permanent installed position.

5. SEPTA shall inspect the indicators before the equipment is unloaded from its carrier and again after it is in permanent installed position before the indicators are removed. Coordinate with SEPTA and provide all men and material for inspection.

6. Survey the route to verify no delivery conflicts. Ensure that all equipment can be delivered to site by road trailers.

7. Ship equipment only upon written approval from SEPTA after factory tests. Ship only equipment in mint condition. Inspect content of all packages prior to shipping and upon arrival.

8. Deliver all products to the site in the manufacturer’s original packing. Upon arrival at site, verify that no damage has been caused in transit.

9. Provide sufficient notice to SEPTA before unloading the autotransformers, circuit breaker assemblies and the autotransformer circuit breakers and to enable witnessing the same.

10. In the event that components are missing, inform the equipment supplier immediately and request advice from SEPTA on how to proceed.

11. In the event of damage, inform the shipper, SEPTA and the equipment supplier immediately and request advice on how to proceed. Take photographs of the damaged equipment, and prepare a written report describing the detected damage and actions taken upon delivery.

12. Insure the test equipment against damage and loss in shipment or during use.

B. Circuit Breakers:
1. Coordinate the delivery with SEPTA. Refer to Section 16331.

C. Autotransformers:
1. Coordinate the place and time of delivery with SEPTA. Refer to Section 16275.

### 3.02 Storage and Handling

A. Store all products in an environment recommended by the manufacturer of the product.

B. Immediately upon arrival at the site or the staging area, store the equipment in dry place protected from the elements. Provide temporary power supply to the circuit breaker and control cabinet anti-condensation space heaters to prevent damage from condensation.

C. Indoor Equipment:

1. Store all indoor equipment, such as the relay and control switchboard, batteries and chargers, SCADA remote terminal unit, indoors until the time when the substation or switching station building is ready to accept the equipment.

2. Store the equipment in weatherproof coverings in a dry and ventilated area in accordance with the manufacturer’s recommendations.

D. Outdoor Equipment:

1. Store all outdoor equipment, such as the 12 kV and 24 kV circuit breakers, autotransformers, disconnect switches and surge arresters, duly protected from weather until the time the concrete pads and steel structures are installed and ready to accept the equipment.

2. Ensure that no condensation takes place in the control cabinets of the circuit breakers.

**END OF SECTION**
SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 Description
   A. This Section specifies the requirements for closing out the Contract in addition to those requirements specified in Paragraph XII of the Agreement.
   B. Contract closeout is the term used to describe collective Contract requirements that are to be fulfilled near the end of the Contract term in preparation for final acceptance and occupancy of the work by SEPTA, as well as final payment to the Contractor and the completion of the Contract.
   C. If in the event that the work of the Contract is completed in stages and/or portions of the work is completed to the full satisfaction of SEPTA and SEPTA is to utilize that completed stage and/or portion, SEPTA shall issue a certificate of substantial completion in accordance with Article 1.03 in this Section.

1.02 Related Sections
   A. Other specific requirements of the Agreement affecting closeout of the Contract.
   B. Section 01300 – Submittals
   C. Section 01305 – Requests for Information
   D. Section 01400 – Quality Requirements
   E. Section 01710 – Final Cleaning
   F. Section 01720 – Project As-Built Documents
   G. Section 01822 – Demonstration and Training – Traction Power Equipment
   H. Section 01830 – Operations and Maintenance Data

1.03 Prerequisites to Substantial Completion
   A. The Contractor shall complete the following before requesting the SEPTA Project Manager's inspection for certification of substantial completion, either for the entire work or for portions of the work. List known exceptions in the request.
      1. What constitutes substantial completion will be determined by the SEPTA Project Manager.
      2. In the progress payment request that coincides with, or is the first request following the date substantial completion is claimed, activities should be either 100 percent complete for the portion of the work claimed as "substantially complete", or list incomplete items, the value of incomplete work, and reasons for the work being incomplete. Include supporting documentation for completion as indicated in the Contract Documents.
      3. Submit written certification to the SEPTA Project Manager that the Contract, or designated portion thereof, is substantially complete.
4. Submit list of items to be completed or corrected, and material delivery dates of major items as applicable.

5. Advise SEPTA of pending insurance change-over requirements.

6. All Contract record documents, maintenance manuals, warranties, and bonds shall be submitted as defined in the Agreement, Section 01720 and Section 01830.

7. Obtain and submit releases enabling SEPTA full, unrestricted use of the work and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.

8. Deliver any access tools, and material stock as required and further defined in Section 01830.

9. All maintenance instructions and training for SEPTA's personnel shall be completed as defined in Section 01822 and Section 01830.

10. Discontinue or change over and remove temporary facilities and services from the Project site as directed by the SEPTA Project Manager along with construction tools and facilities, mock-ups and similar elements.

11. Touch up and otherwise repair and restore marred exposed finishes.

B. Upon receipt of the Contractor's requests for inspection, the SEPTA Project Manager will either proceed with inspection or advise the Contractor of unfilled prerequisites.

1. Following the initial inspection, the SEPTA Project Manager will either prepare the certificate of substantial completion, or will advise the Contractor of work which must be performed before the certificate will be issued. The SEPTA Project Manager will repeat the inspection when requested and when assured that the work has been completed.

2. Results of the completed inspection will form the initial "punchlist" for final acceptance.

3. The "punch list" shall include a reasonable time period to effectuate the work which is mutually agreed upon by all parties.

1.04 Prerequisites to Final Acceptance

A. The Contractor shall complete the following before requesting the SEPTA Project Manager's final inspection for certification of final acceptance, and final payment as required by the Agreement, specifically Agreement Paragraphs XII: F. and I. and VIII H. The Contractor shall list known exceptions, if any, in the request.

1. Submit the final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.

2. Submit an updated final statement, accounting for final additional changes to the Contract sum.

3. Submit a certified copy of the SEPTA Project Manager's final "punch-list" which documents all work which has been completed.
4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data either of the date of substantial completion, or else when SEPTA took possession of and responsibility for corresponding elements of the work.

5. Submit consent of surety, affidavit of payments of debts and claims, affidavit of release of liens, general release by trade contractor of SEPTA, guarantee against defects, any warranties and maintenance bonds, any special documentation such as copy of the Engineer or DER permits or certification of occupancy.

6. Submit evidence of final, continuing insurance coverage which meets the insurance requirements.

7. Submit any remaining record documents and drawings (including as-built drawings), maintenance manuals, final project photographs, damage or settlement survey, property survey, and similar final record information.

B. The SEPTA Project Manager will re-inspect the work upon receipt of the Contractor's notice that the work, including punch-list items resulting from earlier inspections, has been completed, except for those items whose completion has been delayed because of circumstances that are acceptable to the SEPTA Project Manager.

1. Upon completion of re-inspection, the SEPTA Project Manager will either prepare a certificate of final acceptance, or will advise the Contractor of work that is incomplete or of obligations that have not been fulfilled, but which are required for final acceptance.

2. If necessary, the re-inspection procedure will be repeated.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
THIS PAGE NOT USED
SECTION 01710

FINAL CLEANING

PART 1 - GENERAL

1.01 Description
   A. This Section details the work included throughout the construction period, to maintain the buildings, site and drainage system within the Contract limit, in a standard of cleanliness as described in this Section.

1.02 Related Sections
   A. Section 01045 – Cutting and Patching
   B. Section 01300 – Submittals
   C. Section 01305 – Requests for Information
   D. Section 01400 – Quality Requirements
   E. Section 01500 – Construction Facilities and Temporary Controls

1.03 Submittals
   A. In accordance with Section 01300, provide the proposed cleaning material and chemicals for the review of the SEPTA Project Manager.

1.04 Quality Assurance
   A. In addition to the standards described in this Section, meet the pertinent requirements of governmental agencies having jurisdiction.
   B. "Clean," for the purpose of the Article, and except as may be specifically provided otherwise, shall be interpreted as meaning the level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.

PART 2 - PRODUCTS

2.01 Cleaning Material and Equipment
   A. Provide required personnel, equipment and materials needed to maintain the specified standard of cleanliness.

2.02 Compatibility
   A. The Contractor shall use only the cleaning materials and equipment which are compatible with the surface being cleaned, as recommended by the manufacturer of the material and acceptable to SEPTA.
   B. The Contractor shall replace surfaces damaged from improper use of material and/or cleaning methods.
PART 3 - EXECUTION

3.01 Final Cleaning

A. Prior to turning over the substantially completed area to SEPTA maintenance, remove from the area all tools, surplus materials, equipment, scrap debris and waste.

1. THE CONTRACTOR SHALL CONDUCT FINAL PROGRESS CLEANING AS DESCRIBED ABOVE. IF ANY OF THE WORK CONTINUES IN THE SUBSTANTIALLY COMPLETED AREA, CONTINUE THE CLEANING SECTION 01500. SCHEDULE FINAL CLEANING DATE AS APPROVED BY SEPTA.

2. De-energize and ground active substation or switching station equipment per the Contractor and SEPTA safety regulations prior to attempting and cleaning of substation, switching station or OCS structures. Unqualified personnel may not enter substation areas, switching station areas or open electrical enclosures.

B. Site:

1. Unless otherwise specifically directed by SEPTA, sweep grade areas within the Contract limit and paved areas adjacent to the site.

2. The Contractor shall completely remove resultant debris.

3. The Contractor shall remove graffiti from all surfaces and restore surface to original condition.

C. Structures:

1. The Contractor shall visually inspect all existing and finished surfaces and remove all traces of soil, waste materials, smudges, graffiti and other foreign matter.

2. The Contractor shall remove all traces of splashed materials from structure within Contract limit and from adjacent surfaces.

3. The Contractor shall remove graffiti to restore structure to original condition.

4. If necessary to achieve a uniform degree of cleanliness, the Contractor shall wash the exterior of the structure with high-pressure detergent.

5. In the event of stubborn stains not removable with detergent, the Contractor shall utilize light sandblasting or other cleaning methods at no additional cost to SEPTA.

6. The Contractor shall remove paint droppings, spots, stains, and dirt from existing and finished surfaces.

7. The Contractor shall clean existing and new glass surfaces and frames inside and outside.

D. Finished Surfaces:

1. The Contractor shall remove all labels and tags that are strictly used for the convenience of manufacturing, assembly, installation and identifications.

2. The Contractor shall clean glass and glazing to a polished condition. Remove substances which are noticeable on surfaces. Replace any broken glass and damaged transparent materials.
3. The Contractor shall clean stainless steel surfaces (including screens) of all foreign material. Finish surfaces with application of buffed polish material as recommended by the manufacturer.

4. The Contractor shall clean existing and new tile surfaces including the grout joints to a dirt and graffiti free condition.

E. Equipment:

1. The Contractor shall wipe surfaces of all mechanical and electrical equipment including system components to a dirt-free condition. Touch up the surfaces to match with the overall finish of the equipment/system component.

2. The Contractor shall verify that the equipment and system components are properly identified as required by the Contract.

END OF SECTION
SECTION 01720

PROJECT AS-BUILT DOCUMENTS

PART 1 - GENERAL

1.01 Description

A. The Contractor, throughout progress of the work, shall maintain an accurate record of changes to the Contract Drawings and Specifications.

B. The Contractor shall at the time of substantial completion, but prior to requesting release of retainage, transfer the changes to a set of final as-built documents, which shall include an as-built set of construction drawings and an annotated set of specifications.

C. The Contractor shall in addition to the defined requirements to provide paper copies, shall also provide approved final as-built documents in an electronic format for SEPTA’s future use. The format of these electronic files shall be approved by the SEPTA Project Manager prior to submission.

1.02 Related Sections

A. Documents affecting work of this Section include, but are not necessarily limited to, the Agreement and Division 1 of these Specifications.

B. Section 01300 – Submittals

C. Section 01305 – Requests for Information

D. Section 01400 – Quality Requirements

E. Other requirements affecting Project as-built documents may appear in other Sections of these Specifications.

1.03 Submittals

A. The Contractor shall meet the requirements of Section 01300.

B. If submittal requirements are not provided in Section 01300, refer to the requirements of this Section to submit record documents at substantial completion of the work.

1.04 Quality Assurance

A. Accuracy of Records:

1. Thoroughly coordinate changes within the as-built documents, making adequate and proper entries on each page of specifications and each sheet of drawings and other documents where such entry is required to show the change properly.

2. Accuracy of records shall be such that future research for items as installed may rely reasonably on information obtained from the approved final record documents.

B. Make entries on the as-built documents on a weekly basis to include all work changes to the work performed during the last week are an accurate representation of the as-built conditions.
C. Use professional draftsperson to prepare to transfer "job set" information to final as-built documents.

1.05 Product Handling

A. Maintain the "job set" of record documents completely protected from deterioration and from loss and damage until completion of the work and transfer of all recorded data to the final as-built documents.

PART 2 - PRODUCTS

2.01 Record Documents

A. Job Set:

1. Following receipt of SEPTA's Notice to Proceed (NTP), the Contractor, shall secure from SEPTA one (1) complete set of all drawings and Specifications comprising the Contract Documents. This "job set" will be maintained at the site to record all as-built changes.
   a. Maintain one (1) record copy of all design documents and change orders at the work site. The design documents shall be continuously annotated to indicate the following:
      1) All design changes in the field.
      2) Substitutions of items of equipment as changes occur.
      3) Additional details not provided on the original design documents.
      4) All other changes, as required, to show a complete “as built” condition.

2. Periodically update the drawings electronically. Upon completion of the construction, when the design documents include all design and field changes, designate and stamp the documents as record documents.

3. At completion of all work ensure the record documents are sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania and submit to SEPTA. All record documents will become the property of SEPTA.

4. Retain all system design and record documents for a minimum of five (5) years from the final acceptance date of each element of work. The documents shall be accessible to SEPTA during this period.

B. Final As-Built Documents:

1. Updated as-built documents of the original Contract Drawings for all updated Contract Drawings. The Contractor shall furnish electronic copies (CD’s) as well as the full size reproducible. At the preconstruction meeting, SEPTA will furnish electronic copies of the Contract Drawings.

2. Additional as-built drawings as necessary, to describe changes during the Contract period that could not be included on the original Contract Drawings.

3. Annotated specifications to include Contract Specifications with all changes made during the Contract period.

4. "As installed" versions of same size drawings of all fabrication, detail and installation drawings.
PART 3 - EXECUTION

3.01 Maintenance of Job Set

A. The Contractor shall, immediately upon receipt of the job set described in Article 2.01/A in this Section, identify each of the documents with the title "AS-BUILT DOCUMENTS - JOB SET."

B. Preservation:
   1. Devise a suitable method for protecting the as-built job set (job set) in consideration of the Contract duration, the probable number of occasions upon which the job set must be taken out for new entries and for examination; the transfer of information on final as-build documents; and the conditions under which these activities will be performed.
   2. Do not use the job set for any purpose except entry of new data, for review by SEPTA and for the transfer of data to final as-built documents.
   3. Maintain the job set at the site of work.

C. Making Entries on Drawings:
   1. Utilize an erasable colored pencil (not ink or inedible pencil) to clearly describe the change by graphic line and note as required.
   2. Date all entries.
   3. Call attention to the entry by a "cloud" drawn around the area or areas affected.
   4. The Contractor shall in the event of overlapping changes, use different colors for the overlapping changes.

D. Revisions:
   1. Transfer all changes to respective specifications and/or drawings set (if appropriate) immediately, as the change is approved.
   2. Make appropriate entries in the drawings as soon as the change is incorporated in the field.

E. Conversion of Schematic Layouts:
   1. The Contract Drawings may indicate arrangements of conduits, circuits, piping, ducts and similar items shown schematically, and it’s not intended to portray precise physical layout.
   2. The Contractor, subject to SEPTA’s written approval, determines final physical arrangement. However, design of future modifications of the facility requires accurate information as to the final physical layout of items, which must be schematically shown on the final as-built drawings.
   3. Show on the job set of as-built drawings dimensions accurate to within English Dimensioning Standards, the centerline of each run of items such as are described in Article 3.01/E/1 in this Section.
      a. The Contractor shall clearly identify the item by accurate note such as "cast iron drain", "galvanized conduit", and the like.
b. The Contractor shall show, by symbol or note, the vertical location of the item ("under slab ", "in ceiling plenum", "exposed", and the like).

c. The Contractor shall make all identification sufficiently descriptive that it may be related reliably to the specification.

3.02 Final Project Record Information

A. The purpose of the final Project as-built documents is to provide factual information regarding all aspects of the work, both concealed and visible, to enable future modifications of the work to proceed without lengthy and expensive site measurement, investigation and examination.

B. Accuracy of Record Data Prior to Transfer:

1. The Contractor is solely responsible for accurate transfer of all field changes and preparing additional reproducible drawings and specification pages.

C. Transfer of Data to Drawings:

1. Carefully transfer change data shown on the job set to the final as-built documents coordinating the changes as required.

2. Clearly indicate at each affected detail and master drawing a full description of changes made during construction, and the actual location of items.

3. Call attention to each entry by drawing a "cloud" around the areas affected.

4. Make changes neatly, consistently, and with the proper media to assure longevity and clear reproduction.

5. Prepare additional reproducible drawings in the same size as the original Contract Drawings for changes to details (including installation and fabrication drawings) incorporated in the construction that could not be corrected on the as-built drawings. These drawings shall be adequately identified and cross-referenced with pertinent drawing(s) to make it part of the final as-built documents.

D. Transfer of Data to Specifications:

1. Accurately and legibly transfer all information from job set to final annotated Project record specifications set.

E. Review and Submittal:

1. Submit the completed set of final as-built documents to SEPTA - all drawing and schematic as-builds for all field equipment and system componentry are to be received in ACAD and PDF formats. For all updated Contract Drawings, the Contractor shall furnish electronic copies (CD's) as well as the full size reproducible. At the preconstruction meeting, SEPTA will furnish electronic copies of the Contract Drawings.

2. Participate in review meetings as required.

3. Make required changes and promptly deliver the final Project as-built documents to SEPTA.

4. Sign each sheet of the record drawings, certifying that they area an accurate representation of the as-built condition.
5. The final approved set of as-built documents shall be conveyed as five (5) paper copies and five (5) copies of the electronic sets.

3.03 **Changes Subsequent to Acceptance**

A. The Contractor has no responsibility for recording changes in the work subsequent to final completion, except for changes resulting from work performed under warranty.

**END OF SECTION**
THIS PAGE NOT USED
SECTION 01752

SPARE PARTS AND MAINTENANCE MATERIALS – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Furnish all spare parts required for operation and maintenance of the supplied equipment and systems for a period of two years.

B. Furnish complete sets of special tools and test equipment required for maintenance and testing of the systems supplied including thermographic test equipment as specified below.

C. Set up inventory of all spare parts, special tools and test equipment in SEPTA’s facility.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control – Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

D. Section 01822 – Demonstration and Training – Traction Power Equipment

E. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

F. Section 16052 – General Electrical Requirements – Traction Power Equipment

G. Section 16060 – Grounding and Bonding

H. Section 16270 – Distribution Transformers

I. Section 16275 – Installation of Traction Power Autotransformers

J. Section 16290 – Protective Devices and Instrument Transformers

K. Section 16331 – Installation of Circuit Breakers

L. Section 16335 – Surge Protection

M. Section 16791 – Combined Relay and Control Switchboard

N. Section 19610 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

O. Section 16952 – Electrical Testing – Traction Power Equipment (RRD)

1.03 Submittals

A. Submit the following documents for SEPTA’s review and approval:

1. Preliminary and final list of all recommended spare parts, special tools and test equipment.

2. Spare parts, special tools and test equipment catalog including the following:
   a. Inventory of all spare parts, special tools and test equipment.
   b. Fixed unit price for all spare parts valid for two (2) years after substation or switching station acceptance by SEPTA.
c. Statement that guarantees availability of all spare parts, special tools and test equipment for a period of twenty (20) years after substation or switching station acceptance by SEPTA.

3. Inventory:
   a. Provide computer-based inventory for all spare parts, special tools and test equipment.

B. Submit the following documents in hard copy and CD ROM formats:
   1. Manufacturer’s descriptive literature.
   2. Product specifications and performance data.
   3. Calibration requirements and instructions.
   4. List of recommended service centers for warranty administration and repair services.
   5. Operation and maintenance manual.
   6. Spare parts list.
   7. All required software.

1.04 Quality Assurance
   A. Meet the applicable provisions of the most recent issues of the following references:
      1. NFPA 70E, Standard for Electrical Safety in the Workplace.

PART 2 - PRODUCTS

2.01 Spare Parts
   A. Spare Parts for Warranty Repairs:
      1. Spare parts ordered by SEPTA for support of revenue operations shall not be utilized by the Contractor for warranty repairs and warranty parts replacements.
      2. Spare parts required for use by the Contractor to provide warranty support are the responsibility of the Contractor. SEPTA will not be responsible for receiving or storing any parts for warranty support.
      3. At the end of the warranty period, SEPTA may, at its discretion, consider a negotiated price for purchase of all spare parts stocked, but not used, by the Contractor for warranty support.

2.02 Special Tools
   A. Furnish special tools required for operation and maintenance of the equipment installed. Special tools include crimping tools, jigs, fixtures, equipment, hand tools, power tools, circuit-board testers and other tools and equipment necessary to maintain, repair, overhaul, assemble and disassemble the equipment, that are not commonly available from commercial tool suppliers.
   B. Any tool that is not found in the catalog or showroom of the following companies is considered a special tool:
      1. Sears.
2. AeroQuip.
5. AMP.
6. MAC.
7. Williams.
10. Starrett.
11. ACE Hardware.
14. Lowe’s.

C. The Contractor shall provide fall protection suitable for use with the fall protection facilities provided on the substation and switching station installations including autotransformers. Fall protection system at the autotransformer is being provided by the transformer supplier. Tower systems manufactured by the following will be suitable:

1. Winsafe Corporation.
2. Or Approved Equal.

2.03 Test Equipment

A. Provide portable high-pot testers, meggers, relay test sets, transducer test and calibration sets, converter test and calibration sets, and printed circuit board testers to test all equipment supplied.

B. Furnish all equipment complete with all cables, connectors, probes and associated equipment to interface with the test points. Provide carrying case for each item of equipment.

C. Furnish self-contained, solid-state, programmable test and calibration equipment with LCD indicating analog and digital displays of appropriate variables, including, but not limited to, volts, and amperes, phase angle degrees.

D. Supply test units to allow rapid identification of failures on individual assemblies to the Lowest Level Replaceable Unit (LLRU). Furnish test equipment using guided-probe technology to the maximum degree possible to test, troubleshoot and calibrate all electrical, electronic, mechanical and electro-mechanical components.

E. All test and calibration equipment shall be designed to generate accurate signals for testing of the connected equipment. Adjustment of signals shall be independent of each other.

F. Use hook-up multi-conductor cables with multi-pin connectors, as appropriate, to establish all connections required. No high-voltage connections to the test equipment are allowed.
G. Provide diagnostic laptop computers, complete with all operations and maintenance manuals, diagnostic software and inventory software loaded. Provide all cables and hard cases.

H. All desktop test equipment shall operate on 120 VAC, 60 Hz. All portable test equipment shall operate on rechargeable batteries. Furnish rechargeable batteries, chargers and adaptors, as required.

2.04 Thermographic Test Instrument

A. General Requirements:

1. Provide a portable, handheld, thermal infrared imager of rugged, durable, compact and lightweight construction housed in a non-conductive and insulating enclosure.

2. Provide an instrument suitable for specific intended use within electrical preventative maintenance applications to determine electrical equipment hot spots from a safe visual distance away from the equipment and capable of providing images in compliance with NFPA 70E electrical arc-flash hazard access limitations.

3. Imaging procedure must be totally self-contained to a handheld unit, without the use of any additional umbilical connecting cords, battery packs or remote processing equipment. Provide simple operating controls and adjustments that do not take extensive field manipulations, tools, setups or pre-calibrations.

4. Fully test and calibrate the thermal imager equipment prior to delivery. Demonstrate calibration in the field.

B. Accessories:

1. Provide the instrument with full complement of accessories, including:
   a. Rechargeable battery that can operate the instrument continuously for a minimum period of three (3) hours without recharge.
   b. Removable battery pack capable of accepting standard and rechargeable type cell batteries.
   c. Permanent charger station for docking and recharging the instrument when not in use, including:
      1) Battery charging indicator lights on the instrument and on the docking station to indicate charging in progress and charging complete.
      2) Standard 120 VAC, 60 Hz line cord.
   d. USB 1.1 computer cable port connectors and associated cable, 5 feet minimum, for I/O exchange between the instrument and computer.
   e. Impact-resistant, carrying, suitcase type protective hard case, capable of holding the instrument, all its accessories, and spare batteries. Provide the case with case handles, toggle latches and a padlock.
   f. Protective covers to protect the lens, displays and connection ports when not in use.
   g. Vial of any special required lens cleaner that is not otherwise commercially available.
   h. All supporting computer software and hardware that is fully compatible with Microsoft Windows operating system.
   i. Provide the following additional accessories:
      1) RS-232 to USB 1.1 adapter.
      2) Wrist strap.
3) Neck strap.

C. Supply thermographic test equipment and accessories as manufactured by one (1) of the following approved manufacturers:

1. Raytek Corporation, ThermoviewTM Ti30 Thermal Imager.
2. Infrared Solutions, IR-Insight T Infrared Camera.

PART 3 - EXECUTION

3.01 Inventory

A. Provide computer-based list for all recommended spare parts, special tools and test equipment. SEPTA will order the required spare parts and special tools.

B. Include manufacturer’s catalog number, description, quantity recommended for being stocked as spares, quantity installed in the system, unit production price, subcontractor markup and price based on the recommended quantities.

3.02 Availability of Spare Parts, Special Tools and Test Equipment

A. Guarantee availability of all spare parts, special tools and test equipment for a period of twenty (20) years after substation or switching station acceptance by SEPTA. Spare parts and specialty tools shall be provided prior to equipment being commissioned.

3.03 Quantities

A. General Spare Parts:

1. Provide as a part of the equipment to be delivered adequate spare parts in sufficient quantities to enable system maintenance for a period of two (2) years after substation or switching station acceptance by SEPTA. The spare parts list to be provided by the Contractor which will be reviewed and approved by SEPTA. The spare parts list shall include, as a minimum, the equipment:
   a. 46 kV two pole autotransformer circuit breakers.
   b. Autotransformers.
   c. 24 KV feeder circuit breakers.
   d. 12 KV trolley circuit breakers.
   e. Protective relays, bay modules and other components on the relay and control board
   f. RTU and associated equipment
   g. Security and intrusion alarm systems
   h. 12 KV and 24 KV disconnect switches.
   i. 60 Hz and 25Hz battery chargers.
   j. Distribution transformers.

2. The Contractor to provide quantity of spare parts for each substation or switching station. Quantity of spare parts to be reviewed and approved by SEPTA.
3. Following items shall be supplied, at a minimum, as the spare parts. Contractor shall develop the list further based on the equipment selected and submit to SEPTA for approval in the final design phase.
   a. One complete circuit breaker of each type
   b. One 60 Hz and one 25 Hz battery charger
   c. One set of bay modules and relays at a substation
   d. Two PCBs for adding additional status points to the RTU
   e. One thousand feet of control cable of each type
   f. Four sets of indicating lamps used at a substation
   g. Two manually operated disconnect switches
   h. One horn gap switch of each type.

END OF SECTION

THIS PAGE NOT USED
SECTION 01820

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 Description

A. Conduct formalized and documented demonstration of the installed equipment and systems to SEPTA staff and their representatives.

B. Provide technical support for the delivered equipment. Ensure availability of expert services from various equipment suppliers on short notice to assist SEPTA on-site personnel in investigation and resolution of equipment malfunctions during commissioning and warranty period.

C. Provide training for SEPTA personnel to enable SEPTA staff to operate, service, and maintain the equipment and systems furnished. Commence training only at direction of SEPTA, after approval of training related submittals and delivery of sufficient amount of equipment spare parts and special tools. Training shall occur prior to the commissioning of the new equipment.

1.02 Related Sections

A. Section 01300 – Submittals
B. Section 01305 – Requests for Information
C. Section 01400 – Quality Requirements
D. Section 01830 – Operations and Maintenance Data
E. Section 13700 – Intrusion Alarm System
F. Section 13850 – Fire Alarm and Detection System
G. Section 15700 – Heating, Ventilating and Air Conditioning Equipment
H. Section 15935 – Building System Controls
I. Section 16240 – Battery Equipment
J. Section 16700 – Communications

1.03 Submittals

A. Submit the following documents for SEPTA’s review and approval:
   1. Detailed resumes of all technical support and training personnel.
   2. Training plan.
   3. Training program.
   4. Training manuals.
   5. Training materials.

B. At the time of training provide one (1) set of handout materials to each student.
C. Submit one (1) record set after completion of training to the SEPTA Project Manager.

PART 2 - PRODUCTS

2.01 Training Personnel

A. Provide experienced and competent training personnel who have direct and complete knowledge of the equipment and systems supplied and are capable of providing detailed explanations of the operation and maintenance of all equipment and systems.

B. Provide training personnel with minimum of ten (10) years of experience in the design, manufacture, installation and maintenance of the equipment.

C. All training personnel shall be fluent in oral and written English, with a complete understanding of the English language.

D. The training personnel shall be subject to approval by SEPTA. SEPTA reserves the right to request personnel replacement for any reason and have the technical support activity or training subject repeated.

E. Insure that instructors teaching the training courses are familiar with technical information and are able to utilize proper methods of instruction, training aids and audiovisual materials to insure effective presentations.

F. Coordinate with SEPTA to determine the student qualifications, number of students in the class, and the level of training required before preparing the training plan, program, manuals and materials.

G. Utilization of equipment supplier presenters is encouraged and supported by SEPTA. The Contractor is responsible for scheduling and cost of supplier presenters.

2.02 Training Plan

A. Develop a training plan that includes the following:

1. Training course outline, including:
   a. Program introduction and overview.
   b. Statement of overall program goals.
   c. Learning objectives specifically describing the desired knowledge to be gained.

2. Lesson schedule.

3. List of printed material, audio aids and visual aids to be used during lessons.

4. Schedule for written and practical tests.

B. As a minimum, include the following topics in the training plan:

1. Warranty program support.

2. Trouble shooting support.

3. Advanced training and continuing education support.

4. Operation and maintenance activities in the field.
5. Developing alternative sources or spare parts and maintaining contact with spare part suppliers.


C. The Contractor is responsible for providing any special equipment needed to make the presentations, such as audio-visual equipment, blackboards, wipe boards, flip charts and projectors.

D. SEPTA will assist the Contractor in the set up and tear down of training aids and models used in presentations.

2.03 Training Program

A. Based on the training plan, develop a comprehensive training program for SEPTA’s personnel to include both classroom and practical hands-on exercise sessions for equipment, systems and subsystems supplied under the Contract.

B. Arrange the training program in multiple classes of six (6) participants each. Each class would have personnel of similar technical background.

C. Design the course to cover all necessary details for performance of:
   1. Equipment operations and its place in the overall system.
   2. Preventive, corrective and overhaul maintenance.
   3. Test procedures.
   4. Equipment safety procedures.

D. Conduct the program at SEPTA provided facilities.

E. Demonstrate the training program to SEPTA’s management.

F. Classes will be held only during daytime. Develop class schedules in coordination with SEPTA.

G. Personnel attending each class will be designated by SEPTA and a list of attending individuals will be provided to the Contractor.

H. Design and give written and practical tests at suitable points of the course to determine the extent to which employees have learned and can apply the information presented. Submit attendance records and test scores to SEPTA.

I. Update lesson plans as required during the course to construction.

2.04 Training Manuals

A. Provide separate (individual) training manuals for operations and for maintenance personnel. SEPTA staff will use the manuals as text books for the training and for future reference.

B. Provide training manuals containing the following:
   1. A discussion of staff prerequisites.
   2. Program overview and goals.
   3. Individual lessons, containing the following:
a. Overview of each lesson and student learning objectives.

b. Instructional methods and learning activities.

c. Required equipment and resources.

d. A fully developed content of each lesson.

e. Illustrations, charts and graphics, as needed, to enhance content of the lessons.

C. As a minimum, include the following training topics:

1. Step-by-step introduction to each equipment and system function and operation, including terminology and identification of components.

2. Detailed theory of operation to explain theoretical background of operation of equipment being furnished.

3. Routine care including frequency of inspection, cleaning, lubrication and adjustments to include manpower and time requirement.

4. Identification of problem symptoms, troubleshooting procedures and repair (emergency and permanent) procedures.

5. Demonstration of taking out of service, repairing, maintaining, testing and placing into service all components of the system.

6. Demonstration of shutdown and re-starting procedures.

7. Demonstration of disassembly and reassembly of systems and components.

8. Instruction in the use and maintenance of special tools and techniques to perform complex maintenance functions in the field and in the shop.

9. Safety instruction for operation and maintenance activities.

D. Provide illustration with high resolution presentation suitable for producing high-quality images when projected on a typical classroom presentation screen.

E. Maintain, upgrade, and update the training manuals to include the latest data and information. Such maintenance of the training manuals may be performed remotely with notice to SEPTA. With each notice include a list of changes and the location of each change within the training manuals.

F. SEPTA reserves the right record any or all training presentations and activities by the Contractor for its sole use without costs, obligation or liability to SEPTA.

G. Prepare the training manuals in hard copies and electronic format as specified in Section 01830.

### 2.05 Training Materials

A. Provide all training aids, audiovisual equipment and visual aids for the courses.

B. Submit all training materials for approval. Provide one (1) set of training materials per student. The training materials shall include all materials for the students to interact in the learning situations.

C. Provide an adequate supply of high-quality, professionally prepared authoritative and up-to-date reference materials as well as other training aids necessary to impart the essential knowledge to SEPTA staff.
D. Work closely with SEPTA during development of training materials to ensure that the course organization, content and overall quality of training materials meet SEPTA expectations.

E. Use spare parts already supplied to SEPTA to facilitate hands-on training for educational purposes.

F. Restore all equipment utilized for training purposes to as new condition.

G. Illustrate operation of significant components using diagrams or cut-away views.

H. Demonstrate component locations by component cutaways, schematics and wiring diagrams.

I. All training materials shall become the property of SEPTA at the completion of the training program. SEPTA reserves the right to duplicate, at its expense, all films, slides, view graphs, tapes and handouts for its sole use.

J. Replace all training-damaged materials unless the damage resulted from neglect by SEPTA.

PART 3 - EXECUTION

3.01 Duration of Technical Support

A. Begin technical support starting on the day of the equipment acceptance.

B. Provide technical support for the period of one (1) year from substantial completion.

3.02 Training Requirements

A. Provide minimum hours of training for each class for each major items of equipment as shown in Table 01820-1.

Table 01820-1 Training Requirements

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Length of Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC Equipment and Building Controls</td>
<td>One (1) class, four (4) hours each</td>
</tr>
<tr>
<td>Battery Equipment</td>
<td>Two (2) classes, four (4) hours each</td>
</tr>
<tr>
<td>Communications, Security and Fire Alarm Systems</td>
<td>Two (2) classes, eight (8) hours each</td>
</tr>
</tbody>
</table>

END OF SECTION
THIS PAGE NOT USED
SECTION 01822

DEMONSTRATION AND TRAINING – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description
A. Conduct demonstration of the installed equipment and systems to SEPTA staff and their representatives.
B. Provide technical support for the delivered equipment. Ensure availability of expert services from various equipment suppliers on short notice to assist SEPTA on-site personnel in investigation and resolution of equipment malfunctions during commissioning and warranty period.
C. Provide training for SEPTA personnel to enable SEPTA staff to operate, service, and maintain the equipment and systems furnished. Commence training only at direction of SEPTA, after approval of training related submittals and delivery of sufficient amount of equipment spare parts and special tools.
D. The training shall occur before the stage 1 commissioning of the new equipment at each substation.

1.02 Related Sections
A. All requirements that are described in Division 1.
B. Section 01452 – Contractor Quality Control – Traction Power Equipment
C. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment
D. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment
E. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment
F. Section 16052 – General Electrical Requirements – Traction Power Equipment
G. Section 16060 – Grounding and Bonding
H. Section 16270 – Distribution Transformers
I. Section 16275 – Installation of Traction Power Autotransformers
J. Section 16290 – Protective Devices and Instrument Transformers
K. Section 16331 – Installation of Circuit Breakers
L. Section 16335 – Surge Protection
M. Section 16791 – Combined Relay and Control Switchboard
N. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – including HMI
O. Section 16952 – Electrical Testing – Traction Power Equipment (RRD)

1.03 Submittals
A. Submit the following documents for SEPTA’s review and approval:
1. Detailed resumes of all technical support and training personnel.
2. Training plan.
3. Training program.
4. Training manuals.
5. Training materials.

PART 2 - PRODUCTS

2.01 Technical Support and Training Personnel
   A. Provide experienced and competent technical support and training personnel who have
direct and complete knowledge of the equipment and systems supplied and are capable of
providing detailed explanations of the operation and maintenance of all equipment and
systems.
   B. Provide technical support and training personnel with minimum of ten (10) years of
experience in the design, manufacture, installation and maintenance of the equipment.
   C. All technical support and training personnel shall be fluent in oral and written English, with a
complete understanding of the English language.
   D. The technical support and training personnel shall be subject to approval by SEPTA. SEPTA
reserves the right to request personnel replacement for any reason and have the technical
support activity or training subject repeated.
   E. Technical support personnel shall be under direction of SEPTA’s management staff and shall
be integrated with SEPTA’s staff and shall participate in activities of SEPTA personnel. The
technical support personnel shall be available by phone twenty-four (24) hours a day, seven
(7) days a week and available for site work within twenty-four (24) hours, or as may be
required by the nature of the problem to be resolved and SEPTA’s working schedule.
   F. Ensure that all instructors teaching the training courses are familiar with all technical
information and are able to utilize proper methods of instruction, training aids and
audiovisual materials to insure effective presentations.
   G. Coordinate with SEPTA to determine the student qualifications, number of students in the
class and the level of training required before preparing the training plan, program, manuals
and materials.
   H. Utilization of equipment supplier presenters is encouraged and supported by SEPTA. The
Contractor is responsible for scheduling and cost of supplier presenters.

2.02 Training Plan
   A. Develop a training plan that includes the following:
      1. Training course outline, including:
         a. Program introduction and overview.
         b. Statement of overall program goals.
         c. Learning objectives specifically describing the desired knowledge to be gained.
2. Lesson schedule.
3. List of printed materials, audio aids and visual aids to be used during lessons.
4. Schedule for written and practical tests.

B. As a minimum, include the following topics in the training plan:
   1. Reliability program support.
   2. Warranty program support.
   3. Trouble shooting support.
   4. Training and continuing education support.
   5. Technical support for maintenance activities in the field.
   6. Developing alternative sources of spare parts and maintaining contact with spare part suppliers.

C. The Contractor is responsible for providing any special equipment needed to make the presentations, such as audio visual equipment, blackboards, wipe boards, flip charts, and overhead or slide projectors.

D. SEPTA will assist the Contractor in the set up and tear down of training aids and models used in presentations.

2.03 Training Program
A. Based on the training plan, develop a comprehensive training program for SEPTA’s personnel to include both classroom and practical hand-on exercise sessions for all equipment, systems and subsystems supplied under the Contract.

B. Arrange the training program in three (3) classes of six (6) participants each. Each class would have personnel of similar technical background.

C. Design the course to cover all necessary details for performance of:
   1. Equipment operations and its place in the system.
   2. Preventive, corrective and overhaul maintenance.
   3. Test procedures.
   4. Equipment safety procedures.

D. Conduct the program at SEPTA-provided facilities.

E. Demonstrate the training program to SEPTA’s management.

F. Classes will be held only during daytime. Develop class schedules in coordination with SEPTA.

G. Personnel attending each class will be designated by SEPTA and a list of attending individuals will be provided to the Contractor.

H. Design and give written and practical tests at suitable points of the course to determine the extent to which employees have learned and can apply the information presented. All attendance records and test scores will be kept by SEPTA.
I. Update lesson plans as required during the course of design and construction.

2.04 Training Manuals

A. Provide separate training manuals for operations and for maintenance personnel. SEPTA staff will use the manuals as text books for the training and for future reference.

B. Provide training manuals containing the following:
   1. A discussion of staff prerequisites.
   2. Program overview and goals.
   3. Individual lessons, containing the following:
      a. Overview of each lesson and student learning objectives.
      b. Instructional methods and learning activities.
      c. Required equipment and resources.
      d. A fully developed content of each lesson.
      e. Illustrations, charts and graphics, as needed, to enhance content of the lessons.

C. As a minimum, include the following training topics:
   1. Step-by-step introduction to each equipment and system function and operation, including terminology and identification of components.
   2. Detailed theory of operation. Explain theoretical background of operation of all equipment being furnished.
   3. Routine care including frequency of inspection, cleaning, lubrication and adjustments. Include manpower and time requirement.
   4. Identification of problem symptoms, troubleshooting procedures and repair procedures and demonstration of taking out of service, repairing, maintaining, testing and placing into service all components of the system.
   5. Demonstration of shutdown and re-starting procedures.
   6. Demonstration of disassembly and reassembly of systems and components.
   7. Instruction in the use and maintenance of all special tools and techniques to perform complex maintenance functions in the field and in the shop.
   8. Safety instruction for all maintenance activities.

D. Provide all illustrations with high resolution presentation suitable for producing high-quality images when projected on a typical classroom presentation screen.

E. Maintain, upgrade, and update the training manuals to include the latest data and information. Such maintenance of the training manuals may be performed remotely with notice to SEPTA. With each notice include a list of changes and the location of each change within the manuals.

F. SEPTA reserves the right to video tape and/or audio tape any or all training presentations and activities by the Contractor for its sole use, without costs, obligation or liability to SEPTA.
G. Prepare the training manuals in hard copies and electronic format as specified in Section 01832.

2.05 Training Materials

A. Provide all training aids, audiovisual equipment and visual aids for the courses.

B. Submit all training materials for approval. Provide one (1) set of training materials per student. The training materials shall include all materials for the students to interact in the learning situations.

C. Provide an adequate supply of high quality, professionally prepared authoritative and up-to-date reference materials as well as other training aids necessary to impart the essential knowledge to SEPTA staff.

D. Work closely with SEPTA during development of training materials to ensure that the course organization, content and overall quality of all training materials meet SEPTA expectations.

E. Use spare parts already supplied to SEPTA to facilitate hands-on training for educational purposes.

F. Restore all equipment utilized for training purposes to as new condition.

G. Illustrate operation of significant components using diagrams or cutaway views.

H. Demonstrate component locations by component cutaways, schematics and wiring diagrams.

I. All training materials shall become the property of SEPTA at the completion of the training program. SEPTA reserves the right to duplicate, at its expense, all films, slides, view graphs, tapes and handouts for its sole use.

J. Replace all training damaged materials unless the damage resulted from neglect by SEPTA.

PART 3 - EXECUTION

3.01 Duration of Technical Support

A. Begin technical support starting on the day of the equipment acceptance.

B. Provide technical support for the period of one (1) year from substantial completion.

3.02 Training Requirements

A. Provide minimum hours of training for each class for each major item of equipment is shown in Table 01822-1. Split the duration between classroom training and hands-on demonstration at each site.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Length of Training (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autotransformers</td>
<td>Twenty-Four (24)</td>
</tr>
<tr>
<td>Circuit Breakers</td>
<td>Seventy-Two (72)</td>
</tr>
<tr>
<td>Protective Relaying and Control Board</td>
<td>Sixty-Four (64)</td>
</tr>
<tr>
<td>Software for the System</td>
<td>Sixty Four (64)</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>SCADA System</td>
<td>Twenty-Four (24)</td>
</tr>
</tbody>
</table>

**END OF SECTION**
SECTION 01830

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 Description

A. The work of this Section specifies the requirements for preparation and submittal of operations and maintenance data. The data shall be complete and presented in an easily followed format, in accordance with the requirements of this Section.

B. Furnish SEPTA with comprehensive operations and maintenance manuals of all equipment and systems furnished.

C. Prepare manuals uniform in presentation showing all interfaces between equipment and subsystems in sufficient detail to present a complete and clear picture of the equipment and subsystems.

D. Ensure that the nomenclature, functional designations of components and their interconnections are consistent with the as-built drawings.

E. Provide all information needed for optimum and safe maintenance and repair of the equipment.

F. Additional requirements for the traction power equipment operations and maintenance manuals are included in Section 01832.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01305 – Requests for Information

C. Section 01400 – Quality Requirements

D. Section 01410 – Testing and Inspection Services

E. Section 01600 – Material and Equipment

F. Section 01720 – Project As-Built Documents

G. Division 16 Sections.

1.03 Submittals

A. Submit operations and maintenance manuals for each product, equipment and system as follows:

1. One (1) copy of sample format and outline of contents in draft form with the shop drawings.

2. One (1) copy of complete manual in final form on the date of delivery, for review and comment by the SEPTA.

3. Five (5) copies of approved manual after installation and prior to testing.

B. Submit the following manuals for SEPTA’s review and approval:
5. Spare parts manual.

1.04 Quality Assurance
A. Prepare instructions and data by personnel experienced in maintenance and operation of described products, equipment and systems. Data shall be presented in the form of an instructional manual.

1.05 Preparation
A. Prepare manuals using the following materials:
   1. Loose leaf, 20 pound (minimum), three (3) hole punched paper. Bind manuals in heavy duty three (3) ring vinyl covered binders.
   2. Holes reinforced with plastic cloth.
   3. Page size to be 8 1/2 inches by 11 inches.
   4. Foldout diagrams and illustrations. Provide pocket folders for foldout diagrams and illustrations.
   5. Reproducible by dry-copy xerography method.
   6. Oil, moisture and wear-resistant plastic covers.

B. General Requirements for Manuals:
   1. Prepare manuals written in clear grammatical English.
   2. Manuals shall be formatted into three (3) separate parts, namely:
      a. Part 1: Directory to list names, addresses, and telephone numbers of the Architect/Engineer, the Contractor and Subcontractors.
      b. Part 2: Operation and Maintenance Instructions arranged by product or system, and subdivided by Specification Section, and include names, addresses, and telephone numbers of subcontractors and suppliers. Information shall include design criteria, list of equipment, parts lists for each item of equipment, operating instructions, maintenance instructions for equipment, and maintenance instructions for finishes, materials and products.
      c. Part 3: Project Documents and Certificates to include approved shop drawings and product data, testing reports, certificates and copies of warranties and bonds.
   3. Manuals furnished may be the manufacturer's standard publications in regard to size and binding provided they meet the specified requirements relative to quantity and quality of information and data.
   4. Bind manuals within hard or flexible covers. Make illustrations clear, and printed matter, including dimensions and lettering on drawings, easily legible. If reduced drawings are
incorporated into manuals, heavy-up original lines and letters as necessary to retain their legibility after reduction, large drawings may be folded into manuals to page size.

5. Include with each manual electronic media with a searchable PDF format. Enclose the media in an adhesive pocket or bound pocket page, not loose.

6. Clearly identify each manual on the front cover and table of contents pages with at least the following information:

* **OPERATING MANUAL; MAINTENANCE MANUAL; PARTS LIST** or a combination thereof.

C. The content of each manual shall include, but not be limited, to the following elements, as they apply to the specific product, equipment and system:

1. Title page to include the name and function of the equipment, the manufacturer's identification number and the Project Specifications number and title.

2. Table of contents, in numerical order, listing all sections and subsection titles of the operation and maintenance manual with reference to the page on which each starts and a list of included diagrams and drawings.

3. Index in alphabetical order.

4. Front piece recognition illustration of the product, equipment, and system described in the operation and maintenance manual.

5. The manufacturer's literature describing each piece of equipment including major assemblies and subassemblies, and giving the manufacturer's model number and drawing number.

6. Operation instructions including step-by-step preparation for starting, operation, shutdown and draining, and emergency requirements.

7. Diagrams:
   a. Control diagrams as installed by the manufacturer.
   b. Sequence of operation diagrams by the control manufacturer.
   c. Wiring diagrams as installed by the manufacturer.
d. Interlocking diagrams as installed by the manufacturer.
   1) Reproduce diagrams by photographic process to a size not to exceed 11 inches by 17 inches.
   2) Provide only complete, clear and legible diagrams on white paper. Vacuum seal the diagrams in transparent plastic material impervious to moisture and oil, and resist to abrasion.
   3) Other formats which are equal in clarity sharpness, durability and permanence may be considered.
   4) Dimension and lettering on drawings shall be easily legible. If reduced drawings are incorporated into manuals, the original lines shall retain their legibility after reduction. Larger drawings may be folded into manuals to page size. Any reproduction shall be of near perfect quality.

8. The manufacturer’s approved shop drawings.

9. Diagrammatic location, function and tag numbers of each valve.

10. Maintenance instructions to include step-by-step procedures for inspection, operation checks, cleaning, lubrication, adjustments, repair, overhaul, disassembly and reassembly of the equipment for proper operation of the equipment. Include list of special tools that are required for maintenance with the maintenance information.

11. List of possible breakdowns and repairs.

12. The manufacturer's parts list of all functional components, control diagrams and wiring diagrams, giving the manufacturer's model number and the manufacturer's part number.

13. “Long-Lead-Time” spare parts list for all spare parts not readily available on the open market, or for which it is anticipated ordering and delivery time will exceed ten (10) days.

14. List of nearest local suppliers of all equipment parts.

15. Lubrication schedule indicating type and frequency of lubrication.

16. The manufacturer's warranty and guarantee data.

17. List of certificates.

18. Spare parts data as follows:
   a. Complete list of parts and supplies, with current unit prices and sources of supply.
   b. List of parts and supplies that are either normally furnished at no extra cost with purchase of equipment or specified herein to be furnished as part of the Contract.
   c. List of additional items recommended by the manufacturer to assure efficient operation for period of one hundred and twenty (120) days.

19. Appendix including safety precautions, a glossary, and, if available at time of submittal, copies of test reports and other relevant material not specified to be submitted.

20. Delete information on material or equipment not used in the work from the manufacturer’s pre-printed operation and maintenance manual.

21. Format all data contained in the manuals consistently from section to section.

22. Manuals consisting of catalog cuts shall not be acceptable.
23. Supply hard copies of all manuals in approved format and on CD-ROM.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
SECTION 01832

OPERATIONS AND MAINTENANCE MANUALS – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. The work of this Section specifies the requirements for preparation and submittal of operations and maintenance manuals. The manuals shall be complete and presented in an easily followed format, in accordance with the requirements of this Section.

B. Furnish SEPTA with comprehensive operations and maintenance manuals of all equipment and systems furnished for each substation or switching station separately.

C. Prepare manuals written specifically for SEPTA operations and maintenance personnel. Each manual shall contain all information relevant to the substation.

D. Prepare manuals so they are uniform in presentation showing all interfaces between equipment and subsystems in sufficient detail to present a complete and clear picture of the equipment and subsystems.

E. Ensure that the nomenclature, functional designations of components and their interconnections are consistent with the as-built drawings. Equipment designation and labeling shall match as provided on the installed equipment.

F. Provide all information needed for optimum and safe maintenance and repair of the equipment.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control – Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

E. Section 01830 – Operation and Maintenance Data

F. Section 01822 – Demonstration and Training – Traction Power Equipment

G. Section 16052 – General Electrical Requirements – Traction Power Equipment

H. Section 16060 – Grounding and Bonding

I. Section 16270 – Distribution Transformers

J. Section 16275 – Installation of Traction Power Autotransformers

K. Section 16290 – Protective Devices and Instrument Transformers

L. Section 16331 – Installation of Circuit Breakers

M. Section 16335 – Surge Protection

N. Section 16791 – Combined Relay and Control Switchboard
O. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI
P. Section 16952 – Electrical Testing – Traction Power Equipment (RRD)

1.03 Submittals
A. Submit operations and maintenance manuals for each product, equipment and system as follows:
   1. One (1) copy of sample format and outline of contents in draft form with the shop drawings.
   2. One (1) copy of complete manual in final form on the date of delivery, for review and comment by the SEPTA.
   3. Five (5) copies of approved manual after installation and prior to testing.
B. Submit the following manuals for SEPTA’s review and approval:
   5. Spare parts manual.

1.04 Quality Assurance
A. Prepare instructions and data by personnel experienced in maintenance and operation of described products, equipment and systems. Data shall be presented in the form of an instructional manual.

1.05 Preparation
A. Refer to Section 01830 for operation and maintenance data manual format requirements.

PART 2 - PRODUCTS

2.01 General
A. The manuals shall be written by professionals with the understanding of the substation. Supplier’s catalogs and drawings shall be used to supplement the written information.
B. The manuals shall include annotated pictures to indicate location of all major equipment.

2.02 Operations Manual
A. Provide all information needed for the optimum and safe operation of the equipment, including:
   1. Detail description of the substation or switching station, its systems, and their division into subsystems. Use block diagrams, as appropriate, to illustrate basic functions of equipment and interfaces between equipment.
2. General systems familiarization material, such as location, function and operation of equipment, controls, meters, gauges, indicators and switches. Use photos, sketches and cut-section views for explanation.

3. Procedures to enable maintenance staff to operate the individual system components and the system as a whole in its normal and various contingency and emergency modes.

4. Safety precautions for working on or in the vicinity of each equipment

5. Explain, in detail, the operation of circuit breakers and switchgear from SCADA, local area network controller and via local control. Explain various safety interlockings between switchgear and disconnect switches. Explain function of all protective relays in detail.

6. Include step-by-step instructions for equipment energization, operation, normal shutdown and emergency shutdown. Emphasize the safety precautions to be observed during normal operation, inspection and before energization after a maintenance shutdown.

2.03 Preventive Maintenance Manual

A. Provide all information needed to enable maintenance staff to perform periodic inspection tasks to keep the system in satisfactory working order.

B. Include all information needed for preventive maintenance, adjustments, and on-line trouble diagnosis of each equipment and system.

C. Include step-by-step procedures for inspection, operation checks, cleaning, lubrication and adjustments of the equipment.

D. Include maintenance standards, including specifications, wear limits, settings and tolerances.

E. Provide recommended preventive maintenance schedule for all system components.

F. Provide procedures for equipment removal and re-installation.

2.04 Corrective Maintenance Manual

A. Provide all information needed to enable on-line and off-line troubleshooting. Include troubleshooting flow charts for diagnosis of breakdowns of all equipment and systems.

B. Include description of trouble symptoms, methods for diagnosing causes of trouble symptoms and corrective actions.

C. Provide all information needed to enable maintenance staff to troubleshoot, adjust and completely repair all equipment and systems.

D. Include detailed description and operation of each system, using block diagrams, flow diagrams, detailed schematics and functional wiring diagrams.

E. Provide test and repair evaluation procedures.

F. Include safety precautions and procedures, glossary of terms and other relevant material.
2.05  Heavy Repair Manual
   A. Provide all information needed to enable maintenance staff to service, maintain, repair, 
      replace, disassemble, reassemble, rebuild, and overhaul the equipment and the system.
   B. Include detailed description of procedures for long-term periodic maintenance 
      requirements of all components. Include detailed description of mid-life rehabilitation or 
      replacement of any component, as required.

2.06  Spare Parts Manual
   A. Enumerate and describe every component with its related spare parts.
   B. Provide detail drawings of all spare parts. Use drawings showing cutaway isometric and 
      exploded views of subassemblies and components to identify all parts down to the Lowest 
      Level Replaceable Unit (LLRU).
   C. Include the supplier's number, the commercial equivalents and SEPTA stock number. The 
      inclusion of SEPTA stock number will require prior submission of the spare parts catalogs to 
      SEPTA for coding.
   D. Parts common to different assemblies, such as bolts and nuts, shall bear the same 
      Contractor's number in all assemblies, with an index reference to the other assemblies in 
      which they are found. Each part or subassembly shall be identified as part of a next higher 
      assembly.
   E. Commercially available items such as common fastenings, fuses, lamps, fittings and relays 
      shall be identified in a separate list in the parts catalog by the Contractor’s part number and 
      standard hardware nomenclature, sufficient for ordering these items commercially.
   F. Itemize all consumable parts and servicing materials, such as, oils, paints, special 
      compounds and greases.
   G. Provide, at least three (3) supply sources (other than the Contractor) for all required 
      consumables and servicing materials. Of the three (3) required sources, at least two (2) shall 
      be in the United States.
   H. Provide complete list of parts and supplies, with current unit prices and sources of supply.
   I. Provide a list of all functional components, with the manufacturer's model number and the 
      manufacturer's part number.
   J. Provide "Long-Lead-Time" spare parts list for spare parts not readily available on the open 
      market or for which it is anticipated ordering and deliver time will exceed ten (10) days.
   K. Provide the last date of the manufacturer's warranty and guarantee date.

2.07  Special Tools and Test Equipment Manual
   A. Provide list of special tools and test equipment for general upkeep, inspection and 
      maintenance of the equipment.
   B. Provide instructions and directions on how to use special tools and test equipment.
   C. Include setup and testing procedures for all special tools and test equipment and 
      procedures needed for periodic inspection and servicing requirements including lubrication, 
      inspection and adjustment of all apparatus.
D. Provide instructional manuals and user guides for all special tools and test equipment, including parts lists, diagrams, specifications, schematics, as well as maintenance, calibration instructions and trouble-shooting procedures.

PART 3 - EXECUTION

3.01 Interactive Web-Compatible Manuals System

A. Provide all manuals in Interactive Web-Compatible Manual (IWCM) system based on SGML or HTML in combination with a Web Browser.

B. The IWCM shall contain all functional descriptions, repair procedures, overhaul procedures and support information for equipment and components in a browsable format. Provide cross references by “hot links”.

C. Users of each manual in electronic format shall be able to read and scroll through text and illustrations just as if reading a hard copy manual. The user shall be able to search text and illustrations based on key words, text strings and part numbers.

D. The IWCM shall be usable on conventional laptop computers, on Internet and Intranet. The system shall be compatible with commonly-available browsers, such as those developed by Microsoft and Netscape. Provide to SEPTA any other necessary specialized software and hardware required for the system not currently supported by SEPTA.

E. Provide SEPTA Information Technology staff with instructions on development and continued maintenance of the IWCM system.

END OF SECTION
SECTION 02050

DEMOLITION

PART 1 - GENERAL

1.01 Description
A. Requirements for the demolition, removal and disposal of asphalt and concrete pavement, buildings, fence, poles, drainage structures, utility laterals and connections, walls, and foundations and related items including, but not limited to, stairways, railings, posts, piping, ballast, ties, rail, other track material and existing aerial cables, as required for access and performance of work.
B. Demolition of the existing to be abandoned electric manholes is required as part of the Contractor’s work.

1.02 Related Sections
A. Section 01300 – Submittals
B. Section 01305 – Requests for Information
C. Section 01400 – Quality Requirements
D. Section 02083 – Heavy Metals Abatement
E. Section 02205 – Impacted Soil Management
F. Section 02220 – Excavation, Backfill and Compaction

1.03 Submittals
A. General:
   1. Submit in accordance with Contract requirements.
   2. Submit in sufficient detail to show full compliance with Contract Documents.
B. Submit work plan:
   1. Proposed procedures for the demolition and removal of debris.
   2. Sequence of demolition operation.
C. Submit certificates, permits and releases:
   1. Copy of request for discontinuance to utility companies owning, or agency controlling, services and appurtenances affected by demolition work.
   2. Copy of certificates of severance issued by utility company or agency.
   3. Copy of demolition permit from the jurisdictional agency or SEPTA, if required.
   4. Copy of burning permit from the jurisdictional agency or SEPTA, if required.
   5. Copy of releases from each owner of property or facility where demolition debris will be deposited absolving SEPTA of responsibility in connection with such disposal. Follow chain of custody requirements.
1.04 Quality Assurance

A. General:
   1. Meet the federal, state and local hauling, disposal and burning regulations.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Preparation

A. Protection:
   1. Traffic Control Signs:
      a. When pedestrian and driver safety is endangered in the area of removal work, use traffic
         barricades with flashing lights.
   2. Existing Work:
      a. Before beginning any demolition work, the Contractor shall survey the site with the SEPTA
         Project Manager and examine the Contract Drawings and Specifications to determine the
         extent of the work.
      b. SEPTA does not assume any responsibility for the condition of the structures or facilities that
         shall be removed.
      c. The Contractor shall call PA One-Call Utility Location Service prior to any demolition or
         excavating on site.
      d. Before beginning any demolition work, the Contractor shall inspect and examine the items
         to be removed and determine the type of demolition procedures, physical conditions and
         any contingency that would be encountered in removing this item.
      e. The Contractor shall take the necessary precautions to avoid damage to pipes, conduits,
         wires, cables, structures and any other above and below ground facilities that are not
         designated for removal. Damaged items shall be repaired or replaced as directed by SEPTA
         at no additional cost to SEPTA.
      f. The Contractor shall coordinate the work of this Section with all other work and shall
         construct and maintain shoring, bracing and supports as required.
      g. The Contractor shall ensure that structural elements are not overloaded and shall be
         responsible for increasing supports or adding new supports as required as a result of any
         cutting, removal or demolition work performed under this Contract.

3. Facilities:
   a. Prior to commencement of operations, make all necessary arrangements with the proper
      authority for discontinuing service and disconnecting the public utilities that are specified or
      indicated for demolition including gas, electric, telephone, cable television, storm sewers,
      sanitary sewers, water and other facilities.
   b. Protect on-site utilities that are to remain in-service during demolition.
   c. Where removal of existing utilities and pavement is specified or indicated, provide approved
      barricades, temporary covering of exposed areas and temporary services or utilities.
d. The Contractor shall notify SEPTA of utilities encountered during demolition that are not indicated in the Contract Documents. The Contractor shall not remove such utilities until directed by SEPTA.

4. Protection of Personnel:
   a. During the demolition work the Contractor shall continuously evaluate the condition of the structures and facilities being demolished and take immediate action to protect all personnel working in and around the demolition site.
   b. The Contractor shall consider the safety of the work and that of people and property on and adjacent to the work site when determining equipment movement and use of materials and equipment on the work site.
   c. Where the safety of persons is endangered within the area of demolition work, provide barricades and warning lights. Keep unauthorized persons out of the work area.

B. Burning:
   1. The use of burning at the Project site for the disposal of refuse and debris will not be permitted.

C. Use of Explosives:
   1. The use of explosives will not be permitted.

3.02 Installation, Application and Execution

A. Existing facilities to be removed:
   1. Demolish entirely and remove from the site the facilities as indicated in the Contract Drawings.
   2. Demolish entirely and remove from the site any other obstructions that will interfere with construction when directed by SEPTA.
   3. Structures:
      a. Remove and dispose of all buildings, building components, building appurtenances and drainage structures as indicated in the Contract Drawings.
      b. Buildings and drainage structures may be removed intact, removed in sections, or demolished and the resulting material and debris disposed of.
      c. Existing buildings and drainage structures indicated shall be removed to bottom of foundation.
      d. Sidewalks, curbs, gutters and street light bases shall be completely removed, as indicated.
   4. Utilities:
      a. Remove existing sub-surface utilities and laterals as indicated in the Contract Drawings.
      b. Terminate existing utilities in a manner meeting the nationally recognized code covering the specific utility and approved by SEPTA.
      c. Remove meters and related equipment and deliver to a location on the Project site as directed by SEPTA.
      d. Remove existing pipe in accordance with SSRS Article 340-3.
      e. When utility lines are encountered that are not indicated on the Contract Drawings, notify SEPTA for further instruction. The Contractor shall not remove such utilities until directed by SEPTA.

5. Paving and Slabs:
a. Remove concrete paving and concrete slabs as indicated in the Contract drawings.
b. Remove concrete paving and concrete slabs to bottom of foundation.

6. Rail, Ties, ballast and Other Track Material:
   a. Remove rail, ties, ballast and other track material as indicated in the Contract drawings.

7. Fences, Utility Poles and Other Material:
   a. Existing fences, fence posts, utility poles, building stairways, steps, chimneys, column footings, other footings, other foundation components and signs shall be completely removed.
   b. Other on-site rubble and debris shall be completely removed.

B. Filling, Capping and Repairs:
   1. General:
      a. Where removals leave holes and damaged surfaces in the finished work, the Contractor shall repair these holes and damaged surfaces to match adjacent finished surfaces.
   2. Filling:
      a. Holes in the site (ground) surface, open basements, pits and other hazardous openings shall be filled to within 18 inches of the ground surface with suitable fill materials.
      b. When all available suitable clean fill material from the site has been used in filling, all remaining unfilled portions, together with the upper 18 inches shall be completely filled to the ground surface with earth.
      c. The top surface of fills shall be neat in appearance and smooth enough not to constitute a walking hazard.
   3. Capping:
      a. Abandoned utility lines are to be removed and capped as required by the utility owner.
   4. Repairs:
      a. All drainage structures to be demolished shall be removed in their entirety and any gaps in active pipes repaired as required by the utility owner.

C. Disposition of Material:
   1. General:
      a. Unless otherwise indicated in the Contract Documents, all material and equipment recovered during demolition shall become the property of the Contractor and shall be removed from the Project site.
      b. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.
      c. All material which does not meet Clean Fill Policy requirements will be disposed of in accordance with Section 02220.

END OF SECTION
SECTION 02070

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements of demolition and removal of selected portions of substations within this Contract including the buildings and structures.

1.02 Related Sections

A. Division 1 or cutting and patching procedures.
B. Division 1 for general protection and work procedures for alteration Projects.
C. Section 02080 – Hazardous Material Abatement
D. Section 02082 – PCB Material Abatement
E. Section 02083 – Heavy Metals Abatement
F. Section 02084 – Oils and Lubricants Abatement
G. Section 13280 – Asbestos Abatement
H. Section 13285 – Lead Paint Abatement
I. All Division 16 Sections.

1.03 Submittals

A. Submit engineering survey of condition of the electrical and mechanical equipment of the substations.
B. Submit proposed protection measures report that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers. Special attention is invited to the autotransformers and circuit breakers.
C. Schedule of selective demolition activities to indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure SEPTA's operations are not interrupted. Note that some of the equipment has to be removed from the site promptly to make room for the new equipment.
   2. Indicate how long, if at all, utility services will be interrupted.
   3. Coordination for shutoff, capping and continuation of utility services.
   4. Use of elevator and stairs. Note that some of the equipment is installed on building roofs with no stairways.
   5. Coordination of SEPTA's continuing occupancy of portions of existing building and SEPTA's partial occupancy of completed work. Note that some of the equipment will be energized at 12 kV and 24 kV and work will require specified working clearance.
D. Show pre-demolition photographs or video existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations. Meet the requirements of Division 01. Submit before work begins.

E. Documentation indicating that existing warranties are still in effect after completion of selective demolition.

F. Submit an inventory list of items that have been removed and salvaged.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
   1. ASSE A10.6, Safety Requirements for Demolition Operations.
   2. Environmental Protection Agency (EPA) regulations.

1.05 Definition

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to SEPTA ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled. Identify such items and obtain SEPTA approval.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.06 Materials Ownership

A. Unless otherwise indicated, demolition waste becomes property of the Contractor. The Contractor shall remove demolition waste from the site.

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

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

1.07 Pre-Demolition Meetings

A. Conduct pre-demolition conference at Project site.

   1. Inspect and discuss condition of construction to be selectively demolished.

   2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment and facilities needed to make progress and avoid delays.

4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

5. Review areas where existing construction is to remain and requires protection, especially from the electrically energized parts.

**1.08 Field Conditions**

A. SEPTA will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so SEPTA’s operations will not be disrupted. Note that some demolition will require a power outage. Coordinate power outages with SEPTA.

B. Conditions existing at time of inspection for bidding purpose will be maintained by SEPTA as far as practical.

C. Notify SEPTA of discrepancies between existing conditions and Contract Drawings before proceeding with selective demolition.

D. Refer to Section 02080, Section 02082, Section 02083, Section 02084, Section 13280 and Section 13285 for hazardous materials abatement.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify SEPTA.

E. Demolition and hauling equipment and other materials for historic areas shall be of sizes that clear surfaces within historic spaces, areas, rooms and openings, including temporary protection, by 12 inches or more.

F. Storage or sale of removed items or materials on-site is not permitted.

G. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire protection facilities in service during selective demolition operations.

**1.09 Warranty**

A. Remove, replace, patch and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify the warrantor before proceeding. Existing warranties include but are not limited the Signal Room Roof addition at Neshaminy substation.

B. Confirm the existence of any current warranties with SEPTA prior to selective demolition activities.

C. Notify the warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Contract closeout.

**1.10 Coordination**

A. Arrange selective demolition schedule so as not to interfere with SEPTA’s operation.
PART 2 - PRODUCTS

2.01 Performance Requirements

A. Meet the governing EPA notification regulations before beginning selective demolition. Meet the hauling and disposal regulations of authorities having jurisdiction.

B. Meet ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 Examination

A. Engage a Professional Engineer licensed in the Commonwealth of Pennsylvania in electrical and mechanical disciplines to perform an engineering survey of the condition of the substation to determine the potential issues associated with the demolition of selective electrical and mechanical equipment. The survey shall also identify the protective measures required for demolition.

1. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

B. Verify that hazardous materials have been remediated before proceeding with the demolition operations.

C. Record existing conditions by use of measured drawings, preconstruction photographs or video and templates.

1. Meet the requirements specified in Division 01.

2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final work, make permanent record of measurements, materials and construction details required to make exact reproduction.

3.02 Utility Services and Mechanical/Electrical Systems

A. Maintain services/systems indicated to remain and protect them against damage.

B. Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished that are existing services/systems to be removed, relocated or abandoned.

1. Arrange to shut off utilities with utility companies.

2. If services/systems are required to be removed, relocated or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of the substation.

3. Disconnect, demolish and remove fire-suppression systems, plumbing systems, HVAC systems, electrical equipment and components indicated on the Contract Drawings to be removed.
a. Remove portions of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
b. Drain piping to be abandoned in place and cap or plug piping with same or compatible piping material and leave in place.
c. Disconnect and cap services for equipment to be removed and remove equipment.
d. Disconnect and cap services for equipment to be removed and reinstalled and remove, clean, and store equipment; when appropriate, reinstall, reconnect and make equipment operational.
e. Disconnect and cap services for equipment to be removed and salvaged and remove equipment and deliver to SEPTA.
f. Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
g. Cap or plug ducts to be abandoned in place with same or compatible ductwork material and leave in place.

3.03 Protection

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

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied and in-use portions of building.

2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

3. Protect walls, ceilings, floors and other existing finish work that are to remain or that are exposed during selective demolition operations.

4. Cover and protect equipment which is in revenue service.

5. Cover and protect furniture, furnishings and equipment that have not been removed.

B. Provide measures to prevent spillage of oil from the autotransformers and outdoor circuit breakers. Coordinate with SEPTA for removal of asbestos from the indoor circuit breakers before demolition.

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

1. Strengthen or add new supports when required during progress of selective demolition.

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

3.04 Selective Demolition

A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

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

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

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

5. Maintain fire watch during and for at least four (4) hours after flame-cutting operations.


7. Remove decayed, vermin-infested or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

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

10. Dispose of demolished items and materials promptly.

B. Site access and temporary controls:

1. Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Work in Historic Areas:

1. Selective demolition may be performed only in areas of the Contract that are not designated as historic.

D. Removed and Salvaged Items:

1. Clean salvaged items.

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

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

4. Transport items to SEPTA's storage area designated by SEPTA.

5. Protect items from damage during transport and storage.

E. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.

2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.

4. Reinstall items in locations indicated. Meet the installation requirements for new materials and equipment. Provide connections, supports and miscellaneous materials necessary to make item functional for use indicated.

F. Protect construction indicated to remain against damage and soiling during selective demolition.

3.05 Selective Demolition Procedures for Specific Materials

A. Remove no more existing roofing than what can be covered in one (1) day by new roofing and so that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings and roof accessories.

2. Remove existing roofing system down to substrate

B. Concrete:

1. Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

C. Masonry:

1. Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw and then remove masonry between saw cuts.

D. Saw-cut perimeter of area of concrete slabs-on-grade to be demolished, and then break up and remove.

3.06 Disposal of Demolished Materials

A. Remove demolition waste materials from Project site.

1. Do not allow demolished materials to accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3. Remove debris from elevated portions of building by chute, hoist or other device that will convey debris to grade level in a controlled descent.

B. Do not burn demolished materials.

3.07 Cleaning

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

END OF SECTION
THIS PAGE NOT USED
SECTION 02080
HAZARDOUS MATERIAL ABATEMENT

PART 1 - GENERAL

1.01 Description

A. Building Materials:
   1. The purpose of the work described in this Section is to abate regulated and hazardous building materials contained within the building structure per the scope of work. As part of the base scope of work, the Contractor shall be responsible for the removal, transport, and disposal or recycling of all designated items, unless otherwise stipulated, regardless of the actual quantities.
   2. The Contractor shall furnish all labor, materials, equipment, and related items required to remove/abate all substances which are regulated under federal, state, and local statutes and land ban restrictions to the Contract limits as designated herein.

B. Decontamination (Cleaning):
   1. This Section provides a description of methods to be used by the Contractor to clean and/or decontaminate various surfaces and structures as required by the scope of work for this Contract. The specific areas to be cleaned or decontaminated are described in this Project manual and related appendices.
   2. The objective of this Specification is to establish general methods for the decontamination of building surfaces and infrastructures at the facility to provide for the environmental clearance of these materials. However, it is possible that the decontamination will not achieve the objective for clearance.
   3. Where different options are described for decontaminating specific items, the Contractor may use discretion in determining the most appropriate methods, provided they are consistent with those included herein, and agreed to by the SEPTA.

C. Cleaning of Building Surfaces:
   1. The intent of this Section is to clean building surfaces to remove of oily accumulations and other residual impact from floor slabs, and to remove accumulations of dust, grime, dirt, ash, and other buildup from surfaces to reduce emissions during future demolition and/or minimize the potential for debris generated during demolition to be considered contaminated.
   2. The Contractor shall furnish all labor, materials, equipment, and related items required to complete the work described herein in accordance with federal, state and local statutes.
   3. For the purposes of this Specification, building surfaces to be cleaned include, but are not limited to:
      a. Staining, oily accumulations, non-liquid/tacky build-up, grease, dirt, grime, adhesives, wax, paint build-up, coal, ash, and loose paint on floors and shallow trenches, including under wood block and false floors.
b. Staining, grime, dust, grease, wax, adhesives, coal, ash, and other wastes present on walls,
rafters, structural members, interior structures, platforms, mezzanines, equipment,
equipment pads, and other horizontal and vertical surfaces.

c. PCB impact on electrical substation floors, if included as part of the scope of work (Section
2082).

D. Cleaning of Below-Grade Structures:

1. The intent of this work is to clean/decontaminate below-ground structures, including:
   a. Underground process or building system piping and related drains, cleanouts, etc., including
      but not limited to industrial waste sewer piping, storm and sanitary sewer piping, and other
      process-related piping; and, pits, trenches, vaults, manholes, tunnels, sumps, basements,
      etc.
   b. If required as part of the base scope of work, the Contractor shall furnish all labor, materials,
      equipment, and related items necessary to complete the work described herein in
      accordance with applicable federal, state and local regulations.

1.02 Related Sections

A. Section 01300 - Submittals

1.03 Submittals

A. Provide all required submittals as identified in Section 01300.

B. Provide all required submittals as identified, including the Contractor’s method statements
   described herein.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. Applicable Federal and State Occupational Safety and Health regulations and
   environmental statutes.

2. Applicable requirements of Federal, State and Local regulatory agencies.

3. Applicable State Regulations and Codes, and any Municipal requirements.

   Industry.

   Waste.

6. Title 40, Code of Federal Regulations, Part 262, Standards Applicable to Generators of
   Hazardous Waste.

7. Title 40, Code of Federal Regulations, Part 264, Standards for Owners and Operators of
   Hazardous Waste Treatment, Storage, and Disposal Facilities.

8. Title 40, Code of Federal Regulations, Part 265, Interim Status Standards for Owners and
   Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

   Materials.


1.05 Scheduling

A. Provide the anticipated dates for decontamination activities described herein as part of the Contract schedule.

B. The work described herein may require some general demolition of building interiors which must be coordinated with SEPTA for clearance.

C. The Contractor must coordinate and sequence these activities with the other facility decommissioning efforts taking place during the work, especially utility cutting and capping work. In certain areas, the Contractor may not be allowed to conduct work until SEPTA has completed activities in the area.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Packaging and containerization materials and equipment including, but not limited to, the following:

1. Lab packing requirements as per the disposal or recycling facility.

2. Packing and shipping materials for medical wastes and radioactive materials in accordance with aforementioned regulations.

3. Fiberboard barrels.

4. Removable head drums, roll-off boxes, or equivalent, DOT approved.

5. Drum labels and other markings which meet 29 CFR 1926.58(K) and all other federal, state, or local codes and regulations.

6. Spill prevention countermeasure materials and control products, including plastic sheeting and absorbent materials consistent with the requirements of 49 CFR 173 and the Contractor’s spill control plan.

7. Sampling equipment and containers which are consistent with standard USEPA sampling techniques or other appropriate containers.

PART 3 - EXECUTION

3.01 General

A. The Contractor shall be responsible for all worker health and safety procedures, including requirements by SEPTA and personal protection equipment and worker notification, during the removal, handling, and management of all hazardous and regulated materials.

3.02 Removal of Regulated Batteries

A. General:
1. Regulated batteries (lead-acid, nickel-cadmium, NiMH or dry type) may be present throughout the facility, typically in emergency light fixtures, equipment, backup systems, process equipment, control panels or in bulk. The Contractor shall be responsible for the removal and proper handling of all batteries within the Contract limits.

2. Many emergency light fixtures, battery backup systems and/or associated components may be suitable for recycling. The Contractor is encouraged to account for the recycling of such fixtures. Those fixtures which are not suitable for recycling shall be handled and disposed accordingly.

B. Removal Procedures:

1. The Contractor shall locate all regulated batteries throughout the facility and disconnect related electrical or communication feeds. All batteries should be removed from the associated devices. In the event that fixtures or devices may be resold, the Contractor shall remove the entire unit and its components.

2. The Contractor shall properly collect, label and stage all batteries throughout the facility. Batteries must be sorted by type and place in separate collection containers, with the lead-acid battery containers labeled as a hazardous waste. Battery collection containers and storage areas should be well ventilated to eliminate any potential explosion dangers. All batteries shall be recycled or disposed appropriately.

3.03 Removal of Fluorescent and Other High Intensity Lamps

A. General:

1. Throughout the facility, fluorescent bulbs are present either in fixtures or stored in bulk. High-intensity mercury or halide vapor lamps are located throughout the interior and exterior of the buildings, and on light poles throughout the property.

2. Many light fixtures and/or associated components may be suitable for recycling or resale. The Contractor is encouraged to account for the recycling or resale of such fixtures in its bid. Those fixtures which are not suitable for recycling shall be removed and disposed appropriately.

B. Removal and Management Procedures:

1. The Contractor shall be responsible for the removal of all regulated lamps from the associated lighting fixtures. All lamps shall be carefully removed from the fixtures and placed in appropriate sized containers equipped with dividers to isolate bulbs.

2. The Contractor shall manage fluorescent bulbs using one (1) the following procedures:
   a. Transport all bulbs to a SEPTA approved waste management company for recycling or disposal, or
   b. Crush bulbs on-site using an appropriate and regulatory acceptable portable crushing unit. The crushing unit must be self-contained to prohibit emissions. A portable crusher may only be used if local or state regulations allow such use. The Contractor shall demonstrate that a portable crusher is acceptable prior to mobilization.

C. All bulb containers intended for off-site recycling shall be either shrink-wrapped or placed in a secure crate to avoid accidental breakage. All containers shall be labeled as hazardous
waste in accordance with applicable DOT regulations, unless the waste is demonstrated as non-hazardous.

D. The Contractor must use appropriate precautions when handling lamps to avoid accidental breakage. Should accidental breakage of lamps occur, then the lamp debris shall be collected and placed in segregated reinforced drums or similar containers pending disposal.

3.04 Removal of Fluorescent and High Intensity Light Ballasts

A. General:

1. Throughout the facility, numerous fluorescent light ballasts and high intensity lamp ballasts are present either in fixtures or in bulk. The ballasts vary in size and may contain PCBs in excess of regulatory requirements. The Contractor shall be responsible for the removal, inspection, and management of all PCB-containing ballasts according to all federal, state and local requirements.

2. All ballasts shall be inspected for manufacturer indications of the presence or absence of PCBs. Those ballasts which are labeled as non-PCB containing shall be managed separately from those which are to be assumed to contain PCBs until verified with the manufacturer.

3. For ballasts with no obvious markings verifying that no PCBs are present, the Contractor is encouraged to further verify the presence of PCBs in ballasts by contacting the manufacturers to obtain records, if available, of the contents in the ballast models.

B. Removal and Handling of Ballasts:

1. The Contractor shall inspect each ballast within each light fixture in an effort to view the ballast labeling. If a label clearly indicates that a ballast is non-PCB (e.g., label reading "PCB Free" or "No PCBs"), the ballast may remain in the fixture (if the scope of work dictates the fixture is to remain). All other ballasts encountered, labeled or unlabeled, shall be removed from the lighting fixture. The Contractor shall use caution so as not to open or damage the ballasts during removal and handling.

2. The Contractor shall stage all removed ballasts on-site in reinforced containers with appropriate labeling according to 40 CFR 761. The Contractor shall employ adequate spill or leak prevention measures for each storage container. The Contractor shall follow the Contractor's spill control plan when handling all ballasts.

3. The assumed PCB-containing ballasts will be transported and disposed at a SEPTA approved waste management company licensed to accept PCB wastes.

3.05 Removal of Mercury Containing Devices

A. Mercury containing devices may be present within the Contract limits, primarily in thermostats, equipment switches (Mercoid controls, ignitron switches), duct thermometers, temperature switches and other devices. The Contractor shall be responsible for the removal of all mercury containing items within the Contract limits of the scope of work.

B. Each mercury containing device shall be removed from its related equipment and staged in a secured bucket or other approved container. When removing and handling the mercury items, the Contractor must employ all measures outlined in the Contractor's spill control plan to prevent possible leakage due to container damage.
C. The Contractor shall transport all mercury containing items according to all applicable DOT regulations for recycling or disposal.

3.06 Removal of Miscellaneous and Bulk Chemicals

A. General:

1. Small-volume (<5 gallons) and large-volume (>5 gallons) miscellaneous chemicals may be present throughout the facility. These containers may be labeled or unlabeled.

2. The Contractor shall be responsible for the identification, removal, characterization, transport and disposal of all miscellaneous chemicals within the Contract limits of the scope of work.

B. Identification and Classification of Miscellaneous Containers:

1. The Contractor shall set up an on-site staging area to organize and inspect all miscellaneous containers. The staging area must have adequate spill control measures and the Contractor’s spill control plan. The Contractor shall segregate all miscellaneous chemicals into waste classifications, if possible, based on state regulations and requirements of SEPTA approved disposal or reclamation companies. If appropriate and allowable, the Contractor may use a bulking scheme for grouping similar types of chemicals.

2. The Contractor may consolidate non-hazardous oils or other products found in the containers with other non-hazardous equipment oils removed in bulk if the Contractor can demonstrate safe practices, regulatory acceptance of such measures, and in doing so does not co-mingle hazardous wastes with non-hazardous wastes.

3. Upon completion of the staging and identification of chemical containers, the Contractor shall coordinate and/or characterize, if necessary, to facilitate disposal. All transportation and disposition of the miscellaneous containers shall be performed by the Contractor.

4. Lab-packing of many containers may be required. The Contractor shall coordinate with the transporter and/or disposal or recycling facility for specific lab-packing requirements.

3.07 Removal of Pressurized Gas Cylinders

A. Pressurized gas cylinders may be present that contain oxygen, nitrogen, helium, acetylene and other substances. The Contractor is responsible for removal of all pressurized gas cylinders present within the Contract limits. The Contractor shall properly collect, label and stage all gas cylinders throughout the facility. The cylinders shall be staged pending transport in a manner that will minimize the potential for discharge or damage. Management, transportation and recycling or disposal the responsibility of the Contractor.

3.08 Removal of Surface Residues

A. The Contractor shall remove dust and oily residuals and other residues (where designated). Wash water and residuals generated during floor and surface cleaning efforts shall be collected and containerized in appropriate vessels. The Contractor shall stage, characterize, and dispose or treat wash water and residuals.
B. The handling of surface residues and wash water must be performed in accordance with the Contractor’s spill control plan.

3.09 Removal of Non-Hazardous Equipment Oil

A. Oil-containing equipment associated with building control systems are present throughout the facility. In general, types of oil-containing equipment include, but are not limited to air compressors, HVAC compressors, chill water compressors, pumps, fans, motors, gear housings, hydraulic equipment and reservoirs, and elevator motors. The general locations for this equipment are provided in Environmental Investigation Report.

B. Certain equipment may contain oil impacted with PCBs. In these cases, oils shall be removed and managed separately from non-PCB containing oil. PCB containing oils may be managed and disposed by the Contractor (See Section 2082).

C. The Contractor shall drain free-flowing oil from any oil-filled item located on the property, providing it contains more than a de minimis amount of fluid. All oil shall be drained into appropriate storage containers, consolidated if appropriate and allowed, and staged on-site with proper labeling pending transport to a SEPTA approved waste management company. Handling of oil must be performed in accordance with the Contractor’s spill control plan.

3.10 Cleaning of Concrete Flooring

A. The Contractor shall be responsible for cleaning accumulations from building surfaces as described in Article 1.01/C in this Section prior to demolition.

B. Within each designated area, the Contractor shall first remove bulk accumulations. These materials shall be placed in an appropriate container pending future transport and disposal by the Contractor.

C. Upon removal of non-liquid accumulations, each resulting area shall be cleaned. An independent report will be provided. Slab locations with oily accumulations shall be cleaned until there are no further signs of free-flowing oil emanating from the concrete surface, or until it is determined that surface cleaning will not sufficiently decontaminate the concrete matrix. This determination shall be made in conjunction with SEPTA.

D. Areas with accumulations of grime, ash, dirt, wax, grease, dust, sludge, paint build-up, loose paint, coal, ash, etc. shall be cleaned to remove such materials prior to demolition. An independent report will provide further direction. Solid materials not appropriate for inclusions with wash water waste streams shall be managed separately.

E. The Contractor shall employ all residual collection, handling, and management procedures and precautions based on their approved spill control plan.

3.11 Cleaning of Walls and Elevated Building Surfaces

A. The Contractor shall clean grime, staining, dust, dirt, flaking paint, coal, ash, and other waste material from building walls and elevated building surfaces to remain. An independent report will provide further direction. Wash water shall be collected and managed by the Contractor.

B. If the structure(s) is/are to be demolished, or otherwise included as part of the scope of work, the Contractor shall clean elevated building surfaces to remove excess dust, dirt, grime, rust and other loose materials. If requested, the Contractor shall assist SEPTA with
access to the overhead areas. Assistance may include provision of man lifts or other means to facilitate access.

C. The Contractor shall employ all residual collection, handling, and management procedures and precautions according to their approved spill control plan.

D. A final cleaning of the building floor shall be completed by the Contractor to achieve a "broom clean" state prior to demobilization.

3.12 PCB Impacted Concrete Surfaces

A. General:

1. PCB-impacted surfaces may be present in electrical substations, switching stations or other areas within the facility that are regulated under 40 CFR 761 (TSCA), as specified in the scope of work and/or appendices. The Contractor shall be responsible for decontaminating any such areas throughout the facility, if required by the scope of work (See Section 2082 for PCB abatement).

B. Decontamination of Concrete:

1. Within each designated area, the Contractor shall decontaminate the PCB-impacted concrete. Upon completion, the Contractor, in coordination with SEPTA, will confirm proper decontamination through collection and analysis of verification wipe, chip, or core samples, as directed.

2. In the event that the impacted surface(s) are to be removed as part of the overall Contract, the Contractor may remove the concrete slabs or surfaces in full and manage as PCB-impacted waste.

3. Unless otherwise specified, decontamination shall continue until verification samples indicate that PCB-impacted concrete is below the stipulated concentrations from wipe sampling or chip/core sampling. Verification sampling is not required if the slab or surface is removed in full. For waste characterization sampling, the Contractor is encouraged to contact waste companies to identify the method of characterization sampling (wipe vs. bulk) desired by the disposal facility.

4. The Contractor shall employ all collection, handling, and management procedures and precautions.

5. Any decontamination materials used shall be managed by the Contractor.

3.13 Cleaning of Sanitary and Storm Sewer Piping and Drains

A. General:

1. The Contractor shall clean all underground storm and sanitary sewer piping and collection points located on the facility. This shall include removal of any sediments or non-aqueous liquids (if present), followed by cleaning or flushing of the piping. It is the Contractor’s responsibility to locate and access all piping.

B. Cleaning of Sewer Piping:

1. The Contractor shall clean residual materials from all sanitary and storm sewer piping, collection drains and manholes.
2. The Contractor shall clean all materials so that no residual solid materials from storm water catch basins will infiltrate the municipal sewer during the residual cleaning efforts.

3. Once the washing activities are completed, a record of cleaning is to be submitted for the sanitary and storm piping. Designated piping sections may then be capped and/or abandoned.

4. If required as part of the scope of work, storm and sanitary sewer piping and related manholes, sumps, drains and chambers shall be video scoped after cleaning. All piping greater than 4 inches inside diameter shall be video scoped.

5. The Contractor is responsible for the characterization, management, and disposal of any residual materials contained within the sewer systems that are not suitable for discharge to the municipal or plant-specific systems, either as-is or pre-treated by the Contractor.

3.14 Cleaning of Process Piping

A. General:

1. The Contractor shall clean/decontaminate all underground process piping (including, but not limited to, automotive fluid, hydraulic fluid, fuel oil, paint, industrial sewer, paint waste, solvent, and used oil piping) and related drains located on the property to the level necessary to facilitate disposal of the piping. This shall entail removal of any residual materials, including hazardous and non-hazardous solids or non-aqueous liquids (if present). It is the Contractor’s responsibility to locate and access all piping.

B. Cleaning of Piping:

1. The Contractor shall remove any residual solids, liquids, or sludges within underground process piping using a method appropriate for the nature and use of the piping (i.e., turbo vacuum, flushing, compressed air, etc.).

2. Residual materials and decontamination wastes shall be collected in appropriate containers and staged in designated areas pending off-site transport. The Contractor is responsible for the characterization, management, and disposal of any residual materials contained within the process piping systems that are not suitable for discharge to the municipal system, including solids and fluids.

3. All spill prevention and control and countermeasures must be employed as per the Contractor’s spill control plan.

4. Once the decontamination activities are completed, a record of cleaning for the specific segments of process piping shall be issued to SEPTA. Piping may then be removed or abandoned based on the scope of work.

3.15 Cleaning of Below-Ground Structures

A. General:

1. The Contractor shall clean all below-ground structures present within the Contract limits. These underground systems include pits, vaults, manholes, sumps, tunnels, basements and other structures associated with the process, utility and building control systems. This work shall include removal of residuals materials and cleaning.
2. The Contractor shall be responsible for removal of all residual materials contained in the below-ground structures, regardless of volume or composition.

3. Sampling and analysis data for residuals from select pits may be included in the reference documents Environmental Investigation. If present, this data may be used by the Contractor to assist in disposal arrangements as needed; however, any and all additional sampling and analysis required to facilitate disposal acceptance shall be the responsibility of the Contractor.

B. Cleaning of Below-Ground Structures:

1. The Contractor shall initially remove any residual materials present within the designated below-ground structures. Removal may be conducted using a turbo vacuum, manual or equivalent method. The removed materials shall be staged on-site in lined and properly labeled drums, portable tanks or equivalent.

2. The Contractor shall be responsible for the disposition of all residual materials, solid or liquid.

3. Upon removal of residual materials, the Contractor shall clean below-ground structures. Cleaning shall continue until no loose materials, accumulations, residues or liquids remain.

4. After completion of the cleaning process, a visual inspection will be performed by SEPTA. Surfaces shall be accepted as clean when there is no observable loose solids, accumulations, residues or liquids. If such structures and surfaces do not meet these minimum requirements the Contractor shall repeat decontamination as directed by SEPTA at no additional cost to SEPTA unless otherwise stipulated.

5. Upon completion of decontamination of the below-ground structures, the Contractor shall furnish a record of cleaning to SEPTA.

6. The Contractor may abandon/backfill the below-ground structures only upon receiving formal clearance from SEPTA.

7. The Contractor shall employ all water collection, handling and management procedures according to their approved spill control plan.

END OF SECTION
SECTION 02082

PCB ABATEMENT

PART 1 - GENERAL

1.01 Description
A. This Section specifies the inventory and specific information on the quantities of Polychlorinated Biphenyl (PCB) containing materials at each location will be provided in reference documents.

1.02 Related Section
A. Section 02080 - Hazardous Material Abatement

1.03 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. Department of Transportation (DOT).
   3. Toxic Substance Control Act (TSCA).

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Removal of PCB Containing Electric Equipment and Dielectric Fluids (Non-TSCA)
A. The Contractor shall remove and manage non-TSCA regulated PCB containing electrical devices in accordance with this section and 40 CFR 761 (TSCA) as appropriate. Any positive detections of PCBs, regardless of whether they are considered TSCA regulated, are considered PCB containing.

B. The Contractor shall drain and containerize free flowing oil from each transformer or capacitor into appropriate containers or vessels. The containers shall be properly labeled and staged in a secure area equipped with secondary containment in accordance with the Contractor’s spill control plan. Any oil which drains from these devices shall be containerized and stored on-site in DOT approved drums and appropriately labeled.

C. The recovered dielectric fluid shall be transported to an approved disposal or reclamation facility that is licensed to accept PCB wastes. Documentation that the specified facility has been informed of, and has acknowledged, the PCB contents must be provided prior to off-site transport. Final disposition of the PCB containing dielectric oil shall be responsibility of the Contractor.
D. Upon completion of the draining and cleaning, SEPTA will authorize the Contractor to remove the transformer/capacitor carcasses for recycling or disposal.

3.02 Removal of PCB Containing Electrical Equipment and Dielectric Fluids (TSCA Regulated)

A. In the event that oil filled transformers, capacitors or other items are determined to contain PCBs above 50 ppm, the Contractor shall manage these devices under strict accordance with 40 CFR 761.60 (TSCA).

B. The Contractor shall drain and containerize free flowing oil from TSCA regulated equipment into appropriate container or vessel. The containers shall be properly labeled and staged in a secure area equipped with secondary containment in accordance with the Contractor’s spill control plan. Any oil drained from these devices shall be containerized and stored on-site in DOT approved containers and labeled in accordance 40 CFR 761.

C. Upon draining all free flowing oil, the Contractor shall seal all transformer or capacitor openings and stage each empty carcass for subsequent off-site transport. The carcasses shall exhibit proper labeling indicating that they have been emptied.

D. All TSCA regulated PCB dielectric oil, equipment carcasses and related items shall be transported to a SEPTA approved waste facility that is licensed to accept PCB wastes under TSCA. On-site solvent washing of the carcasses is prohibited unless pre-approved by SEPTA.

E. The Contractor shall ensure that formal records of destruction are obtained from the disposal facility for each device, and shall issue these records to SEPTA upon receipt.

3.03 Removal of PCB Containing Electrical Cable (Above Ground)

A. The Contractor shall be responsible for de-energizing electrical cable and providing access so the Contractor can obtain samples and characterize oil impregnated cable wrap. Analytical results shall be submitted to SEPTA for verification upon receipt.

B. The Contractor shall disconnect PCB containing cables at the terminal points and other strategic locations (providing there is no effect on electrical systems to remain), employing all appropriate spill control and prevention methods identified in the Contractor’s spill control plan. Any oil which drains as a result of disconnection shall be containerized and stored on-site in DOT approved containers and labeled as "PCB containing electrical oil" or equivalent, unless otherwise stipulated.

C. All PCB containing cable and oil shall be staged on-site in a secured, spill controlled area as per the Contractor’s spill control plan. Transport and disposal of the PCB containing cable and oil shall be the responsibility of the Contractor.

D. Electrical cable containing PCBs at concentrations below 50 ppm may be recycled, provided the recycler is notified in advance. The Contractor must demonstrate that the recycler has been notified and accepts this condition, and receive authorization from SEPTA that recycling of such materials will be allowed.

E. Electrical cable containing PCBs at concentrations equal to or above 50 ppm shall be managed in accordance with applicable TSCA regulations. Under no circumstances shall any PCB containing cable insulation, sheathing, or other contents be stripped or metal removed onsite.
3.04 Removal of PCB Containing Electrical Cable (Below Ground)

A. The Contractor shall locate and protect underground electrical manholes and vaults prior to demolition, such that the structures are not damaged during site work and can be accessed after demolition.

B. If required as part of the scope of work, underground electrical cables shall then be cut and removed from manholes and, removed from the duct banks, including wiring, conduit, hangers, clamps, supports, etc. back to the plant feeders, mains and electrical buses. Electrical bus plugs shall be removed and turned over to the plant. The Contractor shall plug or cap penetrations through the floor slab to prevent debris or water from entering the duct bank system.

C. Care shall be taken to prevent the release of fluids from the cabling during removal. The Contractor shall collect any fluids released from the structures from which cabling was removed, including manholes, duct banks, vaults and other structures.

D. Electrical cable may include PCB containing insulation or asbestos wrapping. The Contractor shall be responsible for de-energizing cable and provide access so that the Contractor can sample and characterize oil impregnated cable wrap. Analytical results shall be submitted to SEPTA for verification upon receipt.

3.05 Removal of Other PCB Containing Building Materials

A. The Contractor shall be responsible for the verification, removal or other management of all PCB containing building materials referenced herein in accordance with all applicable federal, state and local requirements.

B. The Contractor is encouraged to further verify the presence of PCBs in the above referenced materials in an effort to reduce the volume of material to be disposed.

C. Building materials considered manufactured with PCBs (caulk, expansion joint material, paint, epoxy coatings, adhesives, and other similar materials) that contain PCBs >50 ppm shall be managed in accordance with 40 CFR 761 and amendments.

1. If such materials are removed prior to demolition, they may be subject to regulation as a PCB remediation waste under 40 CFR 761 and shall be disposed at a facility licensed to accept PCB remediation waste. Confirmation of this waste designation shall be made in conjunction with SEPTA.

2. If such materials are not removed prior to demolition, as directed by the scope of work, the demolition debris may be considered a bulk product waste, as defined by 40 CFR 761, and disposed at a solid waste landfill licensed to accept PCB containing materials. Characterization of in-place materials must be performed to demonstrate PCB content of debris generated during demolition. The Contractor must notify the designated landfill through waste disposal profiles or other formal documentation that PCBs are present in certain materials, and include all related data, including characterization results; demonstration of notification and acceptance by the disposal facility is required. Confirmation of this waste designation shall be made in conjunction with SEPTA.

D. Window caulk and expansion joint materials may also contain asbestos. The removal and management of such materials containing both asbestos and PCBs shall be conducted in a
manner that meets regulations governing the handling and management of both such materials.

3.06 Removal of PCB Containing Building Materials

A. The Contractor shall manage the other PCB containing building materials (>50 ppm) referenced herein in one of the following manners:

1. If directed as part of the scope of work, the Contractor shall remove and dispose PCB impacted concrete, caulk, expansion joint materials, epoxy coatings, paints, and other like materials confirmed to contain PCBs using manual techniques prior to demolition. In areas where this work will occur, plastic sheeting or equivalent cover shall be placed on the underlying and/or adjacent surfaces to prevent uncontrolled accumulations of removed materials. The materials shall be removed separately from other demolition debris, carefully segregated, and staged pending disposal.

2. If directed as part of the scope of work, the Contractor may demolish the affected structures with the above referenced materials in place (with the exception of structural materials related to electrical substations or switching stations or other items that are impacted from TSCA regulated releases and/or considered “PCB Remediation Wastes” under TSCA) provided the work is done in a manner that does not result in uncontrolled disassociation of these materials from the building surfaces. Resulting debris shall be segregated and isolated from other wastes and general debris during demolition.

B. If required by the scope of work, structural materials adjacent to caulk/expansion materials (i.e., concrete, block, brick) and/or concrete slabs shall be saw cut at specified locations. Care shall be taken to prevent the uncontrolled release of dust and fragments during the saw cutting. All dust and fragments shall be removed in full and managed in the same manner as the removed materials. Water used during the saw cutting shall be controlled, containerized and managed accordingly.

C. Upon completion of removal efforts, the Contractor shall inspect the area of work for extraneous pieces of the PCB containing materials and remove as necessary.

D. The Contractor shall stage removed materials and related items on-site in reinforced containers with appropriate labeling according to 40 CFR 761.

END OF SECTION
SECTION 02083

HEAVY METALS ABATEMENT

PART 1 - GENERAL

1.01 Description
   A. This Section describes the requirements for heavy metals abatement for the substation gantry and overhead wire support structures. This excludes the existing control buildings. Refer to Section 13285 for control building lead paint abatement requirements.

1.02 Related Sections
   A. Section 13285 - Lead Paint Abatement

1.03 Quality Assurance
   A. Meet the applicable provisions of the most recent issues of the following references:

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Removal of Bulk Lead-Containing Materials
   A. The Contractor shall locate and remove the bulk lead-containing materials from the facility within the Contract limit in accordance with all applicable and appropriate worker health and safety measures under 29 CFR 1920 and 1926.
   B. The Contractor shall properly stage all lead-containing bulk items in a manner that minimizes contact with other media, such as precipitation and unpaved areas. Staged containers shall be properly labeled and placed in a restricted area.
   C. Lead-containing bulk materials shall be recycled or disposed by the Contractor.

3.02 Removal and Management of Process Wastes (Solid)
   A. Solid process-related wastes may be present throughout the facility. These wastes may include, but are not limited to furnace refractory and ash, machining wastes, bag house or ventilation dust, resins or precipitates on gantry and overhead cable support structure surfaces, carbon blocks, etc. The locations and estimated quantities for these and any other items have not been estimated.
B. Characterization of process wastes shall be performed by the Contractor. In the event that the waste materials are considered regulated upon characterization or other means, the materials must be managed appropriately by the Contractor and disposed of by a SEPTA approved waste management or recycling company. The Contractor shall identify its procedures and logic for managing the process wastes in its waste management plan.

END OF SECTION
SECTION 02084

OIL AND LUBRICANTS ABATEMENT

PART 1 - GENERAL

1.01 Description
A. This Section describes the requirements for petroleum contaminated material abatement.

1.02 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. Title 40, Code of Federal Regulations, Part 761, Polychlorinated Biphenyls (PCBs)
      Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 General
A. For the purposes of this Specification, "non-PCB" electrical equipment is defined as any
   transformer, capacitor, or other oil-filled equipment that is labeled as "non-PCB", "PCB
   free" or equivalent manufacturers markings, and where testing has shown no detectable
   concentrations of PCBs. Any positive detections of PCBs, regardless of whether they are
   TSCA regulated, are considered "PCB containing" for the purposes of this manual. This
   definition should not be confused with the definition of PCB containing included in 40 CFR
   761.
B. Oil-filled transformers and capacitors are present in various substations, switching stations
   and related areas. A description of these units, including volume of oil and chemical content,
   is provided in the Environmental Investigation Report.
C. The Contractor shall be responsible for the removal and management of all transformers,
   capacitors, dielectric oil, and other oil-containing equipment within the Contract limits of
   the scope of work, in accordance with applicable regulations, waste management guidelines
   set forth herein, the Contractor’s spill control plan.
D. Primary power cable containing oil-impregnated insulating material may be present
   throughout the property.
E. The Contractor shall be responsible for all applicable worker safety requirements and
   notification when managing electrical equipment. The Contractor shall be responsible for all
   aspects of the handling and disposition of non-PCB and PCB containing substances.
F. The Contractor shall be responsible for the cleanup of any and all dielectric oil released to
   the environment during these activities.
3.02 Removal of Non-PCB Electrical Equipment and Dielectric Fluids

A. The Contractor shall drain and containerize free-flowing oil from the non-PCB transformers designated for removal, and any other electrical items that may be accessed without destruction. The oil from these units shall be placed into reinforced drums or other approved containers. The Contractor may consolidate the dielectric oil with other non-hazardous equipment oils collected as described in this section. Final disposition of the non-PCB transformer oil shall be performed by the Contractor.

B. The Contractor may clean or wash the interior of the non-PCB transformers as appropriate. Rinse liquids may be consolidated with the removed oil and shall be managed and disposed of by the Contractor.

C. Upon completion of the draining and cleaning, SEPTA will authorize the Contractor to remove the transformer/capacitor carcasses for disposition.

D. Oil-containing equipment is not to be transported off-site unless drained, or unless prior approval is provided by SEPTA.

END OF SECTION
SECTION 02110
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of felling trees, cutting vegetation, grubbing stumps and roots, trimming limbs and branches on retained trees and shrubs, and removing refuse, rubbish, trash, debris, dislodged materials and cut vegetation, all within the limits of construction of this Contract. The limits of this specified work shall provide for a useable width to accomplish the work as shown on the Contract Drawings.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. Section 02220 - Excavation, Backfill and Compaction
E. Section 02270 - Erosion and Sedimentation Control

1.03 Submittals
A. Refer to Section 01300 for submittal procedures.
B. If material cleared from the worksite will be deposited on private property, submit two (2) copies of written releases not less than fifteen (15) days prior to the start of the work of this Section. Releases shall absolve SEPTA from responsibility in connection with the depositing of material on private property and shall be signed by the Owners of the property on which the material will be deposited.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. Commonwealth of Pennsylvania, Department of Transportation, Specifications, Publication 408 (PennDOT Specs).

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Preparation
A. General Contractor must call PA One-Call Utility Locating Service prior to beginning clearing and grubbing operations.
B. Trees, other vegetation and material to remain will be delineated by the SEPTA Project Manager prior to start of clearing. Protect trees and other vegetation indicated to remain.

3.02 Installation, Application and Execution

A. Felling, Cutting and Trimming:

1. Fell, cut, and trim trees and shrubs in a manner which will not damage adjacent property, vegetation and material to remain. Trim branches which would either overhang the work area or be within 20 vertical feet of temporary staging areas after limits have been clearly identified and points of trimming clearly designated. Trim with tools designed for that purpose, in a manner which will result in the trees and shrubs suffering no other damage. Trim limbs having diameters larger than 2 inches in accordance with the undercut, overcut and flush cut technique. Coat wounds larger than 1 inch in diameter with tree wound dressing.

B. Grubbing:

1. Grub as required and in a manner which will result in entire stumps being removed and in roots larger than 3 inches in diameter being removed from within 1 foot of the indicated subgrade.

C. Clearing:

1. Gather, load, and transport from the worksite, refuse, rubbish, trash, debris, cut vegetation, trimmed roots and tree branches, grubbed stumps and roots, felled trees and dislodged material.

D. Removal and Disposal of Excess Material:

1. Remove and dispose of all excess material in accordance with Section 02220.

3.03 Field Quality Control

A. The construction methods shall be in accordance with Section 201 of the PennDOT Specs.

END OF SECTION
SECTION 02160

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.01 Description

A. This Section includes temporary excavation support and protection systems.

B. SEPTA owns and uses its right-of-way for the primary purpose of operating a transit and railroad system. Therefore all work shall be done in a manner such that transit and railroad operations and facilities are not interfered with, interrupted or endangered. In addition, any facilities that are a result of the proposed work shall be located to minimize encumbrance to the right-of-way so that SEPTA will have unrestricted use of its property and/or right-of-way for current and future operations.

C. Any trench excavation that would interfere with the SEPTA railway operations or encroach onto adjacent properties or onto public property will be required to be performed with trench excavation support meeting OSHA requirements.

1.02 Related Sections

A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. Section 01500 - Construction Facilities and Temporary Controls
E. Section 02220 - Excavation, Backfill and Compaction

1.03 Submittals

A. Submit shop drawings for approval prepared by a Professional Engineer licensed in the Commonwealth of Pennsylvania qualified for excavation support and protection systems.

1. It is the intent of SEPTA to eliminate or minimize any risk involved with construction or related activities on, over, under, within or adjacent to SEPTA property. Therefore, SEPTA approval of construction plans and specifications for all phases of a proposed project affecting SEPTA Property is required.

2. Include shop drawings and calculations signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

3. All plans are to be individually folded or rolled, and where more than one (1) plan is involved, they shall be assembled into complete sets before submission to SEPTA.

4. The plans are to show all the work which may affect SEPTA Property, and contain a location map and plan view of the Project, with appropriate cross sections and sufficient details. The proposed construction or related activities must be rotated with respect to top of rail (vertical) and centerline of track (horizontal). The plan must also include railroad stationing, property lines, right-of-way and subsurface soil conditions.
5. Each plan shall bear an individual identifying number and original issue date clearly identified on the plans so that it is readily apparent as to what revisions were made and when.

6. The Contractor is advised that the SEPTA’s initial review process requires a minimum twenty (20) work day period.

7. The Contractor shall have no claim for any differences between SEPTA plans and the actual conditions encountered in the field.

8. It is the Contractor’s responsibility to locate and identify all underground utilities prior to performing work. The Contractor shall provide to SEPTA a copy of the PA One Call notification and all responses associated with the notification.

9. Upon completion of the Contract, as-built plans off all permanent installations shall be provided to SEPTA in electronic format on CD-ROM using either Adobe Acrobat or AutoCAD format.

B. Submit photographs or videos, dated and sufficiently detailed, shall be taken of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Photographs of any existing manmade structure visible within 100 feet of any excavation, drilling or pile driving activity will be taken. Documentation of existing conditions prior to start of work and site conditions upon completion of work shall be provided. This may include but not be limited to:

1. Surveys.
2. Photographs.
3. As-built drawings.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. American Association of State Highway and Transportation Officials (AASHTO).
8. Occupational Safety and Health Administration (OSHA).
1.05 Definitions

A. The following terms and conditions shall apply to the Contract, which requires performance of work on the right-of-way or other property of SEPTA.

1. SEPTA is the Southeastern Pennsylvania Transportation Authority.

2. SEPTA Property includes all rights of way and property owned and/or controlled by SEPTA.

3. Owner is the individual, utility, government or corporation having title to the structure to be constructed upon, over or adjacent to railroad property owned or controlled by SEPTA.

4. Utility is the public or private entities with electric power, telephone (including fiber optics), telegraph, cable television, water, gas, oil, petroleum products, steam, chemicals, sewage, drainage, irrigation and similar lines which may or may not be regulated by the Pennsylvania Public Utilities Commission (PUC).

5. Government is the federal, state, town, city, county and other forms of government.

6. Corporation is any firm duly incorporated under laws of a state government.

7. Individual is any party not defined by "Owner, Utility, Government or Corporation".

8. Contractor is the individual, partnership, firm, corporation or any combination thereof, or joint venture, contracting with SEPTA, a Utility, Government, Firm, Company, Corporation, or Individual for work to be done on, over, under, within or adjacent to SEPTA property.

9. Owner or its Contractor as used in this document, does affect the responsibilities of either party for work conducted on, over, under, within or adjacent to SEPTA property.

1.06 Exceptions

A. Exemptions or exceptions to any provisions contained in this document must be authorized in writing by SEPTA's Chief Engineer Infrastructure or designee. Requests for exemptions and/or exceptions will be considered only where it is shown that extreme hardship and/or unusual site specific conditions provide justification and where alternate measures can be prescribed in keeping with the intent of this document. All requests for exceptions shall be fully documented including design data, cost comparisons and other pertinent information.

1.07 General Requirements

A. The Contractor shall plan and conduct the work in such a manner as to safeguard the operations, facilities, right-of-way and property of SEPTA. All work affecting the above items shall be subject to the approval of SEPTA. The Contractor's operations adjacent to, over, or under SEPTA's tracks, facilities, right-of-way, and property shall be governed by SEPTA's standards and by such other requirements as specified by SEPTA so as to insure the safe operation of SEPTA's transit system and facilities, prevent delay to trains and buses, and insure the safety of all concerned, including all Contractors.

B. All work shall be planned, arranged, and conducted so that there will be no interference with or damage to SEPTA operations, including train and surface operations, tracks and rails, signal, telephone and telegraphic services, or damage to the property of SEPTA, or to poles,
wires, and other facilities of tenants on SEPTA’s right-of-way. SEPTA may require additional protection be installed to protect rail or other facilities from damage or disturbance caused by the Contractor’s activities.

C. The work plan shall account for storage of materials so as to prevent trespassers from causing damage to trains or SEPTA property. Whenever work is likely to affect the operations or safety of trains, the method of doing such work shall first be submitted to the SEPTA for approval but such approval shall not relieve the Contractor from liability.

1.08 Engineering and Inspection
A. SEPTA, at its sole discretion, will assign an Engineer or inspector for the general protection of SEPTA property, interests and operations during the construction of the Contract.

1.09 Performance Requirements
A. Design, furnish, install, monitor and maintain excavation support and protection systems capable of supporting excavation sidewalls and of resisting, soil, hydrostatic pressure, superimposed live and dead loads and construction loads.

B. Provide Professional Engineering services needed to assume engineering responsibility, including preparation of shop drawings and a comprehensive engineering analysis by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

C. Prevent surface water from entering excavations by grading, dikes or other means.

D. Install excavation support and protection systems without damaging existing buildings, pavements, utilities, tracks and other improvements adjacent to excavation.

1.10 Project Conditions
A. Do not interrupt existing utilities serving facilities occupied by SEPTA or others unless permitted in writing by SEPTA, and then only after arranging to provide temporary utility services according to requirements indicated.

B. Survey adjacent structures and improvements, employing a Professional Engineer or Professional Land Surveyor licensed in the Commonwealth of Pennsylvania; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

C. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify SEPTA if changes in elevations or positions occur, or if cracks, sags, or other damage is evident in adjacent construction or features.

PART 2 - PRODUCTS
2.01 Materials
A. Provide materials that are either new or in serviceable condition.

B. Structural steel to meet ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
C. Steel sheet piling to meet ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood lagging to be lumber, mixed hardwood, with a minimum nominal rough cut thickness of 4 inches.

PART 3 - EXECUTION

3.01 Design General

A. A temporary shoring wall may be one (1) of the following types unless otherwise approved in the Contract Drawings:
   1. Steel sheet pile wall to be braced, tieback or cofferdam.
   2. Steel soldier piles with lagging to be braced or tieback.
   3. Trench boxes or similar devices. This type of shoring is not permitted where subjected to railroad or rail transit live loading.

B. Temporary shoring walls shall be designed to resist all dead and live loadings (earth pressures, hydrostatic pressures, traffic loads, point loads, line loads and surcharge loads) that the retaining system may experience during the service life of the structure.

C. The temporary shoring walls shall be designed in accordance with the AREMA Manual of Railway Engineering where subjected to railroad or rail transit live loads and AASHTO Standard Specifications for Highway Bridges where subjected to other vehicle loads.

D. The Contractor shall be responsible for the external stability of all temporary shoring walls including any geotechnical investigation necessary to verify the external stability. Temporary shoring walls are not required to resist seismic forces from earthquake events.

E. All temporary shoring walls shall be designed for a minimum of three (3) years design life. Temporary shoring walls that will be in use for more than three (3) years shall be designed as permanent retaining wall structures.

F. Temporary shoring walls shall be designed using appropriate soil properties relative to the anticipated service life. Temporary shoring that will be in-place for a period where excess pore pressures have not dissipated (typically less than four (4) to six (6) months) shall be designed using total (un-drained) soil shear strength parameters. Effective (drained) soil shear strength (drained) parameters should be used when temporary shoring walls are in service sufficiently long (typically more than four (4) to six (6) months) for excess pore pressures to dissipate.

G. The temporary shoring wall shall be constructed in a manner that protects adjacent buildings, bridges, roadways, or railway, and existing traffic, while allowing inspection access for existing facilities and structures. The Contractor shall be responsible for any damages or retrofit to adjacent structures that result from the construction of the temporary shoring wall.

H. All existing structures and/or track adjacent to the excavation shall be monitored for horizontal and vertical movement.

I. Excavated fill material shall not foul or contaminate track ballast.
3.02 Railroad and Rail Transit Requirements

A. SEPTA utilizes Continuous Welded Rail (CWR) on its system. It is imperative to the safety of rail operations and to prevent rail buckling, that the lateral rigidity of the track (which consists of the rail tie structure and the ballast) remains unchanged and intact. The shoulder width and height shall not be modified without express written approval of SEPTA.

B. Shoring protection shall be provided when excavating adjacent to an active railroad track and structures; refer to attached drawing 1S-51232. Shoring will not be required if the following conditions are satisfied:

1. When the track is on level ground or in a cut section, is on stable soil, and the excavation does not encroach upon a 1-1/2 Horizontal: 1 Vertical theoretical slope line starting 1 foot 6 inches below top of rail and at 10 feet minimum from centerline of the track.

2. When the excavation is outside of the zone of influence of an existing foundation.

3. Shoring is not required by OSHA.

C. When the track is on an embankment, excavating the toe of the embankment without shoring may affect the stability of the embankment. Therefore, excavation of the embankment toe without shoring will not be permitted.

D. Preferred protection is the cofferdam type that completely encloses the excavation. Where dictated by conditions, partial cofferdams or shoring with open sides away from the track or structure may be used. Cofferdams shall be constructed using interlocking steel sheet piling driven prior to excavation or steel soldier piles with timber lagging. Consideration for the use of soldier piling and lagging shall be made if the required penetration of steel sheet piling cannot be obtained and when dry, non-running, stable material will be encountered. Wales and struts shall be provided as needed.

E. The following shall be considered when designing shoring:

1. Allowable stresses in materials shall be in accordance with AREMA Manual for Railway Engineering, Chapter 7, 8 and 15.

2. The sheeting shall be designed to support all lateral forces caused by the earth, railroad and other surcharge loads. The railroad loading to be applied is a Cooper E80 loading plus impact. This loading consists of 80 Kip axles spaced 5 feet on centers. For rail transit and light rail applications, a Cooper E60 loading may be used. The surcharge shall be assumed to act on a continuous strip, 8 feet 6 inches wide. Lateral pressures due to surcharge shall be computed using the strip load formula shown in AREMA Manual for Railway Engineering.

3. Use K (at-rest earth pressure) for design of all braced and tieback excavations.

4. The allowable stresses for the sheet piling and other steel members (wales, struts, etc.) shall be in accordance with AREMA Chapter 15, Part 1. These allowable stresses may be increased 10 percent due to the temporary nature of the installations. A factor of safety of at least 1.2 must be used on temporary sheeting for the embedment length (i.e. multiply calculated embedment depth by at least 1.2).

5. Deflection design criteria is as follows:
a. 1/2 inch maximum deflection for shoring within 15 feet from the centerline of the nearest track.
b. 1 inch maximum deflection for shoring greater than 15 feet from the centerline of the nearest track.

3.03 General Requirements and Submittals

A. The Contractor shall submit the following drawings and calculations for SEPTA review and approval.

1. Detailed drawings of the shoring systems showing sizes of all structural members, details of connections and distances from centerline of track to face of shoring.
2. Drawing shall show a section showing height of shoring and track elevation in relation to bottom of excavation.
3. Provide calculations of the shoring design.
4. A Professional Engineer licensed in the Commonwealth of Pennsylvania shall prepare the drawings and calculations, which shall bear his/her seal and signature.

B. A construction procedure for temporary shoring shall be shown on the drawing.

C. The Contractor shall provide a copy of PA One Call location notification of underground utilities.

D. Where physical conditions of design impose insurmountable restrictions requiring the placing of sheeting closer than specified above, the matter must be submitted to SEPTA for approval of any modifications.

3.04 Preparation

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

B. Shore, support and protect utilities encountered.

C. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks and other adjacent occupied and used facilities.

D. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from SEPTA and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by SEPTA or other authorities having jurisdiction.

E. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.

F. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

G. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems, or performance thereof, at no additional cost to SEPTA.
3.05 **Soldier Beams and Lagging**  
A. Install steel soldier beams before starting excavation. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging or soldier beams. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.  
B. Install wood lagging within flanges of soldier beams as excavation proceeds. Fill voids behind lagging with soil and compact. Do not allow excavation to proceed more than 2 feet below bottom of lagging.  
C. Install wales horizontally at appropriate spacing to limit horizontal deflections and secure to soldier beams.

3.06 **Sheet Piling**  
A. Before starting excavation, install one (1) piece sheet piling lengths and tightly interlock to form a continuous barrier. Limit vertical offset of adjacent sheet piling to 36 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.07 **Tiebacks**  
A. Drill for, install, grout and tension tiebacks into position. Test load carrying capacity of each tieback and replace and retest deficient tiebacks.  
   1. Test loading shall be observed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for the design of the excavation support and protection system.  
   2. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.08 **Bracing**  
A. Locate bracing to clear columns, floor framing construction and other permanent work. If necessary to move a brace, install new bracing before removing original brace.  
   1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by SEPTA.  
   2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.  
   3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.09 **Removal and Repairs**  
A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities and utilities.
1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.

2. Repair or replace, as approved by SEPTA, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place when the excavation limits fall within Zone 3 of attached drawing 1S-51232, "Normal Shoring Requirements Adjacent to Track," included at the end of this Section.

3.10 Sheeting and Shoring to Support Tracks

A. Footings for all piers, columns, walls, or other facilities shall be located and designed so that any temporary sheeting and shoring for support of adjacent track or tracks during construction will not be closer than 10 feet from the centerline of the nearest tracks or the toe of the ballast slope, whichever is greater. A minimum distance of 10 feet from centerline of the track to face of nearest point of shoring shall be maintained.

B. Safety railing or fencing shall be installed when temporary shoring is within 12 feet of track or adjacent SEPTA facilities, shops, yards or stations. Installation shall not interfere with required clearances or foul the tracks. Any excavation adjacent to track or structures shall be covered and ramped and provided with barricades as required by SEPTA. A lighted walkway with a handrail, approved by SEPTA, must be provided adjacent to the track for any excavation within 10 feet of the centerline.

C. Excavation adjacent to tracks may require installation of track-bridge and/or lateral restraint trusses. For long shallow excavations parallel to the tracks, track bridges are generally required. The Contractor will be responsible for SEPTA costs associated with the installation, maintenance and removal of temporary support systems.

D. When support of track or tracks is necessary during construction, interlocking steel sheeting, adequately braced and designed to carry Cooper E80 live load plus 50 percent impact allowance is required. Soldier piles and lagging will be permitted for track support ONLY when required penetration of steel sheet piling cannot be obtained, due to site specific conditions that make steel sheet piling placement impracticable, in the opinion of the Engineer.

1. For usual soil conditions and limited excavations, sheeting is required when the near track excavation extends beneath or nearer to the track than the Theoretical Railroad Embankment Line. The Theoretical Railroad Embankment Line is defined as a line that starts at grade, 10 feet from the centerline of the track, and extends downward, away from the track, at a slope of 1 1/2 horizontal to 1 vertical.

2. For special soil conditions, such as soft organic soils and rock conditions, and for unusual excavation conditions, temporary supports for excavations may be necessary even when the limits fall beyond the Theoretical Railroad Embankment Line, requiring site specific analysis by a Professional Geotechnical Engineer licensed in the Commonwealth of Pennsylvania.

3. See attached drawing 1S-51232, "Normal Shoring Requirements Adjacent to Track".

E. Exploratory trenches, 3 feet deep and 15 inches wide, in the form of an "H" with outside dimensions matching the outside of sheeting dimensions, are to be hand dug prior to
placing and driving steel sheeting, in areas where underground installations are known to exist. These trenches are for exploratory purposes only and are to be backfilled with compacted backfill immediately.

F. Where soil or rock anchors are used, all anchors must be tested. Testing shall be in accordance with Post Tensioning Institute standards with 10 percent of the anchors "Performance Tested" and all others "Proof Tested". All tieback anchor stresses are to be in accordance with AREMA.

G. Absolute use of track is required while driving sheeting within 15 feet from centerline of a live track. Track usage shall be prearranged per standard procedures, through SEPTA.

H. Cavities adjacent to the sheet piling, created by the driving of sheet piling, shall be filled with sand, and any disturbed ballast must be restored and tamped immediately in accordance with applicable specifications and standards.

I. Sheet Piling Cutoffs:
   1. During construction, sheeting shall be cut off at an elevation no higher than the top of tie.
   2. Sheet piling shall be cut off at the top of tie during construction. After construction and backfilling has been completed, piling within 10 feet from centerline of track, or when bottom of excavation is below a line extending a 1:1 slope from the end of tie to a point of intersection with the sheeting, shall be cut off 18 inches below existing ground line and left in place.
   3. At the completion of construction activities involving the use of sheet piling, sheet piling may be pulled if there will be no adverse impact to the railroad track support bed, as determined by SEPTA. This will generally be permitted when both of these conditions are met:
      a. The sheeting face is at least 10 feet distant from the centerline of track, and,
      b. The bottom of the excavation that the sheeting supported prior to backfilling, does not fall within an assumed influence zone under the tracks. The assumed influence zone is defined as the area, as seen in cross sectional view, falling beneath the Theoretical Underground Track Disturbance Line. This line is defined as a line that starts at the end and bottom of the ties, and extends from the track outward and downward at a 1:1 (4 degree) slope.
   4. Sheet piling that is to be left in-place, shall be cut off below the ground line:
      a. At least 18 inches below final ground line at the sheeting, and
      b. No higher than 24 inches below the elevation of the bottom of the nearest ties
   5. See attached drawing 1S-51232, "Normal Shoring Requirements Adjacent to Track".

J. Excavations adjacent to the track shall be covered, ramped and protected by handrails, barricades and warning lights, as required by applicable safety regulations, and as directed by SEPTA.

K. Final backfilling of any excavation shall meet the Project Specifications.

L. Provide a detailed schedule of proposed construction operations, detailing each step of the proposed temporary construction operations in proximity to tracks, for review and approval of the proposed operations, and to allow proper inspection and monitoring of operations.
M. Drawings for the proposed temporary sheeting and shoring shall be signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania. Complete design calculations, clearly referenced to the drawings, and easy to review, shall be provided with submission of drawings.

N. Where site specific conditions impose insurmountable restrictions to the design of temporary construction conforming to the limitations listed above, the design of temporary construction shall be developed in close coordination with SEPTA. SEPTA will provide final approval of temporary construction that does not conform to the above limitations.

1. When SEPTA grants approval for sheeting closer than standard minimum clearances, the Contractor shall develop a survey plan, if not already required by the Contract, for the adjacent tracks, to be conducted prior to, during and after the temporary sheeting construction operations. If settlement is detected, construction operations shall be suspended until the track has been returned to its initial condition, and stabilized, as determined by SEPTA.

2. The Contractor shall stockpile 10 tons of approved ballast at the Project site, and maintain that amount in ready reserve, to allow for the possible need to restore track profile.

O. Particular care shall be taken in the planning, design and execution of temporary construction, as relates to railroad slope protection and drainage facilities. Erosion and sediment control best management practices shall be designed and employed, as approved by SEPTA. Any unintended disruption to railroad drainage facilities, caused by the temporary construction, shall be promptly remedied as directed by SEPTA, solely at the Contractor’s cost.

3.11 Requirements for Monitoring during Pile Driving and/or Excavating Operations

A. Pile driving and excavation on, or adjacent to, SEPTA’s property and/or right-of-way shall conform to the following minimum design and submittal requirements.

B. Pile driving will be on a continuous basis for each pile driven. Once a pile is started, it will be driven or cut off at an elevation not to exceed the plane across the top of the rails of any track within 8 feet 6 inches plus 2 inches for each degree of curvature from centerline of track to the closest edge of the excavation.

C. Monitoring points shall be set up not less than one (1) week before the pile driving or excavation operations begin. SEPTA shall be notified prior to establishing monitoring points.

D. Elevation and horizontal alignment readings to establish the initial baseline reading shall begin two (2) days prior to the start of work. Readings shall be for a minimum of two (2) weeks after the completion of the driving or backfilling of the excavation, whichever is longer. Initial readings immediately after any surfacing operations shall serve as new baseline figures. All future readings shall be compared to the adjusted baseline. If the track deviates to an unacceptable degree, work will be stopped and corrections will be made at the Contractor’s expense.

E. Elevation readings will be taken from the top of each rail of each track and alignment readings will be taken from gauge of each rail within the "zone of influence" of the excavation.
F. Readings will be taken once per eight (8) hour shift. The readings will be faxed to SEPTA on a daily basis and all information is to be presented in legible print. During excavation within the sheet pile protected area, the top of rail elevations shall be checked every hour. Additional readings may be required by SEPTA.

G. Stations shall be spaced at no greater than 15 feet 6 inch intervals. The number of stations required will be determined by the length of the excavation parallel to the tracks. There will be four (4) additional stations on each end of the pile driving/excavation operation along the track. Extra stations may be required by SEPTA.

H. Station "0" will be located at the centerline of the project with Stations 1, 2, 3, etc., being to the right, and Stations -1, -2, -3, etc., being to the left, when standing on the near track and looking at the work. In multiple track areas the stations as determined herein are to be carried across each track located within any part of the zone of influence.

I. Readings must show the date, time, weather conditions and temperature. Each reading must also provide the following information: track number, compass direction, station number, base reading (with date), static elevation, change in elevation or alignment (recorded in hundredths and in inches), dynamic reading and total deflection in inches.

J. At each monitoring station a dynamic load measurement will also be taken. The dynamic load measurement device will consist of a wooden stake placed firmly in the ballast and initially in contact with the bottom of the rail. The loaded measurement is the resultant gap between the bottom of the rail and the top of the stake caused by the deflection of the rail under the load of a passing train. Based on field observations of the excavation, and at the option of SEPTA, this requirement may be reduced.

K. Elevation readings taken from the top of rail for static measurement and the dynamic reading shall be combined and the sum compared to the pre-work adjusted baseline. The difference in the sum of these readings will demonstrate the difference in elevation caused by the excavation.

L. SEPTA requires that the track be maintained at all times within established criteria for the specific track classification. At the completion of the Project, the requirement for tamping and realigning the tracks, as a result of settlement caused by the construction activity, remains with the Contractor for the duration as specified by the SEPTA in their initial review of the work plans. This tamping and track realignment will be performed by SEPTA at the sole expense of the Contractor.
3.12 Drawings 15-51232

TYPICAL SHORING CROSS-SECTION

1. Excactions within Zone 1 are recommended to protect railroad embankment. boxed
2. Excavations within Zone 2 are normally required. boxed
3. Excavations within Zone 3 are normally required. boxed
4. No excavations permitted in Zone 4 without the express written permission of the SHORING REQUIREMENTS ADJACENT TO TRACK

END OF SECTION
THIS PAGE NOT USED
SECTION 02205

IMPACTED SOIL MANAGEMENT

PART 1 - GENERAL

1.01 Description
A. This Section describes the requirements for managing impact soil materials.

1.02 Submittals
A. Material Handling Plan for Non-Hazardous Contaminated Soils and Hazardous Soils:
   1. Within forty-five (45) calendar days after award of Contract, the Contractor shall submit to the Engineer for review, a Material Handling Plan (MHP). The MHP must be approved by the Engineer, prior to the Contractor’s commencement of work. The MHP shall, at a minimum, consist of:
      a. The Contractor’s procedures for identifying non-hazardous contaminated soils and hazardous soils that will require excavation and management, including the use of real-time monitoring equipment to evaluate the nature of impacts in the field. Information on the specific model and manufacturer of organic vapor monitoring equipment and calibration procedures are to be provided. It should also include the training and experience of the personnel who will operate the equipment.
      b. The Contractor’s procedures for safely handling non-hazardous contaminated soils, hazardous soils or soils which have not yet been tested but are believed to be potentially contaminated. The procedures must include personnel safety and health as well as environmental protection considerations.
      c. Name, address and telephone number of the proposed Pennsylvania accredited laboratory for analysis of representative soil samples.
      d. Identification of the Contractor’s proposed waste transporter(s). This information shall include:
         1) Name and waste transporter permit number.
         2) Address.
         3) Name of responsible contact for the hauler.
         4) Telephone number for the contact.
         5) Any and all necessary permit authorizations for each type of waste transported.
         6) Previous experience in performing the type of work specified herein.
      e. All staging/stockpiling areas (if stockpiling areas are intended and available), or alternate procedures that will be used. Alternate procedures may include, but are not limited to, agreements from the intended disposal or treatment facilities to accept boring data and/or analytical data previously obtained during the site characterization so that materials may be directly loaded into vehicles for shipment to the disposal facility.
      f. A backup facility should the staging/stockpile areas become unavailable, insufficient in area or not be present by some other unforeseen difficulty.
      g. Identification of the Contractor’s two (2) proposed Treatment Storage or Disposal (TSD) facilities for non-hazardous contaminated soils or hazardous soils (primary and back-up) for final disposal of the soils. The primary TSD shall be an approved soil recycling/treatment facility. The backup facility may be a recycling/treatment facility or a
Pennsylvania Department of Environmental Protection (PADEP) approved lined landfill or other facility approved by PADEP to accept this material.

h. The Contractor shall submit the following information prior to any transportation of soils regarding the temporary and final off-site TSD or facilities where it is proposing to take non-hazardous contaminated soils or hazardous soils.

1) Facility name, state identification number and EPA identification number.
2) Facility location.
3) Name of responsible contact for the facility.
4) Telephone number for contact.
5) Signed letter of agreement to accept waste as specified in this Contract.
6) Signed letter of agreement with a TSD for disposal of waste that may not be land-disposed.
7) Unit of measure utilized at facility for costing purposes.
8) A listing of all permits, licenses, letters of approval, and other authorizations to operate, which are currently held and valid for the proposed facility as they pertain to receipt and management of wastes derived from this Contract.
9) A listing of all permits, licenses, letters of approval, and other authorizations to operate which have been applied for by the proposed facility but not yet granted or issued.
10) The Contractor shall specify and describe the disposal/containment unit(s) that the proposed facility will use to manage the waste. The Contractor shall identify the capacity available in the units and the capacity reserved for the subject waste.
11) The Contractor shall provide the date of the proposed facility’s last compliance inspection under RCRA.
12) A list of all active (unresolved) compliance orders (or agreements), enforcement notices or notices of violations issued to the proposed facility shall be provided. The source and nature of the cause of violation shall be stated, if known.
i. Description of all sampling and field/laboratory analyses that will be needed to obtain disposal facility approval.

B. Health and Safety Plan (HASP):

1. The Contractor shall submit, within forty-five (45) calendar days after the Contract award, a written HASP as specified herein, to the Engineer for review and comment. The Contractor shall make all necessary revisions required by the Engineer and resubmit the HASP to the Engineer and SEPTA for acceptance. Start-up work for the Contract will not be permitted until written acceptance has been issued by the Engineer.

2. Daily safety logs shall be maintained by the Contractor and shall be submitted to the Engineer either on request or on completion of the work. Training logs shall be maintained by the Contractor and submitted to the Engineer and SEPTA either on request or on completion of the work. Daily logs on air monitoring during excavation activities shall be prepared and maintained by the Contractor and submitted to the Engineer either on request or upon completion of the work.

3. A closeout report shall be submitted by the Contractor to the Engineer upon completion of the work within the defined exclusion zones. This report shall summarize the daily safety and monitoring logs and provides an overview of the
Contractor’s performance regarding environmental and safety issues. The report shall carefully document all areas where contamination has been found including pictures, addresses of locations and potential sources.

4. The Contractor shall submit to the Engineer the name, office address and telephone number of the medical consultant utilized. Evidence of baseline medical examinations together with the evidence of the ability to wear National Institute for Occupational Safety and Health (NIOSH) approved respirators (as specified in ASSE/AIHA Z88.6) shall be provided to the Engineer and SEPTA for all construction personnel who are to enter the exclusion zones.

5. All accidents, spills, or other health and safety incidents shall be reported to the Engineer and SEPTA.

C. Water Handling Plan (WHP):

1. Within forty-five (45) calendar days after award of Contract, the Contractor shall submit to the Engineer for review, a Water Handling Plan (WHP) to address Removal, Treatment and Discharge/Disposal of Contaminated Water. The WHP must be approved by the Program Administration, ESS, prior to the Contractor’s commencement of work. The minimum requirements for the WHP are specified in Article 3.04/B in this Section, for each type of disposal (disposal into the combined sanitary/storm sewer or off-site disposal). The Contractor shall maintain a complete, up to date copy of the WHP on the job site at all times.

1.03 Health and Safety

A. Description

1. It is the Contractor’s responsibility to stage and conduct his work in a safe manner. The Contractor shall implement a Health and Safety Plan (HASP) for contaminated/hazardous soil intrusive activities as set forth in 29 CFR 1910.120 and 29 CFR 1926.650-652. The Contractor shall ensure that all workers have at a minimum hazard awareness training. The Contractor shall segregate contaminated work area in secured exclusion zones. These zones shall limit access to the Contractor personnel specifically trained to enter the work area. The exclusion zone shall be set up to secure the area from the public and untrained personnel. The Project health and safety program shall apply to all construction personnel including persons entering the work area. In addition, the Contractor shall protect the public from on-site hazards, including subsurface contaminants associated with on-site activities. The HASP shall be signed off by a Certified Industrial Hygienist and reviewed by the Engineer.

2. Work shall include, but not be limited to:
   a. Implementation of a baseline medical program.
   b. Providing safety equipment and protective clothing for site personnel, including maintenance of equipment on a daily basis; replacement of disposable equipment as required; decontamination of clothing, equipment and personnel; and providing all other health and safety measures.
   c. Providing, installing, operating and maintaining on-site emergency medical first aid equipment as specified in this Section for which payment is not provided under other pay items in this Contract.
d. Providing, installing, operating, maintaining and decommissioning all equipment and personnel decontamination facilities specified within this Section, including, but not limited to, the decontamination pad, decontamination water supply, decontamination water collection equipment and all other items and services required for the implementation of the health and safety requirements for which pay items are not provided elsewhere in this Contract.

e. Provide the minimum health and safety requirements for excavation activities within the limits of this Contract.

f. The HASP as presented in this Section is dynamic with provisions for change to reflect new information, new practices or procedures, changing site environmental conditions or other situations which may affect site workers and the public. The HASP will also address measures for community protection, accident prevention, personnel protection, emergency response/contingency planning, air monitoring, odor control and hazardous chemicals expected on site. Providing a Confined Space Entry Program as defined in 29 CFR 1910.146.

B. Environmental Consulting Services:

1. The Contractor shall retain an independent Environmental Consultant to obtain all permits and perform all field screening, air monitoring, community air monitoring, soil sampling, and health and safety services. The independent Environmental Consultant shall at a minimum provide documentation to the Engineer and SEPTA demonstrating the minimum requirements as set forth below:

a. The independent Environmental Consultant Project supervisor on site and other designated key personnel shall have a minimum of five (5) years of experience in the environmental field dealing with issues associated with contaminated soils. Such experience shall include oversight on environmental, specifically volatile organic compound and dust monitoring services as a routine part of its daily operations.

b. The independent Environmental Consultant must be experienced in work of this nature, size, and complexity and must have previous experience in working with the SEPTA.

c. The independent Environmental Consultant shall furnish a Project list identifying the location, nature of services provided, Owner, Owner’s contact, contact’s telephone number, Project duration and value for at least five (5) Projects.

d. The independent Environmental Consultant shall furnish to the Engineer and SEPTA a staffing plan which identifies the Environmental Consultant’s key personnel and resume documenting their experience, training, licenses and education to justify their roles in the Project. A Health and Safety Officer must be designated.

e. The independent Environmental Consultant shall demonstrate that these key Project personnel have received an approved forty (40) hour OSHA Hazardous Waste Operations and Emergency Response (Hazwoper) Training including most recent eight (8) hour refresher training.

f. If conditions within the exclusion zone are deemed hazardous, then the Contractor and its independent Environmental Consultant shall ensure that all personnel working within identified exclusion zones and/or involved (direct contact) with the handling, storage or transport of hazardous and contaminated materials shall have completed a minimum of forty (40) hours of Health and Safety Training on Hazardous Waste Sites in accordance with 29 CFR 1910.120(e). The training program shall be conducted by a qualified safety instructor. If conditions in the exclusion zone are deemed to be non-hazardous, the independent Environmental Consultant shall provide site specific training.

g. The Contractor shall ensure that on-site management and supervisors directly responsible for or who supervise employees engaged in hazardous waste operations shall
receive the training specified in above and at least eight (8) additional hours of specialized training on managing such operations at the time of job assignment.

C. The HASP shall meet 29 CFR 1910.120/1926.65. This document shall at a minimum contain the following:

1. Description of work to be performed.
2. Site description.
3. Key personnel.
4. Worker training procedures.
5. Work practices and segregation of work area.
8. Personal and community air monitoring procedures and action levels.
9. Personal protective equipment.
10. Decontamination procedures.
13. Spill control, dust control, vapor/odor suppression procedures.
15. Confined space procedures.

D. Measurement:

1. 25 percent of the lump sum price will be paid when the following items are implemented or mobilized:
   a. Medical surveillance program.
   b. Health and safety training.
   c. Health and safety plan.
   d. Environmental and personnel monitoring.
   e. Instrumentation.
   f. Spill control.
   g. Dust control.
   h. Personnel and equipment decontamination facilities.
   i. Personnel protective clothing.
   j. Communications.
   k. Mobilization.

2. 50 percent will be paid in proportional monthly amounts over the period of work.

3. 25 percent will be paid when the operation is demobilized and removed from the Project site.
E. Price to Cover:

1. The lump sum price bid for the health and safety requirements shall include all labor, materials, equipment and insurance necessary to complete the work in accordance with these Specifications. The price bid shall include, but not be limited to, the following:
   a. Providing training, safety personnel, air monitoring and medical examinations as specified.
   b. Providing safety equipment and protective clothing for site personnel, including maintenance of equipment on a daily basis; replacement of disposable equipment as required; decontamination of clothing, equipment and personnel; and all other health and safety activities or costs not paid for under other pay items in this Contract.
   c. Providing, installing, operating and maintaining on-site emergency medical and first aid equipment. This includes all furnishings, equipment, supplies and maintenance of all medical equipment, and all other health and safety items and services for which payment is not provided under other pay items in this Contract.
   d. Providing, installing, operating, maintaining, and decommissioning all personnel and equipment decontamination facilities, including decontamination pad, decontamination water supply, and all other items and services required for the implementation of the health and safety requirements for which pay items are not provided elsewhere in this Contract. Vehicle decontamination pads shall be included in the price of this item. Disposal of decontamination fluid shall be paid for under Article 3.04 in this Section.
   e. Spill Control:
      1) Payment shall account for furnishing, installing, and maintaining all spill control equipment and facilities. Payment will include equipment and personnel to perform emergency measures required to contain any spillage and to remove spilled materials and soils or liquids that become contaminated due to spillage during work within the exclusion zones and handling of excavated soils and liquids from these areas. This collected spill material will be properly disposed of.
      2) Payment under this item shall not include testing, handling, transportation or disposal of petroleum-contaminated/potentially hazardous soils excavated during construction. The price for this work will be paid for under Articles 3.01, 3.02 and 3.03 in this Section as appropriate.
   f. Dust Control:
      1) Payment shall account for furnishing, installing, and maintaining dust control equipment and facilities to be used whenever applicable dust levels are exceeded. Payment will include all necessary labor, equipment, clean water, foam and all other materials required by the Dust Control Plan. The DOH Community Air Monitoring Plan (CAMP) may be used as guidance.
   g. Vapor/Odor Suppression:
      1) Payment shall account for furnishing, installing and maintaining vapor/odor control equipment and facilities to be used whenever organic vapor monitoring or the presence of odors indicates that vapor suppression is required to protect workers or the public. Payment will include all necessary labor, equipment, clean water, foam and all other materials required by the Vapor/Odor Suppression Plan.
   h. Mobilization/Demobilization:
      1) Mobilization:
         a) Payment shall include but not be limited to:
i. All work required to furnish, install and maintain all signs, fencing, support zone facilities, parking areas and all temporary utilities.

ii. All work required to furnish, install, and maintain an office space with phone and utilities for health and safety personnel.

iii. All work required for complete preparation of lay down area for roll-off containers, including sampling and any required fencing.

iv. All direct invoiced cost from bonding companies and government agencies for permits and costs of insurance.

v. All other items and services required for mobilization and site preparation.

2) Demobilization:
   a) Payment shall include but not be limited to all work required to sample the area; remove from the site all equipment, temporary utilities and supporting facilities; performance of necessary decontamination and repairs; disposal of disposable equipment and protective gear and other items and services required for complete demobilization.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASSE/AIHA Z88.6, American National Standard for Respiratory Protection - Respirator Use - Physical Qualifications for Personnel.


PART 2 - PRODUCTS

2.01 Materials

A. Containers shall be as required in the United State Department of Transportation (DOT) regulations.

B. Containers shall be watertight as required in the USDOT regulations and must meet all applicable regulations.

C. Polyethylene to be placed under (20 mil thickness minimum) and over (10 mil thickness minimum) soil piles. If soils are placed in drums, polyethylene must be placed over the drums.

D. The Contractor shall assure that the waste hauler’s appropriate choice of vehicles and operating practices shall prevent spillage or leakage of contaminated material from occurring in route.
E. The Contractor shall provide, install and maintain any temporary loading facilities on site as required until completion of material handling activities. The location and design of any facilities shall be included in the MHP and be approved by the Engineer.

F. All vessels for temporary storage and transport to an off-site disposal facility shall be as required in USDOT regulations.

PART 3 - EXECUTION

3.01 Transporting and Disposal of Non-Hazardous Contaminated Soils

A. Description:

1. This work shall consist of the handling, transportation and disposal of non-hazardous contaminated soils. The materials covered by this Section are soils that are contaminated with petroleum or chemical products but cannot be classified as hazardous waste. For the purpose of this Specification, soil shall be defined as any material excavated below gravel or asphalt base material.

2. Non-hazardous contaminated soils are defined as soils exhibiting one (1) or more of the following characteristics:
   a. Elevated Photo-Ionization Detector (PID) readings, subsequently confirmed by lab analysis.
   b. Visual evidence of contamination.
   c. Petroleum and/or chemical odors.
   d. Soils that have been documented as contaminated in previous environmental reports.

3. Non-hazardous contaminated soils must be stockpiled at an off-site approved location or secured on-site by the Contractor, meeting all required federal, state and local stipulations. Contaminated soils determined to be non-hazardous shall be handled in accordance with this Section for soils determined to be hazardous shall be handled in accordance with the requirements for Article 3.03 in this Section.

4. The Contractor shall retain the services of an independent Environmental Consultant, as specified under Article 1.03 in this Section, to oversee the work required under this Item.

5. Non-hazardous soils shall be delivered to the disposal or treatment facility within thirty (30) calendar days after excavation.

6. The Contractor shall conduct sampling and analysis of the impacted soils as specified under Article 3.02 in this Section. The laboratory results shall be forwarded to the Engineer for review to determine if the soils will be handled and disposed of as contaminated regulated soils or hazardous waste. No other soils shall be sampled or tested without the Engineer’s approval or direction.

7. The Contractor shall ensure that all operations associated with the handling, sampling, loading, transportation, and disposal of non-hazardous contaminated soils are in compliance with all applicable federal, state, and city statutes and regulations.

8. The Contractor shall document the excavation, handling, transportation and disposal of non-hazardous contaminated soils. The Contractor shall supply all equipment, material and labor required to conduct the specified work of this Item.
B. Construction Details

1. Material Handling:
   a. Immediately after excavation of non-hazardous contaminated soil the Contractor shall:
      1) Load material directly onto trucks/tankers/roll offs for disposal off site; or
      2) If interim stockpiling is required, place on a minimum of 20 mil or equivalent plastic ground cloth and cover by minimum of 10 mil polyethylene sheeting or equivalent to protect against leaching or runoff of contaminants into groundwater or storm water. Weight or secure the sheeting by appropriate means and seal seams as approved by the DDC to prevent tearing or removal by weather. Grade surrounding surface to provide for positive drainage away from pile. Stockpile shall not exceed 100 cubic yards.
   b. Institute appropriate procedures and security measures to ensure the protection of site personnel and the public from contaminated materials as described in the approved MHP and Article 1.03 in this Section.
   c. Any soil encountered that appears to contain unknown contaminants (based on visual, odor, or other observation), or that vary substantially from the material originally identified must be segregated in stockpiles and the independent Environmental Consultant promptly notified. Construct stockpiles to the same requirements as stated in Article 3.01/A/1/b in this Section.
   d. Provide any dewatering that is necessary to complete the work. Contaminated water shall be disposed of in accordance with Article 3.04 in this Section.
   e. Provide and operate field organic vapor test equipment, a PID or a flame ionization detector (FID), to detect general organic vapor levels at intervals of approximately fifty (50) cubic yards of soil excavated, when visual or odor observations indicate the material may substantially differ from the soil previously excavated and/or as directed by the independent Environmental Consultant.

2. Off-Site Transportation to Disposal or Treatment Facility:
   a. General:
      1) The Contractor shall furnish all labor, equipment, supplies and incidental costs required to transport contaminated material from the work area to the off-site disposal or treatment facility, and any other items and services required for transporting contaminated material for disposal at an off-site facility.
      2) The Contractor shall submit the name and location of the facility where an off-site scale is located. The Contractor shall also submit a plan to the Engineer for review outlining procedures on controlling trucks leaving the work site and en-route to the off-site scale. The Contractor shall be responsible for tracking all material/vehicles from the site to the off-site scale.
      3) The Contractor shall provide to the Engineer certified tare and gross weight slips for each load received at the accepted facility which shall be attached to each returned manifest.
      4) The Contractor shall coordinate the schedule for truck arrival and material deliveries at the job site to meet the approved Contract schedule.
      5) The Contractor shall inspect all vehicles leaving the Project site to ensure that contaminated soils adhering to the wheels or undercarriage are removed prior to the vehicle leaving the site.
      6) The Contractor shall obtain letters of commitment from the waste haulers and the treatment, disposal or recovery facility to haul and accept shipments. The letter shall indicate agreement to handle and accept the specified estimated quantities
and types of material during the time period specified in the Contract schedule and any time extension as deemed necessary.

7) The Engineer shall review and approve waste profiles before transportation to the TSD facility.

b. Hauling:

1) The Contractor shall coordinate manifesting, placarding of shipments and vehicle decontamination. All quantities shall also be measured and recorded upon arrival at the disposal or treatment facility. If any deviation between the two (2) records occurs, the matter is to be reported immediately to the Engineer and to be resolved by the Contractor to the satisfaction of the Engineer and SEPTA.

2) The Contractor shall be held responsible, at its own cost for any and all actions necessary to remedy situations involving material spilled in transit or mud and dust tracked off-site.

3) The Contractor shall ensure that trucks are protected against contamination by properly covering and lining them with compatible material (such as polyethylene) or by decontaminating them prior to and between acceptances of loads.

4) The Contractor shall be responsible for inspecting the access routes for road conditions, overhead clearance and weight restrictions.

5) The Contractor shall only use the transporter(s) identified in the MHP for the performance of work. Any use of substitute or additional transporters must have previous written approval from the Engineer at no additional cost to the city.

6) The Contractor shall develop, document and implement a policy for accident prevention.

7) The Contractor shall not combine contaminated materials from other Projects with material from this Contract.

8) No material shall be transported until approved by the Engineer.

c. Off-Site Disposal:

1) The Contractor shall use only the facilities identified in the MPH for the performance of the work. Substitutions or additions shall not be permitted without prior written approval from the Engineer, and if approved shall be at no extra cost to SEPTA.

2) The Contractor shall be responsible for acceptance of the materials at an approved facility, for ensuring that the facility is properly permitted to accept the stated materials, and that the facility provides the stated treatment and/or disposal services.

3) The Engineer reserves the right to contact and visit the disposal or treatment facility and regulatory agencies to verify the agreement to accept the stated materials and to verify any other information provided.

4) In the event that the identified and approved facility ceases to accept the stated materials or the facility ceases operations, it is the Contractor’s responsibility to locate an alternate approved and permitted facilities for accepting materials. The alternate facilities must be approved in writing by the Engineer and PADEP in the same manner and with the same requirements as for the original facilities. This shall be done at no extra cost or delay to SEPTA.

5) The Contractor shall obtain manifest forms, and complete the shipment manifest records required by the appropriate regulatory agencies for verifying the material and quantity of each load in unit of volume and weight. Copies of each manifest shall be submitted to the Engineer within four (4) business days following shipment, and within three (3) business days after notification of receipt of the facility. Any
manifest discrepancies shall be reported immediately to the Engineer and be
resolved by the Contractor to the satisfaction of the Engineer.

d. Equipment and Vehicle Decontamination:

1) The Contractor shall design and construct a portable decontamination station to be
used to decontaminate equipment and vehicles exiting from the exclusion zone.
The cost for this work will be paid under Article 1.03 in this Section.

2) Water generated during the decontamination process shall be disposed of in
accordance with Article 3.04 in this Section.

C. Method of Measurement:

1. Quantities for non-hazardous contaminated soils shall be measured in tons. The
tonnage will be determined by off-site truck scales, per Article 3.01/B/2 in this
Section, that are capable of generating load tickets.

D. Price to Cover:

1. The unit bid price bid per ton shall include the cost of furnishing all labor, materials,
plant, equipment, and insurance for excavation, handling, transportation, disposal,
documentation, fees, permits, loading, stockpiling, hauling, and any other incidentals
necessary to complete all the work as specified herein for handling, transporting and
disposal of non-hazardous contaminated soil.

2. Final disposal of hazardous soil shall be paid for under Article 3.03 in this Section.
Disposal of decontamination water shall be paid for under Article 3.04 in this Section.

3. Backfill will be paid for under its respective item as specified in the Contract
Documents.

4. The independent Environmental Consultant shall be paid under Article 1.03 in this
Section.

3.02 Sampling and Testing of Contaminated/Potentially Hazardous Soil for Disposal Parameters

A. Description

1. The work shall consist of collecting and analyzing representative soil samples for
parameters typically requested by the disposal facilities.

B. Sampling and Laboratory Analysis:

1. At least thirty (30) days prior to the commencement of work, the Contractor’s
independent Environmental Consultant must submit a Soil Sampling Plan/Field
Sampling Plan (SSP/FSP) to the Engineer for review and approval. The plan shall
include the name, address and telephone numbers of the proposed laboratory. The
plan shall also include training and experience of the personnel who will collect the
samples.

2. The Contractor shall sample and analyze representative samples of the
contaminated/potentially hazardous soils. Sampling will be performed in accordance
with PADEP Form U Parameters and methodology for disposal within Pennsylvania. If
disposal is out of state, the Contractor will complete the appropriate sampling
methodology and parameters to comply with the appropriate state regulations. The
Contractor will provide the application and approval of the facility to the Engineer.
The cost associated with additional sampling and testing shall be included in the bid price of this Item.

3. All sampling shall be conducted by a person trained in sampling protocols using standard accepted practices for obtaining representative samples.

4. The quality of the data from the sampling program is the Contractor’s responsibility. The Contractor must furnish all qualified personnel, equipment and instruments necessary to carry out the sampling. Unless directed otherwise, all sampling procedures must follow the PADEP sampling guidelines and protocols.

5. All sample containers shall be marked and identified with legible sample labels which shall indicate the Project name, sample location and/or container, the sample number, the date and time of sampling, preservatives utilized and other information that may be useful in determining the character of the sample. Chain-of-custody shall be tracked from laboratory issuance of sample containers through laboratory receipt of the samples.

6. The Contractor shall maintain a bound sample logbook. The Contractor shall provide the Engineer and SEPTA access to it at all times and shall turn it over to the Engineer in good condition at the completion of the work. The following information, as a minimum shall be recorded to the log:
   a. Sample identification number.
   b. Sample location.
   c. Field observation.
   d. Sample type.
   e. Analyses.
   f. Date/time of collection.
   g. Collector’s name.
   h. Sample procedures and equipment utilized.
   i. Date sent to laboratory and name of laboratory.
   j. SEPTA reserves the right to direct the Contractor to conduct alternative sampling in lieu of the parameters described in Article 3.02/B/2 in this Section, if the situation warrants. The substitute sampling parameters shall be of equal or lesser monetary value than those described in Article 3.02/B/2 in this Section, as determined by industry laboratory pricing standards.
   k. Only dedicated sampling equipment may be used to collect these samples. All equipment involved in field sampling must be decontaminated before being brought to the sampling location, and must be properly disposed after use.
   l. Soils exceeding any of the hazardous characteristic criteria meet the legal definition of hazardous soils (rather than non-hazardous contaminated soils) and shall be transported or disposed of under Article 3.03 in this Section. All analyses must be done by a laboratory that has received Pennsylvania accredited. The Contractor must specify the laboratory in the MHP.

C. Price to Cover:

1. The unit price bid shall include the cost of furnishing all labor, materials, plant, equipment, and insurance necessary for sampling, handling, transporting, testing, documentation, fees, permits and any other incidentals necessary to complete the
work as specified herein for sampling and testing of contaminated/potentially hazardous soil.

3.03 Handling, Transporting and Disposal of Hazardous Soils

A. Description:

1. This work shall consist of the handling, transportation and disposal of soils or materials that are listed as hazardous wastes or exhibit any of the characteristics of a hazardous waste, namely ignitability, corrosivity, reactivity, and toxicity, as defined in 40 CFR 261. For the purpose of this Section, soils shall be defined as any materials excavated below gravel or pavement and base.

2. Contaminated soils determined to be hazardous under Article 3.02 in this Section shall be handled, transported and disposed of in accordance with the requirements herein.

3. The independent Environmental Consultant retained by the Contractor, as specified under Article 1.03 in this Section, shall conduct sampling and analysis of above soils to determine which soils are hazardous.

4. All work shall be performed under the direct supervision of the Contractor’s Environmental Consultant, as approved by the Engineer.

5. The Contractor shall ensure that all operations associated with the handling, sampling, loading, transportation and disposal of hazardous materials are in compliance with the applicable federal, state and local statutes.

6. The Contractor shall document the excavation, handling, sampling, and testing, transportation and disposal of hazardous soils. The city shall be listed in the disposal documents as the waste generator.

7. The Contractor shall supply all equipment, material and labor required to conduct the specified work of this Section.

8. The Contractor shall ensure that all operations associated with the handling, sampling, loading, transportation and disposal of hazardous soils are conducted in a manner to protect site personnel, the public and the environment, in accordance with all applicable federal, state, and local laws and regulations.

9. The Contractor shall decontaminate all equipment prior to its removal from the exclusion zone and/or following contact with hazardous materials, as detailed in Article 1.03 in this Section. Water generated during the decontamination process shall be disposed of under Article 3.04 in this Section.

B. Construction Details

1. Material Handling:

a. The Contractor shall institute procedures to protect site personnel and the public from the non-hazardous and hazardous materials as described in Article 1.03 in this Section.

b. The Contractor shall handle hazardous soil as approved in the MHP.

c. Stockpiled materials at the temporary TSD facility shall be handled according to the facility requirements but at a minimum shall be drummed or placed on and covered with polyethylene to protect against erosion and leaching into surrounding soils, the stockpile
area shall be graded for positive drainage away from the pile, and shall be labeled while being held for sampling prior to permanent disposal.

d. Provide any dewatering that is necessary to complete the work. Water shall be disposed of in accordance with Article 3.04 in this Section.

2. Off-Site Transportation and Disposal:

a. The Contractor shall furnish all labor, equipment and supplies required to transport hazardous materials from the work area to the off-site TSD facilities and to acquire any other items and services required for transporting hazardous materials for storage and/or disposal at an approved off-site facility.

b. Weight Measurement:

1) The Contractor shall submit the name and location of the facility where an off-site scale is located. The Contractor shall also submit a plan to the Engineer for review outlining procedures on controlling trucks leaving the work site and on-route to the off-site scale. The Contractor shall be responsible for tracking all materials/vehicles from the site to the off-site scale.

2) The Contractor shall provide to the Engineer certified tare and gross weight slips for each load received at the accepted facility which shall be attached to each returned manifest.

c. General:

1) The Contractor shall organize and maintain the material shipment records/manifests required by law.

2) The Contractor shall coordinate the schedule for truck arrival and material deliveries at the job site to meet the approved Contract schedule. The schedule shall be compatible with the availability of equipment and personnel for material handling at the Project site.

3) The Contractor shall inspect all vehicles leaving the Project site to ensure that hazardous soils adhering to the wheels or under carriage are removed prior to the vehicle leaving the site.

4) The Contractor shall obtain letters of commitment from the waste haulers and the TSD facility to haul and accept shipments. The letter shall indicate agreement to handle and accept the specified estimated quantities and types of material during the time period specified in the Contract schedule and any time extension as deemed as necessary.

d. Hauling:

1) The Contractor shall not deliver waste to any facility other than the TSD facilities listed on the shipping manifest.

2) The Contractor shall coordinate manifesting, placarding, of shipments, and vehicle decontamination. All quantities shall also be measured and recorded upon arrival at the TSD facility. If any deviation between the two (2) records occurs, the matter is to be reported immediately to the Engineer and to be resolved by the Contractor to the satisfaction of the Engineer.

3) The Contractor shall be held responsible, at its own expense, for any and all actions necessary to remedy situations involving material spilled in transit or mud and dust tracked off-site.

4) The Contractor shall ensure that trucks are protected against contamination by properly covering and lining them with compatible material (such as polyethylene) or by decontaminating them prior to any use other than hauling hazardous materials.
5) The Contractor shall be responsible for inspecting the access routes for road conditions, overhead clearance and weight restrictions.

6) The Contractor shall only use the transporter(s) identified in the MHP for the performance of work. Only a transporter with waste transporter permit from Pennsylvania may transport this material. Any use of substitute or additional transporters must have previous written approval from the Engineer at no additional cost to SEPTA.

7) The Contractor shall develop, document and implement a policy for accident prevention.

8) The Contractor shall not combine hazardous materials from other Projects with material from this Contract.

9) The Contractor shall obtain for SEPTA an EPA hazardous waste generator identification number and a representative of SEPTA will review and sign the manifest as the generator.

10) No materials shall be transported until approved by the Engineer.

e. Off-Site Disposal:

1) The Contractor shall be responsible for acceptance of the materials at an approved TSD facility, for ensuring that the facility is properly permitted to accept the stated materials, and that the facility provides the stated storage and/or disposal services.

2) In the event that the identified and approved facility ceases to accept the stated materials or the facility ceases operations, it is the Contractor’s responsibility to locate an alternate approved and permitted facilities for accepting materials. The Contractor is responsible for making the necessary arrangements to utilize the facilities, and the alternate facilities must be approved in writing by the Engineer and SEPTA in the same manner and with the same requirements as for the original facilities. This shall be done with no extra cost or delay to SEPTA.

3) The Contractor is responsible to pay all fees associated with the generation of all excavated hazardous waste.

f. Equipment and Vehicle Decontamination:

1) The Contractor shall design and construct a portable decontamination station to be used to decontaminate equipment and vehicles exiting from the exclusion zone. Disposal of decontamination liquids is described under Article 3.04 in this Section.

g. Record Keeping:

1) The Contractor shall obtain manifest forms, and complete the shipment manifest records required by the appropriate regulatory agencies for verifying the material and quantity of each load in unit of volume and weight. Copies of each manifest shall be submitted to the Engineer within four (4) business days following shipment, and within three (3) business days after notification of receipt of the facility. Any manifest discrepancies shall be reported immediately to the Engineer and be resolved by the Contractor to the satisfaction of the Engineer and SEPTA.

3. Method Measurement:

a. Quantities for hazardous soil shall be measured in tons satisfactorily delivered to the treatment, storage or disposal facility. The tonnage will be determined by off-site truck scales, per Article 3.03/B/2/b in this Section, that are capable of generating load tickets.

4. Price to Cover:

a. The unit price bid per ton shall include the cost of furnishing all labor, materials, plant, equipment, and insurance for excavation, handling, transportation, disposal, documentation, permits, fees, taxes, stockpiling, hauling, and any other incidentals
necessary to complete the work as specified herein for handling, transporting and disposal of hazardous soils.

b. Final disposal of non-hazardous materials shall be paid for under Article 3.01 in this Section. Disposal of decontamination water shall be paid under Article 3.04 in this Section.

c. All backfill material shall comply with the requirements of the PADEP Management of Fill Policy. Backfill will be paid for under its respective item.

3.04 Removal, Treatment and Discharge/Disposal of Contaminated Water

A. General:

1. This work shall consist of the proper removal and disposal of all contaminated groundwater and decontamination water generated during construction operations. The Contractor shall be solely responsible for the proper disposal or discharge of all contaminated water generated at the job site. The Contractor will have the option of treating water on-site for discharge to the combined sanitary/storm sewer system or removing contaminated water for off-site disposal. The Contractor shall be responsible to choose a method compatible to the construction work and shall be compensated on a per day basis regardless of method employed. The Contractor will be compensated for only those days where the system is in full operation.

2. The Contractor shall retain a dewatering/water treatment Specialist (hereinafter the “Specialist”) and laboratory as specified under Article 3.05 in this Section, to conduct any testing that may be required for disposal of impacted water.

3. The dewatering/water treatment Specialist is responsible to obtain all permits; perform all water sampling, testing; and provide ancillary services related to dewatering and water treatment. The Specialist shall at a minimum provide documentation to the Engineer and SEPTA demonstrating the minimum requirements as set forth below:

a. The Specialist shall demonstrate that it has, at a minimum, five (5) years corporate experience in the dewatering. The Specialist should demonstrate expertise dealing with issues associated with contaminated water. During that five (5) year period, the Specialist shall demonstrate that it provided dewatering and water treatment systems a routine part of its daily operations.

b. During the five (5) year period, the Specialist shall demonstrate that it has provided these services with an aggregate cost of $1,000,000 in each of the five (5) years.

c. The Specialist must be experienced in work of this nature, size and complexity.

d. The Specialist shall furnish a Project listing identifying the location, nature of services provided, Owner, Owner’s contact, contact’s telephone number, Project duration and value for at least five (5) Projects in the last five (5) years of a similar nature, size and complexity to this Contract.

e. The Specialist shall furnish to the Engineer a staffing plan which identifies the Specialist key personnel and resume documenting their experience, training, licenses and education to justify their roles in the Contract. A Health and Safety Officer must be designated.

f. If conditions within the exclusion zone are deemed hazardous, then the Contractor and its independent Environmental Consultant shall ensure that all personnel working within identified exclusion zones and/or involved (direct contact) with the handling, storage or transport of hazardous and contaminated material shall have completed a minimum of
forty (40) hours of Health and Safety Training on Hazardous Waste Sites in accordance with 29 CFR 1910.120(e). The training program shall be conducted by a qualified safety instructor. If conditions in the exclusion zone are deemed to be non-hazardous, the Specialist shall be responsible to provide site-specific training to its employees and other affected personnel.

g. The Contractor shall ensure that on-site management and supervisors directly responsible for or who supervise employees engaged in hazardous waste operations shall receive the training specified in above and at least eight (8) additional hours of specialized training on managing such operations at the time of job assignment.

4. The Contractor shall document all operations associated with the handling, sampling and disposal of contaminated water, and ensure that they are in compliance with applicable federal, state, and local statutes and regulations.

5. The Contractor shall supply all labor, equipment, transport, plant, material, treatment and other incidentals required to conduct the specified work of this Section.

6. If water will be disposed of into the combined sanitary/storm sewer system, the Contractor shall ensure the Specialist treats the water to meet the appropriate federal, state and local regulations. The Contractor is responsible for providing settling or filtering tanks and any other apparatus required. Alternatively, the Contractor can provide a plan for transport and disposal at an off-site waste disposal facility.

B. Construction Details:

1. For each disposal method the Contractor proposes to utilize (disposal to combined sanitary/storm sewer or off-site disposal), the WHP shall include the information required in Article 3.04/B/1/a and b in this Section, as appropriate.

a. On-site treatment and discharge tocombined sanitary/storm sewers.

1) The Contractor shall comply with all applicable regulations.

2) The Contractor is solely responsible to obtain all necessary and appropriate federal, state, and local permits and approvals. The Contractor will be responsible for performing all and any system pilot tests required for permit approval.

3) The Contractor shall meet PADEP State Pollutant Discharge Elimination System (NPDES) permits if necessary.

a) Identification and design of the Contractor’s proposed treatment to assure that the water meets the PADEP sewer use guidelines prior to discharge to the sewer, including identification of all materials, procedures, settling or filtering tanks, filters and other appurtenances proposed for treatment and disposal of contaminated water.

b) The name, address and telephone number of the contact for the Contractor’s proposed chemical laboratory, as well as the laboratory’s certifications under federal, state or non-governmental bodies.

c) The name, address and telephone number of the contact for the Contractor’s proposed independent Environmental Consultant.

d) Copies of all submitted permit applications and approved permits the Contractor have received.

4) Materials:
a) The Contractor shall supply all settling or filtering tanks, pumps, filters, treatment devices and other appurtenances for treatment, temporary storage and disposal of contaminated water. All equipment shall be suitable for the work described herein.

5) Execution:
   a) The Contractor is solely responsible for disposal of all water, in accordance with all federal, state and local regulations.
   b) The Contractor is solely responsible for any treatment required to assure that water discharged into the sewer is in compliance with all permits and federal, state, and local statutes and regulations.
   c) The Contractor is solely responsible for the quality of the water disposed of into the sewers.
   d) The Contractor is responsible for sampling and testing of water for the DEP Sanitary/Combined and Storm sewer Effluent Limit concentrations. The quality of the data is the Contractor’s responsibility. Any sampling and testing shall be conducted and paid in accordance with Article 3.05 in this Section.
   e) The Contractor shall be responsible to maintain the discharge rate to the sewer such that all permit requirements are met, the capacity of the sewer is not exceeded and no surcharging occurs downstream due to the Contractor’s actions.
   f) Disposal of Treatment Media:
      i. The Contractor shall be responsible for disposal or recycling of treatment media in accordance with all federal, state and local regulations.
      ii. The Contractor shall provide the Engineer and SEPTA with all relevant documentation concerning the disposal of treatment media, including manifests, bills of lading, certificates of recycling or destruction and other applicable documentation.
      iii. Disposal of treatment media shall not be considered as a separate pay item; instead it shall be considered as incidental work thereto and included in the unit price bid.

2. Off-Site Disposal:
   a. The Contractor shall meet all applicable federal, state and local regulations pertaining to the transportation, storage and disposal of any hazardous and/or non-hazardous materials.
   b. The following shall be submitted to the Engineer and SEPTA prior to initiating any off-site disposal:
      1) Name and waste transporter permit number.
      2) Address.
      3) Name of responsible contact for the hauler.
      4) Any and all necessary permit authorizations for each type of waste transported.
      5) Previous experience in performing the type of work specified herein.
   c. General information for each proposed treatment/disposal facility and at least one (1) backup treatment/disposal facility:
      1) Facility name and EPA identification number.
      2) Facility location.
      3) Name of responsible contact for the facility.
      4) Telephone number for contact.
5) Unit of measure utilized at facility for costing purposes.

d. A listing of all permits, licenses, letters of approval and other authorizations to operate, which are currently held and valid for the proposed facility as they pertain to receipt and management of the wastes derived from this Contract.

e. A listing of all permits, licenses, letters of approval and other authorizations to operate which have been applied for by the proposed facility but not yet granted or issued. Provide dates of application(s) submitted. Planned submittals shall also be noted.

f. The Contractor shall specify and describe the disposal/containment unit(s) that the proposed facility will use to manage the waste and provide dates of construction and beginning of use, if applicable. Drawings may be provided. The Contractor shall identify the capacity available in the units and the capacity reserved for the subject waste.

g. The Contractor shall provide the date of the proposed facility’s last compliance inspection.

h. A list of all active (unresolved) compliance orders, agreements, enforcement notices or notices of violations issued to the proposed facility shall be submitted. The source and nature of the cause of violation shall be stated, if known. If groundwater contamination is noted, details of the facility’s groundwater monitoring program shall be provided.

i. Description of all sampling and field/laboratory analyses that will be needed to obtain disposal facility approval.

j. Execution:

1) General:

a) The Contractor shall organize and maintain the material shipment records/manifests required by federal, state and local law. The Contractor shall include all bills of lading, certificates of destruction, recycling or treatment and other applicable documents.

b) The Contractor shall coordinate the schedule for truck arrival and material deliveries at the job site to meet the approved Contract schedule. The schedule shall be compatible with the availability of equipment and personnel for material handling at the job site.

c) The Contractor shall inspect all vehicles leaving the Project site to ensure that contaminated liquids are not spilling and are contained for transport.

d) The Contractor shall obtain letters of commitment from the waste haulers and the treatment, disposal or recovery facility to haul and accept shipment. The letter shall indicate agreement to handle and accept the specified estimated quantities and types of material during the time period specified in the Contract schedule and any time extension as deemed as necessary.

e) The Contractor shall verify the volume of each shipment of water from the site.

f) The Contractor is responsible for sampling and testing of water for off-site disposal. The quality of the data is the Contractor’s responsibility. Any sampling and testing shall be conducted and paid in accordance with Article 3.05 in this Section.

g) The Contractor shall be responsible for any additional analyses required by the TSD facility, and for the acceptance of the water at an approved TSD facility.

2) Hauling:

a) The Contractor shall not deliver waste to any facility other than the TSD facilities listed on the shipping manifest.

b) The Contractor shall coordinate manifesting, placarding of shipments and vehicle decontamination. All quantities shall also be measured and recorded.
upon arrival at the TSD facility. If any deviation between the two (2) records occurs, the matter is to be reported immediately to the Engineer and shall be resolved by the Contractor to the satisfaction of the Engineer and SEPTA.

c) The Contractor shall be held responsible for any and all actions necessary to remedy situations involving material spilled in transit or mud and dust tracked off-site. This cleanup shall be accomplished at the Contractor’s expense.

d) The Contractor shall be responsible for inspecting the access routes for road conditions, overhead clearance and weight restrictions.

e) The Contractor shall only use the transporter(s) identified in the WHP for the performance of work. Any use of substitute or additional transporters must have previous written approval from the Engineer and SEPTA at no additional cost.

f) The Contractor shall develop, document and implement a policy for accident prevention.

g) The Contractor shall not combine waste materials from other Projects with material from this Contract.

h) The Contractor shall obtain for the city a hazardous waste generator identification number and will sign the manifest as the generator, if necessary.

i) No material shall be transported until approved by the Engineer.

3) Disposal Facilities:

a) The Contractor shall use only the TSD facilities identified in the WHP for the performance of the work. Substitutions or additions shall not be permitted without prior written approval from the Engineer and SEPTA, and, if approved, shall be at no extra cost.

b) The Contractor shall be responsible for acceptance of the material at an approved TSD facility, for ensuring that the facility is properly permitted to accept the stated material, and that the facility provides the stated storage and/or disposal services.

c) In the event that the identified and approved facility ceases to accept the stated materials or the facility ceases operations, it is the Contractor’s responsibility to locate an alternate approved and permitted facilities for accepting materials. The Contractor is responsible for making the necessary arrangements to utilize the facilities, and the alternate facilities must be approved in writing by the Engineer and SEPTA in the same manner and with the same requirements as for the original facilities. This shall be done with no extra cost or delay.

3. Equipment and Vehicle Decontamination:

a. The Contractor shall design and construct a portable decontamination station to be used to decontaminate equipment and vehicles exiting the exclusion zone. The cost for this work shall be paid under Article 1.03 in this Section.

C. Method of Measurement:

1. The quantity for on-site treatment and discharge or off-site disposal shall be on a per day basis.

D. Price to Cover:

1. The per day price bid shall include the cost of furnishing all labor, materials, plant, equipment, and insurance for handling, transportation, disposal, documentation,
permits, hauling, mobilization and demobilization, and any other incidentals thereto to complete the work.

3.05 Sampling and Testing of Contaminated Water

A. Description:

1. The work shall consist of sampling and testing of potentially contaminated groundwater, surface runoff within the excavated area and all contaminated water generated during the decontamination process.

B. Sampling and Testing:

1. The Contractor is responsible, at a minimum, for sampling and testing of contaminated water for the Sanitary/Combined and Storm Sewer Effluent Limit concentrations. The quality of the data is the Contractor’s responsibility. Any additional testing required by the federal, state and/or disposal facilities shall be included in the bid price of this item.

2. All sampling and testing shall be conducted by a person trained in sampling protocols using accepted standard practices and/or the PADEP sampling guidelines and protocols.

3. All sample containers shall be marked with legible sample labels which shall indicate the Project name, sample location and/or container, the sample number, the date and time of sampling, preservatives utilized, how the sample was chilled to 4°C, and other information that may be useful in determining the character of the sample.

4. Chain-of-custody shall be tracked from laboratory issuance of sample containers through receipt of the samples.

5. The Contractor shall maintain a bound sample log book. The Contractor shall provide the Engineer access to it at all times and shall turn it over to the Engineer and PADEP in good condition at the completion of the work. The following information, as a minimum, shall be recorded to the log:
   a. Sample identification number.
   b. Sample location.
   c. Field observation.
   d. Sample type.
   e. Analyses.
   f. Date/time of collection.
   g. Collector’s name.
   h. Sample procedures and equipment used.
   i. Date sent to laboratory/name of laboratory.

6. Only dedicated sampling equipment may be used to collect these samples. All equipment involved in field sampling must be decontaminated before being brought to the site, and must be properly disposed of after use.

7. Samples shall be submitted to the Contractor’s laboratory within the holding times for the parameters analyzed.
8. All analyses must be done by a Pennsylvania accredited laboratory. The Contractor must specify the laboratory in the WHP.

9. Analytical results for water discharged to the sewer and for off-site disposal must be submitted to the Engineer no later than five (5) days after sample collection.

10. SEPTA reserves the right to direct the Contractor to conduct alternative sampling in lieu of the parameters described above, if the situation warrants. The substitute sampling parameters shall be of equal or lesser monetary value than those described above, as determined by industry laboratory pricing standards.

C. Price to Cover:

1. The unit price bid per set shall include the cost of furnishing all labor, materials, plant, equipment, and insurance for handling, transport, sampling, testing, documentation, permits, other incidentals necessary to complete the work of sampling and testing of contaminated water. Any additional costs incurred by the Contractor for sampling and testing of contaminated water shall be included in the bid price of this item.

END OF SECTION
SECTION 02209

GEOTEXTILE FABRIC

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of furnishing all plant, labor, and equipment and performing all operations required for supplying, hauling and placing the geotextile fabric, complete, at locations shown on the Contract Drawings or as directed by SEPTA, and maintaining the filter fabric until placement of the stone material has been completed and accepted.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. Section 02220 - Excavation, Backfill and Compaction

1.03 Submittals
A. In accordance with Section 01300, submit the following for approval:
   1. Certificates of compliance of materials (SEPTA reserves the right to test materials for specification compliance).

1.04 Quality Assurance
A. Meet the applicable provision of the most recent issues of the following references:

PART 2 - PRODUCTS
2.01 Materials

A. The filter fabric shall be non-woven polypropylene or polyester material meeting PennDOT Spec Section 735 Class 4. Refer to Table 02209-1 for geotextile fabric properties.

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum Average Requirement</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength</td>
<td>290 Pounds</td>
<td>ASTM D 4632/D 4632M</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>775 Pounds</td>
<td>ASTM D 6241</td>
</tr>
<tr>
<td>Trapezoidal Tear</td>
<td>100 Pounds</td>
<td>ASTM D 4533/D 4533M</td>
</tr>
<tr>
<td>Apparent Opening Size</td>
<td>&gt; #70 Standard Sieve</td>
<td>ASTM D 4751</td>
</tr>
<tr>
<td>Flow Rate</td>
<td>75 Gal./Min./SF.</td>
<td>ASTM D 4491/D 4491M</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.01 Execution

A. The filter fabric shall be placed at the locations shown on the Contract Drawings or as directed by SEPTA. The surface to receive the fabric shall be prepared to a relatively smooth condition, free of obstructions, depressions, debris and soft or low density pockets of material. All holes, rips or flaws made in the fabric shall be repaired by placing a piece of fabric, which is 1 foot 6 inches larger than the hole in the fabric in all directions, directly over the hole before stone is placed on the fabric. The fabric shall be laid smooth and free of tension, stress, folds, wrinkles or creases. The fabric rolls shall be placed to provide a minimum width of 24 inches of overlap for each adjacent strip. When securing pins are necessary in the placement of the fabric, the pins shall be 3/16 inch diameter steel, pointed at one (1) end, and 22 inches long. All damage to the fabric during its installation or during placement of the stone shall be replaced or repaired by the Contractor at no cost to SEPTA. The fabric shall be protected from sunlight, ultra-violet light, high temperatures, dirt and debris at all times prior to installation.

B. Securing pins with washers shall be inserted through both strips of the 24 inches overlapped fabric at not greater than the intervals in Table 02209-2 along a line through the midpoint of the overlap.

<table>
<thead>
<tr>
<th>Pin Spacing</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 feet</td>
<td>Steeper than 3:1</td>
</tr>
<tr>
<td>3 feet</td>
<td>3:1 to 4:1</td>
</tr>
<tr>
<td>4 feet</td>
<td>Flatter than 4:1</td>
</tr>
</tbody>
</table>

C. Additional pins, regardless of location, shall be installed as necessary to prevent any slippage of the filter fabric.
D. Each securing pin shall be pushed through the fabric until the washer bears against the fabric and secures it firmly to the foundation.

E. The fabric shall be turned down and buried at all exterior limits.

F. The fabric shall be protected at all times during construction from contamination by surface runoff. All fabric so contaminated shall be removed and replaced with uncontaminated fabric.

G. Work shall be scheduled so that the fabric is exposed no more than five (5) days prior to the covering of the fabric with stone.

H. All damage to the fabric during the placement of stone shall be repaired or replaced by the Contractor.

I. Have geotextile inspected by the SEPTA Project Manager prior to backfilling.

END OF SECTION
THIS PAGE NOT USED
SECTION 02220

EXCAVATION, BACKFILL AND COMPACTION

PART 1 - GENERAL

1.01 Description
   A. The work specified in this Section consists of construction of excavating and backfilling for embankment, structures, drainage and utility facilities; field quality control testing and analysis; and designing, furnishing, installing and removing support of excavation.

1.02 Related Sections
   A. Section 01300 - Submittals
   B. Section 01305 - Requests for Information
   C. Section 01400 - Quality Requirements
   D. Section 02070 - Selective Demolition
   E. Section 02110 - Clearing and Grubbing
   F. Section 02160 - Excavation Support and Protection
   G. Section 02205 - Impacted Soil Management
   H. Section 16138 - Duct Work and Electrical Manholes and Handholes

1.03 Submittals
   A. In accordance with Section 01300, submit the following for approval:
      1. Certificates of compliance of materials for liquid limit, plasticity, and dry density. (The SEPTA Project Manager reserves the right to test materials for specification compliance).
      2. Three (3) copies of each field density, liquidity, plasticity and gradation test within twenty-four (24) hours after completion of testing.
      3. Permits for disposal of excavated material:
         a. Obtain written permits and releases from the Owners of property where material will be deposited.
         b. Submit copies of each permit and release from each property Owner absolving the Owner and SEPTA from responsibility in connection with such disposal.

1.04 Quality Assurance
   A. Meet the applicable provisions of the most recent issues of the following references:
      1. AASHTO M43, Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
      2. AASHTO M80, Standard Specification for Coarse Aggregate for Hydraulic Cement Concrete.


5. ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).

6. ASMT D 1556/D 1556M, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

7. ASTM D 2167, Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.


10. ASTM D 6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).


13. 29 CFR 1926, Safety and Health Regulations for Construction.

1.05 Definitions:

A. Approved material is material which meets specified requirements for use as embankment, fill or backfill.

B. Authorized excavation is excavating to neat lines and limits shown and specified; excavating unsuitable material.

C. Backfill is the furnishing, placing and compacting specified materials to the lines and grades indicated and also including:
   1. Testing density, liquid and plastic limits and gradation of compacted backfill.

D. Embankment is the proposed subgrade lines as shown on the Contract Drawings.

E. Excavation is the removing of all materials encountered within the indicated or specified limits, regardless of the nature of the material encountered and the method by which removed and also including:
   1. Dewatering.
   2. Legally disposing of waste materials and storing suitable excavated materials intended for reuse.

F. Excess excavation is material excavated beyond or below typical sections shown, as well as unavoidable over breakage in rock.

G. Grading consists of the following:
1. Excavation of earth and rock for grading.
2. Shaping of constructed embankments and fills.

H. Surcharge is temporary fill section of select material in order to provide soil compaction.
I. Unauthorized excavation is excavating materials which would otherwise be left in place but removal of which is required because the Contractor’s operations have rendered them unstable; excavation which is not specified as authorized excavation, such as excavation beyond neat lines and bottom of footings and trenches as shown.
J. Unsuitable material is material which does not meet specified requirements for use in situ or as embankment, fill or backfill and is prohibited for use in the work.

PART 2 - PRODUCTS

2.01 Materials

A. Embankment, Fill or Backfill:

1. Common Fill and Backfill:
   a. Well graded soil aggregate mixture comprising stone, gravel, sand, silt, clay or combinations of such materials.
   b. Organic matter, debris, cinders and frozen material are prohibited materials.
   c. Particle size to be 4 inches maximum, but not exceeding 1 inch within 1 foot of finished grade.
   d. Liquid limit to be forty (40) maximum, determined in accordance with ASTM D 4318.
   e. Plasticity index to be ten (10) maximum, determined in accordance with ASTM D 4318.
   f. Maximum dry density to be not less than 100 pounds per cubic foot.

2. Backfill for Ground Grid:
   a. Mixture of common fill with limited sand and gravel.
   b. Soil resistivity shall not exceed 20 ohm-meters.
   c. Particle size less than 1 1/2 inches.

3. Open Graded Aggregate Backfill:
   a. Course aggregate meeting AASHTO M80, Class C or better; gradation size No. 67 in accordance with AASHTO M43.

4. Dense Graded Aggregate Backfill:
   a. Course aggregate meeting AASHTO M80, Class C or better; gradation size No. 8 in accordance with AASHTO M43, or meeting PENNDOT Specification Section 350, No. 2A.

2.02 Source of Materials

A. To the extent that it is available, obtain material from excavation operations. If sufficient suitable materials are not available to meet embankment, fill and backfill requirements, obtain material meeting specified requirements from borrow areas at no additional cost to SEPTA.

1. Earth excavation may contain excess moisture in its natural state or may take on excess moisture during handling and stockpiling. Manipulation to proper moisture content
prior to compaction may be necessary. Earth excavation will not be considered as unacceptable backfill material by virtue of its moisture content only.

B. Use only material whose quality, source and zone of placement in the fill have been approved.

C. If borrow areas are provided by SEPTA within the right-of-way, dress and shape such areas to ensure positive drainage when borrow operations are completed.

PART 3 - EXECUTION

3.01 Preparation

A. Prior to any demolition, excavation or embankment activities, the Contractor must call PA One-Call Utility Locating Service.

B. Barricade open excavations and post with warning lights those excavations occurring on property adjacent to or within public access. Operate warning lights during hours from dusk to dawn each day and as otherwise required.

C. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and backfill operations.

D. Indicated locations of known existing facilities and systems are approximate. Investigate and determine exact locations and natures of facilities and systems, and accept sole responsibility for damages thereto caused by construction activities. Before excavating in the vicinity of underground utilities, notify the appropriate jurisdiction. SEPTA does not guarantee that all facilities and systems, which may exist before the work begins, are indicated.

1. Preserve, protect and maintain existing operable drains and sewers during grading operations.

E. Keep excavations dry.

F. Before moving equipment across underground duct banks having less than 4 feet of cover, place decking on the path of that equipment. Extend decking outward from each side of the duct bank for a distance equal to the depth of the bottom of the duct bank, but not further than 4 feet. Decking shall consist of a 3 inch thick timber platform or 1 inch thick steel plate. If duct bank is exposed, do not place decking directly on duct bank.

G. Use of explosives is prohibited.

3.02 Installation, Application and Execution

A. The Contractor is responsible for setting and establishing finish elevations and lines.

B. Haul from site and legally dispose of any excavated materials, at SEPTA approved facilities, which are excess or are determined to be not suitable for filling or backfilling, at no additional cost. Copies of signed off manifests are required to be submitted to SEPTA as proof of offsite disposal before the Contractor shall be paid for the excavation.

C. Do not place, spread, roll or compact fill material that is frozen or thawing, or during unfavorable weather conditions. If interrupted by heavy rain or other unfavorable
conditions, do not resume until ascertaining that the moisture content and density of the previously placed soil are as specified.

3.03 Rough Grading and Filling

A. Perform such soil, concrete, boulder and rock fragment removal or fill as may be required to facilitate the progress of the work. Grading shall be by blading.

B. Fill wells, test pits or holes which will not be completely removed by excavation, with lean concrete, crushed aggregate or clean select soil approved by SEPTA and compacted as specified herein, in layers not exceeding 6 inches after compaction.

C. Fill holes, swales and low points which will not otherwise be removed in the course of the work, to the indicated grades.

3.04 Pumping and Drainage

A. At all times during construction of the work and at its completion for final inspection, by SEPTA, provide and maintain ample means and suitable equipment, consistent with conditions encountered, to promptly remove and properly dispose of or discharge all water entering excavations or other parts of the work.

B. Control surface and subsurface water in excavations at all times until the structures to be built therein are completed and backfilled to approximately final grades.

C. Dispose of or discharge water in a suitable manner approved by SEPTA and in accordance with all applicable regulations so as to avoid damage to adjacent property, existing structures and all work under construction. Do not pump drainage water onto the streets without the written permission in advance from SEPTA. The Contractor is responsible for obtaining all required permits for discharging of water and for meeting all permit conditions throughout the life of the Contract.

D. Provide and maintain settling basins and sumps or settling tanks or other apparatus or equipment for catching and holding settleable matter necessary to meet permits and/or applicable regulations. These shall be frequently cleaned and maintained. All equipment or apparatus maintenance and operation is the responsibility of the Contractor. Wherever water containing mud, clay, sand or other material in suspension, is pumped from the excavations, make suitable provision to insure that the flow will be unobstructed. Take precautions to avoid pumping water through freshly placed concrete.

E. At no time shall the uplift pressure on any structure exceed 80 percent of the downward pressure produced by the weight of the structure and any backfill in place. The Contractor shall submit his proposed methods of controlling uplift pressure to SEPTA for approval prior to the start of excavation.

3.05 Excavation

A. General Requirements:

1. Excavate to the lines and grades indicated.

2. Where authorized by SEPTA, excavations may be cut back to a stable slope as follows:
a. Where the sides of excavations are sloped, angle of slopes shall be as approved by SEPTA but shall not be steeper than allowed by the Title 29 Code of Federal Regulations, Part 1926, Safety and Health Regulations for Construction (OSHA).

b. Maintain sides and slopes of excavations in safe condition until backfilling is completed.

c. Where the Contractor elects to slope the sides of excavations, backfill of the over excavated areas shall be made in the same manner specified for the adjacent excavated area. All additional backfill required shall be at no additional cost to SEPTA.

3. Where sloping is not possible due to space restrictions or the nature of the material excavated, support sides of excavation as specified in Section 02160.

B. Trench Excavation:

1. Excavate trenches for utilities and drainage pipes by the open cut method.

2. Trench, from trench bottom to a point which will be either 2 feet above top of pipe or 1/2 pipe diameter whichever is greater, shall not be wider than that indicated.

3. Trench, from a point which will be either 2 feet above top of pipe or 1/2 pipe diameter whichever is greater, to top of trench, may be wider than widths indicated. Where the width is not indicated, excavate a trench width not less than 6 inches or more than 18 inches from each side of the pipe.

4. In paved areas, cut pavement on the neat lines at the width indicated for the trench. After compacting the backfill, restore pavement structure to a condition equivalent to or better than that of existing adjacent pavement. Restore pavement damaged outside the neat lines at no additional cost.

C. Ground Grid:

1. Excavate to 12 inches below ground grid elevation and compact subgrade to meet specifications.

2. Over excavate and remove rock encountered which will project up to within 12 inches of ground grid.

3.06 Embankment, Fill and Backfill

A. Place initial layer of embankment, fill and backfill only on subgrade which has been inspected and accepted by SEPTA.

B. Place embankment, fill and backfill in 8 inch loose layers, unless otherwise shown, for entire width so that each layer can be uniformly and properly compacted. Compact each layer to the specified density for the entire width of the fill or embankment.

C. Avoid accumulation of large pieces of material at one (1) location. Fill voids and interstices with finer materials.

D. In confined areas, use approved power-activated compactors to achieve required density.

E. Prior to compaction, adjust moisture content of material within required limits by drying or watering either at material source or on fill.

F. Leave struts, braces, lagging and timber sheathing in place as long as needed to support excavation and adjacent facilities and structures.
G. Where utility facilities and structures are supported in place, use special equipment and techniques as required to achieve specified compaction under and around them.

H. When backfilling against structures, place material approximately simultaneously on both sides of structures to equalize opposing horizontal pressures.

I. When backfilling on tops of structures, place material in 6 inch lifts over full area.

J. Under concrete floor and other slabs on grade, place drainage material directly on prepared subgrade which meets density and elevation requirements.

K. Prior to placing embankment against slope greater than 1 vertical to 4 horizontal, cut benches into existing slopes. Height of bench not to exceed 2 feet unless otherwise approved.

L. Maintain embankment, fill and backfill in stable, well-drained condition.

M. Remove material which cannot be compacted to required density within specified tolerances, and replace with suitable material at no additional cost.

N. Where pipes, culverts or structures extend into embankments, construct embankment to at least 2 feet over and 10 feet on either side of the pipe, culvert or structure location prior to excavation of the trench.

O. Trench Backfill:
   1. Except as may be otherwise specified for placement of bedding materials, place backfill around pipes as follows:
      a. Place backfill around bottom half of pipe, in layers not thicker than 4 inches, and in a manner which will ensure that pipe will be supported. Ram and tamp backfill placed under and around pipes with tools and equipment especially designed for that purpose.
      b. Deposit additional backfill to a point 12 inches above top of pipe but leave pipe joints exposed; compact backfill.
   2. After pipe has been tested and accepted, place backfill as specified.

P. Ground Grid:
   1. Backfill 12 inches below and 12 inches above ground grid conductors.
   2. Backfill with material meeting requirements of Article 2.01/B/2 in this Section.
   3. Compact according to the Specifications.
   4. Test for resistivity in place. Use a minimum of four (4) tests. Backfill not meeting resistivity criteria shall be removed and new material installed at the Contractor’s expense.

Q. Allowable Tolerances:
   1. Construct finished subgrade to vary not more than 0.05 foot above or 0.10 foot below elevation shown.
   2. Maintain moisture content of embankment, fill or backfill material within plus or minus 2 percent of optimum moisture content of material.
3. Compact each layer of embankment, fill or backfill material to 95 percent of maximum dry density as determined in accordance with ASTM D 698, Method D, at moisture content within tolerance specified, except as follows:
   a. From upper surface of fill or backfill to a plane 12 inches below bottom of subbase level of vehicular pavement, sidewalks and track beds, compact to 100 percent of maximum dry density at moisture content within tolerance specified.
   b. In areas of 95 percent compaction where utility facilities are located in fill and are not supported on concrete cradles, compact material for a depth of 1 foot directly below bottom of facility to 100 percent of maximum dry density at moisture within tolerance specified.

3.07 Compaction Adjacent to Structures
   A. Compact embankment, fill or backfill materials within 6 feet of wing walls, retaining walls, abutments or other structures using plate compactors, power rammers, small rollers (5100 pounds max.), etc.
   B. Do not overstress structures.
   C. Backfilling against new structures without approval is prohibited.

3.08 Subgrade Preparation
   A. Where the subgrade is on original ground or in cut or where embankment or fill is less than 1 foot, fulfill compaction requirement for 12 inches minimum below final subgrade.
   B. If necessary, scarify original ground and adjust moisture content prior to compacting.
   C. Remove rigid pavements and slabs which would be within 5 feet of finished grade. Rigid pavements and slabs which will be greater than 5 feet below finished grade may be left in-place only if broken into pieces not larger than 3 feet in greatest dimension.
   D. For subgrade on which structures will be placed:
      1. If structures are indicated to be founded on rock and that rock has been undercut to an elevation lower than that indicated, fill undercut space with concrete of same class as that used in structure.
      2. If subgrade material is disturbed, either compact subgrade to 100 percent of maximum dry density when tested in accordance with ASTM D 698; or remove and replace material with pervious material and compact to 100 percent of maximum dry density, tested in accordance with ASTM D 698.
   E. For Subgrade on Which Pipe and/or Conduit Will be placed:
      1. Adjust trench bottom to line and grade by either scraping away soil or placing backfill material as specified.
      2. Smooth bottom of trench; remove rock and unsuitable material which would be within 1 foot of pipe and conduit. Fill undercut space with backfill material and compact to bottom of pipe and conduit elevation.
      3. Cut recess in bottom of trench for pipe bell in a manner which will ensure that pipe barrel will rest on trench bottom.
3.09 Field Quality Control

A. Test Method:

1. Determine the maximum dry density and the optimum moisture content in accordance with ASTM D 698, Method D.

B. Testing:

1. Test each source of material proposed to be used for embankment, fill and backfill and submit test results to the SEPTA Project Manager. Test material for moisture density relationship in accordance with ASTM D 698; for liquid limit in accordance with ASTM D 4318; for plastic limit in accordance with ASTM D 4318.

2. Embankments:
   a. Perform one (1) in-place compaction test for each 5,000 square feet of material placed in each horizontal layer in accordance with either of the following: ASTM D 1556/D 1556m, ASTM D 2167, or ASTM D 6938. Except perform not less than one (1) test for each layer.
   b. Perform one (1) maximum dry density test for every different fill material but not less than one (1) test for every ten (10) compaction tests.

3. Backfill at structures:
   a. Perform one (1) in-place compaction test for every 2500 square feet and every 2 feet of added height but not less than three (3) compaction tests in any day during which material is placed. Perform compaction test in accordance with either of the following: ASTM D 1556/D 1556M, ASTM D 2167, or ASTM D 6938.

4. Trench Backfill:
   a. Perform in-place compaction test every 100 linear feet for every 2 feet of added height, but not less than three (3) tests in any day during which material is placed. Perform compaction tests in accordance with either of the following: ASTM D 1556/D 1556M, ASTM D 2167, or ASTM D 6938.

3.10 Excess Excavated Material

A. The Intent of this Section is that all suitable materials excavated within the limits of the Project site shall be used in the formation of embankment and for backfilling. Where the quantity of excavation exceeds that required to make up embankments or fills to cross section as shown on the Contract Documents, the suitable surplus material shall be wasted on site as directed by SEPTA. If the excess excavated material cannot be disposed of on site, the material shall be removed and disposed of off-site according to Article 3.12 in this Section.

3.11 Unsuitable Material

A. The Contractor shall notify SEPTA upon discovery of any unsuitable material encountered during excavation. The area of unsuitable material shall be over excavated and the unsuitable material shall be replaced with suitable material meeting the requirements of this Section. Before proceeding, the Contractor and SEPTA shall agree upon the area to be over excavated. Unsuitable material shall be wasted on-site as directed by SEPTA. Excavation of unsuitable material shall be included in embankment for measurement and payment. If the unsuitable material cannot be disposed of on site, the material shall be removed and disposed of off-site according to Article 3.12 in this Section.
3.12 Removal and Disposal of Excess Material

A. The Contractor shall properly haul excess excavated materials or excess unsuitable material off-site for recycling or disposal

1. The Contractor shall prepare all necessary waste management notifications and submittals before, during and after the completion of the work. The following submittals and notifications are required:
   a. Health and Safety Plan (Submitted prior to any work being performed onsite).
   b. PA One Call (Completed prior to any work being performed on-site). Notify the SEPTA Project Manager when this is complete.
   c. Provide copies of applicable licenses and permits to haul waste in the appropriate state prior to commencing disposal activities.
   d. Written approval from the disposal facility accepting the impacted materials.
   e. Record real time monitoring data and submit to the SEPTA Project Manager (During the work).
   f. Provide one (1) copy of the laboratory analytical data package to SEPTA Project Manager (For disposal testing).
   g. Provide copies of manifests and/or bills of lading documenting proper disposal (Associated with the shipment of residual waste).
   h. Final report to include but not be limited to safety meeting summaries, air monitoring logs, field data sheets, field notes, all analytical laboratory data and disposal documentation. Prepare all federal, state and local permits that are required for the management and disposal of impacted soil and other wastes.

2. The Contractor shall prepare a soil management plan to manage soils according to PADEP Management of Fill Policy Document Number 258-2182-773 dated August 7, 2010. The soil management plan will include:
   a. Figure showing the location, horizontal and vertical dimensions of the areas that will be excavated and disposed off-site as a residual waste.
   b. Provide a plan for efficient stockpiling, loading and disposing of the materials deemed a residual waste. The plan should include specific details on the location the material will be stockpiled, loaded and the route to be taken off-site in order to transport the impacted materials to the approved landfill.
   c. Provide a schedule and plan for waste characterization sampling. To aid in waste characterization, analytical documents are provided separately to bidders.

3. Provide a post excavation sampling plan that will include a figure showing the extent of excavation areas and the proposed sampling locations in accordance with 25 PA. Code, 40 CFR, and applicable guidance. Submit sampling plan to SEPTA for review and approval before conducting any sampling and testing. Provide a Pennsylvania accredited laboratory for sample analysis to test soils per the Pennsylvania Management of Fill Policy.

4. Excavated materials determined by laboratory analysis to be above regulatory standards outlined in Tables FP-1a and FP-1b of the Pennsylvania Management of Fill Policy shall be disposed of offsite in accordance with applicable federal, state and local regulations. Refer to Section 02205.
5. Do not haul excavated material off-site until the following evidence has been submitted to the satisfaction of SEPTA and has issued written permission to haul the substances off-site.
   a. Laboratory analysis reports for samples collected for applications to recycle or dispose of wastes.
   b. The transportation firm provides proper licensing and permits for transport to the disposal facility and the disposal facility has provided documentation that they will accept the excavated materials and is authorized to transport the excavated materials from the site to the recycling or disposal facility.
   c. The recycling or disposal facility has accepted the excavated material and written acceptance by the facility has been provided to SEPTA.

6. The Contractor shall properly transport excavated materials off site to recycling or disposal sites and recycle or dispose of in accordance with the rules and regulations of the regulatory agencies having jurisdiction. Record transportation, recycling and disposal methods of excavated materials off site in log books, or on manifest forms with the following information recorded for each shipment:
   a. Generating Facility:
      1) Name and address of generating facility.
      2) Date of shipment.
      3) Signature of authorized agent of generating facility.
      4) Quantity of excavated materials.
      5) Description of excavated materials shipment.
   b. Transporter:
      1) Name and address of transporting company.
      2) Signature of driver of transporting vehicle.
      3) Vehicle identification number, registration number and state of registration.
   c. Recycling and Disposal Facility:
      1) Name and address of facility.
      2) Date of shipment received at facility.
      3) Signature of authorized agent of facility.
      4) Indication that excavated material was accepted by the facility.
      5) Quantity of excavated material accepted.
      6) Description of excavated materials accepted.
      7) Method for recycling or disposal of excavated materials.

7. Excavations will be replaced with Clean Fill (As defined in the Pennsylvania Management of Fill Policy) stone or structural backfill.

END OF SECTION
SECTION 02230

SUBBASE

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of approved aggregate placed on the subgrade and in close conformity with the lines, grades, shown on the Contract Drawings or established by SEPTA.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. Section 02520 - Bituminous Concrete Paving

1.03 Submittals
A. In accordance with Section 01300, submit the following for approval:
   1. Submit certificates of compliance of materials for liquid limit, plasticity and dry density. (Note: The Engineer reserves the right to test materials for specification compliance).
   2. Submit three copies of each field density, liquidity, plasticity, and gradation test within twenty-four (24) hours after completion of testing.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
   2. ASTM D 4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   3. PennDOT Specifications Section 350.

PART 2 - PRODUCTS

2.01 Materials
A. The aggregate Subbase shall be well graded material conforming to the requirements of PennDOT Specifications Section 703.2, gradation 2A.
PART 3 - EXECUTION

3.01 Installation

A. The installation shall be in accordance with PennDOT Specifications Section 350.3. Subbase shall be compacted to not less than 98 percent of its dry weight density as determined by ASTM D 1557 or to 85 percent of its relative maximum density as determined by ASTM D 4253, whichever is higher.

END OF SECTION
SECTION 02270

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 Description
A. This Section specifies the furnishing, placement, maintenance and removal of an erosion and sediment pollution control system consisting of soil stabilization and sediment barrier controls within the limits of construction as required during the Contract life.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. Section 02110 - Clearing and Grubbing
E. Section 02209 - Geotextile Fabric
F. Section 02220 - Excavation, Backfill and Compaction

1.03 Submittals
A. In accordance with Section 01300, submit the following for approval:
   1. Certificates of compliance of materials. The SEPTA Project Manager reserves the right to test materials for specification compliance.
   2. Submit three (3) copies of each gradation test within twenty-four (24) hours after completion of testing.
B. The Contractor shall submit to SEPTA a plan showing erosion and sedimentation controls before starting construction for approval. If the proposed limit of disturbance is equal to or greater than 5,000 square feet, the Contractor shall submit an Erosion and Sedimentation Control Plan sealed and signed by a Pennsylvania licensed Professional Engineer to the Bucks County Conservation District (BCCD) and obtain a determination of plan adequacy from the BCCD.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. Commonwealth of Pennsylvania, Department of Transportation, Specifications Publication 408 (PennDOT Specifications).
PART 2 - PRODUCTS

2.01 Materials
   A. Seeding to meet the material requirements of Section 804.2 of the PennDOT Specifications.
   B. Mulching to meet the material requirements of Section 805.2 of the PennDOT Specifications.
   C. Rolled erosion control product to meet the material requirements of Section 806.2 of the PennDOT Specifications.
   D. Compost filter sock to meet the material requirements of Section 807.2 of the PennDOT Specifications.

PART 3 - EXECUTION

3.01 Installation
   A. Seeding to be installed according to Section 804.3 of the PennDOT Specifications.
   B. Mulch to be installed according to Section 805.3 of the PennDOT Specifications.
   C. Rolled erosion control product to be installed according to Section 806.3 of the PennDOT Specifications.
   D. Compost filter sock to be installed according to Section 807.3 of the PennDOT Specifications.

3.02 Field Quality Control
   A. All erosion and sedimentation controls shall be inspected, maintained and repaired until the area served by the control is stabilized, as determined by SEPTA.
   B. All erosion and sedimentation controls shall be inspected weekly and after every precipitation event and shall be cleaned or replaced as required to maintain function. Cleaning to meet Section 801 of the PennDOT Specifications, except that the sediment shall be removed when it has reached one half of the depth of the sediment control structure.
   C. The Contractor shall remove and dispose of all temporary erosion and sedimentation control items after stabilization or as directed by SEPTA.
   D. The Contractor shall keep plan(s) showing erosion and sedimentation controls on site and available for inspection by any governing authorities at all times.

END OF SECTION
SECTION 02450

OIL CONTAINMENT SYSTEMS

PART 1 - GENERAL

1.01 Description
   A. Furnishing and installing a prefabricated and complete geo-synthetic oil barrier and accessory materials including excavation of soil materials to form a secondary containment system around oil filled electrical equipment.
   B. Geo-synthetic barriers are typically installed as a "Passive" secondary containment measure and are also used in "Active Containment" situations to impede or block the flow of oil from reaching drainage structures or waterways.
   C. Excavation and backfilling shall be performed to prevent damage to adjacent properties, buildings, structures, utilities, underground piping, electric cable, cable trays, grounding systems and other facilities.

1.02 Related Sections
   A. Section 01300 - Submittals
   B. Section 01305 - Requests for Information
   C. Section 01400 - Quality Requirements
   D. Section 02220 - Excavation, Backfill and Compaction

1.03 Submittals
   A. Refer to Section 01300.
   B. Submit qualification and experience record for designers.
   C. Submit component dimensions; describe components within assembly and anchorage or fasteners.
   D. Submit shop drawings indicating geo-synthetic barrier dimensions, affected related work and details including overlap at joints.
   E. Submit two (2) samples 6 inches by 6 inches in size illustrating barrier materials.
   F. Submit physical characteristics and engineering calculations where required and identify dimensional limitations.
   G. Submit manufacturer warranty and ensure forms have been completed in SEPTA’s name and registered with the manufacturer.

1.04 Quality Assurance
   A. Design geo-synthetic barrier under direct supervision of a Professional Engineer licensed in the Commonwealth of Pennsylvania and experienced in the design of such work and to accommodate site conditions.
   B. Excavations shall meet local building codes and published standards.
C. The manufacturer shall be company(s) specializing in manufacturing geo-synthetic barrier systems with minimum three (3) years of documented experience.

D. The installer shall be company(s) specializing in installation of geo-synthetic oil barrier or similar systems with minimum three (3) years of documented experience.

E. Engage the services of a trained manufacturer’s representative to be on the Project site during geo-synthetic barrier installation.

F. Meet the applicable provisions of the most recent issues of the following references:

1.05 Delivery, Storage and Handling
A. Handle products of this Section in accordance with the manufacturer’s requirements.
B. Protect geo-synthetic barrier materials during transport and on the Project site storage prior to installation.

1.06 Warranty
A. Provide the manufacturer's warranty against failure of barrier material when installed properly including provision for replacement of failed units.
B. Warranty shall be in effect for the service life of installed product.

PART 2 - PRODUCTS

2.01 Materials
A. Geo-synthetic barrier shall be designed to prevent flow of hydrocarbons from a site by becoming an impervious barrier in the event of an oil release and allow unrestricted water flow during normal rainfall or snow melt events.
B. Geo-synthetic barrier system to be manufactured by the following:
   1. CI Agent Solutions (Geomembrane Liner Solution)
   2. Albarrie Geocomposites Ltd. (SorbWeb Plus)
   3. Or Approved Equal.

2.02 Performance
A. The geo-synthetic barrier shall have a hydrocarbon flow rate of 0 gallons per minute for oil type contained in the transformer.
B. The secondary containment system must be able to contain 110 percent of the oil volume in the equipment, or have a freeboard of 3.5 inches for 100 percent of oil volume, whichever yields the largest storage volume.
C. Geo-synthetic barrier must be able to flow a minimum of 4 gallons per minute per square foot of material with 1 foot of head pressure.
D. To meet Spill Prevention Control and Countermeasures (SPCC) requirements in accordance with 40 CFR 112.

2.03 Fabrication
A. Fabricate components with minimum clearances around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
B. Accurately fit and secure joints and corners. Make joints flush.
C. Prepare components to receive anchor devices.
D. Arrange fasteners and attachments to conceal from view.

2.04 Material for Cover
A. Gradation requirements shall be determined in accordance with AASHTO M57.
B. Fills categorized as “crushed stone” or equivalent clean stone to meet the requirements in Table 02450-1:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>AASHTO M57 (Percent Passing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mm</td>
<td>2 inches</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>1.5 inches 100 (Minimum)</td>
</tr>
<tr>
<td>25 mm</td>
<td>1 inch 95 - 100</td>
</tr>
<tr>
<td>19 mm</td>
<td>0.75 inches -</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>0.5 inches 25 - 60</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>0.375 inches -</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>No. 4 10 (Maximum)</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>No. 8 5 (Maximum)</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>No. 16 -</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.01 Examination
A. Verify dimensions, tolerances and method of attachment.
B. Verify that anchorage devices have been properly installed and located.

3.02 Installation
A. Avoid damage wherever excavation is being done. The width of such excavation shall not exceed the width actually necessary for the proper prosecution of the work.
B. Install geo-synthetic barrier in accordance with the manufacturer’s instructions and in accordance with the Contract Drawings.
C. Overlap and splice barrier sections, as necessary, according to the shop drawings and the manufacturer’s recommendations.
D. Barrier should not be cut or trimmed without the express approval of the manufacturer or their representative.

E. Attach to grade to permit sufficient adjustment to accommodate construction tolerances and other irregularities allowing expeditious progress of the work.

F. Meet SEPTA and operator’s safety practices particularly in close proximity to active electrical equipment.

3.03 Field Quality Control

A. Verify barrier is firmly attached to supports before placing cover material.

3.04 Cleaning and Protection

A. Remove any protective material.

B. Repair minor damage to surfaces to the satisfaction of the manufacturer prior to cover material being installed.

C. Protect barrier during installation of cover material.

END OF SECTION
SECTION 02520

BITUMINOUS CONCRETE PAVING

PART 1 - GENERAL

1.01 Description
A. This work shall consist of constructing a base (binder) course and a wearing (top) course of bituminous concrete pavement on a prepared subbase course in accordance with these Specifications, meeting the lines, grades, thicknesses and typical cross sections shown on the Contract Drawings.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. Section 02220 - Excavation, Backfill and Compaction
E. Section 02230 - Subbase

1.03 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. Provide either bituminous base course:
      a. PennDOT Specifications Section 309 SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, HMA BASE COURSE.
      or
      b. PennDOT Specifications Section 311 SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, WMA BASE COURSE.
   2. Provide either bituminous wearing course:
      a. PennDOT Specifications Section 409 SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED HMA COURSES.
      or
      b. PennDOT Specifications Section 411 SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED WMA COURSES

PART 2 - PRODUCTS

2.01 Materials
A. The wearing course shall be in accordance with Section 409.2 or Section 411.2 of PennDOT Specifications.
B. The base course shall be in accordance with Section 309.2 or Section 311.2 of PennDOT Specifications.
C. The subbase course shall meet the requirements of Section 02230.

PART 3 - EXECUTION

3.01 Installation

A. Construction of a bituminous base course and bituminous wearing course shall be in accordance with Sections 309.3, 311.3, 409.3, 411.3 of the Penn DOT Specifications to the depths and limits shown on the Contract Drawings.

B. Construction of a subbase course shall be in accordance with Section 02230.

END OF SECTION
SECTION 02534

CAST-IN-PLACE CONCRETE CURB

PART 1 - GENERAL

1.01 Description
   A. The work shall consist of furnishing and installing concrete curbs, gutters, and combination curb and gutters.

1.02 Related Sections
   A. Section 01300 - Submittals
   B. Section 01305 - Requests for Information
   C. Section 01400 - Quality Requirements
   D. Section 02220 - Excavation, Backfill and Compaction
   E. Section 02520 - Bituminous Concrete Paving

1.03 Submittals
   A. In accordance with Section 01330 submit the following:
      1. Working drawings indicating expansion joint layout and openings, if different from those indicated in the Contract Drawings.
      2. Mix design for each change of ingredients and ingredient sources, including admixtures.
      3. Certificates of compliance to specifications of materials provided as work of this Section.

1.04 Quality Assurance
   A. Meet the applicable provisions of the most recent issues of the following references:
      1. AASHTO M43, Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
      5. PennDOT Publication 408 Section 630, Plain Cement Concrete Curb.

PART 2 - PRODUCTS

2.01 Materials
   A. Steel forms conforming to requirements in PennDOT Specifications Section 630.3(b).
1. Approved flexible forms of steel or wood may be used for construction of circular curb where radius is 200 feet or less.

B. Concrete to meet PennDOT Specifications 630.2 except use No. 8 coarse aggregate, conforming to AASHTO M43, for concrete placed by extrusion method.
   1. Maximum slump to be 3 inches.

C. Preformed expansion joint filler to be fiber type, ASTM D 1751.

D. Joint Sealer:
   1. Hot-applied to be rubberized joint sealing material, ASTM D 6690.
   2. Cold-applied to be elastomeric type, ASTM C 920.

PART 3 - EXECUTION

3.01 Preparation

A. Excavate to the required depth, then compact the material upon which the curb is to be constructed to a firm, even surface.

B. Forms:
   1. Use acceptable metal forms, except on sharp curves, and short tangent sections, where wood forms may be used if acceptable to SEPTA.
   2. Secure forms in-place with iron stakes spaced on not more than 4 foot centers. Indicate grade of curb tops by an offset guideline.
   3. Forms shall extend full depth of the concrete.

3.02 Installation

A. Placing Concrete:
   1. Cast-in-place to meet the requirements of PennDOT Specifications 630.3(c).
   2. By extruding machine (Where approved SEPTA):
      a. Uniformly feed the concrete to the machine so that concrete maintains the shape of the section without slumping after extrusion.
      b. Voids or honeycombs on the surface of the finished curb will not be allowed. Immediately after extrusion, perform any additional surface finishing required.

B. Unless otherwise required by the standards of the railroad, construct joints as follows:
   1. Expansion Joints:
      a. Place 1/2 inch preformed expansion joint filler on 30 foot intervals, at ends of curb returns and at junctures with structures. Place filler in single piece conforming to curb cross section and depressed 1/2 inch below finished surface.
      b. Where curb is constructed in conjunction with adjacent sidewalk, the expansion joint in the curb and sidewalk shall coincide.
   2. Contraction Joints:
      a. For curb not constructed integrally with new base or pavement, form or saw contraction joint 3/16 inch wide and 2 inches deep at a spacing of 4 feet minimum to 20 feet maximum.
Saw as soon as possible after the concrete has set sufficiently to preclude raveling during the sawing.

b. Fill joint with hot applied joint sealer.

3. Tool the edge of all joints to a 1/4 inch radius, leaving all joints free of mortar and concrete. In all preformed joints, leave the joint exposed for the full length of the joint with clean and true edges.

C. Do not remove forms until such time that it will not be detrimental to the concrete. Correct irregular faces by rubbing with a carborundum stone.

D. Finishing:

1. Finish face of curb to a 3/4 inch radius and the backside to a 1/4 inch radius.

2. Trowel curb faces smooth either to a depth of not less than 2 inches below flow line or to the flow line of integral curb and gutter. Hand finish the top of face of curb with a steel trowel.

3. Provide a final fine brush finish to the top and face of curb with brush strokes parallel to the line of the curb.

4. Allow no coarse aggregate to show on the finished curb surface.

E. Curing to meet the requirements of PennDOT Specifications 711, except that liquid membrane curing compound shall not be used on curb when temperature tends to go lower than 40°F within twenty-four (24) hours after application.

F. Sealing Joints:

1. Seal to within 1/8 inch of the surface, all expansion joints, all joints between curb and vehicular pavements, all joints between gutters and vehicular pavements. Do not seal other joints unless otherwise indicated or directed by the SEPTA.

2. Seal joints with poured joint sealer in conformance with the manufacturer’s recommendations.

G. Backfilling:

1. As soon as possible after the removal of forms, and finishing as specified herein, backfill the voids in front and back of the curb using acceptable embankment material as Specifications in Section 02220.

2. Complete embankments in back of raised curb, as indicated, and as specified in Section 02220, except carefully compact the embankment by means of mechanical tampers, or rollers, if permitted, not exceeding 8 tons.

3. Where curbs are constructed in existing paved areas, all backfill between curb face and pavement shall be made with bituminous concrete base course material, thoroughly compacted in place in accordance with Section 02520.

END OF SECTION
THIS PAGE NOT USED
SECTION 02821
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of furnishing and installing woven wire fencing of the type and height specified and supporting metal posts and hardware as indicated on Contract Drawings.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. Section 03300 - Cast-in-Place Concrete

1.03 Submittals
A. In accordance with Section 01300 and as follows:
   1. Shop drawings indicating details of fence height, cross dimensions and details of posts, post footings, rails, braces, fittings and accessories.
   2. Working drawings including a layout drawing consistent with the Contract Drawings showing the spacing of posts; abrupt changes in grade; and all corner, anchor, end and pull posts and anchorage details.
   3. Certifications that all materials used fully meet the Specifications.
   4. Manufacturer's and installer's qualifications.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   6. Manufacturers to have a minimum of two (2) years of experience in the manufacture and fabrication of commercial quality chain link fence.
7. Installers to have a minimum of two (2) years of experience in the installation of type of fencing provided as work of this Section.

PART 2 - PRODUCTS

2.01 Materials

A. General

1. Unless otherwise specified, material shall meet the requirements of AASHTO M181.

2. All gauge measurements of finished wire shall be United States Steel Wire Gauge or equivalent.

3. Galvanizing shall meet ASTM A 123/A 123M.

4. Temporary construction fencing materials shall be identical to permanent fencing. In addition:
   a. Provide opaque screening material to be securely attached to the construction fence.

5. Provide products of the same manufacture, size, design and materials, and otherwise identical.

B. Non-structure mounted chain link fence to meet the requirements of PennDOT Specifications, Section 624.2, Section 1016.2 and Section 1110.01(a) and as follows:
   a. Provide fence fabric with a size of mesh of 1 inch, 9 gauge.
   c. Provide top and bottom rails, brace rails and fittings per PennDOT Specifications, Pub 408, Section 1016.2 (a).3.

PART 3 - EXECUTION

3.01 Preparation

A. Deliver materials clearly labeled with the manufacturer's original packaging with tags and labels intact and legible.

B. Store on skids to protect from direct contact with the ground.

3.02 Installation

A. Non-structure mounted chain link fence to meet the requirements of PennDOT Specifications, Pub. 408, Section 624.3 and as indicated on the Contract Drawings.

B. Temporary chain link fence to meet the requirements of PennDOT Specifications, Section 624.3 and as follows:
   1. Provide a stable, self-supporting fence system. Alternatively, the Contractor may drive fence posts directly into ground outside of pavement areas, to a minimum depth of at least 3 feet to ensure fence is stable. Concrete foundations are not required.
   2. Securely attach opaque screening material to the outside or construction side of the fence.
END OF SECTION
SECTION 02850

DRILLED CAISSONS

PART 1 - GENERAL

1.01 Description
   A. The work covered by this Section shall include all labor, material, equipment, permits, and services necessary for the installation of caissons for structure foundations and related work, complete, in accordance with the Contract Drawings and as specified herein. Work shall include the following:
      1. Installation of permanent steel casings and excavating for caissons.
      2. Cleaning of caisson excavations.

1.02 Related Sections
   A. Section 02215 – Material Stockpiling, Staging and Disposal
   B. Section 02371 – Excavation Using Tunnel Liner Plate
   C. Section 03100 – Concrete Forms
   D. Section 03200 – Concrete Reinforcement
   E. Section 03300 – Cast-In-Place Concrete
   F. Section 05120 – Structural Steel

1.03 Submittals
   A. Submit a signed statement that the Contractor has inspected both the Project Site and all the subsurface information available to the Contractor.
   B. No later than one (1) month prior to constructing drilled shafts, the Contractor shall submit a Site Specific Work Plan (SSWP), as specified in Division 1 of the Technical Provisions, for review by the SEPTA Project Manager. This SSWP shall include information on the following:
      1. Name and experience record of the drilled shaft superintendent in charge of drilled shaft operations for this Project.
      2. List of proposed equipment to be used including cranes, drills, augers, final cleaning equipment, core sampling equipment, tremies, or concrete pumps, casing, drive hammer for steel casing, etc. The Contractor shall also list the quantities of each piece of equipment proposed and delivery methods.
      3. Details of overall construction operation sequence and the sequence of shaft construction in bents or groups. Details and procedure for casing installation.
      4. Details of reinforcement placement including support and centralization methods.
5. Details of concrete placement including proposed operational procedures for tremie or pumping methods.

C. The SEPTA Project Manager will evaluate the drilled shaft installation plan for conformance with the Contract Drawings, Specifications and Special Provisions. The SEPTA Project Manager will notify the Contractor of any additional information required and/or changes necessary to meet the contract requirements. All procedural approvals given by the SEPTA Project Manager shall be subject to trial in the field and shall not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed in the Contract Drawings and Specifications.

D. Submit shop drawings that include a layout showing the location of each foundation; foundation details; reinforcement steel schedule; bills of material; details; pertinent dimensions; spacing for each foundation; and casing diameter and wall thickness. The shop drawing shall be signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania retained by the Contractor.

E. Submit a detailed description of the procedures to be used for placement of core beams, reinforcing cages and concrete using tremie techniques.

F. Submit concrete mix designs as per Section 03300.

G. Submit certified mill test reports for reinforcing steel, core steel and shell steel.

H. Submit certification by a Land Surveyor licensed in the Commonwealth of Pennsylvania that each foundation meets the tolerances specified and the dimensions and elevations shown. The certification shall include "as-built" reports of field established dimensions, locations, plumbness, and top and bottom elevations.

1.04 Quality Assurance

A. Quality Control Inspection:

1. The Contractor's caisson construction work shall be subject to quality control inspection which will be done by the SEPTA Project Manager.

2. The Contractor shall have the sole responsibility for coordinating his work with the testing and inspection laboratory to assure that all tests and inspection procedures required by the Contract Documents are properly provided. The Contractor shall cooperate fully with the testing and inspection laboratory in the performance of their work.

a. When a suitable bottom is presumably reached in every caisson, the SEPTA Project Manager will determine if the material in the caisson bottom is suitable for bearing. Before placement of concrete, the socket and shell be thoroughly cleaned and the rock inspected as specified herein to verify that the rock is of the class on which the design has been predicated, or of a better class. In case visual inspection cannot be made, other methods at the discretion of the SEPTA Project Manager will be used to determine the class of rock in the socket.

b. The Contractor shall keep a record independent of that made by the SEPTA Project Manager, including items completed each day, job and weather conditions, a log of each caisson drilled with soil or rock strata encountered, water entry and flow, drilling difficulties, obstructions, casing size and location, bottom clean out and water removal, description of bearing material, depth and size of shaft, plumbness, location of caisson center with respect to design location, top of caisson elevation, reinforcing cage and core beam placement,
concreting and other pertinent construction details. These records shall be forwarded in triplicate each day during caisson operations to the SEPTA Project Manager.

B. The Contractor shall employ a testing laboratory to perform concrete testing services for material evaluation tests and to design concrete mixes.

C. Materials and installed work may require testing at any time during progress of work. Allow free access to material stockpiles and facilities.

D. Meet the applicable provisions of the most recent issues of the following references:

3. American Concrete Institute (ACI).
4. American Railway Engineering Association (AREA).
7. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

1.05 Qualifications

A. The work shall be performed by a Specialty Contractor experienced in drilled shaft foundation construction with suitable equipment, competent personnel and reputation. The Contractor shall submit satisfactory evidence of successful completion of at least three (3) recent installations comparable to the scope of this Project, including Project names, location and telephone numbers.

1.06 Field Measurements

A. Verify that field measurements and survey bench marks are as indicated on Contract Drawings.

B. The shaft dimensions, bottom elevation, location and plumbness shall be determined by a Land Surveyor licensed in the Commonwealth of Pennsylvania retained by the Contractor. These measurements shall be taken in the presence of the SEPTA Project Manager.

1.07 Site Conditions

A. Examine the site, drawings, utility records, test boring records, subsurface exploration reports and soil samples available at the offices of SEPTA, Philadelphia, PA to determine all conditions under which caissons are to be installed.

B. Existing utilities which pass through the work area must remain and be maintained or rerouted, or extended as a part of the work under other sections. Utility lines scheduled to remain in service shall be protected from damage or movement caused by the work under this Section.
1. Should uncharted or incorrectly charted piping or other utilities be encountered during the work of this Section, consult the SEPTA Project Manager immediately for directions as to procedure. Cooperate with SEPTA and utility companies in keeping services and facilities in operation. Repair damaged utilities without additional cost to SEPTA to satisfaction of the utility owner.

2. Do not interrupt existing utilities except when permitted in writing by the SEPTA Project Manager and after acceptable temporary utility services have been provided.

C. Consult public and utility company records, records of SEPTA, and other available sources to determine location and extent of underground utility lines. Work performed in the removal or rerouting of the line shall meet the applicable rules and regulations of authorities having jurisdiction.

D. Caissons within 3 feet of any permanent underground obstruction indicated on the Contract Drawings shall be excavated by hand to first uncover the obstruction. Examine available drawings to determine affected caissons. After proper protection of the permanent obstruction has been installed, remainder of caisson may be excavated by machine.

E. Caissons at or near underground utility locations shall be drilled to 1 foot above, and then hand dug to 1 foot below, possible elevation of utility lines shown on the Contract Drawings, whether or not lines are found in those locations.

F. Abandoned utilities encountered during excavation shall be removed from areas of construction as required to install new work. Cap, plug or otherwise properly seal all such lines.

G. If underground utilities are damaged during installation of caissons, the Contractor shall notify the utility owner(s), who may cause the damage to be repaired at the Contractor's expense.

H. Record accurate locations of abandoned and active lines encountered as well as the routes of active utility line rerouted or extended.

I. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions and other limitations affecting transportation to, access into and out of the site of the work. The Contractor shall meet all Pennsylvania State and federal regulations in regard to the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

1.08 Preconstruction Meeting

A. Prior to moving on site, the SEPTA Project Manager will arrange a meeting to discuss, coordinate and schedule the work. Parties to be present are the Architect, the Utility Consultant, the Structural Engineer, the Geotechnical Engineer, the Contractor's Concrete Testing Laboratory, the SEPTA Project Manager, the Caisson Contractor, the Concrete Contractor, the Ready-mix concrete producer and the Admixture manufacturer(s). Agenda will include the size and capacity of equipment to be used, review of boring and groundwater data, caisson inspection procedures and reporting format, safety measures and procedures to be followed, groundwater control, emergency procedures if unanticipated instability of casing, shaft, wall, or bearing surface is encountered and concrete mix design, presentation and discussion of the Site Specific Work Plan.
B. Minutes of the meeting will be recorded, typed and printed by the SEPTA Project Manager and distributed by him to all parties concerned within five (5) days of the meeting.

C. The minutes shall include a statement by the admixture manufacturer(s) indicating that the proposed design mix and placing can produce the concrete properties required by these specifications.

PART 2 - PRODUCTS

2.01 Equipment

A. Drilled foundation excavations shall be made by auger or rotary drill. Auger shall be of vented design to prevent suction in the shaft during bit removal. Provide ample standby equipment so that work may be carried on without interruption.

B. Provide hoisting equipment of sufficient capacity to handle reinforcing cages, sleeves, lagging and other materials.

C. Provide air sludge type pumps in sufficient quantity to adequately handle water infiltration in caisson wells. Maintain adequate air compressor plant to handle required air pumps for pumping of water.

D. In addition to air pumps provide electric-driven pumps of adequate capacity to remove all water.

2.02 Products

A. Steel casings shall be commercially available welded steel pipe or approved equal. Wall thickness shall be sufficient to prevent crushing or deformation of the casing by earth or water pressure. Steel pipe shall have wall thickness and yield stress meeting the industry standards of the ADSC and shall not be less than 0.375 inch thick with a yield stress of not less than 36000 psi. Tolerances on the outside diameter and other dimensions of the steel casing shall be the standard API tolerances applicable to regular steel line pipe.

B. Concrete to have a minimum compressive strength of 4,000 psi in twenty-eight (28) days, with 7 to 9 inch slump, furnished in accordance with Section 03300, except as otherwise specified herein or approved.

C. Reinforcement to meet ASTM A 615/A 615M, Grade 60 and shall meet the requirements specified.

D. Core beam steel sections shall meet ASTM A 572/A 572M, Grade 50, or ASTM A 36/A 36M as shown and shall conform to requirements specified in Section 05120.

PART 3 - EXECUTION

3.01 Construction Methods

A. Drill shafts to the design depths with a drilling machine capable of developing sufficient torque and using methods as approved by the SEPTA Project Manager. Maintain sidewall stability during construction. All material removed from drilled shafts shall be tested, stockpiled and disposed of as per Section 02215.
B. The Contractor shall be solely responsible for the adequacy and performance of all operations. The Contractor shall use proven methods and caisson drilling equipment having the torque capacity and downward drill force capacity suitable for the site conditions. Only labor and supervisory personnel experienced in this type of work shall be employed.

C. Permanent steel shells shall be provided with a carbon steel shoe and shall be seated sufficiently into the top of rock to prevent the flow of water and soil into the caisson shaft. Casings shall have inside diameters not less than indicated shaft sizes, and shall be a minimum of 3/8 inch thick. The casing shall be driven and drilled through overburden material until bedrock is reached and the casing shoe seated and sealed in the rock.

D. As soon as the bearing stratum is reached and the minimum socket excavation is complete, the Contractor shall clean the caisson socket bottom of all loose or soft material and leveled. The SEPTA Project Manager will determine the actual bottom depth. The bottom of caisson elevations indicated on the Contract Drawings are approximate only. The caissons shall be advanced below the top of bedrock to obtain adequate effective socket and end bearing conditions as required by these specifications and confirmed by the SEPTA Project Manager, who will make final approval of caisson shaft and socket conditions. Inspection and approval will be done using the inspection means outlined herein and as indicated in the Contractor's approved caisson installation plan.

E. The Contractor shall provide underwater color video cameras with operators and lights, and certified construction divers if necessary to assist the SEPTA Project Manager in inspecting the caisson sockets. If the SEPTA Project Manager's inspection indicates that the rock is not capable of providing the required bearing value, the shaft length shall be advanced as directed by the SEPTA Project Manager and the above steps repeated, unless other recommendations are made by the SEPTA Project Manager.

F. During excavation of caissons, all openings shall be properly protected and covered to prevent debris from being dislodged into the excavation when work is not in progress.

G. In no case shall the size of caisson socket exceed the size indicated on the Contract Drawings or as specified herein except by express permission of the SEPTA Project Manager. When larger size caisson socket is permitted upon the Contractor's request, payment will be made on size shown on the Contract Drawings.

H. Drilling of caissons or driving of casings shall not be within 20 feet of concrete placed within seven (7) days.

3.02 Reinforcement

A. Reinforcement steel shall be installed as shown on the approved shop drawings and meet Section 03200. All steel shall be free of rust, mud or any deleterious material which would hinder bonding of concrete and steel. Reinforcement cages shall be straight and shall meet the design dimensions. Adequate provisions shall be made to ensure that the reinforcement steel will remain in place throughout placement of concrete and that specified concrete cover for the reinforcement steel is attained and maintained.

3.03 Concrete Placement for Drilled Shaft Foundations

A. Except as otherwise specified or directed, the concrete shall be placed continuously for the entire length of the foundation.
B. After socket bottom has been inspected, tested and shown to meet the Contract Documents, reinforcing steel and steel core beams shall be installed as shown on the Contract Drawings and concrete shall be poured immediately. Provisions shall be made to ensure that reinforcing cage is straight and will remain in place throughout concrete placement with the specified concrete cover maintained. Concrete shall be continuously placed by underwater tremie pumping techniques. Carefully place concrete to ensure against segregation and dislodging of excavation sidewalls and to completely fill the shaft. The tremie and pipe shall be plugged at the end when first inserted into the water filled shaft, and shall be kept a minimum of 5 feet below the fresh concrete surface during placement.

C. Concrete shall be vibrated in the top 10 feet of the caisson.

D. Concrete shall be brought to a true level surface inside the shaft and a full width cross key formed or dowels installed should it become necessary to interrupt placing concrete in any caisson. Prior to placing additional concrete, clean surfaces or laitance and slouch with 1:1 Portland cement grout. The grout shall have a water cement ratio not exceeding that of the concrete. As a minimum, the entire portion of the caisson below the bottom of the permanent shell shall be concreted in the first pour.

E. Provide protection around top of the excavation to prevent debris from being dislodged into the excavation and concrete.

F. If temporary caisson shell(s) are used, they shall be left in place and the annular space(s) grouted.

G. Caissons found to be out of tolerance or to contain shaft discontinuities that will affect the structural integrity of the foundation, in the opinion of the SEPTA Project Manager, will require replacement by the Contractor at his own expense.

H. Test cylinders shall be taken and testing shall be performed in accordance with Section 03300 but not less than one (1) set per day to assure conformance to the specified compressive strength of the concrete.

3.04 Construction Tolerances

A. Bottom elevation of foundation shall be at design depth unless soil conditions require a design modification that shall be approved by SEPTA.

B. Center of each foundation at the top shall not vary radially from the design center by more than 3 inches.

C. Shafts shall be bored plumb to a tolerance of not more than 1.0 percent of the length not exceeding 12.5 percent of the shaft diameter, whichever is less.

3.05 Inspection

A. All shafts will be inspected by the SEPTA Project Manager:
   1. At the time of drilling, to make sure the assigned depth and bearing stratum has been reached.
   2. Prior to the placement of concrete, to make sure the shaft is in proper condition of concreting.
B. Sufficient time shall be provided to permit inspection of the shaft and to check all dimensions and reinforcement.

C. The location, dimensions and elevations of the shaft as drilled and its plumb shall be determined by a Land Surveyor licensed in the Commonwealth of Pennsylvania retained by the Contractor before concrete is placed.

D. Sufficient equipment and personnel shall be supplied by the Contractor to permit safe inspection of all shafts by the SEPTA Project Manager.

E. Suitable lighting shall be provided as required.

F. The Contractor shall furnish corrective design and construction required to rectify deviations exceeding any of the specified tolerances, including replacement of caissons, if necessary, at no additional cost to SEPTA.

G. Shaft discontinuities found that will affect the structural integrity of the foundation based on the opinion of the SEPTA Project Manager will require replacement of the foundation by the Contractor at his own expense.

3.06 Clean-Up

A. Rubbish, debris and material excavated from the caisson shafts resulting from work under this Section shall be collected regularly, removed from the site and legally disposed of per Section 02215.

END OF SECTION
SECTION 03100

CONCRETE FORMS

PART 1 - GENERAL

1.01 Description
   A. This Section covers the concrete formwork for construction of all concrete structures set forth on the Contract Drawings and in these Specifications.

1.02 Related Sections
   A. Section 01300 – Submittals
   B. Section 01305 – Requests for Information
   C. Section 01400 – Quality Requirements
   D. Section 03200 – Concrete Reinforcement
   E. Section 03300 – Cast-In-Place Concrete

1.03 Submittals
   A. Submit manufacturer's descriptive form coating product data and current specification covering named product.
   B. Submit manufacturer's descriptive form tie product data and current specification covering named product.

1.04 Quality Assurance
   A. Provide formwork designed to ensure the tolerances indicated and to include factors pertinent to safety of personnel during construction.
      1. Design formwork in accordance with ACI 347 and in accordance with the following:
         a. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, temporary construction material, foundation pressures, stresses, lateral stability and such other factors pertinent to safety of structure during construction.
         b. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent construction.
   B. Set and maintain concrete forms within tolerance limits stated in ACI 347.
   C. Meet the applicable provisions of the most recent issues of the following references:
      1. ACI 347, Guide to Formwork for Concrete.
      2. APA-The Engineered Wood Association, Panel Handbook & Grade Glossary.

6. Western Lumber Grading Rules 98.

1.05 Delivery, Storage and Handling

A. Storage and Protection:

1. Protect formwork materials before, during and after erection to ensure acceptable finished concrete work. Also protect in-place materials and work of other trades in connection with concrete work.

2. In event of damage to erected forms, make necessary repairs or replacements prior to concrete pours. Perform such corrective work at no increase in Contract price.

PART 2 - PRODUCTS

2.01 Materials

A. Lumber:

1. Form framing, sheathing, struts, braces and shoring in conformance with WWPA Grading Rules or SPIB Grading Rules.

2. Provide rough structural and dimension lumber of allowable species, surfaced four (4) sides as applicable and grade stamped with the appropriate WWPA or SPIB stamp indicating product compliance with PS-20-94.

3. Use lumber free of material defects that would deform the finished concrete product.

B. Plywood:

1. Form sheathing and panels to not be less than 5/8 inch thick Exterior Type B-B Plywood Class I and II conforming to U.S. Product Standard PS-1-95.

2. Use Class II only on surfaces not exposed to view.

C. Steel:

1. Metal Forms of a pre-engineered standard design, conforming to the concrete sections indicated on the Contract Drawings, may be used in lieu of wood forms.

D. Form Ties:

1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties meeting ACI 347.

2. Use snap-off metal ties with ends that break at least 1 1/2 inches from the face of the wall.

3. Do not use removable ties that leave holes larger than 1 inch.

4. Do not use wire ties, flat bands or form ties fabricated on the Project site.

5. Do not use wood spacers.

E. Provide commercial formulation form-coating compounds that will not bond with, stain, nor affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces.
requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 - EXECUTION

3.01 Inspection
A. Prior to placement of concrete, inspect forms for cleanliness and accuracy of alignment.

3.02 Preparation
A. Apply form coatings in accordance with the manufacturer's specifications.
B. Do not allow excess form coating material to accumulate in the forms.
C. Do not allow form coatings to come in contact with construction joints and reinforcing steel.

3.03 Erection
A. Construct forms in accordance with ACI 347 to required dimensions, plumb, straight, mortar tight and paste tight where appearance is important.
   1. Securely brace and shore forms to prevent displacement, bowing and pillowing, and to safely support imposed concrete load.
   2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and such other features as required. Use selected materials to obtain above requirements.
   3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
   4. Form intersecting planes to provide true, clean-cut corners with edge grain of plywood not exposed to concrete.
   5. Build into forms, or otherwise secure in forms, items such as inserts, anchors, miscellaneous metal items and such other embedded items as indicated on the Contract Drawings.
   6. Wet forms sufficiently to prevent joints in wood forms from opening prior to concrete pour.
   7. Do not use stay-in-place metal forms.
B. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement and for placement of concrete.
   1. Securely brace temporary openings and set tightly to forms to prevent the loss of concrete mortar. Locate temporary openings on forms in as inconspicuous location as possible consistent with the requirements of the work.
   2. Provide openings in concrete formwork of the correct size and in the proper location to accommodate other items and operations of construction work passing through forms. Accurately place and securely support items to be built into forms.
C. Earth forms are not permitted.
3.04 Construction

A. Form Removal:

1. Remove forms in accordance with ACI 347 without damage to concrete and in a manner to ensure complete safety and serviceability of the structure.
   a. Do not cut form ties back from the face of the concrete.
   b. Concrete surface shall not contain residual form coating that will interfere with other materials or coatings to be applied.
   c. Concrete containing slag ground granulated blast furnace slag tends to develop strength slower than a concrete containing 100 percent Portland cement.

2. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the anticipated construction loads without distortion or excessive deflection. SEPTA's consent to remove forms does not relieve the Contractor of the responsibility for the safety of the work.

3. When the atmospheric temperature at the site has been continuously above 50°F from the time of the pour, the forms shall be removed at the earliest practical time within the limits set forth in this paragraph and wet curing shall continue without delay.
   a. Forms for walls and other vertical faces may be carefully removed twenty-four (24) hours after the last portion of concrete in the section involved has been placed, provided the concrete has sufficiently hardened to preclude damage resulting from form removal and provided these members are not subjected to loads for a period of fourteen (14) days.
   b. Maintain horizontal forms in place for a minimum of fourteen (14) days or until the concrete, as determined by job-cured cylinders, has attained a compressive strength of 3,000 psi.
   c. When a water-reducing retarder is used in the concrete mix, the normal time periods for removing forms may need to be increased.

4. When the atmospheric temperature at the site drops below 50°F, leave all forms in place for at least five (5) days regardless of the temperature within the protective covering or enclosure. Upon removal of forms, notify SEPTA in order that a review of the newly stripped surfaces may be made before patching.

3.05 Re-Use of Forms

A. Forms for re-use shall meet new form requirements with respect to effect on poured concrete appearance and structural stability.

B. Do not delay or change the concrete pour schedule as a result of reusing forms compared to the schedule obtainable if all forms were new (in the case of wood forms) or if the total required forms were available (in the case of metal forms).

END OF SECTION
PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of furnishing and installing reinforcement for concrete structures.

1.02 Related Sections
A. Section 01300 – Submittals
B. Section 01305 – Requests for Information
C. Section 01400 – Quality Requirements
D. Section 03100 – Concrete Forms
E. Section 03300 – Cast-In-Place Concrete

1.03 Submittals
A. Submit Shop Drawings and Product Data:
   1. Prepare shop drawings of concrete reinforcement in accordance with 315.
   2. Provide drawings showing all fabrication dimensions and locations for placing reinforcement and bar supports; indicate bending diagrams, splicing and lap of rods, shapes, dimensions and details of bar reinforcing and accessories.
   3. Submit manufacturer’s descriptive product data and current specification for each product specified herein, include installation instructions.
B. Submit Test Reports:
   1. Submit copies of reports showing the results of tests conducted in accordance with the American Society for Testing and Materials (ASTM) Specifications.
   2. Test requirements may be waived based upon certified copies of mill test reports.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. ACI 315, Details and Detailing of Concrete Reinforcement.
   2. ACI 318, Building Code Requirements for Structural Concrete.
   5. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
7. ASTM A 767/A 767M, Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement.

1.05 Delivery, Storage and Handling
A. Storage of Materials:
   1. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease and other bond-breaking coatings.
   2. Identify bundles of reinforcing steel with tags wired to steel.

1.06 Project Conditions
A. Protect in-place reinforcement from excessive construction traffic and other work.

PART 2 - PRODUCTS

2.01 Materials
A. Reinforcing Steel:
   1. Epoxy coated reinforcement bars to meet ASTM A 775/A 775M, using ASTM A 615/A 615M, Grade 60, deformed steel.
   2. Epoxy coated fabricated reinforcing bars to meet ASTM A 934/A 934M, using ASTM A 615/A 615M, Grade 60, deformed steel.
   3. Epoxy coated wire to meet ASTM A 884/A 884M, Class A coated, plain-steel wire.
   5. Galvanized reinforcement bars to meet ASTM A 767/A 767M, Class 2, using ASTM A 615/A 615M, Grade 60, deformed steel.
      a. Use epoxy-coated or other dielectric polymer coated wire bar supports for epoxy coated reinforcement.
B. Epoxy Coated Joint Dowel Bars:
   1. Epoxy coated reinforcement bars to meet ASTM A 775/A 775M, using ASTM A 615/A 615M, Grade 60, deformed steel.

C. Rebar Splicing Coupler:
   1. A two (2) piece splicing system manufactured from ASTM A 615/A 615M, Grade 60 deformed rebar (epoxy coated). A dowel bar splicer with integral nailing flange shall be threaded for a threaded dowel-in rebar such that the completed splice exceeds the tensile requirements of ACI 318.
   2. Provide the coupler manufacturer’s plastic internal coupler protector where couplers are provided for anticipated future additions.
   3. Plastic solid sleeve for placement over bar ends to protect threading from damage, contamination and rust.
   4. Use rebar splicing coupler only where shown on the Contract Drawings or where approved by SEPTA.
   5. Manufacturers:
      a. Dayton Superior Corp.
      b. Or Approved Equal.

D. Slab Joint Dowel Bar (for shear transfer):
   1. Plain round bar conforming to requirements of ASTM A 663/A 663M, Grade 70, 75 or 80 which is not burred, roughened or deformed out-of round to slippage is not hindered.
   2. Coat with curing compound to render surface bondless.
      a. Refer to Section 03300 for curing compound.

E. Deformed Bar Anchors:
   1. ASTM A 108 cold worked, deformed wire per ASTM A 1064/A 1064M with minimum yield strength of 70 ksi and minimum ultimate tensile strength of 80 ksi. Bar anchor shall be low carbon steel with the following properties C – 0.23 max, Mn – 0.90 max, P – 0.040 max and S – 0.050 max.
   2. Anchors shall be similar to Nelson, flux-filled deformed bar anchor by one (1) of the following manufacturers:
      a. Type D2L, by Nelson Stud Welding.
      b. Or Approved Equal.

F. Fibermesh:
   1. First quality, 100 percent virgin polypropylene fibers containing no reprocessed olefin materials as manufactured by one (1) of the following manufacturers:
      a. SI Concrete Systems.
      b. Or Approved Equal.
   2. Fibermesh material shall be mixed at rate of 1.5 pounds of fiber to 1 cubic yard of concrete.
3. Add fibrous reinforcement to concrete material at the time concrete is batched. Mix concrete in strict accordance with the fiber reinforcement manufacturer’s instructions in order to achieve uniform three dimensional distribution.

2.02 Fabrication
A. Fabricate reinforcement to the dimensions indicated on the Contract Drawings and within the tolerances given in ACI 315. Perform bending of steel reinforcement by the cold bending method.
   1. Do not use bars with kinks or bends not indicated on the Contract Drawings.
   2. Perform bar shape fabrication in a manner that will not injure the material or lessen the member strength.
   3. Use a designed bending machine, either hand- or power- operated.
   4. Do not field bend bars partially embedded in concrete unless approved by SEPTA.

PART 3 - EXECUTION

3.01 Inspection
A. Notify SEPTA and Independent Testing Agency five (5) working days before placing concrete so the placement of metal reinforcement can be inspected.

3.02 Installation
A. Placing:
   1. Place metal reinforcement accurately and securely brace against displacement within permitted tolerances and in accordance with ACI 318 through the use of reinforcing accessories.
   2. Terminate reinforcement 2 inches from face of expansion joints.
   3. Continue reinforcement across or through construction joints.
   4. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcing around it. Do not bend the reinforcing to clear the obstructions.
   5. Install welded wire fabric as indicated, lapping joints 8 inches and wiring securely. Extend welded wire fabric to within 2 inches of sides and ends of slabs.
   6. Do not lay metal reinforcement on formwork.
   7. Place slab reinforcement supported from the ground on bar chairs made of plastic or steel.
   8. Reinforcement supported from formwork for slabs, use bar chairs made of plastic or steel.
   9. Place additional reinforcement around openings in slabs and walls as detailed on the Contract Drawings.
10. Deformed bar anchors shall be field welded to slab edge steel bent plate as shown on the Contract Drawings.

B. Splicing:

1. Splice metal reinforcement as indicated on the Contract Drawings and in accordance with ACI 318.

2. Welding of crossing bars (tack welding) is not permitted.

3. Secure metal reinforcement at intersections with not less than No. 16 gauge annealed wire or appropriate size clips. When bar spacing is less than 12 inches, tie alternate intersections.

4. Make mechanical butt splice in accordance with the rebar splicing coupler manufacturer’s installation instructions.

C. Slab Joint Dowel Bar Installation:

1. Install one-half the length of coated bar dowel into slab to be poured.

D. Cleaning:

1. Clean or otherwise protect metal reinforcement so that at the time concrete is placed, reinforcement is free from rust, scale or other coatings that will destroy or reduce bond.

E. Concrete Reinforcement Protection:

1. Provide protection for reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Contract Drawings.

END OF SECTION
THIS PAGE NOT USED
SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 Description
   A. The extent of concrete work is shown on Contract Drawings.

1.02 Related Sections
   A. Section 01300 – Submittals
   B. Section 01305 – Requests for Information
   C. Section 01400 – Quality Requirements
   D. Section 03100 – Concrete Forms
   E. Section 03200 – Concrete Reinforcement

1.03 Submittals
   A. Submit product data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint system, curing compounds, grouts and others as requested by SEPTA.
   B. Submit shop drawings for fabrication, bending and placement of concrete reinforcement to SEPTA for approval before fabrication. Meet ACI 315 showing bar schedule, stirrup spacing, diagrams of bent bars and arrangement of concrete reinforcement. Include special reinforcement if required.

1.04 Quality Assurance
   A. Meet the applicable provisions of the most recent issues of the following references:
      1. ACI 301, Specifications for Structural Concrete for Buildings.
      2. ACI 304, Measuring, Mixing, Transporting, and Placing Concrete.
      6. ACI 318, Building Code Requirements for Reinforced Concrete.
      7. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      8. ASTM A 706/A 706M, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.

11. ASTM C 31/C 31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.


20. ASTM C 231/ C 231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.


22. ASTM C 618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

23. Concrete Reinforcing Steel Institute, Manual of Standard Practice.

B. Engage a testing laboratory acceptable to SEPTA to perform material evaluation tests and to design concrete mixes. Furnish test reports in triplicate for approval.

C. Materials and installed work may require testing and retesting, as directed by SEPTA, at any time during progress of work.

PART 2 - PRODUCTS

2.01 Form Materials
A. Refer to Section 03100.

2.02 Concrete Materials
A. Reinforcing Bars:
   1. ASTM A 615/A 615M, grade 60, deformed.
   2. Reinforcing bars to be welded to meet ASTM A 706/A 706M.
   3. Epoxy coated reinforcing bars to meet ASTM A 775/A 775M.

B. Welded wire fabric to meet ASTM A 1064/A 1064M.

C. Dowel bar anchors to meet ASTM A 1064/A 1064M.
D. Deformed welded wire fabric to meet ASTM A 1064/A 1064M.

E. Tie wires to meet ASTM A 1064/A 1064M.

F. Accessories:
   1. Spacers, chairs, ties, mechanical splices and other devices necessary for proper assembly, placing and supporting reinforcement.
   2. Provide plastic tipped or stainless accessory legs at surfaces exposed to view.
   3. Provide plastic or epoxy coated wire ties, slab bolsters and chairs in conjunction with epoxy coated reinforcement.
   4. Chairs shall be sized and spaced to prevent cover loss during construction operations.

G. Supports for Reinforcement:
   1. Provide zinc-coated steel supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bar type supports complying with CRSI specification, unless otherwise acceptable.

H. Portland Cement:
   1. ASTM C 150/C 150M, Type I or II unless otherwise acceptable to SEPTA.
   2. Use one brand of cement throughout the Contract.

I. Fly Ash:
   1. ASTM C 618, Type C or Type F.
   2. Limit use of fly ash not to exceed 25 percent of cement content by weight.

J. Normal Weight Aggregates:
   1. ASTM C 33/C 33M, and as herein specified. Provide aggregates from a single source.
   2. Local aggregates not meeting ASTM C 33/C 33M but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to SEPTA.

K. Water to be drinkable.

L. Air-entraining admixture to meet ASTM C 260/C 260M.

M. Grout to be ready-mix non-shrink non-metallic grout.

2.03 Proportioning and Design of Mixes

A. Prepare design mixes for the type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to SEPTA for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless other-wise acceptable to SEPTA.

B. Design mixes to provide normal weight concrete with the following properties, as indicated on Contact Drawings and schedules:
   1. 4000 psi at twenty-eight (28) day compressive strength; W/C ratio, 0.35; entrained air to be 6 percent plus or minus 1 percent.
C. Proportion and design mixes to result in concrete slump at point of placement on slab to be between 3 inches to 5 inches.

2.04 Concrete Mixes

A. Job-Site Mixing:

1. Mix materials for concrete in appropriate drum type batch machine mixer. For mixers of 1.0 cu. yard, or smaller capacity, continue mixing at least one and one half (1 1/2) minutes, but not more than five (5) minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity large than 1.0 cu. yard, increase minimum one and one half (1 1/2) minutes of mixing time by fifteen (15) seconds for each additional cu. yard, or fraction thereof.

2. Provide batch ticket for each batch discharged and used in work, indicating Project identification name and number, date, mix type, mix time, quantity and amount of water used.

B. Ready-mix concrete to meet the requirements of ASTM C 94/C 94M, and as herein specified.

1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94/C 94M may be required.

2. When air temperature is between 85°F and 90°F, reduce mixing and delivery time from one and one half (1 1/2) hours to seventy-five (75) minutes, and when air temperature is above 90°F, reduce mixing and delivery time to sixty (60) minutes.

PART 3 - EXECUTION

3.01 Placing Reinforcement

A. Meet Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcement placement and supports, and as specified herein and in the Contract Drawings.

B. Accurately position, secure and support reinforcement against displacement by formwork, construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers as required.

C. Place reinforcement to obtain at least minimum coverage for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so that ends are directed into concrete, not toward exposed concrete surfaces.

3.02 Joints

A. No construction joints will be permitted.

3.03 Concrete Placement

A. Before placing concrete, inspect and complete formwork and installation of reinforcing steel.

B. Meet ACI 304 and as herein specified.
1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. Deposit concrete as nearly as practicable to its final location to avoid segregation.

C. Deposit concrete in forms in horizontal layers in a manner to avoid inclined construction joints.

D. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.

E. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not further than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

F. Deposit and consolidate concrete slabs in a continuous operation, until the placing of a panel or section is completed.

G. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and into corners.

H. Bring slab surfaces to correct level with straightedge and strike-off. Use bull floats or derbies to smooth surface, free of humps or hollows.

I. Maintain reinforcing in proper position during concrete placement operations.

J. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement and curing. In hot weather meet ACI 305 and in cold weather meet ACI 306.

3.04 Concrete Curing and Protection

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

2. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than seven (7) days.

3. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least seven (7) days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

B. Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing and by combinations thereof, as herein specified.

C. Provide moisture curing by any of the following methods:

1. Keep concrete surface continuously wet by covering with water.

2. Continuous water-fog spray.
3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4 inch lap over adjacent absorptive covers.

D. Provide moisture-cover curing as follows:
1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

E. Provide curing compound and sealing compound as follows:
1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within two (2) hours). Apply uniformly in continuous operation by power-spray or roller in accordance with the manufacturer’s directions. Maintain continuity of coating and repair damage during curing period.

3.05 Shores and Supports

A. Refer to Section 03100.

3.06 Quality Control Testing During Construction

A. To facilitate testing service, the Contractor shall:
1. Secure and deliver to SEPTA or its testing agency, without cost, preliminary representative samples of the materials the Contractor proposes to use and which are required to be tested.
2. Permit SEPTA to take samples of the placement of concrete. The time that such samples shall be made will be at the discretion of SEPTA at the site. The Contractor shall permit slump tests to be made during the entire concrete placement operation at a frequency determined by SEPTA.

B. Sampling and testing for quality control during placement of concrete shall include the following, as directed by SEPTA.
1. Sampling fresh concrete to meet ASTM C 172/C 172M, except modified for slump to meet ASTM C 94/C 94M.
2. Slump to meet ASTM C 143/C 143M; one (1) test per 60 feet at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
3. Air content to meet ASTM C 173/C 173M, volumetric method for lightweight or normal weight concrete; ASTM C 231/C 231M pressure method for normal weight concrete; one (1) for each day's pour of each type of air-entrained concrete.
4. Test concrete temperature hourly when air temperature is $40^\circ F$ and below, and when $80^\circ F$ and above; and each time a set of compression test specimens made.
5. Compression test specimen to meet ASTM C 31/C 31M; one (1) set of three (3) standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
6. Compressive strength test to meet ASTM C 39/C 39M; one (1) specimens for each day's pour plus additional sets for each 5.0 cubic yard over and above the first 5.0 cubic yard of each concrete class placed in any one (1) day; one (1) specimen tested at seven (7) days, one (1) specimen tested at twenty-eight (28) days, and one (1) specimen retained in reserve for later testing if required.

7. When frequency of testing will provide less than five (5) strength tests for a given class of concrete, conduct testing from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.

C. Test results will be reported in writing to SEPTA within twenty-four (24) hours after tests are made. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at twenty-eight (28) days, concrete mix proportions and materials compressive breaking strength and type of break for both seven (7) day tests and twenty-eight (28) day tests.

D. Impact hammer, sonoscope, or other nondestructive device may be permitted for nondestructive testing but shall not be used as the sole basis for acceptance or rejection.

E. The independent testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by SEPTA. Testing service may conduct tests to determine adequacy of concrete by cored cylinders meeting ASTM C 42/C 42M or by other methods as directed. The Contractor shall pay for such tests conducted, and any other additional testing as may be required, along with sample taking and patching, if required, when unacceptable concrete is verified.

F. Concrete work determined to be below specified requirements by results of load tests or by structural analysis or not meeting compressive strength requirements, or dimensional tolerance requirements, or appearance requirements, or strength of structural members will be rejected and removed and be replaced with new concrete at no expense to SEPTA.

END OF SECTION
PART 1 - GENERAL

1.01 Description
A. This Section covers the requirements for designing, furnishing and placing of pre-cast concrete units.

1.02 Related Sections
A. Section 01300 – Submittals
B. Section 01400 – Quality Control
C. Section 03200 – Concrete Reinforcement
D. Section 03300 – Cast-in-Place Concrete

1.03 Submittals
A. Refer to Section 01300.
B. Submit shop drawings showing unit dimensions and section details, finishes, reinforcement and connection details, lifting and erection inserts, all other embedded items including related mechanical and electrical work, and layout diagrams identifying installation locations and member identification marks.
C. Submit evidence of specified plant certification.

1.04 Quality Assurance
A. Refer to Section 01400 for general requirements and procedures.
B. The fabrication plant to be certified under the PCI Plant Certification program and be subject to inspection and approval by the SEPTA Project Manager.
C. Manufacture and install pre-cast units so that each unit after erection meets the dimensional tolerances listed in PCI MNL117.
D. Meet the applicable provisions of the most recent issues of the following references:
   1. AWS D1.1, Structural Welding Code – Steel.
   2. PCI MNL117, Manual for Quality Control for Plants and Production of Architectural Pre-cast Concrete Products.

1.05 Delivery, Storage and Handling
A. Lift and support units only at designated lifting and supporting points.
B. Transport units in a manner which will not result in overstressing or damage during delivery, handling and storage of units.
C. Place stored units so that identification marks are discernible.
PART 2 - PRODUCTS

2.01 Materials
   A. Concrete to meet Section 03300 and be Class 4000.
   B. Use continuous material for formwork to produce units without visible joints.
   C. Reinforcing steel to meet Section 03200.
   D. Provide hot-dipped galvanized steel or non-corrosive metal for anchors, dowels and accessories embedded in pre-cast units.

PART 3 - EXECUTION

3.01 General
   A. Fabricate precast units in accordance with PCI MNL117 and as specified herein.

END OF SECTION
SECTION 03600

GROUT

PART 1 - GENERAL

1.01 Description
A. This Section specifies the grouts for the individual grouting requirements stated in other Sections of the Specifications and where indicated on the Contract Drawings.

1.02 Related Sections
A. Section 03930 – Concrete Repair
B. Section 04011 – Masonry Cleaning

1.03 Submittals
A. Submit manufacturer's descriptive product data and current specifications covering named manufactured products specified in this Section. Include placing instructions. Submit product data for the following:
   1. Non-shrink non-metallic grout.
B. Submit mix proportions for all mortar and grout to be used throughout the Project including material specifications and laboratory test results. With each mortar and grout mix, indicate locations to be used and whether mix is to be proportioned in the field or by off-site supplier.

1.04 Quality Assurance
A. Grout installer to be a certified installer with documented history installing the manufacturer’s products according to the manufacturer’s specifications.
B. Furnish the grout manufacturer's current independent laboratory test results on grout performance qualifications indicating the grout as non-shrink from time of placement as meeting the following:
   1. Early height change of 0.0 percent to 4.0 percent, according to ASTM C 827/C 827M.
   2. Hardened height change of 0.0 percent to 0.3 percent according to ASTM C 1090/C 1090M.
   3. Indicating 4,000 psi strength developed with a trowelable mix within twenty-four (24) hours.
   4. Indicating placement time based on initial set of not less than sixty (60) minutes, according to ASTM C 191.
   5. Indicating 8,000 psi strength at twenty-eight (28) days.
C. Testing Agency Services:
   1. Testing agency used for concrete sampling and testing shall be employed at the Contractor’s expense to take periodic field samples of mortar and grout for testing.
Grout shall be sampled and tested in accordance with ASTM C 1019. Mortar shall be sampled and tested in accordance with ASTM C 270 and ASTM C 780.

D. Meet the applicable provisions of the most recent issues of the following references:


1.05 Delivery, Storage and Handling

A. Provide protective covering over materials to prevent moisture damage and contamination of grout materials during delivery and handling.

B. Store grout materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.06 Project Conditions

A. Protect against high and low temperatures and unfavorable environmental conditions in accordance with American Concrete Institute (ACI) standards for placement of concrete.

B. On any day when minimum anticipated night time temperature is 32°F or less, in addition to meeting with general procedures above, heat grout materials to 90°F to produce in-place grout temperature of not less than 70°F at end of work day. Retain protective blankets or enclosures for not less than forty-eight (48) hours.

1. Period of protection may be reduced to twenty-four (24) hours when Type III Portland cement is used for grout.

C. Do not heat water for mortar or grout to more than 160°F.

PART 2 - PRODUCTS
2.01 Materials

A. Provide a factory premixed non-shrink non-metallic grout material containing no corrosive irons, aluminums, chemicals or gypsums and meeting the following limitations:

1. Grout shall meet performance requirements of ASTM C 1107/C 1107M Grades A, B, and C.
2. Use Type I (Normal) cement for grout applications not in contact with sewage.
3. Use Type II (Sulfate Resistant) cement for grout applications in contact with sewage.
4. Manufacturers:
   a. U.S. Grout Corporation; FIVE STAR.
   b. Or Approved Equal.

B. Water to be potable quality, free from deleterious amounts of acids, alkalis and organic substances.

2.02 Grout Quality

A. Non-shrink non-metallic grout to be use ready-mix type requiring only the addition of water. Do not add other materials. Water requirement proportions shall meet the manufacturer's specifications for the desired mix consistency.

PART 3 - EXECUTION

3.01 Preparation

A. Clean surfaces to be grouted to be free of oil, grease, laitance, dirt and other contaminants. Remove loose material. Remove rust, paint and oil from metal components in contact with grout.

1. Perform additional surface preparation in accordance with the manufacturer's instructions.

B. Use forming procedures that allow proper and complete placement of grout.

1. Pre-treat wood forms with forming oils so that they do not absorb moisture.
2. Anchor support elements of formwork so no movement is possible. Remove supports only after grout has hardened.

C. Use power operated mechanical mixer of sufficient capacity to carry out batch mixing without interruption.

1. Mix non-shrink non-metallic grout in accordance with the manufacturer's instructions.

3.02 Installation

A. Perform grout placement in accordance with the recommendations of ACI and the manufacturer's published specifications for mixing and placing. Place non-shrink non-metallic grout only where indicated on the Contract Drawings.
3.03 Cleaning and Protection

A. Clean masonry after mortar is thoroughly set and cured.
   1. Scrape off adhered mortar particles by hand, using non-metallic tools.
   2. Test cleaning methods on half of sample panel, leaving other half in original state.
   3. Meet the directions of the concrete unit masonry manufacturer and NCMA Tek Bulletin No. 45 for cleaning CMU. ALL EXPOSED CONCRETE MASONRY UNITS SHALL BE POWER WASHED FOR FINAL CLEANING. Refer to Section 04011.
   4. NO ACID BASED CLEANING SOLUTIONS SHALL BE ALLOWED.

B. Institute protective measures as required to ensure that unit masonry work will be clean and undamaged at substantial completion.

END OF SECTION
PART 1 - GENERAL

1.01 Description
A. This work is removing and patching designated areas of deteriorated concrete of the existing horizontal surfaces, including the repair of cracks. Concrete repair is classified into three types as follows:
   1. Type 1 areas are where deteriorated concrete extends to a maximum depth of 1 inch, and/or a maximum area of 4 square feet.
   2. Type 2 areas are where deteriorated concrete extends beyond the depth of 1 inch, and/or an area of 4 square feet.
   3. Type 3 areas are where cracks, having a width greater than or equal to 0.05 inches, are present on exposed concrete surfaces.
B. Parging of vertical and overhead surfaces with Portland cement-based, polymer-modified, finishing compound.

1.02 Related Sections
A. Section 03200 – Concrete Reinforcement
B. Section 03300 – Cast-In-Place Concrete
C. Section 09662 – Electrically Insulated Floor Covering
D. Section 09910 – Paints and Coatings
E. Section 09965 – Graffiti Resistant Coatings

1.03 Submittals
A. Submit product data for each type of product.
B. Submit design mixtures for each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.
C. Submit material certificates for each of the following signed by the manufacturers:
   1. Cementitious materials.
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Curing compounds.
   5. Floor and slab treatments.
7. Adhesives.
8. Semi-rigid joint filler.

D. Submit material test reports for the following from a qualified testing agency:
   1. Include service record data indicating absence of deleterious expansion of concrete due
to alkali aggregate reactivity.

E. Submit formwork shop drawings prepared by or under the supervision of a Professional
   Engineer licensed in the Commonwealth of Pennsylvania, detailing fabrication, assembly and
   support of formwork.
   1. Indicate proposed schedule and sequence of stripping formwork, shoring removal, and
      re-shoring installation and removal.

F. Submit floor surface flatness and levelness measurements indicating compliance with
   specified tolerances.

G. Submit field quality control reports.

1.04 Quality Assurance

A. A qualified installer who employs on Project personnel qualified as ACI certified Flatwork
   Technician and Finisher and a supervisor who is an ACI certified Concrete Flatwork
   Technician.

B. A firm experienced in manufacturing ready-mixed concrete products and meets the ASTM C
   94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's Certification of Ready Mixed Concrete
      Production Facilities.

C. An independent agency, acceptable to authorities having jurisdiction, qualified according to
   ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing
      Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
   2. Personnel performing laboratory tests shall be ACI certified Concrete Strength Testing
      Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency
      laboratory supervisor shall be an ACI certified Concrete Laboratory Testing Technician,
      Grade II.

D. Meet the applicable provisions of the most recent issues of the following references:
   1. ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and
      Mass Concrete.
   2. ACI 301, Specifications for Structural Concrete for Buildings.
   3. ACI 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
6. ACI 308, Standard Practice for Curing Concrete.
7. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
17. Pennsylvania Department of Transportation Publication 408, Section 1042, Latex Modified Mortar.
18. SCAQMD 1168, Amended Rule 1168 for Adhesive and Sealant Applications.

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

1.06 Field Conditions
A. Meet ACI 306 for cold weather placement and as follows:
   1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions or low temperatures.
   2. When average high and low temperature is expected to fall below 40°F for three (3) successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   4. Do not use calcium chloride, salt or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Meet ACI 305 for hot weather placement and as follows:
   1. Maintain concrete temperature below 90°F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is
calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is the Contractor's option.

2. Fog-spray forms, steel reinforcement and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots or dry areas.

PART 2 - PRODUCTS

2.01 Materials

A. Patching Material:
   1. Class A Cement Concrete:
      a. Minimum compressive strength 4000 psi at twenty-eight (28) days.

2. Cement:
   a. ASTM C 150/C 150M, Type II.

3. Concrete Aggregates:
   a. Process aggregate meeting requirements of ASTM C 33/C 33M except use No. 8 coarse aggregate.

4. Concrete Bonding Compound:
   a. Compressive strength to be 8,000 psi minimum.
   b. Tensile strength to be 4,000 psi minimum.
   c. Bond strength to be 1,700 psi minimum.
   d. Mixed epoxy resin adhesive shall meet ASTM C 881/C 881M, Type II, Grade 2, Class B and C.

5. Latex Modified Mortar:
   a. Compressive strength to be 3,500 psi minimum at twenty-eight (28) days.

B. Reinforcement Bars:
   1. Epoxy Coated Reinforcement Bars:
      a. ASTM A 775/A 775M, using ASTM A 615/A 615M, Grade 60, deformed steel.

2. Epoxy Coated Welded Wire Fabric:
   a. ASTM A 884/A 884M, Class A coated, plain-steel.
   b. Coating to be G60.

C. Finishing compound for vertical and overhead parging:
   1. Portland cement based, polymer modified, finishing compound for interior or exterior overhead or vertical applications that will receive a coating of sealer or paint.
      a. ARDEX OVP; manufactured by ARDEX Engineered Cements, or approved equal.

   2. Meet or exceed the following values for material cured at 73°F and 50 percent relative humidity:
      a. Trowel application.
      b. VOC to be 0 g/L, calculated SCAQMD 1168.
      c. Color to be concrete gray.

   3. A smooth and uniform finished surface is required.
PART 3 - EXECUTION

3.01 Construction

A. To prepare the concrete surface, sound all exposed concrete surfaces with a light hammer to locate all areas of spalled or delaminated concrete in the presence of SEPTA’s representative. Mark the edges of the delaminated and spalled area. Layout the repair area limits approximately 3 inches beyond the edges of the spalled and delaminated area. Square up all repair areas. Do not use irregular or odd repair areas. Outline the areas with a 1 inch deep vertical saw-cut before scarifying operations. Repair work may begin before scarifying operations. If after scarifying, another area or areas of deteriorated concrete are found beyond the initial saw-cut peripheries, make new saw-cuts for the extended repair limits. Sandblast or water blast to remove partially loosened chips of concrete. In the areas where reinforcement is found to be surrounded by deteriorated concrete or where at least one-half of the rebar surface area is exposed, the depth of concrete removal shall be such as to include all deteriorated concrete but not less than that depth necessary to allow for 1 inch minimum annular clearance around the reinforcing bars. Blow all removal areas clean with oil-free compressed air and protect them against any contaminate detrimental to the bond of the patching material. Care shall be taken during the removal of the designated portions of the structure to avoid damaging the portions that are to remain in place. Satisfactorily repair any damage to the structure beyond the limits of this work due to the construction operations at no expense to SEPTA.

B. Power driven hand tools for removal of deteriorated concrete are required and are subject to the following restrictions:
   1. Do not use pneumatic hammers with more weight than nominal 30 pound class.
   2. Do not operate pneumatic hammers or mechanical chipping tools at an angle in excess of 45 degrees relative to the surface of wall.
   3. Do not place pneumatic tools in direct contact with reinforcing steel.
   4. Use hand tools such as hammers and chisels, or small air chisels to remove final particles of unsound concrete or to provide necessary clearances around reinforcement bars.

C. Clean all existing reinforcement bars to remain with a wire brush, water blast or sand blast. Straighten and coat with neat cement. Remove all portions of damaged or heavily corroded reinforcement bars and replace with the same type of bars. Type 1 repairs will not require wire mesh reinforcement unless otherwise specified by SEPTA. In cases of Type 2 repairs, galvanized welded wire fabric (WWF 4 x 4 W2.9 x W2.9) shall be installed for areas where deteriorated concrete extends less than a depth of 4 inches or tied to dowel bars (#5 at 12 inches) for the area where deteriorated concrete extends beyond the depth of 4 inches. Place the wire mesh reinforcement with a 2 inch clearance from new concrete surface and a minimum 1 inch clearance from the existing sound concrete surface.

D. Prior to placing new concrete in Type 2 repairs, coat contact surfaces with an epoxy bonding compound. Place concrete against contact surface while epoxy bonding compound is still tacky to ensure bond between contact surface and fresh concrete. Wire brush or sandblast hardened epoxy before recoating with fresh epoxy.

E. Repair all cracks in Type 3 repairs by injecting epoxy resin. Injection materials shall be a low viscosity, two (2) part epoxy-resin system meeting the requirements of ASTM C 881, Type II.
Surfaces adjacent to cracks shall be cleaned of dirt, dust, grease, oil, efflorescence or other foreign materials detrimental to the bond of the epoxy-injection-surface seal system. Use of acids or other corrosives will not be permitted. Cleaning methods shall not introduce foreign materials into the crack repair area in such a manner that the penetration of the epoxy adhesive is hindered. A surface seal material as recommended by the adhesive manufacturer shall be used to confine the injection adhesive in the crack during injection and curing. It shall have adequate strength to hold injection fittings or ports and prevent vent leakage during injection. Do not inject the cracked area until after the surface sealer has hardened. Inject the epoxy with a hand gun, pressure pot, or injection machine or as recommended by the manufacturer. Injection of epoxy adhesive shall begin at the lowest point on the crack. When the material begins to flow from the next higher entry port, remove the nozzle, plug the port and insert the nozzle in the next higher entry port. Continue the operation until the crack is completely filled. If port to port travel of the epoxy adhesive is not indicated, the work shall immediately be stopped and SEPTA notified. When cracks are completely filled, epoxy shall be cured for sufficient time in accordance with the manufacturer’s recommendations. The face of the crack shall be finished flush to the adjacent surface and show no indentations or protrusions caused by the placement of entry ports.

F. Patching

1. Type 1:
   a. Immediately before placement of the latex, thoroughly wet the clean surface for a period of not less than one (1) hour. Vacuum or blow out all standing water in depressions, holes or areas of concrete removal with clean, oil-free compressed air. Maintain surface in a damp, puddle-free condition. Brush latex mortar on to the damp, prepared surface. Ensure that all surfaces receive a thorough, even coating and the rate of progress is limited so that the brushed materials do not become dry before it is covered with additional material. Place the latex during periods where ambient temperature is 45°F or greater. Do not place latex above ambient temperatures of 84°F. Stop the placement at any time SEPTA’s representative determines that a satisfactory surface finish is not being achieved.

2. Type 2:
   a. Construct Type 2 patches with Class A cement concrete. Immediately after final cleaning, apply epoxy bonding compound to all exposed surfaces within the repair area. Place concrete in repair area while epoxy bonding is still tacky. Sandblast and remove epoxy bonding compound that has hardened. Use a pencil or other appropriate vibrator to consolidate the concrete. Work concrete into saw cuts extending beyond the corners of the repair area. Strike-off and shape the concrete to match the surrounding wall surface. Use preformed cellular polystyrene temporary forms to keep concrete out of existing joints. Do not patch across a joint and saw cut later.

3. Use temporary forms and bracing, if necessary, to hold concrete until a “green” state has been reached.

4. Provide horizontal rustification grooves, vertical construction joints and exposed aggregate finish as necessary to match the existing wall finish.

G. Cure patches made with latex modified mortar and Class A cement concrete, but do not use liquid membrane curing unless allowed. Do not apply live loads to patches until concrete has reached a minimum compressive strength of 3,300 psi.
H. Apply anti-graffiti sealer to all exposed concrete surfaces after all the repairs have been made. Refer to Section 09965.

END OF SECTION
THIS PAGE NOT USED
SECTION 04011

MASSONRY CLEANING

PART 1 - GENERAL

1.01 Description

A. The work of this Section includes testing approaches to masonry cleaning on a variety of stains, and the cleaning of all surfaces as listed in the Contract Drawings consisting of the brick and concrete masonry units.

B. The Contractor shall test each cleaning method for sufficiency. If a cleaning method and material are used and do not produce satisfactory results, the next level of harshness / abrasiveness cleaning is to be used. This is considered the testing method. Under no circumstances are any building materials to be damaged during this test cleaning process. If the masonry cannot be satisfactorily cleaned to a satisfactory condition as determined by the SEPTA, the materials, not satisfactorily cleaned, shall be replaced as per Option “A.”

C. Cleaning is intended to remove all surface dirt, other deposits and all coatings and paints including graffiti from the masonry to achieve a lighter, more uniform color. Surfaces shall be evenly cleaned with no evidence of streaking, bleaching or unnatural color variations. All masonry materials shall be left free of any residual chemical cleaner and pH neutral. Cleaning shall not damage adjacent materials.

1. The work involved in cleaning masonry work post repair or replacement shall follow the materials and methods as outlined in this Section. At interior locations, the cleaned area shall be isolated to repaired / replaced areas so as to reduce the amount of cleanup. This work shall be done a minimum of twenty-one (21) days after the work is complete, allowing for full cure times.

2. Areas at the interior and exterior which have excessive staining that was not removed under the recent cleaning campaign shall follow the methods and materials as outlined in this Section. This work shall be cleaned before the general building cleaning.

3. The work described in the Contract Documents that is specific to removal of these stains and substances is outlined in this Specification Section. If the masonry cannot be cleaned to a satisfactory condition as determined by SEPTA, the materials shall be replaced as per Option “A.”

4. A final general building cleaning will be conduced at the entire interior and exterior. This is to be the final and last step of cleaning. When cleaning any portion of the interior all measures shall be taken to eliminate the water / cleaning products from dispersing any further than the immediate area.

1.02 Related Sections

A. Section 04012 – Brick Masonry Repair

B. Section 07190 – Water Repellents
1.03 Submittals

A. Submit written description of method to be used for general masonry cleaning, based on cleaning tests.

B. Submit all manufacturers’ literature for cleaning materials to be used including product data, use limitations and MSDS.

C. Submit samples of each chemical cleaning agent to be tested in their original unopened containers.

D. Submit sample of agent proposed for protection of all glass, wood, metal, and polycarbonate materials from acids and alkaline cleaning agents.

E. Submit sample of solvent-resistant polyethylene sheeting for protection from acid and alkaline cleaning agents.

F. Submit cleaning tests:
   1. Provide two (2) test panels, measuring 1 foot by 1 foot square that is representative of the effect of each cleaning material and method on the most heavily soiled and generally soiled areas of the interior and exterior façade for each different material covered in this Section. Notify SEPTA a minimum of seven (7) days in advanced of test panel inspection.
   2. Repeat cleaning tests as required until desired results are reached and approval of materials and methods are obtained. Do not proceed with cleaning until SEPTA approval has been given.

1.04 Quality Assurance

A. A paint removing firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory authorized service representatives who are available for consultation and Project site inspection, preconstruction product testing and on site assistance.

B. A chemical cleaning firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory authorized service representatives who are available for consultation and Project site inspection, preconstruction product testing and on site assistance.

C. Prepare a written cleaning program that describes cleaning process in detail, including materials, methods and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.
   1. If materials and methods other than those indicated are proposed for any stage of cleaning work, add a written description of such materials and methods, including evidence of successful use on comparable Projects and demonstrations to show their effectiveness for this Project.

D. Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Clean an area approximately 25 square feet for each type of masonry and surface condition.
a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
b. Allow a waiting period of not less than seven (7) days after completion of sample cleaning to permit a study of sample panels for negative reactions.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.

E. All environmental restrictions (city, state and federal) and safety code requirements regarding items in this Section should be observed. This will likely entail effluent collection and neutralization.

1.05 Definitions

A. Very low-pressure spray to be under 100 psi.
B. Low-pressure spray to be 100 to 400 psi; 4 to 6 gallons per minute.
C. Medium-pressure spray to be 400 to 800 psi; 4 to 6 gallons per minute.
D. High-pressure spray to be 800 to 1200 psi; 4 to 6 gallons per minute.

1.06 Coordination

A. The Contractor shall coordinate the work of this Section with all other Sections for the successful completion of the Contract.
B. Cleaning brick shall be carried out prior to pointing or other masonry repair work.
C. General cleaning shall not be performed within twenty-one (21) days of composite patching, pointing or masonry repair techniques to allow for repairs to fully cure.

1.07 Sequencing and Scheduling

A. Perform masonry-cleaning work in the following sequence:
   1. Remove plant growth.
   2. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured and dried to prevent the intrusion of water and other cleaning materials into the wall.
   3. Remove paint.
   4. Clean masonry surfaces.
   5. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning. Refer to Section 07190.

B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units according to masonry repair Section 04012. Patch holes in mortar joints according to masonry repointing Sections.

1.08 Sample of Cleaning Methods and Agents

A. The purpose of testing is to determine most appropriate cleaning agent, strength and dwell time of cleaning agent, method of application, method and duration of rinsing, and to
ensure that cleaned masonry surfaces can be obtained with no detrimental effect to masonry or other materials on or adjacent to the building. The lowest strength cleaning agent bringing the desired degree of cleaning shall be used.

B. Apply materials as specified to at least two (2) designated areas, each approximately 1 foot by 1 foot. Modify soak and dwell time as needed to achieve satisfactory results. Rinse until pH of wet wall is equal to that of clean water from tap.

C. Follow all the product manufacturers' application instructions unless otherwise noted in this Section.

D. SEPTA will be on-site at all times during the testing process and will provide instruction and guidance throughout duration of process. Location of test areas will be determined by SEPTA prior to testing.

1.09 Evaluation of Cleaning Example

A. Sample shall be evaluated by SEPTA.

B. Cleaning method, agent, concentration and dwell time shall be selected by SEPTA.

C. Items to be evaluated:
   1. Cleanliness of the test area. Masonry is not to be over-cleaned.
   2. Discoloration of masonry.
   3. Alteration to texture, sheen or loss of material.
   4. Duration of water rinse and pressure.
   5. Dilution of concentrate.
   6. Duration of exposure.
   7. Number of applications.

D. After receiving approval of cleaning materials and cleaning methods, the Contractor shall clean one (1) sample of 2 square feet. The approved samples shall serve as the standards of quality for the rest of the cleaning.

1.10 Product Handling

A. All materials are to be delivered to the job site in original unopened containers bearing the manufacturer name and label. Store and handle materials in strict compliance with the manufacturer's instructions. Do not store on the ground.

B. Protect materials from tampering, acts of vandalism, possible injury to workers, the general public, intrusion of foreign materials and moisture. All vessels shall have tight fitting covers. At no time shall vessels containing chemicals be carried to working levels when vessels are open.

1.11 Job Protection

A. Prevent chemical cleaning agents from spilling or dripping down surfaces, on to projections (sills, windows, ledges, etc.) or on to the ground. Remove any spilled or dripped materials immediately and rinse well.
B. Provide adequate protection from chemical cleaning agents and rinse water for all glass, metal and polycarbonate surfaces around and beneath the surfaces being worked on and any adjacent surfaces not included in this work. Ventilate as necessary to prevent fume build-up. Apply masking agent to comply with the manufacturer's recommendations. Do not apply liquid masking agent to painted or porous surfaces.

C. Cleaning shall not begin until average daily temperatures remain above 50°F. Do not clean during adverse weather conditions, except to wash down any cleaning agent already applied. The Contractor shall alter cleaning procedures if considered necessary because of temperature changes.

D. Do not clean if the temperature of air or masonry drops below 40°F. Do not clean within seven (7) days of anticipated freezing temperatures.

E. If temperatures rise above 85°F, protect areas being worked on with tarps or other shading devices to reduce heat from direct sun. Do not allow chemicals to dry on masonry.

F. Do not clean during rain or when rain is imminent.

G. Protect all surrounding areas and the general public from wind carried chemicals. Beware of wind drift.

H. Surrounding areas shall be protected from contact with chemical cleaning agents and rinse water. Surrounding areas shall include, but shall not be limited to, adjacent surfaces, including masonry and structures, private property including automobiles, vegetation and all other surfaces that would be adversely affected if placed in contact with the cleaning agents.

I. Do not allow run off from the cleaning process to enter sewer system or contaminate water supplies. Dispose of effluent in safe and legal way.

J. The Contractor shall take all necessary precautions for the protection of property and public safety from cleaning agents, rinse water, and wind-drifting chemical cleaners and water.

K. The Contractor will use all necessary precautions to protect persons performing the work and others from harmful effects of the cleaning agents and rinse water. Workers shall be required to wear protective clothing, goggles, face shields, gloves and other clothing or equipment in compliance with governing federal, state and local safety codes and regulations.

L. Staging must be well maintained and equipped with steel cables. Use only synthetic fiber ropes and safety lines, appropriate for use with approved cleaning compounds as to prevent damage to the lines.

M. The Contractor shall provide, erect and maintain barricades, danger signals and warning signs as needed.

PART 2 - PRODUCTS

2.01 Equipment

A. Brushes shall be stiff natural bristle brushes or soft-fiber masonry washing brushes, never metal.

B. No spray application of chemicals shall be allowed.
C. Use pressure (1500-2000 psi) washer at EXTERIOR ONLY equipped with a fan-shaped spray tip, and a spacer to prevent work and application to occur at a minimum of 18 inches away which disperses water at an angle of 45 degrees. Washer shall be capable of operation at maximum 2500 psi, and must be capable of providing a flow rate of 6 gallons per minute.

D. No metal fittings that can corrode or deposit corrosive materials on the masonry are to be used.

E. Use non-staining closed-cell polyethylene foam backer rod stock for placing in open joints. Diameter of backer rod shall be 25 percent greater than joint width.

F. Polyethylene sheeting affixed with tape that will not leave residue or strippable, liquid, film-forming type for protection of glass, wood, metal, and polycarbonate materials from acidic cleaner to be used for masking.

1. Manufacturers:
   a. Diedrich Acid Guard, manufactured by Diedrich Chemicals.
   b. Sure Klean Acid Stop, manufactured by ProSoCo.
   c. Or Approved Equal.

2.02 Cleaning Agents

A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.

B. For mortar and grout spills use 101 Lime Solvent from ProSoCo, Kansas City, KS or approved equal.

   1. Any additional cleaning shall leave all surfaces with no evidence of streaking, bleaching or unnatural color variations.

C. For stains, efflorescence, carbon build-up and mastics use light, medium and heavy duty restoration cleaners by ProSoCo., Kansas City, KS or approved equal.

   1. Use the lightest duty cleaner for the application, even if the process takes two (2) to three (3) coats to produce acceptable quality.

D. Chemical cleaner for brick only, maximum 2 percent solution of hydrofluoric acid with trace of phosphoric acid and surfactants in water, such as Diedrich 101-G Granite or approved equal, Terra Cotta & Brick Cleaner, diluted 1:6 with water or as demonstrated by test panels. Areas of heavy soiling may require a higher chemical concentration. The most dilute combination of water and chemical, which is found to effectively clean the masonry, shall be used.

E. Dilute acidic cleaner solution for non-glazed masonry with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended in writing by the chemical-cleaner manufacturer.

PART 3 - EXECUTION

3.01 Inspection

A. Before starting any work of this section, the Contractor shall make a complete inspection of entire facade to identify and confirm all surfaces to be cleaned and all areas that will require
special care in cleaning. Review the Contract Drawings describing existing conditions of concern (e.g. open joints, deteriorated brick or precast) and carefully inspect these areas on the building. Notify SEPTA immediately if discrepancies or changed conditions exist. Do not proceed until such discrepancies are resolved.

B. Prior to cleaning, determine degree of cleaning to be carried out and review areas requiring additional treatment with SEPTA Approved cleaning test panels will serve as the standard for cleaning all materials outlined in Article 1.01 of this Section.

3.02 Preparation for Cleaning

A. Open Joints:
   1. Remove deteriorated mortar carefully from joints. Follow procedures outlined in Section 04012.
   2. Flush all debris and residual mortar dust from joints with water.
   3. When joints are dry, point or install backer rod to depth equal to one-half the joint width. Maintain strict tolerance throughout installation.

B. Dry brush any areas with loose dirt or soil, or extreme dirt build-up, to remove as much material as possible, prior to wet cleaning.

3.03 General Cleaning Procedures

A. Cleaning shall begin at the bottom of the facade and slowly and continuously progress upward.

B. Thoroughly wet surfaces prior to application of detergent. Wet surfaces with low pressure water spray. Surfaces shall not be allowed to dry prior to application of chemical cleaner.

C. To avoid streaking on walls, all wall surfaces immediately below the area being cleaned shall be kept wet and rinsed free of dripping detergent.

D. Thoroughly pre-wet the area to be cleaned and that surrounding and below it. Take pH reading of masonry prior to the application of cleaning chemicals. A pressure water spray not to exceed 200 psi shall be used for pre-wetting and maximum of 500 psi for rinsing of masonry surfaces. Sprayer shall be equipped with fan tipped nozzle (45 degrees) and be capable of providing a minimum flow rate of 6 gallons per minute.

E. Apply a coating of diluted cleaner in the concentrations determined by cleaning tests to surface using a natural or synthetic fiber brush (i.e., soft bristled nylon).

F. Allow the chemical cleaner to remain on the surface for three (3) to five (5) minutes, scrubbing lightly with a natural or fiber brush. No metal or wire brushes are to be used.

G. Rinse making sure to wash each portion of the masonry surface with concentrated water pressure spray. Pressure rinse from the bottom of cleaned area upward and then down again. Take great care to ensure that all detergent is rinsed from masonry. Do not allow chemicals to dry on surfaces.

H. Reapply chemical cleaner if necessary. Do not exceed two (2) applications without SEPTA’s approval.

I. Allow area of application and areas below and surrounding to fully dry after rinsing.
J. Rinsing:
   1. Application of the rinse water is extremely important. As much water pressure as possible (without damaging the surface) shall be used to apply the rinse water so all traces of the chemical cleaning agents are completely removed. Thoroughly rinse from the bottom of the treated area to the top and down again covering each section of the surface.
   2. Rinse until the wet masonry surface is of the same pH as the rinse water. Surfaces shall be tested with pH strips.

K. All scaffolding, platforms and barricades shall be water-washed in the middle and at the end of each work day. Ground area shall be water-washed at the end of each work day.

L. Protect the public from overspray.

3.04 Completion
   A. Clean adjacent areas and remove any debris or accumulated matter.
   B. Clean and restore all sidewalks, paving and adjacent areas/objects soiled or damaged as the result of cleaning operations.
   C. Remove all protective materials.

END OF SECTION
SECTION 04012

BRICK MASONRY REPAIR

PART 1 - GENERAL

1.01 Description

A. Section Includes:
   1. Repairing brick masonry, including replacing units.
   2. Removing abandoned anchors.
   3. Painting steel uncovered during the work.
   4. Repointing joints with mortar.

1.02 Related Sections

A. Section 02070 – Selective Demolition
B. Section 04011 – Masonry Cleaning

1.03 Submittals

A. Submit product data for each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include recommendations for product application and use. Include test data substantiating that products meet the requirements.

B. Submit shop drawings:
   1. Include plans, elevations, sections and locations of replacement masonry units on the structure, showing relation of existing and new or relocated units.
   2. Include plans, elevations, sections and locations of repointing work on the structure.
   3. Show provisions for expansion joints or other sealant joints.
   4. Show provisions for flashing, lighting fixtures, conduits and weep holes as required.
   5. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.

C. Submit samples for initial selection of the following:
   1. Submit sets of colored mortar that will be left exposed in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
      a. Have each set contain a close color range of at least three (3) samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
      b. Submit with precise measurements on ingredients, proportions, gradations and source of colored sands from which each sample was made.
2. Sand Types Used for Mortar:
   a. Minimum 8 oz. of each in plastic screw-top jars.

3. Submit sets of patching compound samples in the form of plugs (patches in drilled holes) in sample units of masonry representative of the range of masonry colors on the building.
   a. Have each set contain a close color range of at least three (3) samples of different mixes ofpatching compound that matches the variations in existing masonry when cured and dry.

4. Include similar samples of accessories involving color selection.

5. Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
   a. Have each set contain a close color range of at least three (3) samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
   b. Submit with precise measurements on ingredients, proportions, gradations and source of colored sands from which each sample was made.

6. Sand Type Used for Pointing Mortar:
   a. Minimum 8 oz. of each in plastic screw-top jars.

D. Submit samples for verification of the following:

1. Each type of brick unit to be used for replacing existing units. Include sets of samples to show the full range of shape, color and texture to be expected. For each brick type, provide straps or panels containing at least four (4) bricks. Include multiple straps for brick with a wide range.

2. Each type of patching compound in the form of briquettes, at least 3 inches long by 1 1/2 inches wide. Document each sample with the manufacturer and stock number or other information necessary to order additional material.

3. Each type of accessory and miscellaneous support.

4. Each type, color and texture of pointing mortar in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
   a. Include with each sample a list of ingredients with proportions of each. Identify sources, both supplier and quarry, of each type of sand and brand names of cementitious materials and pigments if any.

E. Submit qualification data for brick masonry repair specialist including field supervisors and workers and testing service.

F. Submit preconstruction test reports for existing masonry units and mortar and replacement masonry units.

G. Submit quality control program.

1.04 Quality Assurance

A. Engage an experienced brick masonry repair firm to perform work of this Section. Firm shall have completed work similar in material, design and extent to that indicated for this Contract with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repair work.
1. Brick masonry repair specialist firm shall maintain experienced full time supervisors on the Project site during times that brick masonry repair work is in progress.

2. When masonry units are being patched, assign at least one (1) worker per crew who is trained and certified by the manufacturer of patching compound to apply its products.

B. Engage an experienced brick masonry repointing firm to perform work of this Section. Firm shall have completed work similar in material, design and extent to that indicated for this Contract with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repointing work.

1. Brick masonry repointing specialist firms shall maintain experienced full time supervisors on the Project site during times that brick masonry repointing work is in progress.

C. Prepare a written quality control program for this Contract to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

D. Prepare mockups of brick masonry repair and repointing to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.

1. Prepare sample areas for each type of masonry repair work performed. If not otherwise indicated, size each mockup not smaller than two (2) adjacent whole units or approximately 48 inches in least dimension. Construct sample areas in locations in existing walls where directed by the SEPTA Project Manager unless otherwise indicated. Demonstrate quality of materials, workmanship and blending with existing work. Include the following as a minimum:
   a. Four (4) brick units replaced.
   b. Three (3) small holes as directed for each type of brick indicated to be patched.

2. Rake out joints in two (2) separate areas, each approximately 36 inches high by 48 inches wide for each type of repointing required, and repoint one (1) of the areas.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the SEPTA Project Manager specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of substantial completion.

E. Meet the applicable provisions of the most recent issues of the following references:


14. SSPC-SP 2, Hand Tool Cleaning.
15. SSPC-SP 3, Power Tool Cleaning.
16. SSPC-SP 6, Commercial Blast Cleaning.

1.05 Delivery, Storage and Handling
A. Deliver masonry units to the Project site strapped together in suitable packs or pallets or in heavy duty cartons and protected against impact and chipping.
B. Deliver packaged materials to the Project site in the manufacturer's original and unopened containers, labeled with the manufacturer's name and type of products.
C. Store cementitious materials on elevated platforms, under cover and in a dry location. Do not use cementitious materials that have become damp.
D. Store hydrated lime in the manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two (2) days.
E. Store sand where grading and other required characteristics can be maintained and contamination avoided.
F. Handle masonry units to prevent overstressing, chipping, defacement and other damage.

1.06 Definitions
A. Low Pressure Spray to be 100 to 400 psi; 4 to 6 gallons per minute.
B. Rebuilding (Setting) Mortar is mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
C. Saturation Coefficient is the ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of masonry units to freezing and thawing.

1.07 Sequencing and Scheduling
A. Order sand and gray Portland cement for colored mortar immediately after approval of mockups. Take delivery of and store at Project site enough quantity to complete Contract.
B. Perform brick masonry repair work in the following sequence, which includes work specified in this and other Sections:

1. Remove plant growth.
2. Inspect masonry for open mortar joints and point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint.
4. Clean masonry.
5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
6. Repair masonry, including replacing existing masonry with new masonry materials.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.

1.08 Preconstruction Testing

A. Engage a qualified testing agency to perform preconstruction testing on masonry units as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Test each proposed type of replacement masonry unit according to sampling and testing methods in ASTM C 67 for compressive strength, twenty-four (24) hour cold water absorption, five (5) hour boil absorption, saturation coefficient and initial rate of absorption (suction).
3. Test each type of existing masonry unit indicated for replacement according to testing methods in ASTM C 67 for compressive strength, twenty-four (24) hour cold water absorption, five (5) hour boil absorption, saturation coefficient and initial rate of absorption (suction). Carefully remove five (5) existing units from locations designated by the SEPTA Project Manager. Take testing samples from these units.
4. Test existing mortar according to ASTM C 295/C 295M, modified as agreed by testing service and the SEPTA Project Manager for Contract requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.
5. As directed by the SEPTA Project Manager, provide temporary patch materials followed by permanent repairs at locations from which existing samples were taken.
1.09 Field Conditions

A. Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed according to the product manufacturers' written instructions and specified requirements.

B. Repair masonry units only when air temperature is between 40°F and 90°F and is predicted to remain so for at least seven (7) days after completion of the work unless otherwise indicated.

C. Meet the following cold weather procedures for masonry repair unless otherwise indicated:
   1. When air temperature is below 40°F, heat mortar ingredients, masonry repair materials and existing masonry walls to produce temperatures between 40°F and 120°F.
   2. When mean daily air temperature is below 40°F, provide enclosure and heat to maintain temperatures above 32°F within the enclosure for seven (7) days after repair.

D. Meet the following hot weather procedures for masonry repair unless otherwise indicated:
   1. Protect masonry repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90°F and above unless otherwise indicated.

E. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

PART 2 - PRODUCTS

2.01 Materials

A. Source Limitations:
   1. Obtain each type of material for repairing brick masonry (brick, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.
   2. Obtain each type of material for repointing brick masonry (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.02 Masonry Materials

A. Face Brick:
   1. As required to complete brick masonry repair work.
   2. Units with colors, color variation within units, surface texture, size and shape that match existing brickwork and with physical properties within 10 percent of those determined from preconstruction testing of selected existing units.
   3. Special Shapes:
      a. Provide molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.
b. Provide specially ground units, shaped to match patterns, for arches and where indicated.
c. Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are unacceptable procedures for fabricating special shapes.

4. Tolerances as fabricated to meet the tolerance requirements in ASTM C 216, Type FBX.

2.03 Mortar Materials

A. Portland cement to meet ASTM C 150/C 150M, Type I or Type II, except Type III may be used for cold weather construction; white or gray, or both where required for color matching of mortar.
   1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated lime to meet ASTM C 207, Type S.

C. Masonry cement to meet ASTM C 91/C 91M.

D. Mortar cement to meet ASTM C 1329/C 1329M.

E. Mortar sand to meet ASTM C 144.
   1. Match size, texture and gradation of existing exposed mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
   2. Natural sand or ground marble, granite or other sound stone of color necessary to produce required mortar color.

F. Mortar pigments to meet ASTM C 979/C 979M, compounded for use in mortar mixes and having a record of satisfactory performance in masonry mortars.

G. Water to be potable.

2.04 Manufactured Repair Materials

A. Factory mixed cementitious product that is custom manufactured for patching brick masonry.
   1. Use formulation that is vapor and water permeable (equal to or more than the masonry unit), exhibits low shrinkage, has lower modulus of elasticity than masonry units being repaired and develops high bond strength to all types of masonry.
   2. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
   3. Formulate patching compound in colors and textures to match each masonry unit being patched. Provide sufficient number of colors to enable matching of the color, texture and variation of each unit.

2.05 Ties and Anchors

A. Ties and anchors shall extend at least 1 1/2 inches into veneer but with at least a 5/8 inch cover on outside face.

B. Provide ties and anchors specified in this article that are made from materials that meet the following unless otherwise indicated:

C. Adjustable Masonry Veneer Anchors:
   1. Provide anchors that allow vertical adjustment but resist a 100-lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
   2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075 inch thick steel sheet, galvanized after fabrication.
   3. Fabricate wire ties from 0.187 inch diameter, hot dip galvanized steel wire unless otherwise indicated.
   4. Fabricate wire connector sections from 0.187 inch steel wire.

2.06 Accessory Materials

A. Setting buttons and shims to be resilient plastic, non-staining to masonry, sized to suit joint thicknesses and bed depths of masonry units, less the required depth of pointing materials unless removed before pointing.

B. Masking tape to be non-staining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

C. Antirust coating to be fast curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to MPI #23 (surface-tolerant, anticorrosive metal primer) or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.
   1. Use coating requiring no better than SSPC-SP 2, SSPC-SP 3 or SSPC-SP 6 surface preparation according to the manufacturer’s literature or certified statement.
   2. Use coating with a VOC content of 400 g/L or less.

D. Select materials and methods of use based on the following, subject to approval of a mockup:
   1. Previous effectiveness in performing the work involved.
   2. Minimal possibility of damaging exposed surfaces.
   3. Consistency of each application.
   4. Uniformity of the resulting overall appearance.
   5. Do not use products or tools that could leave residue on surfaces.

2.07 Mortar Mixes

A. Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
   1. Thoroughly mix pointing mortar cementitious materials and sand together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this
dampened condition for fifteen (15) to thirty (30) minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one (1) hour of final mixing; do not re-temper or use partially hardened material.

B. Produce mortar of color required by using specified ingredients. Do not alter specified proportions without the SEPTA Project Manager's approval.
   1. Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.

C. Do not use admixtures in mortar unless otherwise indicated.

D. Mix mortar materials in the following proportions:
   1. Rebuilding (setting) mortar by volume to meet ASTM C 270, proportion specification is to match existing mortar mix.
   2. Add mortar pigments to produce exposed, rebuilding (setting) mortar of colors required.
   3. Pointing mortar by type to meet ASTM C 270, proportion specification, Type N unless otherwise indicated; with cementitious material limited to Portland cement and lime, masonry cement or mortar cement. Add mortar pigments to produce mortar colors required.

PART 3 - EXECUTION

3.01 Protection
   A. Prevent mortar from staining face of surrounding masonry and other surfaces.
      1. Cover sills, ledges and other projecting items to protect them from mortar droppings.
      2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
      3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

   B. Remove gutters and downspouts and associated hardware adjacent to masonry and store during masonry repointing. Reinstall when repointing is complete.

3.02 Masonry Repair and Repointing
   A. Repaired and/or repointed surfaces are to have a uniform appearance as viewed from 20 feet away by the SEPTA Project Manager.

3.03 Abandoned Anchor Removal
   A. Remove abandoned anchors, brackets, wood nailers and other extraneous items no longer in use unless indicated to remain.
      1. Remove items carefully to avoid spalling or cracking masonry.
      2. Notify the SEPTA Project Manager before proceeding if an item cannot be removed without damaging surrounding masonry. Do the following where directed:
a. Cut or grind off item approximately 3/4 inch beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
b. Immediately paint exposed end of item with two (2) coats of antirust coating, following the coating manufacturer’s written instructions and without exceeding the manufacturer’s recommended dry film thickness per coat. Keep paint off sides of recess.

3. Patch hole where each item was removed unless directed to remove and replace masonry unit.

3.04 Brick Removal and Replacement

A. At locations indicated, remove bricks that are damaged, spalled or deteriorated or are to be reused. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
   1. When removing single bricks, remove material from center of brick and work toward outside edges.

B. Support and protect remaining masonry that surrounds removal area.

C. Maintain flashing, reinforcement, lintels and adjoining construction in an undamaged condition. Coordinate with new flashing, reinforcement and lintels, which are specified in other Sections.

D. Notify the SEPTA Project Manager of unforeseen detrimental conditions including voids, cracks, bulges and loose units in existing masonry backup, rotted wood, rusted metal and other deteriorated items.

E. Remove in an undamaged condition as many whole bricks as possible.
   1. Remove mortar, loose particles and soil from brick by cleaning with hand chisels, brushes and water.
   2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
   3. Store brick for reuse. Store off ground, on skids and protected from weather.
   4. Deliver cleaned brick not required for reuse to SEPTA unless otherwise indicated.
   5. Refer to Section 02070.

F. Clean masonry surrounding removal areas by removing mortar, dust and loose particles in preparation for brick replacement.

G. Replace removed damaged brick with other removed brick in good condition, where possible, or with new brick matching existing brick. Do not use broken units unless they can be cut to usable size.

H. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.
   1. Maintain joint width for replacement units to match existing joints.
   2. Use setting buttons or shims to set units accurately spaced with uniform joints.

I. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head and collar joints. Butter ends with enough mortar to fill head joints and shove into place.
Wet both replacement and surrounding bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.

1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
2. Rake out mortar used for laying brick before mortar sets according to this Section. Point at same time as repointing of surrounding area.
3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.

J. Cure mortar by maintaining in thoroughly damp condition for at least seventy-two (72) consecutive hours, including weekends and holidays.

1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.05 Repointing Masonry

A. Rake out and repoint joints to the following extent:

1. Joints at locations indicated and of the following defects:
   a. Holes and missing mortar.
   b. Cracks that can be penetrated 1/4 inch or more by a knife blade 0.027 inch thick.
   c. Cracks 1/8 inch or more in width and of any depth.
   d. Hollow-sounding joints when tapped by metal object.
   e. Eroded surfaces 1/4 inch or more deep.
   f. Deterioration to point that mortar can be easily removed by hand, without tools.
   g. Joints filled with substances other than mortar.

2. Do not rake out and repoint joints where not required.

B. Rake out joints as follows, according to procedures demonstrated in approved mockup:

1. Remove mortar from joints to minimum depth of two and one-half (2 1/2) times joint width, but not less than 5/8 inch or not less than that required to expose sound, unweathered mortar. Do not remove unsound mortar more than 2 inches deep; consult SEPTA for direction.

2. Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum or flush joints to remove dirt and loose debris.

3. Do not spall edges of masonry units or widen joints. Replace or patch damaged masonry units as directed by the SEPTA Project Manager.

C. Notify SEPTA of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal and other deteriorated items.

D. Pointing with Mortar:
1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.

2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch until a uniform depth is formed. Fully compact each layer and allow it to become thumbprint hard before applying next layer.

3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than 3/8 inch. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.

4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.

5. Cure mortar by maintaining in thoroughly damp condition for at least seventy-two (72) consecutive hours, including weekends and holidays.

6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

E. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least thirty (30) days before beginning cleaning work.

3.06 Painting Steel Uncovered During the Work

A. Notify the SEPTA Project Manager if steel is exposed during masonry removal. Where the SEPTA Project Manager determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Remove paint, rust and other contaminants according to SSPC-SP 2, SSPC-SP 3 or SSPC-SP 6 as applicable to meet the paint manufacturer’s recommended preparation.

2. Immediately paint exposed steel with two (2) coats of antirust coating, following the coating manufacturer’s written instructions and without exceeding the manufacturer’s recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than 1/16 inch, notify the SEPTA Project Manager before proceeding.

3.07 Masonry Unit Patching

A. Patch the following masonry units unless another type of repair or replacement is indicated:

1. Units indicated to be patched.

2. Units with holes.

3. Units with chipped edges or corners. Patch chipped edges or corners measuring more than 3/4 inch in least dimension.
4. Units with small areas of deep deterioration. Patch deep deteriorations measuring more than 3/4 inch in least dimension and more than 1/4 inch deep.

B. Remove and replace existing patches unless otherwise indicated or approved by the SEPTA Project Manager.

C. Patching Bricks:

1. Remove loose material from masonry surface. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least 1/4 inch thick, but not less than recommended in writing by the patching compound manufacturer.

2. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of masonry unit.

3. Mix patching compound in individual batches to match each unit being patched. Combine one (1) or more colors of patching compound, as needed, to produce exact match.

4. Rinse surface to be patched and leave damp, but without standing water.

5. Brush-coat surfaces with slurry coat of patching compound according to the manufacturer’s written instructions.

6. Place patching compound in layers as recommended in writing by the patching compound manufacturer, but not less than 1/4 inch or more than 2 inches thick. Roughen surface of each layer to provide a key for next layer.

7. Trowel, scrape or carve surface of patch to match texture and surrounding surface plane or contour of masonry unit. Shape and finish surface before or after curing, as determined by testing, to best match existing masonry unit.

8. Keep each layer damp for seventy-two (72) hours or until patching compound has set.

9. Remove and replace patches with hairline cracks or that show separation from brick at edges, and those that do not match adjoining brick in color or texture.

3.08 Final Cleaning

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes and clean water applied by low pressure spray.

1. Do not use metal scrapers or brushes.

2. Do not use acidic or alkaline cleaners.

B. Clean adjacent non-masonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Remove masking materials, leaving no residues that could trap dirt.
3.09 Field Quality Control
   A. Engage a qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
   B. Allow SEPTA the use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the work completed.
   C. Notify the inspectors and SEPTA in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors and SEPTA have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

3.10 Masonry Waste Disposal
   A. Unless otherwise indicated, excess masonry materials are the Contractor's property.
   B. Remove masonry waste and legally dispose of off SEPTA's property.

END OF SECTION
SECTION 04200
UNIT MASONRY

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section includes unit masonry.
   1. Concrete Masonry Units (CMUs):
      a. Standard block to be utilized in concealed or cavity wall applications
   2. Face brick.
   3. Extruded brick.
   5. Stone trim units.
   6. Mortar and grout.
   7. Steel reinforcing bars.
   8. Masonry joint reinforcement.
   9. Ties and anchors.
  10. Embedded flashing.
  11. Miscellaneous masonry accessories.
  12. Masonry cell fill.
  13. Products installed but not furnished under this Section:
      a. Steel lintels in unit masonry.
      b. Steel shelf angles for supporting unit masonry.
      c. Cavity wall insulation.

1.02 Related Sections
A. Section 04011 – Masonry Cleaning
B. Section 04012 – Brick Masonry Repair
C. Section 04212 - Terra Cotta Masonry
D. Section 05120 – Structural Steel Framing
E. Section 07190 – Water Repellents
F. Section 07620 – Sheet Metal Flashing and Trim
G. Section 07900 – Joint Sealers
H. Section 09910 – Paints and Coatings
1.03 Submittals

A. Submit product data for each type of product.

B. Submit shop drawings for the following:
   1. Masonry Units:
      a. Show sizes, profiles, coursing and locations of special shapes.
   2. Reinforcing Steel:
      a. Detail bending, lap lengths and placement of unit masonry reinforcing bars. Meet ACI 315. Show elevations of reinforced walls.
   3. Fabricated Flashing:
      a. Detail corner units, end-dam units and other special applications.

C. Submit samples for verification for each type and color of the following:
   1. Exposed CMUs.
   2. Common brick, in the form of straps of five (5) or more bricks.
   3. Extruded brick, in the form of straps of five (5) or more bricks.
   4. Special brick and concrete shapes.
   5. Pigmented and colored-aggregate mortar. Make samples using same sand and mortar ingredients to be used on Contract.
   6. Weep holes and cavity vents.
   7. Accessories embedded in masonry.

D. Submit a list of materials used in constructing mockups indicating the product names together with the manufacturers, the manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
   1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of SEPTA and approved in writing.

E. Submit qualification data for testing agencies.

F. Submit material certificates for each type and size of the following:
   1. Masonry Units:
      a. Include data on material properties and material test reports substantiating compliance with requirements.
      b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
      c. For exposed brick, include test report for efflorescence according to ASTM C 67.
      d. For masonry units used in structural masonry, include data and calculations establishing average net area compressive strength of units.
   2. Include name of the manufacturer, brand name and type for cementitious materials.
   3. Mortar admixtures for face brick.
4. Include description of type and proportions of ingredients for pre-blended, dry mortar mixes.

5. Include description of type and proportions of ingredients for grout mixes.

6. Reinforcing bars.

7. Joint reinforcement.

8. Anchors, ties and metal accessories.

G. Submit mix designs for each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention and ASTM C 91/C 91M for air content.

2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

   a. For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type and resulting net-area compressive strength of masonry determined according to TMS 602.

   b. Detailed description of methods, materials and equipment to be used to meet the requirements for cold weather and hot weather procedures.

1.04 Quality Assurance

A. Coordinate masonry with all trades requiring items to be built-in.

B. Particular care is to be taken in designing interfaces of masonry anchors and waterproofing membrane and in placement of through wall flashing to bring any water that penetrates the system out to the exterior.

C. Testing agency to be qualified according to ASTM C 1093 for testing indicated.

D. Build mockups to verify selections made under sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

   1. Build mockups for each type of exposed unit masonry construction 72 inches long 60 inches high by full thickness, including face and backup wythes and accessories.

      a. Include a sealant-filled joint at least 16 inches long in each mockup.

      b. Include lower corner of window opening, at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.

      c. Include through wall flashing installed for a 24 inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12 inch length of flashing left exposed to view (omit masonry above half of flashing).

      d. Include metal studs, water resistive barrier, veneer anchors, flashing, cavity drainage material and weep holes in exterior masonry veneer wall mockup.

   2. Erect mockups in the presence of SEPTA before installation of materials.

   3. Use mockup as standard of comparison for masonry work built of same material.

   4. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
5. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
6. Protect accepted mockups from the elements with weather resistant membrane.
7. Approval of mockups is for color, texture and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
   a. Approval of mockups is also for other material and construction qualities specifically approved by SEPTA in writing.
   b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.
8. Do not destroy or move mockup until work is completed and accepted.

E. Meet the applicable provisions of the most recent issues of the following references:
2. ACI 315, Details and Detailing for Concrete Reinforcement.
7. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
10. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
11. ASTM A 767/A 767M, Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
18. ASTM C 90, Standard Specification for Loadbearing Concrete Masonry Units.
22. ASTM C 140/C 140M, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
28. ASTM C 331/C 331M, Standard Specification for Lightweight Aggregates for Concrete Masonry Units.
30. ASTM C 426, Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.
34. ASTM C 744, Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
38. ASTM C 1093, Standard Practice for Accreditation of Testing Agencies for Masonry.
39. ASTM C 1262, Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units.
42. ASTM C 1405, Standard Specification for Glazed Brick (Single Fired, Brick Units).


46. ASTM D 2000, Standard Classification System for Rubber Products in Automotive Applications.


48. NCMA TEK 8-4A, Cleaning Concrete Masonry.

49. TMS 402, Building Code Requirements for Masonry Structures.

50. TMS 602, Specification for Masonry Structures.

1.05 Delivery, Storage and Handling

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver pre-blended, dry mortar mix in moisture-resistant containers. Store pre-blended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.06 Definitions

A. CMU(s) is a Concrete Masonry Unit(s).

B. Reinforced Masonry is masonry containing reinforcing steel in grouted cells.

1.07 Field Conditions

A. Protect masonry during construction by cover tops of walls, projections and sills with waterproof sheeting at end of each day’s work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
2. Where one (1) wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least twelve (12) hours and concentrated loads for at least three (3) days after building masonry walls or columns.

C. Prevent grout, mortar and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Meet cold weather construction requirements contained in TMS 602.
   1. Use liquid cleaning methods only when air temperature is 40°F and higher and will remain so until masonry has dried, but not less than seven (7) days after completing cleaning.

E. Meet hot weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.01 Manufacturers
   A. Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source or single manufacturer for each product required.

   B. Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.02 Performance Requirements
   A. Provide structural unit masonry that develops indicated net area compressive strengths at twenty-eight (28) days.
      1. Determine net area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit strength method) according to TMS 602.
      2. Determine net area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.
2.03 Unit Masonry

A. Masonry standard to meet TMS 602, except as modified by requirements in the Contract Documents.

B. Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed work and will be within 20 feet vertically and horizontally of a walking surface.

C. Meet the requirements for fire resistance rated assembly designs indicated.
   1. Where fire resistance rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.04 Concrete Masonry Units

A. Manufacturers:
   1. Normal Weight CMU to be 16 inch by 8 inch face dimension by thickness indicated on Contract Drawings. Plain face with the manufacturer's standard color and texture.

B. Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for sills, stretchers, lintels, corners, jambs, sashes, movement joints, headers, bonding and other special conditions.

C. CMUs to meet ASTM C 90.
   1. Provide units with minimum average net-area compressive strength of 2150 psi.
   2. Density classification to be normal weight.
   3. Manufactured to dimensions 3/8 inch less than nominal dimensions.
   4. Provide color and texture matching the range represented by the Contractor's sample for exposed faces.

2.05 Brick

A. Manufacturer:
   1. Glen grey color to match existing, Sanded Smooth, Type 1 Standard:
      a. Brick mortar color to be selected from the manufacturer’s standard color options.
   2. Or Approved Equal.

B. Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, soldiers and lintels.
3. Provide special shapes for applications requiring brick of size, form, color and texture on exposed surfaces that cannot be produced by sawing.

4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

C. Face brick to meet ASTM C 216, Grade SW, type FBX.
   1. Use for masonry cavity wall applications.
   2. Provide units with minimum average net area compressive strength of 3000 psi (average of five (5) brick for ASTM C 216 grade brick).
   3. Actual dimensions of units to be 3 5/8 inches wide by 2 1/4 inches high by 7 5/8 inches long.

D. Extruded brick to meet ASTM C 216, Grade SW, Type FBS.
   1. Use for double wythe brick wall applications.
   2. Provide units with minimum average net area compressive strength of 3000 psi (average of five (5) brick for ASTM C 216 grade brick.)
   3. Actual dimensions of units to be 3 5/8 inches wide by 2 1/4 inches high by 7 5/8 inches long, cored.

E. Refer to Section 07190 for clear sealer for exterior brick.

F. Glazed brick to be single-fired glazed brick meeting ASTM C 1405, Division H40V (void areas between 25 and 40 percent of gross cross sectional area).
   1. Where shown to "match existing," provide glazed brick matching color range, texture, and size of existing adjacent brickwork.

2.06 Mortar and Grout Materials

A. Portland cement to meet ASTM C 150/C 150M, Type I or II, except Type III may be used for cold weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
      a. Hydrated lime to meet ASTM C 207, Type S.
      b. Portland cement lime mix to be packaged blend of Portland cement and hydrated lime containing no other ingredients.
      c. Masonry cement to meet ASTM C 91/C 91M.
      d. Mortar cement to meet ASTM C 1329/C 1329M.
      e. Mortar pigments to be natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and meeting ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.
      f. Colored cement products to be packaged blend made from Portland cement and hydrated lime or masonry cement and mortar pigments, all meeting the specified requirements, and containing no other ingredients.
         1) Formulate blend as required to produce color indicated or, if not indicated, as selected from the manufacturer's standard colors.
         2) Pigments shall not exceed 10 percent of Portland cement by weight.
3) Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.

g. Aggregate for mortar to be ASTM C 144.
   1) For mortar that is exposed to view, use washed aggregate consisting of natural sand or
      crushed stone.
   2) For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the
      No. 16 sieve.
   3) White mortar aggregates to be natural white sand or crushed white stone.
   4) Colored mortar aggregates to be natural sand or crushed stone of color necessary to
      produce required mortar color.

h. Aggregate for grout to meet ASTM C 404.

i. Water to be potable.

2.07 Reinforcement

A. Zinc-coated galvanized steel reinforcing bars to meet ASTM A 767/A 767M, Grade 60
   (Grade 420).

B. Reinforcing bar positioners to be wire units designed to fit into mortar bed joints spanning
   masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from
   0.148 inch steel wire, hot dip galvanized after fabrication. Provide units designed for
   number of bars indicated.
   1. Masonry-joint reinforcement to meet ASTM A 951/A 951M.
      a. Interior walls to be mill galvanized carbon steel.
      b. Exterior walls to be hot dip galvanized carbon steel.
      c. Wire size for side rods to be 0.187 inch diameter minimum.
      d. Wire size for cross rods to be 0.148 inch diameter minimum.
      e. Wire size for veneer ties to be 0.148 inch diameter minimum.
      f. Spacing of cross rods, tabs and cross ties to be not more than 16 inches on center.
      g. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry joint reinforcement for single wythe masonry to be ladder type with single pair of
   side rods.

D. Masonry Joint Reinforcement for Multiwythe Masonry:
   1. Ladder type with one (1) side rod at each face shell of hollow masonry units more than 4
      inches wide, plus two (2) side rods at each wythe of masonry 4 inches wide or less.
   2. Tab type, either ladder or truss design, with one (1) side rod at each face shell of backing
      wythe and with rectangular tabs sized to extend at least halfway through facing wythe,
      but with at least 5/8 inch cover on outside face.
   3. Adjustable (two (2) piece) type, either ladder or truss design, with one (1) side rod at
      each face shell of backing wythe and with separate adjustable ties with pintle and eye
      connections having a maximum horizontal play of 1/16 inch and maximum vertical
      adjustment of 1 1/4 inches. Size ties to extend at least halfway through facing wythe but
      with at least 5/8 inch cover on outside face. Ties have hooks or clips to engage a
      continuous horizontal wire in the facing wythe.
E. Masonry joint reinforcement for veneers anchored with veneer anchors to be single 0.187 inch diameter, hot dip galvanized carbon steel continuous wire.

2.08 Ties and Anchors
A. Ties and anchors shall extend at least 1 1/2 inches into veneer but with at least a 5/8 inch cover on outside face.

B. Provide ties and anchors specified in this article that are made from materials that meet the following unless otherwise indicated:
   1. Mill galvanized, carbon steel wire to meet ASTM A 1064/A 1064M, with ASTM A 641/A 641M, Class 1 coating.
   5. Steel plates, shapes and bars to meet ASTM A 36/A 36M.
   6. Stainless steel bars to meet ASTM A 276/A 276M or ASTM A 666, Type 304.

C. Corrugated metal ties to be metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 inch to 0.5 inch and an amplitude of 0.06 inch to 0.10 inch made from 0.030 inch thick steel sheet, galvanized after fabrication.

D. Individual wire ties to be rectangular units with closed ends and not less than 4 inches wide.
   1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
   2. Where wythes do not align and are of different materials, use adjustable ties with pintle and eye connections having a maximum adjustment of 1 1/4 inches.
   3. Fabricate wire from 1/4 inch diameter, hot dip galvanized steel wire.

E. Provide adjustable anchors for connecting to structural steel framing that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Anchor section for welding to steel frame via crimped 1/4 inch diameter, hot dip galvanized steel wire.
   2. Tie section to be triangular shaped wire tie made from 1/4 inch diameter, hot dip galvanized steel wire.

F. Provide adjustable anchors for connecting to concrete that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Connector section to have dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.105 inch thick steel sheet, galvanized after fabrication.
2. Tie section to be triangular shaped wire tie made from 1/4 inch diameter, hot dip galvanized steel wire.

3. Corrugated metal ties to be metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 inch to 0.5 inch and an amplitude of 0.06 inch to 0.10 inch made from 0.105 inch thick steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete.

G. Partition top anchors to be 0.105 inch thick metal plate with a 3/8 inch diameter metal rod 6 inches long welded to plate and with closed end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot dip galvanized after fabrication.

1. Fabricate rigid anchors from steel bars 1 1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.
   a. Corrosion protection to be hot dip galvanized to meet ASTM A 153/A 153M.

2.09 Embedded Flashing Materials

A. Provide metal flashing meeting Section 07620 and as follows:

1. Copper to meet ASTM B 370, Temper H00, cold rolled copper sheet, 16-oz./sq. ft. weight or 0.0216 inch thick or ASTM B 370, Temper H01, high yield copper sheet, 12-oz./sq. ft. weight or 0.0162 inch thick.

2. Fabricate through wall flashing with drip edge where indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.

3. Fabricate through wall flashing with sealant stop where indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
   a. Fabricate metal drip edges from stainless steel or copper (refer to Contract Drawings for locations of each material.) Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
   b. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
   c. Fabricate metal expansion joint strips from stainless steel to shapes indicated.
   d. Solder metal items at corners.

B. Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.

2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.

3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.

4. Where flashing is fully concealed, use metal flashing.

C. Single wythe CMU flashing system is a system of CMU cell flashing pans and interlocking CMU web covers made from UV resistant, high density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.
D. Solder and sealants for sheet metal flashings to be as specified in Section 07620.

E. Provide the flashing manufacturer's standard adhesives, primers and seam tapes products or products recommended by the flashing manufacturer for bonding flashing sheets to each other and to substrates.

F. Termination bars for flexible flashing to be stainless steel sheet 0.019 inch by 1 1/2 inches with a 3/8 inch sealant flange at top.

2.10 Miscellaneous Masonry Accessories

A. Pre-molded filler strips meeting with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed control joint gaskets to be made from styrene butadiene rubber compound, meeting ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond breaker strips to be asphalt saturated felt meeting ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

D. Use the following weep/cavity vent products unless otherwise indicated:
   1. Rectangular plastic weep/vent tubing to be clear butyrate, 3/8 by 1 1/2 by 3 1/2 inches long.
   2. Mesh weep/vent to be free draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from the manufacturer's standard, color to match the mortar.

E. Cavity drainage material to be a free draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Provide one (1) of the following configurations:
      a. Strips, full depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.

2.11 Masonry Cell Fill

A. Lightweight aggregate fill to meet ASTM C 331/C 331M.

2.12 Mortar and Grout Mixes

A. Do not use admixtures, including pigments, air entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds or other admixtures unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use Portland cement lime mortar unless otherwise indicated.
   3. For exterior masonry, use Portland cement lime mortar.
   4. For reinforced masonry, use Portland cement lime mortar.
   5. Add cold weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
6. All mortar shall be mixed from Portland cement, lime, sand and potable water only. No masonry cement or mortar cement products will be accepted for concrete masonry unit construction.

B. Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions and thoroughly blend ingredients before delivering to Project site.

C. Mortar for unit masonry to meet ASTM C 270, proportion specification. Provide the following types of mortar for applications stated unless another type is indicated:
   1. For masonry below grade or in contact with earth use Type M.
   2. For reinforced masonry use Type S.
   3. For mortar parge coats use Type S.
   4. For exterior, above grade, load bearing and non-load bearing walls and parapet walls; for interior load bearing walls; for interior non-load bearing partitions; and for other applications where another type is not indicated use Type N.
   5. For interior non-load bearing partitions Type O may be used instead of Type N.

D. Use colored cement product or select and proportion pigments with other ingredients to produce color required for pigmented mortar. Do not add pigments to colored cement products.
   1. Pigments may be added to mortar to obtain colored mortars, provided that they are produced specifically for use in mortar mixes and they can be demonstrated to have been successfully employed for this purpose. All colored mortars must be pre-approved by SEPTA.
   2. Pigments shall not exceed 10 percent of Portland cement by weight.
   3. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
   4. Mix to match the Contractor’s sample.
   5. Use pigmented mortar for exposed mortar joints as indicated on the Contract Drawings.
      a. Pigmented mortar to be used with CMU block and brick visible to public.

E. Produce required mortar color by using colored aggregate mortar and natural color or white cement as necessary to produce required mortar color.
   1. Mix to match the Contractor’s sample.
   2. Use colored aggregate mortar for exposed mortar joints as indicated on the Contract Drawings.

F. Grout for unit masonry to meet ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that meet TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, with a minimum compressive strength of 3000 psi and installed in accordance with TM 402 for high or low lift procedures.
2.13 Masonry Cleaners

A. The manufacturer's proprietary acidic standard strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by the cleaner manufacturer and the manufacturer of masonry units being cleaned.

B. Refer to Section 04011 for cleaning of existing unit masonry.

PART 3 - EXECUTION

3.01 Examination

A. Examine conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

1. For the record, prepare written report, endorsed by installer, listing conditions detrimental to performance of the work.

2. Verify that foundations are within tolerances specified.

3. Verify that reinforcing dowels are properly placed.

4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.02 Installation

A. Build cavity and composite walls and other masonry construction to full thickness shown. Build single wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. Match coursing, bonding, color and texture of existing masonry.

G. Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
3.03 **Tolerances**

A. **Dimensions and Locations of Elements:**

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.

2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.

3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. **Lines and Levels:**

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2 inch maximum.

7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. **Joints:**

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.

2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed joint and head joint thicknesses by more than 1/8 inch.

5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one (1) masonry unit to the next.
3.04  Laying Masonry Walls

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement type joints, returns and offsets. Avoid using less than half size units, particularly at corners, jambs, and, where possible, at other locations.

B. Coursing shall be coordinated with windows and door heads so that fractions of courses are avoided at openings.

C. Unless otherwise indicated, lay exposed masonry in running bond do not use units with less than nominal 4 inch horizontal face dimensions at corners or jambs.

D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4 inch horizontal face dimensions at corners or jambs.

E. Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

F. As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

G. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

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

I. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts and similar items unless otherwise indicated.

J. Build non-load bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.
   2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2 inch clearance between end of anchor rod and end of tube. Space anchors 48 inches on center unless otherwise indicated.
   3. Wedge non-load bearing partitions against structure above with small pieces of tile, slate or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.05  Mortar Bedding and Joints

A. Lay CMUs as follows:
   1. Bed face shells in mortar and make head joints of depth equal to bed joints.
   2. Bed webs in mortar in all courses of piers, columns and pilasters.
   3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct applied finishes (other than paint) unless otherwise indicated.

E. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.06 Cavity Walls

A. Cavity walls shall be designed so that all components including the air space, air/vapor barrier, flashing, cavity drainage mat, weeps, and vents and all other elements work in an integrated fashion to allow free drainage of water through the cavity, out of the weeps and away from the structure as well as allowing the movement of air through weeps and vents to allow drying of the cavity. Locate weeps in conjunction with through wall flashing at lintels, sills, relieving angles and a minimum of 8 inches above finish grade at the bottom of the wall; vents should be positioned near the top of the cavity wall, above the highest flashing/weep location.

B. Bond wythes of cavity walls together using one (1) of the following methods:

1. Provide individual metal ties as shown installed in horizontal joints, but not less than one (1) metal tie for 2.67 square feet of wall area spaced not to exceed 16 inches on center horizontally and 16 inches on center vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches on center vertically.
   a. Where bed joints of wythes do not align, use adjustable type (two (2) piece type) ties.
   b. Where one (1) wythe is of clay masonry and the other of concrete masonry, use adjustable type (two (2) piece type) ties to allow for differential movement regardless of whether bed joints align.

2. Install masonry joint reinforcement in horizontal mortar joints.
   a. Where bed joints of both wythes align, use ladder type reinforcement extending across both wythes.
   b. Where bed joints of wythes do not align, use adjustable type (two (2) piece type) reinforcement with continuous horizontal wire in facing wythe attached to ties.
   c. Where one (1) wythe is of clay masonry and the other of concrete masonry, use adjustable type (two (2) piece type) reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.

3. Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not more than 8 inches clear horizontally and 16 inches clear vertically.
C. Bond wythes of cavity walls together using bonding system indicated on the Contract Drawings.

D. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

E. Parge cavity face of backup wythe in a single coat approximately 3/8 inch thick. Trowel face of parge coat smooth.

3.07 Masonry Cell Fill

A. Pour lightweight aggregate fill into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one (1) story high, but not more than 20 feet.

3.08 Masonry Joint Reinforcement

A. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches on center.
   2. Space reinforcement not more than 8 inches on center in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T- and L-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by the manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures and other special conditions.

F. All structural reinforcement shall meet ASTM A 615/A 615M grade 60 and shall be epoxy coated according to ASTM A 775/A 775M.

3.09 Anchoring Masonry to Structural Steel and Concrete

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to meet the following:
   1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 24 inches on center vertically and 36 inches on center horizontally.
3.10 Control and Expansion Joints

A. Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one (1) of the following methods:
   1. Fit bond breaker strips into hollow contour in ends of CMUs on one (1) side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
   2. Install preformed control joint gaskets designed to fit standard sash block.
   3. Install interlocking units designed for control joints. Install bond breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
   4. Install temporary foam plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:
   1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
   2. Build flanges of factory fabricated, expansion joint units into masonry.
   3. Build in compressible joint fillers where indicated.
   4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 07900.

D. Provide horizontal, pressure relieving joints by either leaving airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 07900, but not less than 3/8 inch.
   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.11 Lintels

A. Install steel lintels where indicated.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.12 Flashing, Weep Holes and Cavity Vents

A. Placement of reinforcement, veneer anchors, flashing and similar items to be built into masonry systems are to be coordinated by the system installers.

B. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

C. Install flashing as follows unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant or tape as recommended by the flashing manufacturer.

2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.

3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches and 1 1/2 inches into the inner wythe. Form 1/4 inch hook in edge of flashing embedded in inner wythe.

4. At masonry veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches with upper edge tucked under water resistive barrier and air barrier, lapping at least 4 inches. Fasten upper edge of flexible flashing to sheathing through termination bar.

5. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

6. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1 1/2 inches or as recommended by the flashing manufacturer, and seal lap with elastomeric sealant meeting the requirements in Section 07900 for application indicated.

7. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant meeting the requirements in Section 07900 for application indicated.

8. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.

9. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

10. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

D. Install single wythe CMU flashing system in bed joints of CMU walls where indicated to meet the manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

E. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
F. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
   1. Use specified weep/cavity vent products to form weep holes.
   2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
   3. Space weep holes formed from plastic tubing or wicking material 16 inches on center.
   4. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose fill insulation.
   5. Trim wicking material flush with outside face of wall after mortar has set.

G. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches, to maintain drainage.
   1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than 24 inches above top of pea gravel.

H. Place cavity drainage material in airspace behind veneers to meet the configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

I. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
   1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through wall flashing and weep holes above horizontal blocking.

3.13 Reinforced Unit Masonry Installation

A. Construct temporary formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Meet the requirements in TMS 602 for placing reinforcement.

C. Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Meet the requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches.

3.14 Field Quality Control

A. Engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections.
Retesting of materials that fail to meet the specified requirements shall be done at the Contractor’s expense.

B. Special inspections according to Level B in TMS 402.
   1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
   2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes and locations of reinforcement.
   3. Place grout only after inspectors have verified proportions of site prepared grout.
      a. One (1) set of tests to be conducted prior to construction.
      b. One (1) set of tests for each 5000 square feet of wall area or portion thereof.

C. Test each type of concrete masonry unit provided according to ASTM C 140/C 140M for compressive strength.

D. For each mix provided, test mortar aggregate ratio test (proportion specification) according to ASTM C 780.

E. For each mix provided, test according to ASTM C 780. Test mortar (property specification) for mortar air content and compressive strength.

F. For each mix provided, test grout (compressive strength) according to ASTM C 1019.

G. For each type of construction provided, prism test according to ASTM C 1314 at seven (7) days and at twenty-eight (28) days.

3.15 Parging

A. Parge exterior faces of below grade masonry walls, where indicated, in two (2) uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp cure parging for at least twenty-four (24) hours and protect parging until cured.

3.16 Repairing, Pointing and Cleaning

A. Remove and replace masonry units that are loose, chipped, broken, stained or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. During the tooling of joints, enlarge voids and holes, except weep holes and completely fill with mortar. Point up joints, including corners, openings and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel un-cleaned for comparison purposes. Obtain SEPTA's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.


6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.17 Masonry Waste Disposal

A. Unless otherwise indicated, excess masonry materials are the Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION
SECTION 05090

METAL FASTENERS, JOINING AND WELDING

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section includes all metal fasteners, joining, welding, brazing and soldering.

B. Select appropriate fastener types, sizes, styles, lengths, materials, grades and finishes for all equipment. If fastener details are not listed on the Contract Drawings, fasteners shall be selected in accordance with industry standards and the manufacturer’s recommendations.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control – Traction Power Equipment

C. Section 01612 – Delivery, Storage, and Handling – Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

E. Section 01822 – Demonstration and Training – Traction Power Equipment

F. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment

G. Section 05090 – Metal Fasteners, Joining and Welding

H. Section 09910 – Paints and Coatings

I. Section 16052 – General Electrical Requirements – Traction Power Equipment

J. Section 16060 – Grounding and Bonding

K. Section 16075 – Electrical Identification

L. Section 16290 – Protective Devices and Instrument Transformers

M. Section 16310 – Transmission and Distribution

N. Section 16331 – Installation of Circuit Breakers

O. Section 16335 – Surge Protection

P. Section 16791 – Combined Relay and Control Switchboard

Q. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

R. Section 16952 – Electrical Testing – Traction Power Equipment (RRD)

1.03 Submittals

A. Submit the following documents for SEPTA’s review and approval:

1. Welding, brazing and soldering procedures, including:

   a. Quality assurance measures.
b. Inspection procedures.
c. Defect repair procedures.
d. Welding, brazing, and soldering procedure qualification records.

2. Submit welder certifications. Use only qualified welders in accordance with the requirements of the AWS and ASME B&PV Code Section IX.

3. Submit structural fasteners. Identify the fastener manufacturer, material grade and plating material finish. Hold the documentation for a period not less than the expiration of the warranty on the last item of equipment delivered.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

2. ANSI C80.1, American National Standard for Electric Rigid Steel Conduit (ERSC).
4. ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
5. ASME B1.1, Unified Inch Screw Threads (UN and UNR Thread Form)
7. ASME B18.21.1 Lock Washers (Inch Series).
13. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
16. AWS C1.1, Recommended Practices For Resistance Welding.
17. AWS D1.1, Structural Welding Code – Steel.
18. AWS D1.2, Structural Welding Code – Aluminum.
20. AWS D1.6, Structural Welding Code – Stainless Steel.
21. FS QQ-P-416, Plating (Cadmium) Electrodeposited.
22. AWS Handbooks Volumes 1, 2, 3, 4 & 5.
24. MIL HDBK-132, Protective Finishes for Metal and Wood Surfaces.
25. MS-21044, Nut, Self-Locking, Hexagon, Regular Height, 250 degrees F, 125 ksi FTU and 60 ksi FTU.
26. NEMA FB 1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
27. SAE J429, Mechanical and Material Requirements for Externally Threaded Fasteners.

PART 2 - PRODUCTS

2.01 Threaded Fasteners
   A. Screws, Bolts and Nuts:
      1. Use carbon, alloy and martensitic steel fasteners plated with zinc in accordance with Federal Specification QQ-P-416, Class 2 or 3, Type II.
      2. Use zinc plating in accordance with ASTM B 633, Type II SC2, SC3 or SC4 standards.
      3. Any proposed alternate surface coating must be qualified by salt spray testing by an independent laboratory. In order to be qualified, the alternate coating must meet the same criteria as required by ASTM B 633, SC2, SC3 or SC4 as applicable.
   B. Prevailing Torque Locknuts:
      1. Use nylon insert type locknuts conforming to ANSI or MS-21044 standards.
      2. Use distorted thread locknuts where sufficient clearance to install nylon insert type locknuts is not available or where the locknut is exposed to temperatures above 200°F.

2.02 Washers and Lock Washers
   A. Where high strength fasteners are applied, use hardened washers in accordance with ANSI or ASTM Standards.
   B. Use lock washers, meeting ANSI or ASTM Standards. If applicable, use prevailing torque nuts.

2.03 Rivets and Lock Pins
   A. Use austenitic stainless steel or aluminum rivets and lock pins, as appropriate to the materials being joined.
   B. Use swage-locking fasteners, Huckbolt-type fasteners, and lock pins conforming to Military Specification MIL-P-23469.

PART 3 - EXECUTION
3.01 Joining and Fastening

A. General:

1. Fit properly all joints, whether exposed or concealed. Hold gaps between joints to a dimension not larger than 10 percent of the thinner material being joined, or 0.005 inch, whichever is greater. Make gaps uniform in width. Manufacture edges of panels smooth and provide well finished appearance.

2. Repair excessive gaps at fayed surfaces with metal shims of the same material. Fasten the shims permanently (not with adhesives) to one (1) of the parts being joined.

3. Use isolating and moisture-proofing materials to prevent corrosion when joining parts of dissimilar metal.

4. Minimize the number of different sizes and types of fasteners used.

5. Use fasteners that are U.S. standard, meeting ASME B1.1 or ASME B1.13M.

6. For all fasteners exposed to view provide either bright finish or provide finish matching the surfaces being joined. Install all fasteners so that the fastener head is flush with the mating surface.

7. Connections to electrical and electronic heat producing apparatus:
   a. Take into account the thermal expansion of the components being fastened when selecting screws, bolts, nuts, flat washers and lock washers.
   b. For joining copper, stainless steel or high expansion alloys, use austenitic stainless steel fasteners.
   c. All critical bolts in any application and general-purpose bolts shall be sized to the design strengths for Grade 2 bolts and Class A nuts. The actual hardware used shall be a minimum Grade 5.
   d. Zinc-plated steel fasteners SAE J429, Grade 5 or Grade 8.

B. Threaded Fasteners:

1. Make all screws or bolts used to secure access panels to equipment enclosure captive to the panel in which they are used.

2. Use a reusable mechanical locking device for inaccessible bolts to prevent the bolt head from turning when the nut is being turned.

3. Self-tapping screws are only permitted where they will not be removed for normal maintenance more frequently than once in five (5) years. Use self-tapping screws manufactured of plated martensitic stainless steel.

4. Torque locknuts in accordance with the manufacturer recommendations or conduct tests to determine the appropriate installation torque. Provide at least two (2) screw threads visible beyond all nuts.

C. Washers and Lock Washers:

1. Use washers under the head of all bolts and under all nuts.

2. Lock washers shall not be used for fatigue applications where the fastener must be torqued and marked. If applicable, prevailing torque nuts shall be used for these applications.
D. Rivets and Lock Pins:
   1. Machine smooth all rough surfaces of the collar end of the fasteners where accessible to maintenance personnel.

3.02 Welding, Brazing and Soldering

A. Clean the area in accordance with applicable parts of Section 2 in MIL HDBK-132.

B. Provide spacing of resistance and spot welds appropriate to the design. All welding practices shall be in accordance with requirements of AWS D1.1, AWS D1.2, AWS D1.3 and AWS Handbooks.

C. Resistance welding shall be in accordance with either AWS C1.1 or AMS-W-6858A. Requirements for statically loaded structures shall be applied.

D. Torch brazing - heating above 840°F - follow the recommendations contained in the AWS Welding Handbook, Volume 2. For brazing, use only personnel qualified in accordance with AWS B2.2.


F. Clean all welds exposed to view.

END OF SECTION
THIS PAGE NOT USED
SECTION 05120

STRUCTURAL STEEL

PART 1 - GENERAL

1.01 Description
A. Furnish all labor, materials, tools and equipment, and perform all operations in connection with structural steel work, as indicated on the Contract Documents.

1.02 Related Sections
A. Section 01300 – Submittals
B. Section 03600 – Grout
C. Section 09910 – Paints and Coatings

1.03 Submittals
A. Submit product data and shop drawings under provisions of Section 01300.
B. Submit shop drawings:
   1. Prepare shop detail drawings, bill of materials and erection plans for the material.
   2. Provide the required details for the fabrication, shop assemblies and field installation of the members as shown on the Contract Drawings.
      a. Show member sizes and their lengths.
      b. Include details of cuts, copes, connections, cambers, drilling, fabrication and erection tolerances and other pertinent data.
      c. Show end preparations for welds. Include sizes, types and lengths of welds. Indicate welds by AWS symbols.
      d. Include sizes, types and lengths of connection bolts.
      e. Show field splices as specified on the Contract Drawings.
      f. Show lifting lugs or holes when required.
      g. A system of identification marking whereby each member for a particular elevation shall have the same prefix letter.
      h. Mark columns with the same designation shown on the Contract Drawing column schedule.
      i. Column base plates, if shipped loose, shall carry the same piecemark as their connecting columns.
      j. Use separate identifying letters for prefixing for independent structures.
      k. When shipment sequence is required, the sequence number shall prefix the member marking.
      l. Furnish erection bolts and nuts.
      m. Mark total weight on shop assembled members and truss sections.
      n. Include shop primer.
      o. Furnish setting diagrams, template and directions for the installation of structural framing anchor bolts, bearing plates and other embedded items.
p. Mill columns to bear at bases and splices.

3. Design detail connections based on the loads and requirements specified on the Contract Drawings and the provisions specified in AISC manual.

4. Shop detail drawings, bill of materials and erection plans shall be completed and checked prior to submittal to SEPTA for review and comment.

5. The review by SEPTA will not relieve the Contractor's responsibility for correctness of the work.

6. SEPTA will have the right to use the Contractor's shop drawings, bill of materials and erection plans for subsequent work or any other work not covered by these specifications.

C. Submit mill test reports:

1. Submit certified copies of reports for analyses and tests required by referenced ASTM specifications, including test reports for electrodes used in fabrication and mechanical tests for high strength threaded fasteners, shear connectors and unfinished bolts and nuts, and structural steel primer paint.

2. Submit results of nondestructive testing as applicable.

D. Submit manufacturer's specifications and installation recommendations:

1. Submit certified copies of manufacturer's specifications and installation recommendations.

E. Submit welding records and data:

1. Prior to commencing any work requiring welding, submit the procedure which will be used for pre-qualifying welders and welding procedures. For all procedures other than those set forth in Article 5.1 of AWS D1.1, submit a copy of procedure qualification test records.

2. Submit certified copy of qualification test record for each welder, welding operator and tacker who will be employed in the work.

3. Submit descriptive data for field welding equipment, including type and electrical power requirements.

1.04 Quality Assurance

A. Submit shop quality control manual prior to fabrication. The manual shall meet the applicable requirements of these Specifications.

B. Submit welding and repair welding procedures and procedure qualification test records. All welding procedure qualifications and welder performance qualifications shall be in accordance with AWS D1.1.

C. Submit heat treatment, cleaning, painting and preparation for shipment procedures.

D. Submit nondestructive procedures as applicable.

E. Meet the applicable provisions of the most recent issues of the following references:

3. ANSI B 18.2.1, Square and Hex Bolts and Screws inch Series Including Hex Cap Screw and Lag Screws Supplement.
4. ANSI B 18.2.2, Square and Hex Nuts.
11. ASTM A 193/A 193M, Standard Specification or Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
14. ASTM A 500/A 500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
21. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
22. AWS D1.1, Structural Welding Code –Steel.
23. AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Examination.
25. AWS A5.1, Covered Carbon Steel Arc Welding Electrodes.
27. AWS A5.20, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
28. SSPC-SP 2, Hand Tool Cleaning.
29. SSPC-SP 3, Power Tool Cleaning.

1.05 Delivery, Storage and Handling
A. Perform shop inspection and shipment in accordance with requirements of Specifications.
B. All material shall be subject to inspection by SEPTA before released for shipment.
C. Fabricate and ship material in the sequence specified in the purchase order as required by the Contract erection schedule. Ship stairs, grating, floor plate, handrail and field bolts with the structural steel unless otherwise noted.
D. Load material carefully and brace it securely for shipment. Block plates for use of unloading slings. Small pieces shall be bundled or boxed. Ship bolts in kegs, however, small lots may have sizes separated in sacks and boxed. Mark all containers clearly for identification.

PART 2 - PRODUCTS

2.01 Materials
   1. Rolled steel plates and bars to meet ASTM A 36/A 36M and ASTM A 588/A 588M.
   2. W-shapes to meet ASTM A 992/A 992M.
   3. Channels, angles, M-shapes and S-shapes to meet ASTM A 36/A 36M.
   4. HSS tubes and pipes to meet ASTM A 1085/A 1085M.
   5. Steel pipe to meet ASTM A 53/A 53M, grade B.
   7. Anchor bolts to meet ASTM A 307, grade A, or ASTM A 36/A 36M.
   8. Unfinished threaded fasteners to meet ASTM A 307, grade A.
  10. High strength bolts to meet ASTM F 3125/F 3125M.
  11. Nuts to meet ASTM A 563.
  12. Washers to meet ASTM F 436.
  13. Checkered plate to meet ASTM A 283/A 283M.
15. Weld electrodes to meet E70XX per AWS A5.1 or A5.5.
16. Galvanizing to meet ASTM A 123/A 123M.
17. Prime paint to be "10-99 Tnemec Primer" or approved equal.
18. Non-shrink grout to be Five Star non-shrink cementitious grout or approved equal for column base plate.
19. Plate assemblies, when required by the Contract Drawings, shall be furnished complete with stiffeners and all attachments.
   a. Fabricate and assemble plates of structural steel in accordance with ASTM A 36/A 36M unless otherwise noted on the Contract Drawings. Plate fabrication welding details, qualification and procedures shall meet AWS D1.1. Make careful visual examination for all welds to ensure that there is no slag, inclusions, craters, cracks or undercuts in accordance with AWS Specifications. Remove defects in accordance with AWS D1.1.
   b. Bevel plate edges for shop welds where shown and accurately cut void of ragged edges. Shop-weld rings, angles, stiffeners, etc., to their respective plates.
   c. When specified on the Contract Drawings, shop fit assemblies and pack and ship them in the largest practical sections to prevent distortion or damage during shipping.
20. Grating:
   a. Grating shall be of the rectangular skid resistant welded type having 3/16 inch bearing bars, of depth specified on the Contract Drawings, spaced 13/16 inch on centers, with cross bars spaced not more than 4 inches on center and welded into the bearing bars to form an anti-slip surface. All grating shall be hot dip galvanized after fabrication in accordance with ASTM A 123/A 123M. Grating shall be neatly cut and banded around openings.
   b. Grating panels shall be removable and bars of adjacent panels shall be in line. Grating fasteners shall consist of 1/4 inch diameter flux filled stainless steel welding studs with stainless steel, hexagonal nuts and 14 gauge hot dip galvanized "U" clips fitting between and hooking over the bearing bars. Four (4) clips shall be provided for panels under 10 feet long and six (6) clips shall be provided for panels 10 feet and longer. Fasteners shall be furnished with an excess of 5 percent over net requirements.

2.02 Fabrication


B. Unless noted on the Contract Drawings, use field connections with high strength bolted friction type connections for beam and bracing connections.

C. Miscellaneous:
   1. Provide bolted erection seat angles for equal depth members framed to opposite sides of column webs. Do not use connections requiring the "Knifing" of beam web into the connection without specific approval of SEPTA.
   2. Shop attach curb plates and angles to members unless otherwise noted on the Contract Drawings. Seal weld curb plates continuous on both sides at all vertical joints and where noted on the Contract Drawings.
3. Design compact bracing connections with minimum size gusset plates. Where practical, shop connect bracing gusset plates to beams or bracing members.

4. Make shearing accurate, and clean the cuts to be without drawn, ragged or split edges. Fabricate all copes, blocks and other re-entrant cuts with 1/2 inch minimum radius fillet.

5. Provide maximum shop assembly for all materials including, but not limited to, roof truss sections, walkways, hatch covers and frames. Shop stairs shall be assembled with stringers and treads attached.

6. Round off all structural steel sharp edges to hold paint more effectively.

7. Drill drain holes in structural steel as necessary to avoid the retention of liquids. Coat the holes to prevent corrosion.

8. Arrange bolt heads and nuts so as to not protrude into walkways.

9. All rolled material before being laid off or worked in any way shall be straight. If straightening or flattening is necessary, it shall be done by methods that will not injure the materials. After punching and before assembling, the material shall again be straightened if required by SEPTA. Sharp kinks and bends may be cause for rejection.

10. Fabricate shearing and clipping neatly and accurately. Finish all portions of the work exposed to view neatly.

11. If bolt holes have to be reamed to correct a misfit; use oversized bolts.

12. Stiffeners of plate girders carrying stress shall be faced on ends where the load is applied and brought to a true contact bearing with the flange; the other ends of the stiffeners shall be sheared square and brought to a tight fit with the flange. All other stiffeners shall be sheared square and brought to a tight fit with the flange to provide full bearing. Web splice plates and fillers under stiffeners shall be cut to fit within 1/8 inch of flange on each end. Stiffeners and splice plates shall not be crimped. Filler plates shall be used as required. When bolts carrying computed stress pass through fillers, the fillers shall be extended and bolted to distribute the total stress uniformly.

D. Welding:

1. Welding shall meet AISC Specification and the AWS D1.1. Welders, welding operators and weld procedures shall be qualified in accordance with AWS D1.1. Welding electrodes shall be AWS A5.1 low hydrogen Class E70 for manual shielded metal-arc welding, or AWS A5.17 F7X for submerged arc welding, or AWS A5.20, classification E70T-X for flux cored arc welding, unless otherwise specified on the Contract Drawings.

2. Welding details, qualifications and procedures for built-up girders and cover plates on columns and beams shall meet AWS D1.1. Make web and flange splices, pre-qualified butt welded joints unless otherwise noted on the Contract Drawings. Make splices of different thickness plates, tapered transition joints. Radiograph butt welds, when noted on the Contract Drawings.

3. Perform fillet welds to full size and of proper profile for the full length specified on the Contract Drawings. Make butt welds full penetration unless otherwise noted on the Contract Drawings. Follow preheat requirements of the welding specifications. Examine welds carefully to insure that there are no slag inclusions, craters, cracks or undercuts in accordance with AWS Specifications. Remove defects by chipping or grinding and then
re-weld. Care shall be taken in assembling and fitting. Control welding to minimize shrinkage stresses and distortion. Clamp or otherwise hold connection angles to insure close contact with beam webs during welding. Perform finished work with good quality and a neat appearance without warpage.

E. Bolting:

1. Make field connections friction type joints, assembled with high strength bolts, unless otherwise noted on the Contract Drawings, in accordance with AISC Specification for structural joints using ASTM F 3125/F 3125M bolts.

2. Use ASTM F 3125/F 3125M heavy hexagon structural bolts furnished with heavy semi-finished hexagon nuts of dimensions meeting ANSI B18.2.2 and one (1) hardened washer per bolt. Bolting material shall be in accordance with ASTM F 3125/F 3125M.

3. Furnish bolts for connections to existing steel and for connections to members furnished by others.

4. Paint contact surfaces of joints except where specifically noted on the Contract Drawings that contact surfaces shall be free of paint.

5. ASTM A 307, grade A bolts may be used for girts, door and window framing connections and where noted on the Contract Drawings.

6. Provide an excess of 5 percent of net requirements for each size and type of bolt, together with a bolt summary list.

7. When erection fit up bolts are required, provide unfinished ASTM A 307 bolts in the amount of 15 percent of the net requirements of high strength field bolts. These bolts shall have square heads and be used, with hex nuts.

F. Shop Painting:

1. Proper shop painting is important as the steel will be subject to exterior exposure. Unless otherwise noted on the Contract Drawings, prepare all steel for painting after fabrication in accordance with surface preparation specification SSPC-SP 3, and shop paint with one (1) coat of prime paint meeting the manufacturer’s instructions and recommendations, applied in accordance with paint application specification. Do not paint surfaces in contact with concrete and areas within 3 inches of field welds.

2. Do not add thinners or additives to the paint. The dry film thickness shall not be less than 2 1/2 mils or more than 3 1/2 mils. Paint shall be dry before steel is loaded for shipment. Make painted erection marks on members legible and durable. Apply special paints in accordance with the paint manufacturer's instructions.

PART 3 - EXECUTION

3.01 Erection

A. Provide surveys to establish permanent benchmarks necessary for the erection of structural steel. Check elevations of concrete surfaces, and locations of anchor bolts and similar items, before erection proceeds.

B. Anchor Bolts:
1. Furnish and install templates and other devices as needed for setting of bolts and other anchors which are to receive structural steel.

2. Install anchor bolts in templates and secure these templates to the forms for concrete after the installation of reinforcing steel.

C. Setting Bases and Bearing Plates:

1. Clean concrete bearing surfaces free from bond reducing materials and then roughen to improve bond to surface. Clean the bottom surface of base and bearing plates.

2. Set base plates and bearing plates for structural members in their proper positions and secure them with wedges or threaded fasteners.

3. Column base plates shall be finished over the area in contact with the column shaft in accordance with AISC Specification 1.21.3.

D. Assembly:

1. Clean the bearing surfaces and other surfaces which will be in permanent contact before assembly.

2. Set structural frames accurately to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before fastening. Splice only where indicated.

3. Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads.

4. Provide temporary guy lines to achieve alignment of the structures as erection proceeds.

5. Level and plumb individual members of the structure within AISC tolerances.

6. Perform adjustments to compensate for discrepancies in elevations and alignment. Immediately report errors in fabrication or deformation resulting from handling or transportation, which prevents the proper erection and fitting of parts, to SEPTA.

7. Establish required leveling and plumbing measurements at the mean operating temperature of the structure. Make allowances for the difference between temperature at time of erection and the mean temperature at which the structure will be when completed and in service.


9. Tighten anchor bolts after the supporting members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with the edge of the base or bearing plate prior to grouting. Nuts on anchor bolts under base plates may be used in lieu of wedges or shims.

3.02 Non-Shrink Grout

A. Install grout in accordance with Section 03600.
3.03  **Touch-Up**
A. After erection, clean chips, skips and abrasions where paint has been removed, damaged or burned. Clean field bolts and field welds and coat as set forth under shop painting.
B. Clean areas where galvanized surfaces have been damaged as a result of handling and erection, or where field welding or bolting has occurred. Coat these areas with a field applied galvanizing compound.

3.04  **Testing**
A. Perform nondestructive testing, using magnetic particle testing method in accordance with AWS D1.1, for ten percent of shop welds.

3.05  **Inspection**
A. Inspect field-assembled bolted construction in accordance with AISC Specification for Structural Joints using ASTM F 3125/F 3125M bolts.
B. Inspect field welds by method selected by SEPTA from AWS D1.1.

**END OF SECTION**
THIS PAGE NOT USED
SECTION 05210

STEEL JOISTS

PART 1 - GENERAL

1.01 Description
A. This Section specifies fabricating, furnishing and installing steel joists at locations indicated on the Contract Drawings.

1.02 Related Work
A. Section 05120 - Structural Steel

1.03 Submittals
A. Submit manufacturer's specifications and installation instructions for each type of joist and its accessories. Include manufacturer's certification that joists meet the SJI requirements.
B. Submit detailed drawings showing layout of joist units, special connections, jointing and accessories. Include the mark, number, type, location and spacing of joists and bridging. Include templates or location drawings for installation of anchor bolts.
C. Submit certificates certifying welders employed on the work, verifying AWS qualifications within the previous twelve (12) months.

1.04 Quality Assurance
A. Provide joists fabricated in compliance with the following, and as herein specified.
   1. SJI standard specifications and load tables for steel joists.
B. The steel joist fabricator shall provide evidence of successful fabrication of steel joist systems of similar size and complexity for a continuous period of at least five (5) years or immediately prior to the bid date. Fabricator must be certified by SJI to manufacture joists meeting SJI standards.
C. The steel joist erector shall provide evidence of successful erection of steel joist systems of similar size and complexity for a continuous period of five (5) years immediately prior to the bid date.
D. Qualification of Welding Work:
   1. Qualify welding processes and welding operators in accordance with AWS D1.1.
   2. Joists welded in place are subject to inspection and testing.
   3. Shop welds made on joists are subject to inspection and testing.
E. Professional Engineer Qualifications:
   1. A licensed Professional Engineer in the Commonwealth of Pennsylvania experienced in engineering services related to steel joist systems shall prepare design calculations, shop drawings and other structural data necessary to meet the Contract requirements.
F. An independent testing agency shall be engaged to perform field inspections and prepare reports. Provide access to places where work is being performed.

G. Meet the applicable provisions of the most recent issues of the following references:
   3. AWS D1.1, Structural Welding Code - Steel.

1.05 Delivery, Storage and Handling
   A. Deliver, store and handle steel joists as recommended by SJI. Handle and store joists in a manner to avoid deforming members, to avoid excessive stresses and to maintain shop coat of paint intact without rusting.

PART 2 - PRODUCTS

2.01 Manufacturers
   A. Vulcraft.
   B. The New Columbia Joist Company, subsidiary of Nicholas J. Bouras, Inc.
   C. Canam Steel Corporation.
   D. Or Approved Equal.

2.02 Materials
   A. Steel to meet SJI requirements; use steel having a yield strength of 50,000 psi.
   B. The manufacturer’s standard accessories meeting SJI requirements.
   C. Use welding electrodes meeting the current AWS Specifications adopted by SJI.

2.03 Fabrication
   A. Fabricate steel joists in accordance with SJI Specifications.
B. Provide holes in chord members where shown for securing other work to the steel joists, deduct the area of holes from the area of the chord when calculating the strength of the member.

C. Bridging:
   1. Provide horizontal and/or diagonal type bridging for joists, meeting SJI requirements.
   2. Provide bridging anchors for ends of all bridging lines terminating at walls or beams.

D. Provide end anchorages to secure joists to adjacent construction, meeting SJI requirements, unless otherwise indicated.

E. Provide header units for K-series joists to support tail joists at opening in roof system not framed with steel shapes.

F. Coatings:
   1. All steel shall be hot dip galvanized in accordance with ASTM A 123/A 123M.
      a. Coating weight to meet ASTM A 123/A 123M.
      b. Repair areas damaged by welding, flame cutting or during handling, transport and erection by an approved method in accordance with ASTM A 780/A 780M.

G. Provide special depth bearings for K-series joists where shown on the Contract Drawings or where K-series joists are adjacent to LH- or DLH-series joists.

H. Provide ceiling extensions in those areas where ceiling materials attach directly to joist bottom chord. Extend such ends no closer than 1 inch from wall surfaces.

PART 3 - EXECUTION

3.01 Erection

A. Place and secure steel joists in accordance with SJI, final shop drawings and as herein specified.
   1. Prior to erection, erector shall check elevations of bearing surfaces before proceeding with erection. Report discrepancies to Project representative.

B. Placing Joists:
   1. Do not start placement of steel joists until supporting work is in place and secured.
   2. Place joists on supporting work, adjust, and align in accurate locations and spacing before permanently fastening.
   3. Provide temporary bridging, connections and anchors to ensure lateral stability during construction.

C. Bridging:
   1. Install bridging simultaneously with joist erection, before any construction loads are applied.
   2. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams.
3. Rows of bridging shall not be less than shown in the SJI Standard Specification; see bridging table. In addition, a single line of bridging shall be provided at the first bottom chord panel point at each end of every joist.

4. Space bridging rows in span so spacing between bridging is uniform.

D. Fastening Joists:

1. Field weld ends of joists to supporting steel in accordance with SJI for the type of joist used. Coordinate welding sequence and procedure with the placing of joists.

END OF SECTION
SECTION 05310

STEEL DECKING

PART 1 - GENERAL

1.01 Description
   A. The Section includes:
      1. Roof deck.
      2. Composite floor deck.

1.02 Submittals
   A. Submit product data for each type of deck, accessory and product indicated.
   B. Submit shop drawings:
      1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories and attachments to other construction.
   C. Submit welding certificates.
   D. Submit product certificates for each type of steel deck.
   E. Submit product test reports based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following meets the requirements:
      1. Power actuated mechanical fasteners.
      2. Acoustical roof deck.
   F. Submit evaluation reports for steel deck.
   G. Submit field quality control reports.

1.03 Quality Assurance
   A. Testing Agency to be qualified according to ASTM E 329 for testing indicated.
   B. Qualify procedures and personnel according to AWS D1.3.
   C. Meet the applicable provisions of the most recent issues of the following references:
      1. American Iron and Steel Institute (AISI).
      2. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.04 Delivery, Storage and Handling

A. Protect steel deck from corrosion, deformation and other damage during delivery, storage and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 Performance Requirements

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

B. Fire resistance ratings to meet ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

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

2.02 Roof Deck

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
5. Cordeck.
6. DACS, Inc.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
11. Roof Deck, Inc.
12. Valley Joist; Subsidiary of EBSCO Industries, Inc.
14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
15. Or Approved Equal.
B. Fabricate roof deck panels, without top flange stiffening grooves, to meet "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized steel sheet to meet ASTM A 653/A 653M, Structural Steel (SS), Grade 40 zinc coating.
2. Galvanized and shop primed steel sheet to meet ASTM A 653/A 653M, Structural Steel (SS), G60 zinc coating; cleaned, pretreated and primed with the manufacturer's standard baked on, rust inhibitive primer.
3. Finish to be exposed galvanized.
4. Provide deck profile as indicated on the Contract Drawings.
5. Provide cellular deck profile as indicated on the Contract Drawings, with bottom plate.
6. Provide profile depth as indicated on the Contract Drawings.
7. Provide design uncoated steel thickness as indicated on the Contract Drawings.
8. Provide span condition as indicated on the Contract Drawings.
9. Side laps to be overlapped or interlocking seam at the Contractor's option.

2.03 Composite Floor Deck

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
5. Cordeck.
6. DACS, Inc.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
10. Roof Deck, Inc.
11. Verco Manufacturing Co.
12. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
13. Or Approved Equal.

B. Fabricate floor deck panels, with integrally embossed or raised pattern ribs and interlocking side laps, to meet "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized steel sheet to meet ASTM A 653/A 653M, Structural Steel (SS), Grade 40, G60 zinc coating.
2. Provide profile depth as indicated on the Contract Drawings.
3. Provide design uncoated steel thickness as indicated on the Contract Drawings.
4. Provide span condition as indicated on the Contract Drawings.

2.04 Non-Composite Form Deck

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
5. Cordeck.
6. DACS, Inc.
7. Marlyn Steel Decks, Inc.
8. New Millennium Building Systems, LLC.
10. Roof Deck, Inc.
11. Valley Joist; Subsidiary of EBSCO Industries, Inc.
13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
14. Or Approved Equal.

B. Fabricate ribbed steel sheet non-composite form deck panels to meet "SDI Specifications and Commentary for Non-Composite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized steel sheet to meet ASTM A 653/A 653M, Structural Steel (SS), Grade 40, G60 zinc coating.
2. Provide profile depth as indicated on the Contract Drawings.
3. Provide design uncoated steel thickness as indicated on the Contract Drawings.
4. Provide span condition as indicated on the Contract Drawings.
5. Side laps to be overlapped or interlocking seam at the Contractor's option.

2.05 Accessories

A. Provide the manufacturer's standard accessory materials for deck that meet the requirements indicated.
B. Mechanical fasteners to be corrosion resistant, low velocity, power actuated or pneumatically driven carbon steel fasteners; or self-drilling, self-threading screws.

C. Side lap fasteners to be corrosion resistant, hexagonal washer head; self-drilling, carbon steel screws, No. 10 minimum diameter.

D. Flexible closure strips to be vulcanized, closed cell, synthetic rubber.

E. Miscellaneous sheet metal deck accessories to be steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359 inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour stops and girder fillers to be steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

G. Column closures, end closures, Z-closures and cover plates to be steel sheet, of same material, finish and thickness as deck unless otherwise indicated.

H. Galvanizing repair paint to meet ASTM A 780/A 780M.

I. Repair paint to be the manufacturer's standard rust inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.01 Examination

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

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

3.02 Installation

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

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

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

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck and support of other work.

H. Meet the AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to the deck manufacturer’s written instructions.

3.03 Roof Deck Installation

A. Fasten roof deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1 1/2 inches long, and as follows:
   1. Weld diameter to be 3/4 inch, nominal.
   2. Weld edge and interior ribs of deck units with a minimum of two (2) welds per deck unit at each support. Space welds 18 inches apart, maximum.

B. Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches for 1 1/2 inch deck and 36 inches for 3 inch deck, and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon steel screws.
   2. Fasten with a minimum of 1 1/2 inch long welds.

C. Install deck ends over supporting frame with a minimum end bearing of 1 1/2 inches, with end joints as follows:
   1. End joints to be lapped 2 inches minimum or butted at the Contractor’s option.

D. Install ridge and valley plates, finish strips, end closures and reinforcing channels according to the deck manufacturer’s written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof deck panels unless otherwise indicated.

E. Install flexible closure strips over partitions, walls, and where indicated.

F. Install with adhesive according to the manufacturer’s written instructions to ensure complete closure.

3.04 Floor Deck Installation

A. Fasten floor deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   1. Weld diameter to be 3/4 inch, nominal.
   2. Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.

B. Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon steel screws.
2. Fasten with a minimum of 1 1/2 inch long welds.
C. Install deck ends over supporting frame with a minimum end bearing of 1 1/2 inches with end joints as follows:
   1. End joints to be lapped or butted at the Contractor's option.
D. Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.
E. Weld steel sheet column closures, cell closures and Z-closures to deck, according to SDI recommendations, to provide tight fitting closures at open ends of ribs and sides of deck.

3.05 Field Quality Control
A. The Contractor will engage a qualified testing agency to perform tests and inspections.
B. Field welds will be subject to inspection.
C. Testing agency will report inspection results promptly and in writing to the Contractor and SEPTA.
D. Remove and replace work that does not meet the specified requirements.
E. Additional inspecting, at the Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.06 Protection
A. Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and the manufacturer's written instructions.
B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of substantial completion.

END OF SECTION
THIS PAGE NOT USED
SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.01 Description

A. This Section specifies items and assemblies fabricated from structural steel shapes and other materials as shown and specified.

B. Items specified:

1. Support for wall mounted items.
2. Shelf angles.
3. Caged roof access ladder with security door.
4. Painted cast iron rain water leaders.

1.02 Related Sections

A. Section 01300 – Submittals
B. Section 01400 – Quality Requirements
C. Section 04200 – Unit Masonry
D. Section 05120 – Structural Steel
E. Section 09910 – Paints and Coatings
F. Section 09960 – High Performance Coatings

1.03 Submittals

A. Submit in accordance with Section 01300.

B. Submit shop drawings:

1. Each item specified, showing complete detail, location in the Project, material and size of components, method of joining various components and assemblies, finish, location, size and type of anchors.
2. Mark items requiring field assembly for erection identification and furnish erection drawings and instructions.
3. Provide templates and rough-in measurements as required.

C. Submit manufacturer's certificates:

1. Live load designs as specified.

D. Submit welding certificates.

E. Submit design calculations for specified live loads including dead loads.

F. Submit qualification data for a Professional Engineer licensed in the Commonwealth of Pennsylvania.
G. Submit setting drawings and instructions for installation of anchors to be preset into concrete and masonry work, and for the positioning of items having anchors to be built into concrete or masonry construction.

H. Submit analysis data; for ladders; including analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

1.04 Quality Assurance

A. Field welding is not permitted.

B. Qualify procedures and personnel according to AWS D1.1.

C. Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

D. Each manufactured product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly and presently manufacturing items of type specified.

E. Assemble products to the greatest extent possible before delivery to the site. No field welding will be permitted without the permission of the SEPTA Project Manager.

F. Include additional features, which are not specifically prohibited by this Specification, but which are a part of the manufacturer's standard commercial product.

G. Employ a Professional Engineer licensed in the Commonwealth of Pennsylvania competent in design and structural analysis to fabricate ladders and other metal fabrications in compliance with industry standards and local codes.

H. SEPTA reserves the right to shop inspect at any time during the fabrication and finishing processes.

I. SEPTA reserves the right to require NDE inspection from an independent testing agency, at no cost to SEPTA.

J. The Contractor must notify SEPTA five (5) days prior to beginning fabrication and finishing, to determine if SEPTA shall require a shop inspection prior to allowing the product to move forward to the next stage.

K. Field Visit and Measurements:

1. Any discrepancies between the Contact Drawings and what is in the field shall be brought to the attention of the SEPTA Project Manager. It is assumed that slight variation may exist and this is to be expected. Extras associated with discrepancies shall only be granted where these discrepancies can be proved to be a major consequence on the design and fabrication.

2. It is recommended that the fabricator visit the site prior to bidding on any fabrication in which the size of the Project may require special on-site handling requirements or where the fabrication must fit into existing conditions.

L. Meet the applicable provisions of the most recent issues of the following references:

19. ASTM A 500/A 500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
22. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
23. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
43. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
44. AWS D1.1, Structural Welding Code - Steel.
45. AWS D1.2, Structural Welding Code - Aluminum.
46. AWS D1.3, Structural Welding Code - Sheet Steel.
47. FS RR-T-650E, Treads, Metallic and Nonmetallic, Nonskid.
49. NAAMM AMP 500-505, Metal Finishes Manual.
50. NAAMM MBG 531, Metal Bar Grating Manual.
51. NAAMM MBG 532, Heavy Duty Metal Bar Grating Manual.
52. OSHA 1910.27, Fixed Ladders.
53. SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel.
54. SSPC-SP 1, Solvent Cleaning.
55. SSPC-SP 2, Hand Tool Cleaning.
56. SSPC-SP 3, Power Tool Cleaning.
57. SSPC-SP 6, Commercial Blast Cleaning.

1.05 Delivery, Storage and Handling
A. Deliver materials in protective wrappings with each item labeled with installation location.
B. Deliver, store and handle all materials to prevent damage by breaking, water or moisture and contamination by foreign materials.
C. Store materials on a clean, dry surface or platform, off ground, covered, separate from each other and protected from deterioration and the elements. Bear fully along all supported edges on level and true structural supports. Ventilate to avoid condensation.
D. Handle all materials in a manner which will prevent undue stress on component parts, sealants and structural members. Do not rack, torque or cause load forces in an inappropriate manner. Lift panels from top only unless specifically instructed by the manufacturer.

1.06 Warranty
A. Ladder:
   1. The manufacturer has responsibility for an extended corrective period for work of this Section for a period of five (5) years from date of substantial completion against all the conditions indicated below, and when notified in writing from SEPTA, the manufacturer shall promptly and without inconvenience and cost to SEPTA correct said deficiencies.
      a. Defects in materials and workmanship.
      b. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.
      c. Within the warranty period, the manufacturer shall, at its option, repair, replace or refund the purchase price of defective ladder.
   2. The manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. The manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor. The
manufacturer makes no other warranty, expressed or implied, to the merchantability, fitness for a particular purpose, design, sale, installation, or use, of the ladder; and shall not be liable for incidental or consequential damages, losses of or expenses resulting from the use of ladder products.

PART 2 - PRODUCTS

2.01 Design Criteria

A. Engage a qualified Professional Engineer licensed in the Commonwealth of Pennsylvania, as defined in Section 01400 to design ladders, including attachment to building construction.

B. Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:
   1. Wind loads on exterior items to be as indicated on the Contract Drawings.

C. Aluminum ladders shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

D. Exterior decorative formed metal items, including anchors and connections, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Component importance factor to be 1.0.

E. Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections and other detrimental effects.
   1. Temperature change to be 120°F ambient; 180°F material surfaces.

2.02 Metals

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

B. Steel Plates, shapes and bars to meet ASTM A 36/A 36M.
   1. Rolled steel floor plate to meet ASTM A 36/A 36M.

C. Steel tubing to meet ASTM A 500/A 500M, cold formed steel tubing.

D. Steel pipe to meet ASTM A 53/A 53M standard weight (schedule 40) unless otherwise indicated.
   1. Galvanized for exterior locations.
   2. Type S, Grade A unless specified otherwise.
   3. NPS (inside diameter) as shown.

E. Cast iron to be either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
2.03 Hardware

A. Rough Hardware:
   1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated or zinc coated by electro-galvanizing process. Galvanized G90 where specified.
   2. Use G90 galvanized coating on ferrous metal for exterior work unless non-ferrous metal or stainless is used.

2.04 Fasteners

A. Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc plated fasteners with coating meeting ASTM B 633 or ASTM F 1941/F 1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade and class required.
   1. Provide stainless steel fasteners for fastening aluminum.
   2. Provide stainless steel fasteners for fastening stainless steel.
   4. Provide bronze fasteners for fastening bronze.

B. Steel bolts and nuts to be regular hexagon head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel bolts and nuts to be regular hexagon head bolts, ASTM F 3125/ F 3125M, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless steel bolts and nuts to be regular hexagon head annealed stainless steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1 (A1).

E. Anchor bolts to meet ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
   1. Hot dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors to be capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

G. Cast-in-place anchors in concrete to be either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers and shims as needed, all hot dip galvanized per ASTM F 2329/F 2329M.

H. Post installed anchors to be chemical anchors.
   1. Material for interior locations to be carbon steel components zinc plated to meet ASTM B 633 or ASTM F 1941/F 1941M, Class Fe/Zn 5, unless otherwise indicated.
   2. Material for exterior locations and where stainless steel is indicated to be Alloy Group 1 (A1) stainless steel bolts, ASTM F 593, and nuts, ASTM F 594.
3. Blind bolts to be Type HB – Hollo Bolt or approved equal.

2.05 Miscellaneous Materials

A. Provide primers that meet Section 09910.

B. Primer formulated for exterior use over zinc coated metal and compatible with finish paint systems indicated.

C. Galvanizing repair paint to be high zinc dust content paint meeting SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous paint to be cold applied asphalt emulsion meeting ASTM D 1187/D 1187M.

E. Non-shrink, nonmetallic grout to be factory packaged, non-staining, noncorrosive, nongaseous grout meeting ASTM C 1107/C 1107M. Provide grout specifically recommended by the manufacturer for interior and exterior applications.

2.06 General Fabrication

A. Material:
   1. Use material as specified. Use material of commercial quality and suitable for intended purpose for material that is not named or its standard of quality not specified.
   2. Use material free of defects which could affect the appearance or service ability of the finished product.

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

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

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

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

F. Weld corners and seams continuously to meet the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing. Weld in accordance with AWS.
   5. Welds shall show good fusion, be free from cracks and porosity, and accomplish secure and rigid joints in proper alignment.
6. Where exposed in the finished work, continuous weld for the full length of the members joined and have depressed areas filled and protruding welds finished smooth and flush with adjacent surfaces.

7. Finish welded joints to match finish of adjacent surface.

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

1. Miter or butt members at corners.

2. Where frames members are butted at corners, cut leg of frame member perpendicular to surface, as required for clearance.

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

I. Cut, reinforce, drill and tap metal fabrications as indicated to receive finish hardware, screws and similar items.

1. Accurately cut, machine and fit joints, corners, copes and miters.

2. Fit removable members to be easily removed.

3. Design and construct field connections in the most practical place for appearance and ease of installation.

4. Fit pieces together as required.

5. Fabricate connections for ease of assembly and disassembly without use of special tools.

6. Joints firm when assembled.

7. Conceal joining, fitting and welding on exposed work as far as practical.

8. Do not show rivets and screws prominently on the exposed face.

9. The fit of components and the alignment of holes shall eliminate the need to modify component or to use exceptional force in the assembly of item and eliminate the need to use other than common tools.

J. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.

2. Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members or causing failure of the anchor or fastener, and suit the sequence of installation.

3. Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.

4. Fasteners for securing metal fabrications to new construction only, may be by use of threaded or wedge type inserts or by anchors for welding to the metal fabrication for installation before the concrete is placed or as masonry is laid.
5. Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self drilling and tapping screws or bolts, except where otherwise specified.

K. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1 1/2 inches, with a minimum 6 inch embedment and 2 inch hook, not less than 8 inches from ends and corners of units and 24 inches on center, unless otherwise indicated.

L. Size:
   1. Size and thickness of members as shown.
   2. When size and thickness is not specified or shown for an individual part, use size and thickness not less than that used for the same component on similar standard commercial items or in accordance with established shop methods.

M. Connections:
   1. Except as otherwise specified, connections may be made by welding, riveting or bolting.
   2. Field riveting will not be approved.
   3. Design size, number and placement of fasteners, to develop a joint strength of not less than the design value.
   4. Size and shape welds to develop the full design strength of the parts connected by welds and to transmit imposed stresses without permanent deformation or failure when subject to service loadings.
   5. Use rivets and bolts of material selected to prevent corrosion (electrolysis) at bimetallic contacts. Plated or coated material will not be approved.
   6. Use stainless steel connectors for removable member's machine screws or bolts.

N. Workmanship:
   1. General:
      a. Fabricate items to design shown.
      b. Furnish members in longest lengths commercially available within the limits shown and specified.
      c. Fabricate straight, true, free from warp and twist, and where applicable square and in same plane.
      d. Provide holes, sinkages and reinforcement shown and required for fasteners and anchorage items.
      e. Provide openings, cut outs and tapped holes for attachment and clearances required for work of other trades.
      f. Prepare members for the installation and fitting of hardware.
      g. Cut openings in gratings and floor plates for the passage of ducts, sumps, pipes, conduits and similar items. Provide reinforcement to support cut edges.
      h. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.

O. Finish:
   1. Finish exposed surfaces in accordance with NAAMM Metal Finishes Manual.
2. Steel and iron to meet NAAMM AMP 504.
   a. Zinc coated (galvanized) to meet ASTM A 123/A 123M, G90 unless noted otherwise.
   b. Surfaces exposed in the finished work:
      1) Finish smooth rough surfaces and remove projections.
      2) Fill holes, dents and similar voids and depressions with epoxy type patching compound.
   c. Shop Prime Painting:
      3) Surfaces of Ferrous Metal:
         a) Items not specified to have other coatings.
         b) Galvanized surfaces specified to have prime paint.
         c) Remove all loose mill scale, rust and paint, by hand or power tool cleaning as defined in SSPC-SP 2 and SSPC-SP 3.
         d) Clean of oil, grease, soil and other detrimental matter by use of solvents or cleaning compounds as defined in SSPC-SP 1.
         e) After cleaning and finishing apply one (1) coat of primer as specified in Section 09910.
   4) Non-ferrous metals to meet NAAMM 500 series.

P. Protection:
   1. Spot prime all abraded and damaged areas of zinc coating which expose the bare metal using zinc rich paint on hot dip zinc coat items and zinc dust primer on all other zinc coated items.

2.07 Miscellaneous Framing and Supports
A. Provide steel framing and supports not specified in other Sections as needed to complete the work.
B. Fabricate units from steel shapes, plates and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.
C. Galvanize miscellaneous framing and supports where indicated.
D. Prime miscellaneous framing and supports with primer specified in Section 09910.

2.08 Shelf Angles
A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4 inch bolts, spaced not more than 6 inches from ends and 24 inches on center, unless otherwise indicated.
   1. Provide mitered and welded units at corners.
   2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
C. Galvanize and prime all shelf angles located in exterior walls.
D. Prime shelf angles located in exterior walls with primer specified in Section 09910.

2.09 **Loose Bearing and Leveling Plates**
A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
B. Galvanize plates.
C. Prime plates with zinc rich primer. Refer to Section 09910.

2.10 **Steel Weld Plates and Angles**
A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the work. Provide each unit with no fewer than two (2) integrally welded steel strap anchors for embedding in concrete.

2.11 **Metal Ladders**
A. General:
   1. Meet ANSI A14.3
B. Manufacturers:
   1. The basis of design is O’Keeffe’s, Inc.; 325 Newhall St. San Francisco, CA 94124, Tel: (888) 653-3333, http://www.okeeffes.com.
   2. ACL Industries, Inc.
   3. ALACO Ladder Co.
   4. Or Approved Equal.
C. Fixed Cage Ladder:
   1. Low Parapet Access with Roofover Rail Extensions:
      a. Model 532 as manufactured by O’Keeffe’s Inc Or Approved Equal.
      b. Security door.
D. Clear anodic finish to be AA-M10C22A41 mechanical finish as fabricated. Architectural Class I, clear coating 0.018 mm or thicker.
E. Material:
   1. Aluminum sheet to be Alloy 5005-H34 to meet ASTM B 209.
   2. Aluminum extrusions to be Alloy 6063-T6 to meet ASTM B 221.
F. Fabrication:
   1. Rungs to be not less than 1 1/4 inches in section and 18 3/8 inches long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.
      a. Rungs shall withstand a 1,500 pound load without deformation or failure.
   2. Channel side rails to be not less than 1/8 inch wall thickness by 3 inches wide.
3. Heavy duty tubular side rails to be assembled from two (2) interlocking aluminum extrusions no less than 1/8 inch wall thickness by 3 inches wide. Construction shall be self-locking stainless steel fasteners, full penetration TIG welds and clean, smooth and burr free surfaces.

4. Roof rail extension to be not less than 3 feet 6 inches above the landing and shall be fitted with deeply serrated, square, tubular grab rails.

5. Security doors to be formed 1/8 inch thick aluminum sheet. Security panels shall extend on both sides, perpendicular to the door face, to within 2 inches of the wall. Security door shall be furnished with continuous aluminum piano hinge and heavy duty forged steel locking hasps.

6. Ladder safety post to be retractable hand hold and tie off.

7. Safety Cage:
   a. Fabricate ladder safety cages to comply with the authority having jurisdiction. Assemble by welding. Spacing of primary hoops, secondary hoops and vertical bars shall not exceed that required by code.
   b. Safety cage hoops and vertical bars to be 3/16 inch by 2 inches aluminum bar.

2.12 Rain Leader
   A. Plain round complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
   B. Material to be cast iron.

2.13 Finishes
   A. Finish metal fabrications after assembly.
   B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.14 Steel and Iron Finishes
   A. Hot dip galvanize items as indicated to meet ASTM A 153/A 153M for steel and iron hardware and ASTM A 123/A 123M for other steel and iron products.
      1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
   B. After galvanizing, thoroughly clean railings of grease, dirt, oil, flux and other foreign matter, and treat with metallic phosphate process.
   C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed on fireproofing, or masonry, or unless otherwise indicated.
      1. Shop prime with primers specified in Section 09910.
   D. Prepare surfaces for shop priming to meet the requirements indicated below:
      1. Exterior items to meet SSPC-SP 6.
      2. Items indicated to receive zinc rich primer to meet SSPC-SP 6.
3. Items indicated to receive primers specified in Section 09960 to meet SSPC-SP 6.
4. Other items to meet SSPC-SP 3.
E. Apply shop primer to meet SSPC-PA 1 for shop painting.

PART 3 - EXECUTION

3.01 Examination and Inspection
A. SEPTA reserves the right to shop inspect at any time during the fabrication and finishing process.
B. The Contractor must notify SEPTA five (5) days prior to beginning fabrication, galvanizing and painting, to determine if SEPTA shall require a shop inspection prior to allowing the product to move forward to the next stage.

3.02 Installation
A. Perform cutting, drilling and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack and twist, set parallel or perpendicular as required to line and plane of surface and measured from established lines and levels.
B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut or abrade surfaces of exterior units that have been hot dip galvanized after fabrication and are for bolted or screwed field connections.
C. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws and other connectors.
   1. Provide temporary bracing for such items until concrete or masonry is set.
   2. Place in accordance with setting drawings and instructions.
   3. Build strap anchors into masonry as work progresses.
D. Set frames of gratings, covers, corner guards, trap doors and similar items flush with finish floor or wall surface and, where applicable, flush with side of opening.
E. Field weld in accordance with AWS.
   1. Design and finish as specified for shop welding.
   2. Use continuous weld unless specified otherwise.
F. Install anchoring devices and fasteners as shown and as necessary for securing metal fabrications to building construction as specified. Expansion anchors should be used where shown on the Contract Drawings and elsewhere except where shown otherwise. Power actuated drive pins may be used except for removable items and where members would be deformed or substrate damaged by their use.
G. Spot prime all abraded and damaged areas of zinc coating as specified and all abraded and damaged areas of shop prime coat with same kind of paint used for shop priming.
H. Isolate aluminum from dissimilar metals and from contact with concrete and masonry materials as required to prevent electrolysis and corrosion.

3.03 Installation of Miscellaneous Framing and Supports

A. Install framing and supports to meet the requirements of items being supported, including the manufacturers' written instructions and requirements indicated on shop drawings.

B. Anchorage to Structure:
   1. Secure angles and clips to structure as shown or as required.
   2. Secure supports to mid height of concrete beams when inserts do not exist with expansion anchors and to slabs, with expansion anchors unless shown otherwise.
   3. Secure steel plate and steel angles to slabs or masonry walls with expansion anchors unless shown or specified otherwise.

3.04 Installing Bearing and Leveling Plates

A. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.

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

3.05 Clean and Adjusting

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

   1. Apply by brush or spray to provide a minimum 2.0 mil dry film thickness.

B. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09910.

C. Clean field welds, bolted connections and abraded areas and repair galvanizing to meet ASTM A 780/A 780M.

D. Clean after installation exposed pre-finished and plated items and items fabricated from stainless steel, aluminum and copper alloys, as recommended by the metal manufacture and protected from damage until completion of the Contract.

E. Clean after installation exposed pre-finished and plated items and items fabricated from stainless steel, as recommended by the metal manufacture and protect from damage until completion of the Contract.

F. If any surface staining becomes apparent, stainless steel must be cleaned and repassivated by experienced personnel. If this action is deemed necessary by the SEPTA Project Manager, the Contractor shall submit their proposed process and a mock-up to SEPTA for approval prior to start of work.
G. Only approved stainless steel cleaners shall be used. Strong unapproved acids such as muriatic or cleaners containing chlorine shall not be used.

END OF SECTION
SECTION 05520

HAND RAILS AND RAILINGS

PART 1 - GENERAL

1.01 Description
   A. This Section includes stainless steel pipe railings

1.02 Related Sections
   A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

1.03 Submittals
   A. Submit product data for the following:
      1. Grout, anchoring cement and paint products.
   B. Submit shop drawings including plans, elevations, sections, details and attachments to other work.
      1. For installed products indicated to meet the design loads, include structural analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.
   C. Submit welding certificates.
   D. Submit qualification data for a Professional Engineer licensed in the Commonwealth of Pennsylvania.
   E. Submit product test reports based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.04 Quality Assurance
   A. Obtain each type of railing through one (1) source from a single manufacturer.
   B. Meet the applicable provisions of the most recent issues of the following references:
      1. AWS D1.6, Structural Welding Code - Stainless Steel.
      4. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

1.05 Performance Requirements
A. Engineer railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
   1. Stainless steel to meet 60 percent of minimum yield strength.
B. Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails:
      a. Uniform load of 50 lbf/ft applied in any direction.
      b. Concentrated load of 200 lbf applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Top Rails of Guards:
      a. Uniform load of 50 lbf/ft applied in any direction.
      b. Concentrated load of 200 lbf applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   3. Infill of Guards:
      a. Concentrated load of 50 lbf applied horizontally on an area of 1 square foot.
      b. Infill load and other loads need not be assumed to act concurrently.
C. Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
   1. Temperature change (range) to be 120°F, ambient; 180°F, material surfaces.
D. Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.06 Delivery, Storage and Handling
A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.07 Project Conditions
A. Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on shop drawings.
1. Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

2. Provide allowance for trimming and fitting at site.

1.08 Coordination and Scheduling

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls.

C. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.01 Metals

A. Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations or blemishes.

B. Brackets, flanges and anchors to be cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.02 Stainless Steel

A. Tubing to meet ASTM A 554, Grade MT 304.

B. Castings to meet ASTM A 743/A 743M, Grade CF 8 or CF 20.

C. Plate and sheet to meet ASTM A 666, Type 304.

D. Woven wire mesh to be intermediate crimp, square pattern, 2 inch woven wire mesh, made from 0.135 inch nominal diameter wire meeting ASTM A 580/A 580M, Type 304.

2.03 Fasteners

A. Provide the following:
   1. Type 304 stainless steel fasteners for stainless steel railings.

B. Select fasteners of type, grade and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:
   1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

   2. Provide square or hex socket flat head machine screws for exposed fasteners, unless otherwise indicated.
D. Provide cast-in-place anchors, fabricated from corrosion resistant materials with capability to sustain, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and equal to four (4) times the load imposed when installed in concrete, as determined by testing per ASTM E 488/E 488M conducted by a qualified independent testing agency.

2.04 Miscellaneous Materials

A. Welding rods and bare electrodes to be selected according to AWS specifications for metal alloy welded.

B. Bituminous paint to be cold applied asphalt emulsion that meets ASTM D 1187/D 1187M.

C. Non-shrink, nonmetallic grout to be factory packaged, non-staining, noncorrosive, nongaseous grout meeting ASTM C 1107. Provide grout specifically recommended by the manufacturer for interior and exterior applications.
   1. At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by the manufacturer for exterior use.

2.05 Fabrication

A. Fabricate railings to meet the requirements indicated for design, dimensions, member sizes and spacing, details, finish and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

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

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill and tap as indicated to receive finish hardware, screws and similar items.

G. Fabricate railings with welded connections, unless otherwise indicated.

H. At welded connection cope components at connections to provide close fit or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusions without undercut or overlap.
   3. Remove flux immediately.
   4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
I. At non-welded connections connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
   1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
J. Close exposed ends of railing members with prefabricated end fittings.
K. Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.
L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
M. For removable railing posts, fabricate slip fit sockets from steel tube or pipe whose inner diameter is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
N. Fabricate infill panels from woven wire mesh crimped into 1 inch by 1/2 inch by 1/8 inch metal channel frames. Make wire mesh and frames from same metal as railings in which they are installed.
   1. Wire mesh is 2 inch by 2 inch square pattern.
O. Where indicated, provide toe boards at railings around openings and at edge of open sided floors and platforms. Fabricate to dimensions and details indicated.

2.06 Finishes
   A. Meet NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.07 Stainless Steel Finishes
   A. Remove tool and die marks and stretch lines or blend into finish.
   B. Wire mesh shall have standard mill finish.
   C. Bright directional polish #4 mill finish for tubing and standard mill finish for wire mesh.
   D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.01 Installation
   A. Fit exposed connections together to form tight, hairline joints.
   B. Perform cutting, drilling and fitting required for installing railings. Set railings accurately in location, alignment and elevation; measured from established lines and levels and free of rack.
1. Do not weld, cut or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

   C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

   D. Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in place construction.

### 3.02 Railing Connections

A. At non-welded connections use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. At welded connections use fully welded joints for permanently connecting railing components. Meet the requirements for welded connections in Article 2.05 in this Section whether welding is performed in the shop or in the field.

### 3.03 Anchoring Posts

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout, mixed and placed to meet the anchoring material manufacturer's written instructions.

B. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8 inch buildup, sloped away from post.

C. Anchor posts to metal surfaces with oval flanges, angle type or floor type as required by conditions, connected to posts and to metal supporting members as follows:

   1. For stainless steel pipe railings, weld flanges to post and bolt to supporting surfaces.

D. Install removable railing sections, where indicated, in slip fit metal sockets cast in concrete.

### 3.04 Anchoring Railing Ends

A. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

### 3.05 Adjusting and Cleaning

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
3.06 Protection

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by the railing manufacturer. Remove protective coverings at time of substantial completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION
SECTION 05530

STEEL GRATINGS

PART 1 - GENERAL

1.01 Description
A. This Section includes the following:
   1. Galvanized steel grating.
   2. Metal frames and supports for gratings.
B. Furnish all labor, materials, tools and equipment, and perform all operations in connection with gratings, as indicated on the Contract Documents.

1.02 Related Sections
A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.
B. Section 05120 – Structural Steel
C. Section 05520 – Hand Rails and Railings

1.03 Submittals
A. Submit manufacturer’s descriptive literature and specifications covering manufactured products specified herein.
   2. Paint products.
   3. Include complete information necessary for fabrication and erection of the specified products.
   4. Indicate size and weight of shapes, type and location of shop and field connections; the type, size and extent of welds and welding sequence when required. Use standard welding symbols of the American Welding Society in shop drawings.
B. Submit metal fabrication shop drawings are to identify the detail as indicated on the Contract Drawings and be complete as to the detail of the product and location in the Project, the size and weights of members, the methods of joining various components, the quantity, finish, the location and type of anchors and necessary measurements. Include plans, elevations, sections, details and attachments to other work.
   1. Provide templates for anchors and bolts specified for installation under other Sections.
   2. For installed products indicated to meet the design loads, include structural analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.
   3. Provide easy-to-read markings on shop and erection drawings for shop assemblies which require markings for erection identification.
4. Note on shop drawings variations in tolerances or clearances between various products.
5. Use standard welding symbols of the American Welding Society on shop drawings.
6. Furnish setting diagrams, templates and directions for the installation of metal fabrications.
C. Submit welding certificates.
D. Submit qualification data for a Professional Engineer licensed in the Commonwealth of Pennsylvania.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. American Iron and Steel Institute (AISI).
   3. ASME B 18.22.1, Plain Washers.
   17. AWS D1.1, Structural Welding Code - Steel.
19. SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel.
20. SSPC-SP 6, Commercial Blast Cleaning.

1.05 Delivery, Storage and Handling
A. For outside storage, store steel products above the ground surface on platforms, skids, blocking or similar supports.
   1. Protect steel products from exposure to conditions that produce rust on the product.
B. Deliver and handle steel items so no parts are bent, broken or otherwise damaged and avoid damage to other adjoining and surrounding material and work during handling and erection.

1.06 Project Conditions
A. Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication and indicate measurements on shop drawings.
   1. Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating gratings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
   2. Provide allowance for trimming and fitting at site.

1.07 Coordination
A. Coordinate installation of anchorages for gratings, grating frames and supports. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 Manufacturers
A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Galvanized Steel Gratings:
      a. Ohio Gratings, Inc.
      b. IKG Borden: (Type W/B).
      c. Or Approved Equal.

2.02 Manufactured Units
A. Galvanized steel grating to be removable type, fabricated to panel sizes and thickness as indicated on the Contract Drawings. Construction details in conformance with the NAAMM Metal Bar Grating Manual.
   1. Provide bearing bars, cross bars and bent connecting bars of welding quality mild carbon steel meeting ASTM A 1011/A 1011M.
   2. Bar Spacing:
a. Bearing bars to be 1 3/16 inches center to center.
b. Cross bars to be 4 inches center to center.

3. Bar connection to be welded.

4. Galvanizing to meet ASTM A 123/A 123M.

5. Anchor clips to be AISI Type 316 stainless steel, two (2) each panel.

6. Grating bar ends banded same depth as bars. Openings cutting two (2) or more bearing bars require banding. Openings for pipes, ducts, conduits and similar objects require banding.

7. Split panels in two (2) individual sections to facilitate removal of panels at pipes, ducts, conduits and similar objects passing through grating panels.

8. Except where indicated otherwise on the Contract Drawings, provide gratings with factory applied anti-slip surfacing of either of the following types:
   a. Aluminum oxide grit/metal matrix grating walking surface to receive a uniformly dispersed aluminum oxide grit particle coating encapsulated in a metal matrix and metal bonded to the grating by an electric-arc spray process.
   b. Aluminum oxide grit/epoxy matrix grating walking surface to receive a uniformly dispersed aluminum oxide grit particle coating embedded in an epoxy matrix and epoxy bonded to the grating.

2.03 Ferrous Metals

A. Steel plates, shapes and bars to meet ASTM A 36/A 36M.
B. Wire rod for grating crossbars to meet ASTM A 510/A 510M.
C. Uncoated steel sheet to meet ASTM A 1011/A 1011M, structural steel, Grade 30.
D. Galvanized steel sheet to meet ASTM A 653/A 653M, structural quality, Grade 33, with G90 coating.
E. Expanded metal, carbon steel to meet ASTM F 1267, Class 1.
F. Expanded metal, galvanized steel to meet ASTM F 1267, Class 2, Grade A.

2.04 Fasteners

A. Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating meeting ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless steel fasteners for fastening aluminum. Select fasteners for type, grade and class required.

B. Steel bolts and nuts to be regular hexagon head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless steel bolts and nuts to be regular hexagon head annealed stainless steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

D. Plain round washers to meet ASME B18.22.1.

E. Helical, spring type lock washers to meet ASME B18.21.1.
2.05 Miscellaneous Metals

A. Welding rods and bare electrodes to be selected according to American Welding Society specifications for metal alloy that is welded.

B. Galvanizing repair paint to be high zinc dust content paint for re-galvanizing welds in steel, meeting SSPC-Paint 20.

C. Bituminous paint to be cold applied asphalt emulsion meeting ASTM D 1187/D 1187M.

2.06 Fabrication

A. Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

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

C. Form from materials of size, thickness and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Meet the American Welding Society recommendations and the following for welding:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusions without undercut or overlap.
   3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

2.07 Grating Frames and Supports

A. Fabricate from metal shapes, plates and bars of welded construction to sizes, shapes and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
   1. Unless otherwise indicated, fabricate from same basic metal as gratings.
   2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches on center and provide minimum anchor units in the form of steel straps 1 1/4 inches wide by 1/4 inch thick by 8 inches long.

B. Fabricate from glass fiber reinforced plastic shapes of sizes, shapes and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
   1. Unless otherwise indicated, use shapes made from same resin as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integral anchors.

C. Galvanize steel frames and supports in the following locations:
   1. Exterior.

2.08 Steel Finishes

A. Meet the NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish gratings, frames and supports after assembly.

C. For those items indicated for galvanizing, apply zinc coating by the hot dip process meeting ASTM A 123/A 123M.

D. Prepare uncoated ferrous metal surfaces to meet the minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
   1. Exteriors (SSPC Zone 1B) to meet SSPC-SP 6.

E. Apply shop primer to uncoated surfaces of gratings, frames and supports, except those with galvanized finishes and those to be embedded in concrete or masonry, unless otherwise indicated. Meet SSPC-PA 1 for shop painting.

PART 3 - EXECUTION

3.01 Installation

A. Provide anchorage devices and fasteners where necessary for securing gratings to in place construction. Include threaded fasteners for concrete and masonry inserts, through bolts, lag bolts and other connectors.

B. Perform cutting, drilling and fitting required for installing gratings. Set units accurately in location, alignment and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.
   1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut or abrade the surfaces of exterior units that have been hot dip galvanized after fabrication and are for bolted or screwed field connections.

E. Meet the following requirements for field welding:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusions without undercut or overlap.
   3. Remove welding flux immediately.
3.02 Installing Metal Bar Gratings
   A. Install gratings to meet the recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
   B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by the grating manufacturer for type of installation conditions shown.
   C. Attach non-removable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.03 Adjusting and Cleaning
   A. Cleaning and touchup painting of field welds, bolted connections and abraded areas of shop paint are specified in Division 9.
   B. Clean field welds, bolted connections and abraded areas and repair galvanizing to meet ASTM A 780/A 780M.

END OF SECTION
THIS PAGE NOT USED
SECTION 05610
MISCELLANEOUS METALS

PART 1 - GENERAL

1.01 Description
A. This Section specifies furnishing and installing all miscellaneous metal works.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 05120 – Structural Steel
C. Section 09910 – Paints and Coatings

1.03 Submittals
A. Submit shop drawings of metal fabrications proposed to be used shall be submitted in accordance with Section 01300.
B. Submit shop drawings for the fabrication and assembly of all items and assemblies. They shall show anchorage, accessory items, and adjacent materials and conditions.

1.04 Quality Assurance
A. Materials and workmanship to be furnished under this Specification, including all accessories, shall meeting the Commonwealth of Pennsylvania Building Code (International Building Code).
B. Welding processes and welding operators shall be qualified in accordance with AWS Standard Qualification Procedure.
C. Field measurement shall be taken prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. Allowance for fitting and trimming shall be made wherever the taking of field measurements before fabrication might delay the work.
D. Items shall be pre-assembled in the shop to the greatest extent possible. Units shall be field assembled or re-assembled only to the extent necessary. Units shall be clearly marked for reassembly and installation coordinated.
E. Meet the applicable provisions of the most recent issues of the following references:
5. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.


22. SSPC-SP 1, Solvent Cleaning.

23. SSPC-SP2, Hand Tool Cleaning.

24. SSPC-SP 3, Power Tool Cleaning.

25. SSPC-SP 7, Brush-off Blast Cleaning.

PART 2 - PRODUCTS

2.01 General

A. Only materials which are smooth and free of surface blemishes shall be used for the fabrication of miscellaneous metal work which will be exposed to view.
B. Blemishes shall be removed by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.

2.02 Materials
A. Steel plate, shapes and bars to meet ASTM A 36/A 36M.
B. Steel plates to be bent or cold formed to meet ASTM A 283/A 283M, Grade C.
C. Hot rolled carbon steel bars to meet ASTM A 575.
D. Cold finished steel bars to meet ASTM A 108.
E. Hot rolled carbon steel sheets and strips to meet ASTM A 568/A 568M and ASTM A 1011/A 1011M.
F. Cold rolled carbon steel sheets to meet ASTM A 1008/A 1008M.
G. Galvanized carbon steel sheets to meet ASTM A 526/A 526M; with 1.25 ounce commercial zinc coat that meets ASTM A 653/A 653M.
H. Steel bar grating to meet the requirements of the NAAMM "Metal Bar Grating Manual."
I. Extruded aluminum pipe and tube of Schedule 40 size to meet ASTM B 429/B 429M, 6064-T6.
J. Aluminum plate bar and sheet to meet ASTM B 209, 6061-T6 or ASTM B 221, 6063-T6.
L. Two (2) coats of bituminous paint shall be applied on one (1) or both surfaces wherever dissimilar metals, or metal and masonry, would otherwise be in contact to separate metals. Gasketed fasteners shall be used where required to eliminate the possibility of corrosive or electrolytic action.

2.03 Fasteners
A. For securing aluminum plate cover placed across brick opening for roof drain leaders, use 1 inch by 1/4 inch raw plugs (nail-in type) with one (1) piece drive anchors Or Approved Equal. All other masonry anchorage devices shall be expansion shield type with threaded fasteners.
B. Toggle bolts shall be tumble wing type; type, class and style as required.
C. Zinc coated fasteners, with ASTM A 153/A 153M; zinc coating (hot dip) on iron and steel hardware shall be used for exterior use or where built into exterior walls. Fasteners shall be selected for the type, grade and class required for the installation of miscellaneous metal items.
D. Standard bolts and nuts shall be ASTM A 307; carbon steel, externally and internally threaded standard fasteners, grade A, regular hexagon head.
E. Lag bolts shall be square head type.
F. Machine screws shall be cadmium plated steel.
G. Plain washers, screws (machine, slotted or cross recessed and round) shall be general assembly grade carbon steel.
H. Lock washers shall be helical spring type carbon steel.
I. Clip angles, brackets and flanges shall be of same material to be fastened.

J. Grout shall be that specifically recommended by the manufacturer for interior and exterior applications of type specified and shall meet ASTM C 1396/C 1396M.

2.04 Miscellaneous Framing, Supports and Lintels

A. Miscellaneous units shall be fabricated to the size, shapes and profiles shown or, if not shown, of the required dimensions to receive other work to be retained by the framing.

B. Items shall be fabricated from structural steel shapes, plates and steel bars, of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Unit shall be cut, drilled, and tapped to receive hardware and similar items to be anchored to the work.

C. Units shall be equipped with integrally welded anchor straps, for casting into poured concrete or building into masonry wherever required.

D. Miscellaneous framing, supports and lintels shall include, but are not limited to:
   1. Miscellaneous clips and angles.
   2. Frames for gratings.
   3. Closure and support angles.
   4. Loose lintels and lintels assemblies.
   5. Loose bearing and leveling plates.

2.05 Cast Abrasive Nosings

A. Nosings for concrete steps shall be aluminum, with nonslip abrasive finish of size and configuration shown on the Contract Drawings, with cast on bolt anchor, 1/4 inch diameter by 1 inch deep.

B. Pattern of abrasive surface shall be checkered.

2.06 Miscellaneous Metal Fabrications

A. Miscellaneous metal fabrications shall be fabricated to the sizes, shapes and profile shown.

B. Except as otherwise shown, items shall be fabricated from carbon steel sheets, be of all welded construction using mitered corners, with a minimum number of joints for field connection.

C. Units shall be equipped with integrally welded anchor straps for building into masonry wherever required.

D. Miscellaneous metal fabrications shall include, but are not limited to:
   1. Closure trims.

2.07 Steel Bar Gratings

A. Steel bar gratings shall be Irving Grating, type CM-2, galvanized, Or Approved Equal by SEPTA, with bearing bars, 1 1/4 inch by 3/16 inch on center.

B. Steel bar gratings shall be welded to steel support beams.
2.08 Shop Painting

A. Miscellaneous metal work surfaces and edges, except those members or portions of members to be embedded in masonry, are to be field painted unless otherwise indicated.

B. Rust, scale and other deleterious materials shall be removed before the shop coat of paint is applied. Heavy rust and loose mill scale shall be cleaned in accordance with SSPC-SP 2, or SSPC-SP 3, or SSPC-SP 7. Oil, grease and similar contaminants shall be removed in accordance with SSPC-SP 1.

C. One (1) shop coat of metal primer paint shall be applied to fabricated metal items and two (2) coats of paint to surfaces which are inaccessible after assembly or erection. Color of second coat shall be changed to distinguish it from the first coat.

D. Metal primer paint shall be brushed or sprayed on, in accordance with the manufacturer's instructions, at a rate to provide a uniform dry film thickness of 4.0 mils for each coat immediately after surface preparation. Methods which will result in full coverage of joints, corners, edges and all exposed surfaces shall be used for applying paint.

PART 3 - EXECUTION

3.01 General

A. The Contractor shall furnish and coordinate anchorage setting drawings, diagrams, templates, instructions and other directions for installation of anchorages, such as sleeves, anchor bolts and miscellaneous items having integral anchors which are to be imbedded in masonry construction.

B. Delivery of items to the Project site shall be coordinated with work of other trades to avoid delays.

C. Work shall be accurately set in location, alignment and elevation; plumb, level, true and free or rack; measured from established lines and levels.

D. Exposed connections shall fit accurately together to form tight, hairline joints. Weld connections, which are not to be left as exposed joints, but cannot be shop welded because of shipping limitations, shall be welded in the field.

E. Field welding, where approved by SEPTA, shall meet the AWS Code for procedures for Manual Shielded Metal Arc Welding, appearance and quality of welds made and methods used in correcting welding work.

F. Exposed joints shall be ground smooth and cleaned and painted in accordance with Section 09910.

3.02 Setting Fabrications

A. Bottom surfaces of units shall be cleaned, set, positioned and plumbed.

B. Grout shall be packed solidly between units and masonry to ensure that no voids remain.

C. Non-removable units shall be welded to supporting members of frameworks.
3.03 Adjust and Clean

A. Field welds, bolted connections and abraded areas of shop paint shall be cleaned, and exposed areas shall be painted with same paint used for shop painting. Paint shall be applied by brush to provide a minimum thickness of 4.0 mils.

END OF SECTION
SECTION 05900

METAL RESTORATION AND CLEANING

PART 1 - GENERAL

1.01 Description
   A. Provide all labor, materials, tools, equipment and services necessary for cleaning, repair and reinstalling existing metal as indicated. Clean metal only where cleaning is indicated.

1.02 Related Sections
   A. Section 02070 – Selective Demolition
   B. Section 05500 – Metal Fabrications

1.03 Submittals
   A. Submit manufacturer’s product data for each product proposed for use in the work. Include instructions for handling, storage and application of each product.
   B. Submit shop drawings including floor plans/elevations, locating each metal piece and identifying each with a sequential number which corresponds to that metal piece. Do not use the same number for more than one (1) piece. Indicate the size of each piece either on the plan or in the schedule.
   C. Submit qualification data for metal refinishing specialist.
   D. Submit preconstruction test reports for chemical cleaning of metal.
   E. Submit quality control submittals:
      1. Submit signed certification that materials are in accordance with the specified requirements.
   F. Submit photographs of each metal piece as it exists in place prior to dismantling. Show surface on which metal piece is mounted so that it can be identified, and label each photograph with space name and metal piece number.

1.04 Quality Assurance
   A. A qualified metal cleaning specialist shall be experienced in using mechanical and chemical methods on the types of metal surfaces indicated.

1.05 Delivery, Storage and Handling
   A. Delivery:
      1. Schedule delivery of materials at the site at such time as required for proper coordination of work. Receive materials in the manufacturer’s unopened packages and bearing the manufacturer’s label.
   B. Storage and Handling:
1. Store materials in a dry and well ventilated place, adequately protected from damage and exposure to the elements.

PART 2 - PRODUCTS

2.01 Materials

A. Cleaning Materials:
   1. Surfactant is a non-ionic surface active agent composed of an anhydrous mixture of alkylaryl polyether alcohols.
      a. Source:
         1) Triton X-100 by Rohm and Haas Company, Or Approved Equal. Triton X-100 is available from Fisher Scientific Company, 201-796-7100; J. T. Baker Chemical Co., 201-859-2151; and various photographic supply stores.
         2) Equivalent products by other manufacturers will only be considered for use after safety and effectiveness have been demonstrated through description of chemical and physical properties and effects; and comparison testing at site.
   2. Ethanol to be industrial grade, denatured ethanol.
   3. Water to be clean, potable, and free of acids and other deleterious substances.
   4. Brushes to be medium stiffness nylon bristle, natural bristle or stiff animal hair brushes selected for maximum cleaning efficiency but with least potential for surface injury to material being cleaned.

B. Color to match cleaned existing finish of representative metal pieces designated by SEPTA.

PART 3 - EXECUTION

3.01 Preparation

A. Protect surrounding surfaces from liquids used in cleaning. Continuously collect and dispose of liquids and other waste.
   1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to meet the manufacturer’s written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
   2. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping and water penetration into building interiors.

3.02 Cleaning

A. Remove all loose dirt and dust with soft bristle brushes.
B. Wash with a surfactant solution:
1. Prepare a 2 percent solution of surfactant (2 1/2 fluid ounces to one gallon of warm water).
2. Pre-wet area to be cleaned with warm water.
3. Wash surfaces with surfactant solution applied to a soft lint free cloth. Thoroughly wash all surfaces, including recesses and crevices. Use small soft brushes or cotton swabs to reach into narrow crevices. Control and collect run-off of solution; do not allow it to contact other surfaces.
4. Rinse surfaces with ethanol applied to a soft lint free cloth. Thoroughly rinse all surfaces, including recesses and crevices. Control and collect ethanol; do not allow it to contact other surfaces.
5. Remove dirt built-up in crevices with acetone applied to cotton swabs after the initial surfactant washing and rinsing.
6. Repeat washing and rinsing procedures as necessary to remove all dirt and surfactant residue.

3.03 Removal and Reinstallation of Metal Pieces
A. Perform removal work in a systematic manner and use such methods as required to complete the work indicated on the Contract Drawings and as needed for completion of the work and the Contract objectives in accordance with the requirements of the Contract Specification. Removal of metal pieces shall not damage surrounding metal pieces not affected by Contract scope.
B. Neatly cut openings and holes plumb, square and true to dimensions required. Use cutting methods least likely to damage metal to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
C. Neatly trim and cut metal slats as needed as per Contract scope.
D. Reinstall metal slats to match existing installation. Reinstallation of metal pieces shall not damage surrounding metal pieces not affected by Contract scope.
E. Clean metal pieces of dirt and extraneous material.

3.04 Adjusting and Cleaning
A. Touch-up scratches and other defects with same paint as used for refinishing. Remove, strip, polish, refinish, if touch-up work is unacceptable to the SEPTA Project Manager, until completed work is acceptable.
B. Wipe completed work carefully with a soft cloth to remove fingerprints and dirt and leave in perfect condition.

END OF SECTION
SECTION 06100

ROUGH CARPENTRY

PART 1 - GENERAL

1.01 Description
A. Provide fire retardant rough carpentry work as shown and as specified per Contract Documents, including, but not limited to:
   1. Wood grounds, blocking and nailers.
   2. Plywood mounting boards at electrical / mechanical rooms.

1.02 Related Sections
A. Section 01400 – Quality Requirements
B. Section 07620 – Sheet Metal Flashing and Trim
C. Section 07900 – Joint Sealers

1.03 Submittals
A. Submit product data for each type of process and factory fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials meeting the requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials meeting the requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   3. For fire retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
B. Submit a statement; for products receiving a waterborne treatment; that moisture content of treated materials was reduced to levels specified before shipment to Project site.
C. Submit quality control submittals:
   1. Provide documentation that engineered composite wood and agrifiber products are third party certified as meeting ANSI standard requirements for formaldehyde emissions and/or contain no added urea-formaldehyde resins.
      a. ANSI A208.1, Particleboard.
      b. ANSI A208.2, Medium Density Fiberboard (MDF) for Interior Applications.
D. Submit certification from treating plant stating chemicals and process used and net amount of preservatives retained are in conformance with specified standards.
E. For dimension lumber specified to meet minimum allowable unit stresses, submit species and grade selected for each use and design values approved by the ALSC Board of Review.

F. Submit evaluation reports for the following, from ICC-ES:
   1. Wood preservative treated wood.
   2. Fire retardant treated wood.
   3. Engineered wood products.
   4. Shear panels.
   5. Power driven fasteners.
   7. Expansion anchors.
   8. Metal framing anchors.

1.04 Quality Assurance

A. Testing agency to be qualified in providing classification marking for fire retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. All fabricators shall have experience in the successful completion of Projects employing similar materials, applications and performance requirements.

C. Lumber to meet American Softwood Lumber Standard PS 20 by the U.S. Department of Commerce.

D. Grading Rules:
   1. Douglas Fir, Hem-Fir, Idaho White Pine and other - Western Wood Products Association (WWPA) or West Coast Lumber Inspection Bureau (WCLIB).
   2. Southern Pine - Southern Pine Inspection Bureau (SPEB).

E. Meet the applicable provisions of the most recent issues of the following references:
   1. ANSI A208.1, Particleboard.
   2. ANSI A208.2, Medium Density Fiberboard (MDF) for Interior Applications.
   3. ASME B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
19. AWPB LP-2, Pressure Treated with Water-Borne Preservatives, Above Ground Use.
20. ICC-ES (AC70), Acceptance Criteria for Fasteners Power-Driven into Concrete, Steel and Masonry Elements.

1.05 Delivery, Storage and Handling

A. Delivery:

1. Schedule delivery of materials at the site at such time as required for proper coordination of the work. Receive materials in the manufacturer’s unopened packages and bearing the manufacturer’s label.

B. Storage and Handling:

1. Store materials in a dry and well ventilated place, adequately protected from damage and exposure to the elements.

2. Stack lumber, plywood and other panels; place spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 Materials

A. Lumber:
1. Furnish seasoned dimensional lumber dressed to nominal sizes indicated with 19 percent maximum moisture content.

2. Concealed board lumber, less than 2" thick to be Southern Pine No. 3 (SPIB), any species No. 4 (WWPA) or any species Standard (WCLM)

3. Miscellaneous lumber - grounds, nailers and blocking to be standard grade, No. 3 grade, or better grade unless otherwise indicated; Douglas Fir, Hem-Fir, Idaho White Pine or Southern Pine.

B. Fasteners and Anchoring Devices:

1. Provide items of type required for secure installation of the work. Items shall be galvanized for exterior use. Unless indicated otherwise, meet the federal specifications applicable to each type.

2. Fasteners and anchors for wood treated with waterborne preservatives shall be hot dip galvanized or stainless steel if the wood will be exposed to moisture.

C. Pressure treat the following wood items, and other items indicated on the Contract Drawings, with waterborne preservatives meeting AWPB LP-2 (for above ground use). Redry wood to a maximum moisture content of 19 percent after treatment.

1. Blocking, cants and similar members used in conjunction with roofing, copings, waterproofing and related flashing and trim.

2. Blocking, furring and similar concealed members in contact with exterior masonry and concrete (including interior wythe of exterior walls), and all sills for framing.

D. Fire Retardant Treated Materials:

1. Where fire retardant treated materials are indicated, use materials meeting the requirements in this Section, that are acceptable to authorities having jurisdiction and with fire test response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

2. Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional twenty (20) minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   a. Use treatment that does not promote corrosion of metal fasteners.
   b. Exterior type treated materials shall meet the requirements specified above for fire retardant treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
   c. Interior type A treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
   d. Design value adjustment factors for treated lumber shall be tested according ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841. For enclosed roof framing, framing in attic spaces and where high temperature fire retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project’s climatological zone.
3. Kiln dry lumber after treatment to a maximum moisture content of 19 percent. Kiln dry plywood after treatment to a maximum moisture content of 15 percent.

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

5. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by testing agency.

6. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants or otherwise adversely affect finishes.

7. Treat all rough carpentry unless otherwise indicated. Insert other items that require treatment but are not likely to be indicated on the Contract Drawings.

2.02 Fasteners

A. Provide fasteners of size and type indicated that meet the requirements specified in this Section for material and manufacture.

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

B. Nails, brads and staples to meet ASTM F 1667.

C. Power Driven Fasteners:

   1. Provide fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES (AC70).

D. Wood screws to meet ASME B18.6.1.

E. Lag bolts to meet ASME B18.2.1.

F. Steel bolts to meet ASTM A 307, Grade A; with ASTM A 563/A 563M hex nuts and, where indicated, flat washers.

G. Expansion anchor bolt and sleeve assemblies of material indicated below with capability to sustain, without failure, a load equal to six (6) times the load imposed when installed in unit masonry assemblies and equal to four (4) times the load imposed when installed in concrete as determined by testing per ASTM E 488/E 488M conducted by a qualified independent testing and inspecting agency.

   1. Carbon steel components, zinc plated to meet ASTM B 633, Class Fe/Zn 5.

   2. Stainless steel with bolts and nuts to meet ASTM F 593 and ASTM F 594, Alloy Group 1 or ASTM F 836M, Grade A1 or A4.

PART 3 - EXECUTION

3.01 Installation

A. Wood Nailers, Blocking and Grounds:
1. Provide items where required for attachment of other work.

2. Size and space fasteners as required to support applied loading.

3. Counter sink bolts and nuts flush with surfaces, unless otherwise shown. Build into masonry during installation of masonry work. Where possible, anchor to form work before concrete placement. Shims shall be cedar shingles or redwood wedges.

B. Provide all wood blocking, attachment strips, rough framing and sheathing at coping coverings, canopy fascias, metal covered work, base flashing, railing sleeves and similar locations where indicated or required. Wood shall be preservative treated by pressure method as specified.

C. Install plywood with grain texture perpendicular to bearing members edges and ends occurring only over bearings.

D. Provide all rough hardware, such as nails, screws, anchors, bolts, buck anchors, clips, brackets, braces, fittings and other rough hardware required for the proper fitting, connecting and erecting of the work.

E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches on center.

F. Provide fire blocking in furred spaces, stud spaces and other concealed cavities as indicated and as follows:
   1. Fire block furred spaces of walls, at each floor level, at ceiling and at not more than 96 inches on center with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   2. Fire block concealed spaces of wood framed walls and partitions at each floor level, at ceiling line of top story and at not more than 96 inches on center where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2 inch nominal thickness.
   3. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet on center.

END OF SECTION
SECTION 07190

WATER REPELLENTS

PART 1 - GENERAL

1.01 Description
A. Section includes penetrating, MPI approved water repellent treatments for the following vertical and horizontal surfaces:
   2. Clay brick masonry.

1.02 Related Sections
A. Section 04200 – Unit Masonry

1.03 Submittals
A. For each type of product indicated, submit manufacturer’s printed statement of VOC content, manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat, printout of current "MPI Approved Products List" for each product category specified in Article 2.01 of this Section that specifies water repellents approved by MPI, with the proposed product highlighted.
B. Submit a 12 inch by 12 inch sample for each type of water repellent and substrate indicated with specified water repellent treatment applied to half of each sample.
C. Submit qualification data for applicator.
D. Submit product certificates for each type of water repellent.
E. Submit preconstruction test reports for water repellent treated substrates.
F. Submit field quality control reports.
G. Submit sample warranty.

1.04 Quality Assurance
A. An employer of workers trained and approved by the manufacturer for water repellent application.
B. Meet MPI standards indicated and provide water repellents listed in its "MPI Approved Products List."
C. Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects, and to set quality standards for materials and execution.
D. Locate mockups in locations that enable viewing under same conditions as the completed work.
   1. Size to be 10 square feet each.
E. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.

F. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of substantial completion.

G. Meet the applicable provisions of the most recent issues of the following references:

4. ASTM D 5703, Standard Practice for Preparatory Surface Cleaning for Clay Brick Masonry.

1.05 Preconstruction Testing

A. Engage a qualified testing agency to perform preconstruction testing of water repellents on field mockups.

1. In addition to verifying performance requirements, use mockups to verify the manufacturer's written instructions for application procedure and optimum rates of product application to substrates.
2. Propose changes to materials and methods to suit the Contract.
3. Notify SEPTA seven (7) days in advance of the dates and times when mockups will be tested.

1.06 Field Conditions

A. Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to the manufacturers' written instructions and warranty requirements:

1. Concrete surfaces and mortar have cured for not less than twenty-eight (28) days.
2. Building has been closed in for not less than thirty (30) days before treating wall assemblies.

3. Ambient temperature is above 40°F and below 100°F and will remain so for twenty-four (24) hours.

4. Substrate is not frozen and substrate surface temperature is above 40°F and below 100°F.

5. Rain or snow is not predicted within twenty-four (24) hours.

6. Not less than twenty-four (24) hours have passed since surfaces were last wet.

7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.07 Warranty

A. The manufacturer’s standard form in which the manufacturer agrees to repair or replace materials that fail to maintain water repellency specified in Article 2.01 in this Section within specified warranty period.

1. Warranty period to be five (5) years from date of substantial completion.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Water repellents shall meet the following performance requirements as determined by preconstruction testing on substrates representing those indicated for this Contract.

B. Minimum 80 percent reduction of water absorption after twenty-four (24) hours for treated compared to untreated specimens when tested according to the following:


2. Clay brick to meet ASTM C 67.

C. Water-vapor transmission to meet one (1) or both of the following:

1. Maximum 10 percent reduction water vapor transmission of treated compared to untreated specimens, according to ASTM E 96/E 96M.

2. Minimum 80 percent water vapor transmission of treated compared to untreated specimens, according to ASTM D 1653.

D. Water penetration and leakage through masonry to be a minimum 90 percent reduction in leakage rate of treated compared to untreated specimens, according to ASTM E 514/E 514M.

E. Maximum 5 percent loss of water repellent performance after two thousand and five hundred (2500) hours of weathering according to ASTM G 154 compared to water repellent treated specimens before weathering.

F. Chloride-ion intrusion in concrete to meet NCHRP Report 244, Series II tests.

1. Reduction of water absorption to be 80 percent.
2. Reduction in chloride content to be 80 percent.

2.02 Penetrating Water Repellents

A. Silane, penetrating water repellent to be clear, containing 20 percent or more solids of alkyltrialkoxy silanes; with alcohol, mineral spirits, water or other proprietary solvent carrier; and with 400 g/L or less of VOCs.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates, areas and conditions, with the applicator present, for compliance with requirements and conditions affecting performance of the work.

1. Verify that surfaces are clean and dry according to the water repellent manufacturer's requirements. Check moisture content in three (3) representative locations by method recommended by the manufacturer.

2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.

3. Verify that required repairs are complete, cured and dry before applying water repellent.

B. Test pH level according to the water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

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

3.02 Preparation

A. Allow concrete and other cementitious materials to age before application of water repellent, according to the repellent manufacturer's written instructions.

B. Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to the water repellent manufacturer's written instructions and as follows:

1. Remove oil, curing compounds, laitance and other substances that inhibit penetration or performance of water repellents on cast-in-place concrete according to ASTM E 1857.

2. Clay brick masonry to meet ASTM D 5703.

C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.

D. Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water repellent treatment has been installed and cured.

E. Do not apply water repellent until sealants for joints adjacent to surfaces receiving water repellent treatment have been installed and cured.
1. Water repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent and sealant materials identical to those required.

3.03 Application

A. Engage a factory authorized service representative to inspect the substrate before application of water repellent and to instruct the applicator on the product and application method to be used.

B. Apply coating of water repellent on surfaces to be treated using 15 psi pressure spray with a fan type spray nozzle, roller or brush to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Meet the manufacturer's written instructions for application procedure unless otherwise indicated.

C. Apply a second saturation coating, repeating first application. Meet the manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult the manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.04 Field Quality Control

A. SEPTA reserves the right to invoke the following procedure at any time and as often as SEPTA deems necessary during the period when water repellent is being applied:

1. The Contractor will engage the services of a qualified testing agency to sample water repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed and certified in presence of the Contractor.

2. Testing agency will perform tests for compliance of water repellent material with product requirements.

3. SEPTA may direct the Contractor to stop applying water repellents if test results show material being used does not meet the product requirements. The Contractor shall remove noncomplying material from Project site, pay for testing and correct deficiency of surfaces treated with rejected materials, as approved by SEPTA.

B. In the presence of SEPTA, hose down a dry, repellent treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.

1. Notify SEPTA seven (7) days in advance of the dates and times when surfaces will be tested.

2. Reapply water repellent until coverage test indicates complete coverage.

3.05 Cleaning

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water repellent application as work progresses. Correct damage to work of other trades caused by water repellent application, as approved by SEPTA.

B. Meet the manufacturer's written cleaning instructions.

END OF SECTION
THIS PAGE NOT USED
SECTION 07210
BUILDING INSULATION

PART 1 - GENERAL

1.01 Description
A. This Section covers the requirements of the building insulation as follows:
   1. Perimeter insulation under slabs-on-grade.
   2. Cavity wall insulation.
   3. Concealed building insulation.
   4. Vapor retarders.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. Section 04200 - Unit Masonry
E. Section 07500 - Membrane Roofing
F. Section 13121 - Prefabricated Building

1.03 Submittals
A. Submit product data for each type of product indicated.
B. Submit product test reports based on evaluation of comprehensive tests performed by a
   qualified testing agency for insulation products.
C. Submit research and evaluation reports for foam plastic insulation applied to the insulation
   of the prefabricated building for Section 13121.
D. Submit manufacturer's catalog cuts, data sheets and installation instructions.
E. Submit product test reports based on evaluation of comprehensive tests performed by a
   qualified testing agency for insulation products.
F. All submittals are to be in accordance with Section 01300.

1.04 Quality Assurance
A. Obtain each type of building insulation through one (1) source from a single manufacturer.
B. Provide insulation and related materials with the fire test response characteristics indicated,
   as determined by testing identical products per test method indicated below by UL or
   another testing and inspecting agency acceptable to authorities having jurisdiction. Identify
   materials with appropriate markings of applicable testing and inspecting agency.
   1. Surface burning characteristics to meet ASTM E 84.
2. Fire resistance ratings to meet ASTM E 119.

C. Meet the applicable provisions of the most recent issues of the following references:
   6. All other applicable local codes.

1.05 Delivery, Storage and Handling

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling and other sources. Meet the manufacturer’s written instructions for handling, storing and protecting during installation.

B. Protect plastic insulation as follows:
   1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before time of installation.
   3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 Materials

A. Provide insulating materials that meet the requirements and the referenced standards.
   1. Sizes of performed units to fit applications indicated; selected from the manufacturer's standard thicknesses, widths and lengths.

B. Rigid insulation to be cellular polyurethane or polyisocyanurate board, rigid, closed cell, high density with 50 psi compressive strength, 6.3 inch maximum vapor transmission; 0.30 percent maximum water absorption; thermal resistance value of R-13 at 75°F, R-30 for the roof insulation manufacturer's standard sizes.

C. Miscellaneous materials to be galvanized metal clips, zinc coated wires, adhesives and devices for anchoring insulation as recommended by the insulation manufacturer.
2.02 Manufacturers

A. Subject to compliance with the requirements, provide products by one (1) of the following manufacturers:

1. Extruded-Polystyrene Board Insulation:
   a. Dow / Styrofoam Cavity Mate SE.
   b. Owens Corning.
   c. Or Approved Equal.

2.03 Auxiliary Insulating Materials

A. Adhesive for bonding insulation to be a product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

B. Protection board to be a pre-molded, semi-rigid asphalt/fiber composition board, 1/4 inch thick, formed under heat and pressure, of standard sizes.

2.04 Insulation Fasteners

A. Subject to compliance with the requirements, provide one (1) of the following manufacturers:

1. Adhesively Attached, Spindle Type Anchors:
   a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
   b. Eckel Industries of Canada Limited; Stic-Klip Type N Fasteners.
   c. Gemco; Spindle Type.
   d. Or Approved Equal.

2. Insulation Retaining Washers:
   a. AGM Industries, Inc.; RC150.
   b. AGM Industries, Inc.; SC150.
   c. Gemco; Dome-Cap.
   d. Gemco; R-150.
   e. Gemco; S-150.
   f. Or Approved Equal.

3. Insulation Standoff:
   a. Gemco; Clutch Clip.
   b. Or Approved Equal.

4. Anchor Adhesives:
   a. AGM Industries, Inc.; TACTOO Adhesive.
   b. Eckel Industries of Canada Limited; Stic-Klip Type S Adhesive.
   c. Gemco; Tuff Bond Hanger Adhesive.
   d. Or Approved Equal.

B. Adhesively attached, spindle type anchors to be plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and meeting the following requirements:
1. Plate to be perforated galvanized carbon steel sheet, 0.030 inches thick by 2 inches square.

2. Spindle to be copper coated, low carbon steel, fully annealed, 0.105 inches in diameter, length to suit depth of insulation indicated.

C. Insulation retaining washers to be self-locking washers formed from 0.016 inch thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1 1/2 inches square or in diameter.

1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
   a. Crawlspace.
   b. Ceiling plenums.
   c. Attic spaces.
   d. Where indicated.

D. Insulation standoff to be a spacer fabricated from galvanized mild steel sheet for fitting over spindle of insulation anchor to maintain air space of dimension indicated between face of insulation and substrate to which anchor is attached.

1. Air space to be 1 inch.

E. Anchor adhesive to be a product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners and substrates.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates and conditions, with the installer present, for compliance with the requirements for Sections in which substrates and related work are specified and other conditions affecting performance.

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

3.02 Preparation

A. Transmit submittals required by this Section.

B. Furnish products as indicated.

C. Ensure that substrates are in suitable condition to receive the work.

D. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.03 Installation

A. Place rigid insulation with all edges in contact.

B. Carefully cut and fit insulation around pipes, conduits and other obstructions. If water piping is located on inside of insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
C. Do not compress insulation in excess of 10 percent.

D. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice and snow.

E. Meet the insulation manufacturer’s written instructions applicable to products and application indicated.

F. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

3.04 Installation of General Building Insulation

A. Apply insulation units to substrates by method indicated, meeting the manufacturer’s written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Set vapor retarder faced units with vapor retarder to warm side of construction, unless otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.

1. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

C. Install board insulation on concrete substrates by adhesively attached, spindle type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to the anchor manufacturer’s written instructions. Space anchors according to the insulation manufacturer’s written instructions for insulation type, thickness and application indicated.

2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.

3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation retaining washers, taking care not to compress insulation below indicated thickness.

4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.05 Installation of Vapor Retarders

A. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping not less than two (2) wall studs. Fasten vapor retarders to framing at top, end and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches on center.

C. Seal overlapping joints in vapor retarders with adhesives or vapor retarder tape according to the vapor retarder manufacturer’s instructions. Seal butt joints and fastener penetrations with vapor retarder tape. Locate all joints over framing members or other solid substrates.
D. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by the vapor retarder manufacturer.

E. Seal joints caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with vapor retarder tape to create an airtight seal between penetrating objects and vapor retarder.

F. Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor retarder tape or another layer of vapor retarder.

3.06 Protection

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION
SECTION 07500

MEMBRANE ROOFING

PART 1 - GENERAL

1.01 Description

A. Section includes the following membrane roofing items:

1. Adhered ethylene-propylene-diene-monomer (EPDM) roofing system.
2. Vapor retarder.
3. Roof insulation.
4. Roof pavers.
5. Roof drain.

1.02 Related Sections

A. Section 07620 – Sheet Metal Flashing and Trim
B. Section 07720 – Roof Accessories
C. Section 07900 – Joint Sealers

1.03 Submittals

A. Submit product data for each type of product.
B. Submit shop drawings for roofing system including plans, elevations, sections, details and attachments to other work, including:

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of roofing and fastening spacing and patterns for mechanically fastened roofing.
4. Insulation fastening patterns for corner, perimeter and field-of-roof locations.
C. Submit samples for verification of the following products:

1. Sheet roofing, of color required.
D. Submit qualification data for the installer and the manufacturer.
E. Submit manufacturer certificates signed by the roofing manufacturer certifying that roofing system meets the requirements specified in Article 2.02 in this Section.

1. Submit evidence of meeting the performance requirements.
F. Submit product test reports for components of roofing system, tests performed by the manufacturer and witnessed by a qualified testing agency.
G. Submit research/evaluation reports for components of roofing system, from ICC-ES.
H. Submit field quality control reports.
I. Submit sample warranties for the manufacturer's special warranties.
J. Submit maintenance data for roofing system to be included in maintenance manuals.

1.04 Quality Assurance

A. A qualified manufacturer that is UL listed or FM Global approved for roofing system identical to that used for this Contract.

B. A qualified firm that is approved, authorized, or licensed by the roofing system manufacturer to install the manufacturer's product and that is eligible to receive the manufacturer's special warranty.

C. Meet the applicable provisions of the most recent issues of the following references:

16. FM Global 4450, Approval Standard for Class 1 Insulated Steel Deck Roofs.

1.05 Delivery, Storage and Handling
A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with the manufacturer’s name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by the roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling and other sources. Store in a dry location. Meet the insulation manufacturer’s written instructions for handling, storing and protecting during installation.
D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.06 Definitions
A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA’s "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.07 Pre-installation Meetings
A. Preliminary roofing conference to be completed a minimum of thirty (30) days before starting roof deck construction. Conduct conference at the Project site.
   1. Meet with SEPTA, SEPTA's insurer if applicable, the testing and inspecting agency representative, the roofing installer, the roofing system manufacturer's representative, the deck installer, and the installers whose work interfaces with or affects roofing, including the installers of roof accessories and roof mounted equipment.
   2. Review methods and procedures related to roofing installation, including the manufacturer’s written instructions.
   3. Review and finalize construction schedule, and verify availability of materials, the installer's personnel, equipment and facilities needed to make progress and avoid delays.
   4. Examine substrate conditions and finishes for compliance with requirements, including flatness and fastening.
   5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs and condition of other construction that affects roofing system.

7. Review governing regulations and requirements for insurance and certificates if applicable.

8. Review temporary protection requirements for roofing system during and after installation.

9. Review roof observation and repair procedures after roofing installation.

B. Pre-installation roofing conference to be completed a minimum of ten (10) days prior to the start of work. Conduct conference at the Project site.

1. Meet with SEPTA, SEPTA's insurer if applicable, the testing and inspecting agency representative, the roofing installer, the roofing system manufacturer's representative, the deck installer, and the installers whose work interfaces with or affects roofing, including the installers of roof accessories and roof mounted equipment.

2. Review methods and procedures related to roofing installation, including the manufacturer's written instructions.

3. Review and finalize construction schedule, and verify availability of materials, the installer's personnel, equipment and facilities needed to make progress and avoid delays.

4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.

5. Review structural loading limitations of roof deck during and after roofing.

6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs and condition of other construction that affects roofing system.

7. Review governing regulations and requirements for insurance and certificates if applicable.

8. Review temporary protection requirements for roofing system during and after installation.

9. Review roof observation and repair procedures after roofing installation.

1.08 Field Conditions

A. Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to the manufacturer's written instructions and warranty requirements.

1.09 Warranty

A. The manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

B. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers and other components of roofing system.
C. Warranty period to be thirty (30) years from date of substantial completion.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Manufacturers:
   1. Carlisle SynTec, Inc.
   2. Firestone Building Products.
   4. Or Approved Equal.

B. Obtain components, including roof insulation, fasteners, fastening plates and edgings for roofing system, from the same manufacturer as membrane roofing or approved by the membrane roofing manufacturer.

2.02 Performance Requirements

A. Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement and exposure to weather without failure due to defective manufacture, fabrication, installation or other defects in construction. Roofing and base flashings shall remain watertight.
   1. Roofing system shall withstand two thousand (2000) hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
   2. Roofing system shall resist impact damage when tested according to ASTM D 3746/D 3746M or ASTM D 4272/D 4272M.

B. Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by the roofing manufacturer based on testing and field experience.

C. Roofing, base flashings and component materials to meet the requirements in FM Global 4450 or FM Global 4470 as part of a roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
   1. Fire/windstorm classification to be Class 1A-90.
   2. Hail resistance rating to be MH.

D. Solar reflectance index to be not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

E. Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low slope roof products.

2.03 EPDM Roofing

A. ASTM D 4637/D 4637M uniform, flexible EPDM sheet.
   1. Thickness to be 90 mils, nominal.
2. Exposed face color to be white.

2.04 Auxiliary Roofing Materials

A. Auxiliary materials recommended by the roofing system manufacturer for intended use and compatible with roofing.

1. Liquid type auxiliary materials shall meet the VOC limits of authorities having jurisdiction.

2. Adhesives and sealants that are not on the exterior side of weather barrier shall meet the following limits for VOC content:
   a. Plastic foam adhesives to be 50 g/L.
   b. Gypsum board and panel adhesives to be 50 g/L.
   c. Multipurpose construction adhesives to be 70 g/L.
   d. Fiberglass adhesives to be 80 g/L.
   e. Single-ply roof membrane adhesives to be 250 g/L.
   f. Single-ply roof membrane sealants to be 450 g/L.
   g. Non-membrane roof sealants to be 300 g/L.
   h. Sealant primers for non-porous substrates to be 250 g/L.
   i. Sealant primers for porous substrate to be 775 g/L.
   j. Other adhesives and sealants to be 250 g/L.

B. Sheet flashing to be 60 mil thick EPDM, partially cured or cured, according to application.

C. Protection sheet to be epichlorohydrin or neoprene non-reinforced flexible sheet, 55 mil to 60 mil thick, recommended by the EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease and oil.

D. Bonding adhesive to be the manufacturer's standard.

E. Modified asphaltic fabric backed membrane adhesive to be the roofing system manufacturer's standard modified asphalt, asbestos free, cold applied adhesive formulated for compatibility and use with fabric backed membrane roofing.

F. Water based, fabric backed membrane adhesive to be the roofing system manufacturer’s standard water based, cold applied adhesive formulated for compatibility and use with fabric backed membrane roofing.

G. Low rise, urethane, fabric backed membrane adhesive to be the roof system manufacturer's standard spray applied, low rise, two (2) component urethane adhesive formulated for compatibility and use with fabric backed membrane roofing.

H. Seaming material to be the manufacturer's standard, synthetic rubber polymer primer and 3 inch wide minimum, butyl splice tape with release film.

I. Lap sealant to be the manufacturer's standard, single component sealant, colored to match membrane roofing.

J. Water cutoff mastic to be the manufacturer's standard butyl mastic sealant.

K. Metal termination bars to be the manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 inch by 1/8 inch thick; with anchors.
L. Metal battens to be the manufacturer’s standard, aluminum zinc alloy coated or zinc coated steel sheet, approximately 1 inch wide by 0.05 inch thick, pre-punched.

M. Fasteners to be factory coated steel fasteners and metal or plastic plates meeting the corrosion resistance provisions in FM Global 4470, designed for fastening membrane to substrate and acceptable to the roofing system manufacturer.

N. Provide pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips and other accessories.
   1. Provide white flashing accessories for white EPDM membrane roofing.

O. Liquid coating to be a product specifically formulated for coating EPDM membrane roofing, as follows:
   1. Type to be acrylic emulsion.
   2. Type to be chlorosulfonated polyethylene meeting ASTM D 3468/D 3468M.
   3. Color to be as selected by SEPTA from the manufacturer's full range.

2.05 Vapor Retarder

A. Polyethylene film to meet ASTM D 4397, 6 mils thick, minimum, with maximum permeance rating of 0.13 perm.
   1. The manufacturer's standard lap adhesive, FM Global approved for vapor retarder application.

B. Laminated sheet to be polyethylene laminate, two (2) layers, reinforced with cord grid, with maximum permeance rating of 0.06 perm.
   1. Pressure sensitive tape of type recommended by the vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

C. Self-adhering sheet vapor retarder to meet ASTM D 1970, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40 mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

2.06 Roof Insulation

A. Preformed roof insulation boards manufactured by the EPDM roofing manufacturer, selected from the manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global approved roof insulation.

B. Polyisocyanurate board insulation to meet ASTM C 1289, Type II, Class 1, Grade 3, felt or glass fiber mat facer on both major surfaces.

C. Provide factory tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

D. Provide preformed saddles, crickets, tapered edge strips and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
2.07 Insulation Accessories
   A. Roof insulation accessories recommended by the insulation manufacturer for intended use and compatibility with roofing.
   B. Factory coated steel fasteners and metal or plastic plates meeting the corrosion resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate and acceptable to the roofing system manufacturer.
   C. Cover board to meet ASTM C 208, Type II, Grade 2, cellulosic fiber insulation board, 1/2 inch thick.

2.08 Walkways
   A. Factory formed, nonporous, heavy duty, solid rubber, slip resisting, surface textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to the roofing system manufacturer.

2.09 Low Profile Roof Drain
   A. Cast iron body with combination membrane flashing clamp/gravel guard and low silhouette cast iron dome, painted to match color of adjacent roof surface.

PART 3 - EXECUTION

3.01 Examination
   A. Examine substrates, areas and conditions, with the installer present, for compliance with requirements and other conditions affecting performance of the work:
      1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof drain bodies are securely clamped in place.
      2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
      3. Verify that surface plane flatness and fastening of steel roof deck meets the requirements.
      4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
      5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation
   A. Clean substrate of dust, debris moisture and other substances detrimental to roofing installation according to the roofing system manufacturer's written instructions. Remove sharp projections.
B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof drain plugs when no work is taking place or when rain is forecast.

C. Install insulation strips according to the acoustical roof deck manufacturer's written instructions.

### 3.03 Roofing Installation

A. Install roofing system according to the roofing system manufacturer's written instructions.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition.

### 3.04 Substrate Board Installation

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

1. Fasten substrate board to top flanges of steel deck according to recommendations in FM Global’s "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

2. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter and field of roof according to the roofing system manufacturers' written instructions.

### 3.05 Vapor Retarder Installation

A. Loosely lay polyethylene film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches and 6 inches, respectively. Continuously seal side and end laps with tape.

B. Loosely lay laminate sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches and 6 inches, respectively. Continuously seal side and end laps with tape.

C. Prime substrate if required by the manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3 1/2 inches and 6 inches, respectively. Seal laps by rolling.

D. Completely seal vapor retarder at terminations, obstructions and penetrations to prevent air movement into roofing system.

### 3.06 Insulation Installation

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
B. Meet the roofing system and the insulation manufacturer’s written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two (2) or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

   1. Where installing composite and non-composite insulation in two (2) or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

   1. Cut and fit insulation within 1/4 inch of nailers, projections and penetrations.

G. Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board type roof insulation to deck type.

   1. Fasten insulation according to requirements in FM Global’s "RoofNav" for specified Windstorm Resistance Classification.

H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck.

   1. Fasten cover boards according to requirements in FM Global’s "RoofNav" for specified Windstorm Resistance Classification.

3.07 Adhered Membrane Roofing Installation

A. Adhere fabric backed roofing over area to receive roofing according to the membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.

B. Start installation of roofing in presence of the roofing system manufacturer's technical personnel.

C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by the manufacturer. Stagger end laps.

D. Apply bonding adhesive to substrate and underside of roofing at rate required by the manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.

E. Apply fabric backed membrane adhesive to substrate at rate required by the manufacturer and install fabric backed roofing.

F. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations and perimeters.
G. Apply roofing with side laps shingled with slope of roof deck where possible.

H. Clean both faces of splice areas, apply splicing cement and firmly roll side and end laps of overlapping roofing according to the manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.

   1. Apply a continuous bead of in-seam sealant before closing splice if required by the roofing system manufacturer.

I. Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing according to the manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.

J. Repair tears, voids and lapped seams in roofing that do not meet the requirements.

K. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

L. Adhere protection sheet over membrane roofing at locations indicated.

3.08 Base Flashing Installation

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to the roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.09 Field Quality Control

A. The Contractor shall engage a third party qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to SEPTA.

B. Flood test each roofing area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains and flood with potable water.

   1. Flood to an average depth of 2 1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.

   2. Flood each area for twenty-four (24) hours.

   3. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
C. Arrange for the roofing system manufacturer's technical personnel to inspect roofing installation on completion.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not meet the specified requirements.

E. Additional testing and inspecting, at the Contractor's expense, will be performed to determine if replaced or additional work meets the specified requirements.

3.10 Walkway Installation
A. Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to the roofing system manufacturer's written instructions.

3.11 Protection and Cleaning
A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to SEPTA.

B. Correct deficiencies in or remove membrane roofing system that does not meet the requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of substantial completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by the manufacturer of affected construction.

3.12 Roofing Installer's Warranty Sample
WHEREAS _______________________________ of ___________________________, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following Project:

Owner: <Insert name of Owner>.
Address: <Insert address>.

Building Name/Type: <Insert information>.
Address: <Insert address>.

Area of Work: <Insert information>.
Acceptance Date: _________________.

Warranty Period: <Insert time>.
Expiration Date: __________________.

AND WHEREAS the Roofing Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period.

NOW THEREFORE the Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or
cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

This Warranty is made subject to the following terms and conditions:

Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

- lightning; peak gust wind speed fire; failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration and decomposition; faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work; vapor condensation on bottom of roofing; and activity on roofing by others, including construction contractors, maintenance personnel, other persons and animals, whether authorized or unauthorized by the Owner.

When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.

Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.

During Warranty Period, if the Owner allows alteration of work by anyone other than the Roofing Installer, including cutting, patching and maintenance in connection with penetrations, attachment of other work and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the Owner engages the Roofing Installer to perform said alterations, Warranty shall not become null and void unless the Roofing Installer, before starting said work, shall have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

The Owner shall promptly notify the Roofing Installer of observed, known or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for the Roofing Installer to inspect work and to examine evidence of such leaks, defects or deterioration.

This Warranty is recognized to be the only warranty of the Roofing Installer on said work and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve the Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents,
regardless of whether Contract was a Contract directly with the Owner or a subcontract with the Owner's Contractor.

IN WITNESS THEREOF, this instrument has been duly executed this _____________ day of ______________________, ________________.

Authorized Signature: ______________________________.
Name: ________________________________.
Title: ________________________________.

END OF SECTION
SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 Description
   A. Requirements for galvanized flashing and trim.
   B. Synthetic underlayment to prevent corrosion between sheet metal and pressure treated wood.

1.02 Related Sections
   A. Section 01300 – Submittals
   B. Section 05500 – Metal Fabrications
   C. Section 06105 – Miscellaneous Carpentry
   D. Section 07500 – Membrane Roofing
   E. Section 07900 – Joint Sealers

1.03 Submittals
   A. Submit product data for each type of product and accessory indicated. Include construction details, material descriptions, dimension of individual components and profiles, and finishes.
   B. Submit shop drawings showing layouts of sheet metal flashing and trim, including plans, elevations, sections and details. Distinguish between shop and field assembled work. Include the following:
      1. Identify material, thickness, weight and finish for each item and location in Contract.
      2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams and dimensions.
      3. Details for fastening, joining, supporting and anchoring sheet metal flashing and trim, including layout and spacing of fasteners, clips, cleats and attachments to adjoining work.
      4. Details for termination points and assemblies, expansion joints and expansion covers, edge conditions including eaves, ridges, valleys, rakes, crickets and counter-flashings.
   C. Submit samples for verification of each type of exposed finish required, prepared on samples of size indicated below:
      1. Sheet metal flashing to be 12 inches long. Include fasteners, cleats, clips, closures and other attachments.
      2. Trim to be 12 inches long. Include fasteners and other exposed accessories.
      3. Accessory samples to be full size.
      4. Annodized aluminum samples to show full range to be expected for each color required.
D. All submittals are to be in accordance with Section 01300.

E. Submit sample warranty for special warranty.

F. Submit maintenance data for sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

G. Submit product test reports for each product performed by a qualified testing agency.

H. Submit product certificates for each type of coping and roof edge flashing that is SPRI ES-1 tested and FM Approvals approved.

1.04 Quality Assurance

A. Provide a fabricator regularly engaged in the fabrication of each specified material whose products have a successful record of in service performance.

B. Meet the "Architectural Sheet Metal Manual", as published by the Sheet Metal and Air Conditioning Design Builder National Association, Inc. (SMACNA) and these Specifications. Conform to dimensions and profiles shown unless more stringent requirements are indicated.

C. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leak-proof, secure and noncorrosive installation.

D. Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical roof eave fascia, fascia trim, approximately 48 inches long, including supporting construction cleats, seams, attachments, underlayment and accessories.
   2. Approval of mockups is for other material and construction qualities specifically approved by SEPTA in writing.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by SEPTA in writing.
   4. Approval mockups may become part of the completed work if undisturbed at time of substantial completion.

E. Underlayment is required for separation of sheet metal and pressure treated wood regardless of any manufacturers printed literature or statement indicating underlayment is not required.

F. Exposed fasteners shall not be acceptable.

G. Meet the applicable provisions of the most recent issues of the following references:
   1. AAMA 621, Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zing-Aluminum Coated Steel Substrates.
3. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
10. AWS A5.22, Specification for Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods.
11. FS O-F-506, Flux Soldering Paste Liquid.
13. FS TT-C-494, Coating Compound, Bituminous, Solvent Type, Acid Resistant.
16. Sheet Metal and Air Conditioning Contractors' Association (SMACNA).

1.05 Delivery, Storage and Handling

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weather-tight and ventilated covering. Do not store sheet metal flashing and trim material in contact with other materials that might cause staining, denting or other surface damage.

1.06 Coordination

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints and seams to provide leak-proof, secure and noncorrosive installation.
1.07 Pre-installation Meeting

A. Conduct a pre-installation conference at Project site.
   1. Review construction schedule. Verify availability of materials, the installer's personnel, equipment and facilities needed to make progress and avoid delays.
   2. Review special roof details, roof drainage, roof penetration flashing, equipment curbs and condition of other construction that affect sheet metal flashing and trim.
   3. Review requirements for insurance and certificates if applicable.
   4. Review sheet metal flashing observation and repair procedures after flashing installation

1.08 Warranty

A. The manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory applied finishes within specified warranty period.
   1. Deterioration to exposed metal finish includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling or failure of paint to adhere to bare metal.
   2. Finish warranty period to be identical to roof warranty from date of final acceptance.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement and exposure to weather without failure due to defective manufacture, fabrication, installation or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet metal standard for flashing and trim to meet NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Manufacture and install copings and roof edge flashings that are listed in FM Approvals "RoofNav" and approved for windstorm classification, Class 1A-90. Identify materials with name of fabricator and design approved by FM Approvals.

D. Manufacture and install copings tested according to SPRI ES-1 and capable of resisting the following design pressure:
   1. Design pressure to be as indicated on the Contract Drawings.

E. Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
   1. Temperature change to be 120°F, ambient; 180°F, material surfaces.
2.02 Materials
   A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
   B. Sheet metal to be galvanized steel to meet ASTM A 653/A 653M commercial quality G 90.
   C. Stainless steel to meet ASTM A 240/A 240M or ASTM A 666, Type 316, dead soft, fully annealed; with smooth, flat surface.
   D. Flux for solder to meet FS O-F-506, Type I for galvanized metal.
   E. Solder to meet ASTM B 32, 63 percent tin and 37 percent lead.
   F. Electrodes to meet AWS A5.22, Type E308L-16.
   G. Nails, screws and rivets to be 18-8 stainless steel.
   H. Tin to be new block material, commercial tin.
   I. Plastic cement to meet FS SS-C-153.
   J. Bituminous coating to meet FS TT-C-494

2.03 Parapet Scuppers
   A. Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4 inch wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following material:
      1. Galvanized steel to be 0.028 inch thick.

2.04 Underlayment Materials
   A. Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220°F; and meeting the physical requirements of ASTM D 226/D 226M for Type I and Type II felts.
      1. Basis of design is ATAS ATA Shield Underlayment Or Approved Equal.
      2. Synthetic underlayment shall be installed between sheet metal and pressure treated wood.

2.05 Finishes
   A. Provide zinc coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 coating designation pre-painted by coil coating process to meet ASTM A 755/A 755M.
      1. Surface to be smooth, flat.
      2. Exposed Coil Coated Finish:
         a. Three (3) coat fluoropolymer to meet AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat and apply coating to exposed metal surfaces to meet the coating and resin manufacturers' written instructions.
      3. Color as selected by SEPTA from the manufacturer's full range.
4. Pretreat with manufacturer's standard white or light colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil for concealed finish.

2.06 Low Slope Roof Sheet Metal Fabrications

A. Fabricate copings in minimum 96 inch long, but not exceeding 10 foot long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
   1. Joint style to be butt, with 12 inch wide concealed backup plate.
   2. Fabricate copings from the following material:
      a. Galvanized steel to be 0.040 inch thick.

B. Fabricate roof and roof to wall transition expansion joint cover from the following material:
   1. Galvanized steel to be 0.034 inch thick.

C. Fabricate base flashing from the following material:
   1. Galvanized steel to be 0.028 inch thick.

D. Fabricate counter-flashing from the following material:
   1. Galvanized steel to be 0.022 inch thick.

E. Fabricate flashing receivers from the following material:
   1. Galvanized steel to be 0.022 inch thick.

F. Fabricate roof penetration flashing from the following material:
   1. Galvanized steel to be 0.028 inch thick.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates, areas and conditions, with the installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
   1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage and securely anchored.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation

A. Transmit submittals required by this Section.
B. Furnish products as indicated.
C. Ensure that substrates are in suitable condition to receive the work.

3.03 Fabrication and Installation

A. Fabricate and install in conformance with the "Architectural Sheet Metal Manual", as
published by the Sheet Metal and Air Conditioning Design Builder National Association, Inc. (SMACNA) and these Specifications.

### 3.04 Forming

A. Form sheet metal to the dimensions and shapes required with molded and broken surfaces true and angles accurate.

B. Form flat locked seams that are not subject to stress, 1/2 inch wide. Flat locked seams that are subject to stress, 1 inch wide.

C. Form lap expansion seams not less than 4 inches wide and fill with white lead or other caulking material.

D. Cap flat seams in the direction of flow where exposed to the weather.

E. Provide 1/2 inch hem (minimum) at exposed edges of sheet metal.

F. Provide a minimum of one (1) lap expansion seam in any straight run of 4 feet or more, not more than 8 feet from any corner and at not more than 16 feet on center in straight runs.

G. Punch or drill and rivet, providing invisible rivets and seams, where multiple layers of metal occur. Continuously solder or weld the folded edges and wipe or grind smooth to provide texture to match surrounding metal.

H. Fabricate flashing for corners of the building at least 4 feet long in each direction.

I. Minimum radius of break in sheet metal shall be twice the thickness of the metal.

J. Miter corners and join by locked and soldered joints.

K. Furnish and install reglets for flashing in the forms for concrete and within other materials.

### 3.05 Welding

A. Weld with direct current, reverse polarity equipment utilizing the minimum current to minimize distortion of the metal.

B. Utilize start and run-off tabs to assure uniformity of weld terminations.

### 3.06 Soldering

A. Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edge of sheets to be soldered to a width of 1 1/2 inches except where pre-tinned surface would show in finished work.

1. Do not solder pre-painted, metallic coated steel.

2. Do not use open flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

### 3.07 Installation

A. Install sheet metal with continuous concealed clips of the same gauge, in lengths not exceeding 8 feet, spaced 1/8 inch apart for expansion and fastened to the structure at not more than 8 inches on center. Fold fastened edge of the clips back over the fastener.
B. Secure flashing in reglets with not less than two (2) 3/4 inch lead wedges spaced at not more than 24 inches on center. Apply sealant to cover the wedges and provide a weather-tight joint.

C. Install sleeves for roof penetrations with 4 inch flanges and 10 inch high flared top counter flashing with 1/8 inch by 1 1/2 inch drawband. Sleeves shall match metal standing seam roofing configuration.

D. Provide pitch dams and install in plastic cement.

E. Anchor sheet metal flashing and trim and other components of the work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants and other miscellaneous items as required to complete sheet metal flashing and trim system.
   1. Torch cutting of sheet metal flashing and trim is not permitted.

F. Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by the fabricator or the manufacturers of dissimilar metals.
   1. Coat side of uncoated aluminum, stainless steel and lead sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal or cementitious construction.
   2. Where installing metal flashing directly on cementitious or wood substrates, install a course of underlayment and cover with a slip sheet or install a course of polyethylene underlayment.

G. Install exposed sheet metal flashing and trim without excessive oil canning, buckling and tool marks.

H. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds and elastomeric sealant.

I. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   1. Space cleats not more than 12 inches apart. Anchor each cleat with two (2) fasteners. Bend tabs over fasteners.

J. Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.

K. Use fasteners of sizes that will penetrate substrate not less than recommended by the fastener manufacturer to achieve maximum pull out resistance.
   1. Exposed fasteners shall not be accepted.
3.08 Underlayment Installation
A. Install synthetic underlayment, wrinkle free, according to the manufacturers' written instructions and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

3.09 Roof Drainage System Installation
A. Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

3.10 Roof Flashing Installation
A. Install sheet metal roof flashing and trim to meet the 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.
B. Anchor roof edge flashing to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
   1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 24 inch centers.
C. Anchor copings to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
   1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 24 inch centers.
   2. Anchor interior leg of coping with screw fasteners and washers at 24 inch centers.
D. Install counter-flashing umbrella for pipe or post with close fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.
E. Coordinate installation of counter-flashing with installation of base flashing. Insert counter-flashing in reglets or receivers and fit tightly to base flashing. Extend counter-flashing 4 inches over base flashing. Lap counter-flashing joints a minimum of 4 inches and bed with elastomeric sealant.
   1. Secure in a waterproof manner by means of interlocking folded seam or blind rivets and sealant.
F. Coordinate installation of roof penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
   1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
   2. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.11 Wall Flashing Installation
A. Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall opening components such as windows, doors and louvers.

B. Install continuous head, sill, jamb and similar flashings to extend 4 inches beyond wall openings for openings in frame construction.

3.12 Miscellaneous Flashing Installation

A. Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.13 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
SECTON 07720
ROOF ACCESSORIES

PART 1 - GENERAL

1.01 Description
A. Section includes the following roof accessory items:
   1. Roof curbs.
   2. Equipment supports.
   3. Preformed flashing sleeves.

1.02 Related Sections
A. Section 05500 – Metal Fabrications
B. Section 07500 – Membrane Roofing
C. Section 07620 – Sheet Metal Flashing and Trim
D. Section 09910 – Paints and Coatings
E. Section 15700 - Heating, Ventilating and Air Conditioning Equipment
F. Section 16070 - Hangers, Anchors and Supports

1.03 Submittals
A. Submit product data for each type of roof accessory.
   1. Include construction details, material descriptions, dimensions of individual components
      and profiles, and finishes.
B. Submit shop drawings for roof accessories.
   1. Include plans, elevations, keyed details and attachments to other work. Indicate
      dimensions, loadings and special conditions. Distinguish between plant and field
      assembled work.
C. Submit samples for each exposed product and for each color and texture specified,
   prepared on samples of size to adequately show color.
D. Submit delegated design submittal for roof curbs and equipment supports indicated to meet
   the performance requirements and design criteria, including analysis data signed and sealed
   by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for
   their preparation.
   1. Detail mounting, securing and flashing of roof mounted items to roof structure. Indicate
      coordinating requirements with roof membrane system.
   2. Detail fabrication and attachment of wind restraints. Show anchorage details and
      indicate quantity, diameter and depth of penetration of anchors.
E. Submit coordination roof plan drawings, drawn to scale, and coordinating penetrations and roof mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof mounted items including mechanical and electrical equipment, ductwork, piping and conduit.
4. Required clearances.

F. Submit sample warranties for the manufacturer’s special warranties.

G. Submit operation and maintenance data for roof accessories to include in operation and maintenance manuals.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. AAMA 611, Voluntary Specification for Anodized Architectural Aluminum.
2. AAMA 621, Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zing-Aluminum Coated Steel Substrates.
10. ASTM A 500/A 500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
12. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
32. MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
33. MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.
34. National Association of Architectural Metal Manufactures (NAAMM).
35. NFPA 204, Standard for Smoke and Heat Venting.
36. UL 972, Burglary-Resisting Glazing Material.
1.05 Delivery, Storage and Handling

A. Delivery:
   1. Schedule delivery of materials at the site at such time as required for proper coordination of work. Receive materials in the manufacturer’s unopened packages and bearing the manufacturer’s label.

B. Storage and Handling:
   1. Store materials in a dry and well ventilated place, adequately protected from damage and exposure to the elements.

1.06 Coordination

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leak-proof, weather-tight, secure and noncorrosive installation.

B. Coordinate dimensions with rough-in information or shop drawings of equipment to be supported.

1.07 Warranty

A. The manufacturer's standard form in which the manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory applied finishes within specified warranty period.

   1. Fluoropolymer finish deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling or failure of paint to adhere to bare metal.

   2. Finish warranty period to be ten (10) years from date of final acceptance.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking or fastener disengagement due to defective manufacture, fabrication, installation or other defects in construction.

B. Engage a Professional Engineer licensed in the Commonwealth of Pennsylvania to design roof curbs and equipment supports to meet the wind performance requirements, including comprehensive engineering analysis using performance requirements and design criteria indicated.

C. Wind restraint performance as indicated on the Contract Drawings.

2.02 Roof Curbs

A. Internally reinforced roof curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on the Contract Drawings, bearing continuously on roof structure, and capable of meeting performance
requirements; with welded or mechanically fastened and sealed corner joints, straight sides and integrally formed deck mounting flange at perimeter bottom.

B. Coordinate dimensions with roughing-in information on shop drawings of equipment to be supported.

C. Refer to the Contract Drawings for the supported load capacity.

D. Material to be zinc coated (galvanized) steel sheet, 0.052 inch thick minimum.
   1. Finish to be two (2) coat fluoropolymer.
   2. Color as selected by SEPTA from the manufacturer's full range.

E. Construction:
   1. Curb profile to be the manufacturer's standard compatible with roofing system.
   2. On ribbed or fluted metal roofs, form deck mounting flange at perimeter bottom to conform to roof profile.
   3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
   4. Level top of curb with roof slope accommodated by use of leveler frame.
   5. Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
   6. Factory insulated with 1 1/2 inch thick glass fiber board insulation.
   7. Liner to be the same material as curb, of the manufacturer's standard thickness and finish.
   8. Factory installed wood nailer continuous around curb perimeter.
   9. Provide wind restraint straps, welded strap connectors and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
   10. Where portion of roof curb is not covered by equipment, provide weather-tight platform cap formed from 3 inch thick plywood covered with metal sheet of same type, thickness and finish as required for curb.
   11. Metal counter-flashing to be the manufacturer's standard, removable, fabricated of same metal and finish as curb.
   12. Provide security grille where indicated.
   13. Provide damper tray or shelf with opening of size indicated.

2.03 Equipment Supports

A. Internally reinforced perimeter or rail type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on the Contract Drawings, spanning between structural supports; capable of meeting performance requirements; with welded corner joints and integrally formed structure-mounting flange at bottom.
B. Coordinate dimensions with roughing-in information or shop drawings of equipment to be supported.

C. Supported Load Capacity: Shall be coordinated with the requirements of Section 15700 and Section 16070.

D. Material to be zinc coated (galvanized) steel sheet, 0.052 inch thick minimum.
   1. Finish to be two (2) coat fluoropolymer.
   2. Color as selected by SEPTA from the manufacturer's full range.

E. Construction:
   1. Curb profile to be the manufacturer's standard compatible with roofing system.
   2. Factory insulated with 1 1/2 inch thick glass fiber board insulation.
   3. Liner to be the same material as equipment support, of the manufacturer's standard thickness and finish.
   4. Factory installed wood nailers continuous around support perimeter.
   5. Provide wind restraint straps, welded strap connectors and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
   6. Where portion of equipment support is not covered by equipment, provide weather tight platform cap formed from 3/4 inch thick plywood covered with metal sheet of same type, thickness and finish as required for curb.
   7. Metal counter-flashing to be the manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
   8. On ribbed or fluted metal roofs, form deck mounting flange at perimeter bottom to conform to roof profile.
   9. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
   10. Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.
   11. Provide security grilles where indicated.

2.04 Pipe and Duct Supports

A. Fixed height cradle type pipe supports to be polycarbonate pipe stand accommodating up to 1 1/2 inch diameter pipe or conduit; with provision for pipe retainer and with the manufacturer's support pad or deck plate as recommended for penetration free installation over roof membrane type; as required for quantity of pipe runs and sizes.

B. Fixed height roller bearing pipe supports to be polycarbonate pipe stand with stainless steel roller carrying assembly accommodating up to 7 inch diameter pipe or conduit; with provision for pipe retainer and with the manufacturer's support pad or deck plate as recommended for penetration free installation over roof membrane type; as required for quantity of pipe runs and sizes.
C. Adjustable height roller bearing pipe supports to be polycarbonate pipe stand base, pipe support and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating up to 18 inch diameter pipe or conduit; with provision for pipe retainer and with the manufacturer's support pad or deck plate as recommended for penetration free installation over roof membrane type; as required for quantity of pipe runs and sizes.

D. Adjustable height structure mounted pipe supports to be extruded aluminum tube, filled with urethane insulation; 2 inches in diameter; accommodating up to 7 inch diameter pipe or conduit, with provision for pipe retainer; with aluminum baseplate, EPDM base seal, the manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, stainless steel roller and retainer, and extruded aluminum carrier assemblies; as required for quantity of pipe runs and sizes.

E. Curb mounted pipe supports to be galvanized steel support with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck mounting flange at perimeter bottom; with adjustable height roller bearing pipe support accommodating up to 20 inch diameter pipe or conduit and with provision for pipe retainer; as required for quantity of pipe runs and sizes.

F. Duct supports to be extruded aluminum, urethane insulated supports, 2 inches in diameter; with the manufacturer's recommended hardware for mounting to structure or structural roof deck.
   1. Finish to be manufacturer's standard.

2.05 Pipe Portals

A. Curb mounted pipe portal to be insulated roof curb units with welded or mechanically fastened and sealed corner joints, straight sides and integrally formed deck mounting flange at perimeter bottom; with weather-tight curb cover with single or multiple collared openings and pressure sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless steel snaplock swivel clamps.

B. Flashing pipe portal to be formed aluminum membrane mounting flashing flange and sleeve with collared opening and pressure sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

2.06 Preformed Flashing Sleeves

A. Exhaust vent flashing to be double walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and slotted metal collar.
   1. Metal to be aluminum sheet, 0.063 inch thick.
   2. Diameter as indicated on the Contract Drawings.
   3. Finish to be the manufacturer's standard.

B. Vent stack flashing to be metal flashing sleeve, uninsulated, with integral deck flange.
   1. Metal to be aluminum sheet, 0.063 inch thick.
   2. Height to be 7 inches.
3. Diameter as indicated on the Contract Drawings.
4. Finish to be the manufacturer's standard.

2.07 Metal Materials

A. Zinc coated (galvanized) steel sheet to meet ASTM A 653/A 653M, G90 coating designation and mill phosphatized for field painting where indicated.
   1. Mill phosphatized finish to be the manufacturer's standard for field painting.
   2. Where field painting is indicated, apply pretreatment and white or light colored, factory applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   3. Pre-painted by the coil coating process to meet ASTM A 755/A 755M. Prepare, pretreat and apply coating to exposed metal surfaces to meet the coating and resin manufacturers' written instructions.
      a. Two (2) coat fluoropolymer finish to meet AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
   4. After cleaning and pretreating, apply the manufacturer's standard two (2) coat, baked-on powder coat finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
   5. Pretreat with the manufacturer's standard white or light colored acrylic or polyester backer concealed finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Aluminum zinc alloy coated steel sheet to meet ASTM A 792/A 792M, AZ50 coated.
   1. Where field painting is indicated, apply pretreatment and white or light colored, factory applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   2. Pre-painted by the coil coating process to meet ASTM A 755/A 755M. Prepare, pretreat and apply coating to exposed metal surfaces to meet the coating and resin manufacturers' written instructions.
      a. Two (2) coat fluoropolymer finish to meet AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
   3. After cleaning and pretreating, apply the manufacturer's standard two (2) coat, baked-on enamel or powder coat finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
   4. Pretreat with the manufacturer's standard white or light colored acrylic or polyester backer concealed finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

C. Aluminum sheet to meet ASTM B 209, the manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
   1. Mill finish as manufactured.
   2. Where field painting is indicated, apply pretreatment and white or light colored, factory applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   3. Clear anodic finish to meet AAMA 611, or thicker.
4. Color anodic finish to meet AAMA 611, or thicker.

5. Prepare, pretreat and apply exposed coil coated finish to exposed metal surfaces to meet the coating and resin manufacturers' written instructions.
   a. Two (2) coat fluoropolymer finish to meet AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

6. Baked enamel or powder-coat finish to meet AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Meet the coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

7. Pretreat with the manufacturer's standard white or light colored acrylic or polyester backer concealed finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

D. Aluminum extrusions and tubes to meet ASTM B 221, the manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

E. Stainless steel sheet and shapes to meet ASTM A 240/A 240M or ASTM A 666, Type 304.

F. Steel shapes to meet ASTM A 36/A 36M, hot dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.

G. Steel tube to meet ASTM A 500/A 500M, round tube.

H. Galvanized steel tube to meet ASTM A 500/A 500M, round tube, hot dip galvanized according to ASTM A 123/A 123M.

I. Steel pipe to meet ASTM A 53/A 53M, galvanized.

2.08 Miscellaneous Materials

A. Provide materials and types of fasteners, protective coatings, sealants and other miscellaneous items required by the manufacturer for a complete installation.

B. Acrylic glazing to meet ASTM D 4802, thermoformable, monolithic sheet, manufacturer's standard, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).

C. Polycarbonate glazing to be thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar resistance rated according to UL 972 with an average impact strength of 12 to 16 ft-lbf/in. of width when tested according to ASTM D 256, Method A (Izod).

D. Cellulosic fiber board insulation to meet ASTM C 208, Type II, Grade 1, thickness as indicated.

E. Glass fiber board insulation to meet ASTM C 726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3°F x h x sq. ft./Btu x in. at 75°F, thickness as indicated.

F. Polyisocyanurate board insulation to meet ASTM C 1289, thickness and thermal resistivity as indicated.

G. Wood nailers to be softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and meeting AWPA C2; not less than 1 1/2 inches thick.

H. Bituminous coating to be cold applied asphalt emulsion that meets ASTM D 1187/D 1187M.
I. Underlayment:
   1. ASTM D 226/D 226M, Type II (No. 30), asphalt saturated organic felt, non-perforated.
   2. 6 mil thick polyethylene sheet that meets ASTM D 4397.
   3. Slip sheet building paper, 3 lb/100 sq. ft. minimum, rosin sized.
   4. Self-adhering, high temperature sheet to be a minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene film top surface laminated to layer of butyl or SBS modified asphalt adhesive, with release paper backing; cold applied. Provide primer when recommended by the underlayment manufacturer.
   5. The roof accessory manufacturers recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide non-removable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
      6. Fasteners for zinc coated or aluminum zinc alloy coated steel to be Series 300 stainless steel or hot dip zinc coated steel according to ASTM A 153/A 153M or ASTM F 2329.
      7. Fasteners for aluminum sheet to be aluminum or Series 300 stainless steel.
      8. Fasteners for stainless steel sheet to be Series 300 stainless steel.

J. Gaskets to be the manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene or cork.

K. Elastomeric sealant to meet ASTM C 920, elastomeric polyurethane polymer sealant as recommended by the roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

L. Butyl sealant to meet ASTM C 1311, single component, solvent release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

M. Asphalt roofing cement to meet ASTM D 4586/D 4586M, asbestos free, of consistency required for application.

2.09 General Finish Requirements

A. Meet NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates, areas, and conditions, with the installer present, to verify actual locations, dimensions and other conditions affecting performance of the work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage and securely anchored.
C. Verify dimensions of roof openings for roof accessories.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Installation

A. Install roof accessories according to the manufacturer's written instructions.
   1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
   4. Install roof accessories to resist exposure to weather without failing, rattling, leaking or loosening of fasteners and seals.

B. Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by the manufacturer.
   1. Coat concealed side of accessories with bituminous coating where in contact with wood, ferrous metal or cementitious construction.
   2. Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with the manufacturer's recommended slip sheet.
   3. Bed flanges in thick coat of asphalt roofing cement where required by the manufacturers of roof accessories for waterproof performance.

C. Install each roof curb so top surface is level.
D. Install equipment supports so top surfaces are level with each other.
E. Heat and Smoke Vent Installation:
   1. Install heat and smoke vent so top perimeter surfaces are level.
   2. Install and test heat and smoke vents and their components for proper operation according to NFPA 204.
F. Verify that gravity ventilators operate properly and have unrestricted airflow. Clean, lubricate and adjust operating mechanisms.
G. Pipe support installation to meet MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping and support together.
   1. Pipes of Various Sizes:
      a. Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
H. Secure flashing sleeve to roof membrane according to the flashing sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to the roof membrane manufacturer's instructions.
I. Seal joints with elastomeric or butyl sealant as required by the roof accessory manufacturer.

### 3.03 Repair and Cleaning

A. Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.

B. Touch up factory primed surfaces with compatible primer ready for field painting according to Section 09910.

C. Clean exposed surfaces according to the manufacturer’s written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION
SECTION 07900

JOINT SEALERS

PART 1 - GENERAL

1.01 Description
A. Section covers all sealant and caulking materials and their application, wherever required for complete installation of building materials or systems.

1.02 Related Sections
A. Section 01300 – Submittals
B. Section 04200 – Unit Masonry
C. Section 05120 – Structural Steel
D. Section 07620 – Sheet Metal Flashing and Trim

1.03 Submittals
A. Submit in accordance with Section 01300.
B. Submit manufacturer's installation instructions for each product used.
C. Submit samples for initial selection of the manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
D. Submit samples for verification of each kind and color of joint sealant required, provide samples with joint sealants in 1/2 inch wide joints formed between two (2) 6 inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
E. Submit joint sealant schedule to include the following information:
   1. Joint sealant application, joint location and designation.
   2. Joint sealant manufacturer and product name.
   3. Joint sealant formulation.
   4. Joint sealant color.
F. Submit the manufacturer's literature and data:
   1. Caulking compound.
   2. Primers.
   3. Sealing compound, each type, including compatibility when different sealants are in contact with each other.
   4. The manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
1.04 Quality Assurance

A. The installer is to be qualified in installing joint sealants similar in material, design, and extent to those indicated for this Contract and whose work has resulted in joint sealant installations with a record of successful in service performance.

B. Obtain each type of joint sealant through one (1) source from a single manufacturer.

C. Obtain test results from a qualified testing agency based on testing current sealant formulations within a twelve (12) month period.
   1. An independent testing agency qualified according to ASTM C 1021.
   2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
   3. Test elastomeric joint sealants according to SWRI’s Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion in peel and indentation hardness.
   4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

D. Before installing elastomeric sealants, field test their adhesion to joint substrates in accordance with the sealant manufacturer’s recommendations:
   1. Locate test joints where indicated or, if not indicated, as directed by the Contractor.
   2. Conduct field tests for each application indicated below:
      a. Each type of elastomeric sealant and joint substrate indicated.
      b. Each type of non-elastomeric sealant and joint substrate indicated.
   3. Notify SEPTA seven (7) days in advance of dates and times when test joints will be erected.
   4. Arrange for tests to take place with the joint sealant manufacturer’s technical representative present.

E. Project Conditions:
   1. Do not proceed with installation of joint sealants under the following conditions:
      a. When ambient and substrate temperature conditions are outside limits permitted by the joint sealant manufacturer or are below 40°F.
      b. When joint substrates are wet.
   2. Do not proceed with installation of joint sealants where joint widths are less than those allowed by the joint sealant manufacturer for applications indicated
   3. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

F. Meet the applicable provisions of the most recent issues of the following references:
5. ASTM C 919, Standard Practice for Use of Sealants in Acoustical Applications.

1.05 Delivery, Handling and Storage
A. Deliver materials in the manufacturers' original unopened containers, with brand names, date of manufacture, shelf life and material designation clearly marked thereon.
B. Carefully handle and store to prevent inclusion of foreign materials.
C. Do not subject to sustained temperatures exceeding 90°F or less than 40°F.

1.06 Field Conditions
A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by the joint sealant manufacturer or are below 40°F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by the joint sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.07 Warranty
A. Warranties specified in this Article shall not deprive SEPTA of other rights that SEPTA may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties under requirements of the Contract Documents.
B. Written installer’s warranty, signed by the installer agreeing to repair or replace elastomeric joint sealants that do not meet the performance and other requirements specified in this Section within specified warranty period.
   1. Warranty period to be two (2) years from date of final acceptance.
C. Written standard manufacturer’s warranty, signed by the elastomeric sealant manufacturer agreeing to furnish elastomeric joint sealants to repair or replace those that do not meet the performance and other requirements specified in this Section within specified warranty period.
   1. Warranty period to be twenty (20) years from date of final acceptance.

D. Warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
   1. Movement of the structure resulting in stresses on the sealant exceeding the sealant manufacturer’s written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
   2. Disintegration of joint substrates from natural causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 General
   A. Provide only products which are recommended and approved by their manufacturer for the specific use to which they are put and which meet all requirements of the Contract Documents.
      1. For each generic product, use only materials from one (1) manufacturer.
      2. Provide only materials, which are compatible with each other and with joint substrates.
      3. Colors of exposed sealers to match color of adjoining materials; to be approved by SEPTA.

2.02 Sealants
   A. S-1:
      1. ASTM C 920, polyurethane or polysulfide.
      2. Type M.
      3. Class 25.
      4. Grade NS.
   B. S-2:
      1. ASTM C 920, polyurethane or polysulfide.
      2. Type M.
      3. Class 25.
      4. Grade P.

C. S-3:
1. ASTM C 920, polyurethane or polysulfide.
2. Type S.
3. Class 25, joint movement range of plus or minus 50 percent.
4. Grade NS.
6. Minimum elongation of 700 percent.

D. S-4:
1. ASTM C 920 polyurethane or polysulfide.
2. Type S.
3. Class 25.
4. Grade NS.

E. S-5:
1. ASTM C 920, polyurethane or polysulfide.
2. Type S.
3. Class 25.
4. Grade P.

F. S-6:
1. ASTM C 920, silicone, neutral cure.
2. Type S.
3. Class to have joint movement range of plus 100 percent to minus 50 percent.
4. Grade NS.
6. Minimum elongation of 1200 percent.

G. S-7:
1. ASTM C 920, silicone, neutral cure.
2. Type S.
3. Class 25.
4. Grade NS.
6. Structural glazing application.

H. S-8:
1. ASTM C 920, silicone, acetoxy cure.
2. Type S.
3. Class 25.
4. Grade NS.
6. Structural glazing application.

I. S-9:
1. ASTM C 920 silicone.
2. Type S.
3. Class 25.
4. Grade NS.

J. S-10:
1. ASTM C 920, coal tar extended fuel resistance polyurethane.
2. Type M/S.
3. Class 25.
4. Grade P/NS.

K. S-11:
1. ASTM C 920 polyurethane.
2. Type M/S.
3. Class 25.
4. Grade P/NS.
5. Shore A hardness of 35 to 50.

L. S-12:
1. ASTM C 920, polyurethane.
2. Type M/S.
3. Class 25 to have joint movement range of plus or minus 50 percent.
4. Grade P/NS.
5. Shore A hardness of 25 to 50.
M. S-13:
   1. Pourable Penetration Sealant, 1-Part, non-shrink.
   2. ASTM C 920, polyether sealant.
   3. Type S
   4. Class 25
   5. Grade NS.

2.03 Caulking Compound
   A. C-1:
      1. ASTM C 834, acrylic latex.
   B. C-2:
      1. One (1) component acoustical caulking, non-drying, non-hardening, synthetic rubber.

2.04 Joint Sealant Backing
   A. Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by the sealant manufacturer based on field experience and laboratory testing.
   B. Backup rod sealant backings to meet ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
      1. Type C to be closed cell material with a surface skin.
      2. Elastomeric tubing sealant backings to be neoprene, butyl, EPDM or silicone tubing to meet ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26°F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth and otherwise contribute to optimum sealant performance.
   C. Bond breaker tape to be polyethylene tape or other plastic tape recommended by the sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.05 Filler
   A. Mineral fiber board to meet ASTM C 612, Class 1.
   B. Thickness same as joint width.
   C. Depth to fill void completely behind back-up rod.

2.06 Primer
   A. As recommended by the manufacturer of caulking or sealant material.
   B. Stain free type.
2.07 Cleaners Non-Porous Surfaces

A. Chemical cleaners acceptable to the manufacturer of sealants and sealant backing material free of oily residues and other substances capable of staining or harming joint substrates and adjacent non-porous surfaces and formulated to promote adhesion of sealant and substrates.

PART 3 - EXECUTION

3.01 Inspection

A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.

B. Coordinate for repair and resolution of unsound substrate materials.

C. Inspect for uniform joint widths and that dimensions are within tolerance established by the sealant manufacturer.

3.02 Preparations

A. Prepare joints in accordance with the manufacturer's instructions and SWRI.

B. Clean surfaces of joint to receive caulking or sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt and frost. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil free compressed air. Porous joint substrates include the following:
   a. Concrete.
   b. Masonry.
   c. Unglazed surfaces of ceramic tile.

2. Remove laitance and form release agents from concrete.

3. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates or leave residues capable of interfering with adhesion of joint sealants.
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

C. Do not cut or damage joint edges.

D. Apply masking tape to face of surfaces adjacent to joints before applying primers, caulking
or sealing compounds.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Apply primer to sides of joints wherever required by the compound manufacturer's painter instructions.
   1. Apply primer prior to installation of back-up rod or bond breaker tape.
   2. Use brush or other approved means that will reach all parts of joints.

F. Take all necessary steps to prevent three (3) sided adhesion of sealants.

3.03 Backing Installation

A. Install back-up material to form joints enclosed on three (3) sides as required for specified depth of sealant.
B. Where deep joints occur, install filler to fill space behind the back-up rod and position the rod at proper depth.
C. Cut fillers installed by others to proper depth for installation of back-up rod and sealants.
D. Install back-up rod, without puncturing the material, to a uniform depth, within plus or minus 1/8 inch for sealant depths specified.
E. Where space for back-up rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two (2) opposing surfaces.
F. Take all necessary steps to prevent three (3) sided adhesion of sealants.

3.04 Sealant Depths and Geometry

A. At widths up to 1/4 inch, sealant depth equal to width.
B. At widths over 1/4 inch, sealant depth 1/2 of width up to 1/2 inch maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

3.05 Installation

A. General:
   1. Apply sealants and caulking only when ambient temperature is between 40°F and 100°F.
   2. Do not use polysulfide base sealants where sealant may be exposed to fumes from bituminous materials or where water vapor in continuous contact with cementitious materials may be present.
   3. Do not use sealant type listed by the manufacturer as not suitable for use in locations specified.
   4. Apply caulking and sealing compound in accordance with the manufacturer's printed instructions.
5. Avoid dropping or smearing compound on adjacent surfaces.
6. Fill joints solidly with compound and finish compound smooth.
7. Tool joints to concave surface unless shown or specified otherwise.
8. Finish paving or floor joints flush unless joint is otherwise detailed.
9. Apply compounds with nozzle size to fit joint width.
10. Test sealants for compatibility with each other and substrate. Use only compatible sealant.

B. For application of sealants, follow requirements of ASTM C 1193 unless specified otherwise.

3.06 Field Quality Control
A. Field test joint sealant adhesion to joint substrates as recommended by the sealant manufacturer:
   1. Test completed elastomeric sealant joints as follows:
      a. Perform ten (10) tests for first 1000 feet of joint length for each type of elastomeric sealant and joint substrate.
      b. Perform one (1) test for each 1000 feet of joint length thereafter or one (1) test per each floor per elevation.

B. Inspect joints for complete fill, for absence of voids and for joint configuration meeting the specified requirements. Record results in a field adhesion test log.
C. Inspect tested joints and report on the following:
   1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.
   2. Compare these results to determine if adhesion passes the sealant manufacturer’s field adhesion hand pull test criteria.
   3. Whether sealants filled joint cavities and are free from voids.
   4. Whether sealant dimensions and configurations meet the specified requirements.
D. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration and sealant dimensions.
E. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
F. Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or meet the other requirements. Retest failed applications until test results prove sealants meet the indicated requirements.

3.07 Cleaning
A. Scrape off fresh compound accidentally smeared on adjoining surface immediately and rub clean with a solvent as recommended by the caulking or sealant manufacturer.

B. After filling and finishing joints, remove masking tape.

C. Leave adjacent surfaces in a clean and unstained condition.

3.08 Locations

A. Exterior Building Joints, Horizontal and Vertical:

1. Metal to metal to be Type S-1, S-2.

2. Metal to masonry or stone to be Type S-1.

3. Masonry to masonry or stone to be Type S-1.

4. Stone to stone to be Type S-1.

5. Cast stone to cast stone to be Type S-1.

6. Threshold setting bed to be Type S-1, S-3, S-4.

7. Masonry expansion and control joints to be Type S-6.

8. Wood to masonry to be Type S-1.

B. Metal Reglets and Flashings:

1. Flashings to wall to be Type S-6.

2. Metal to metal to be Type S-6.

C. Sanitary Joints:

1. Walls to plumbing fixtures to be Type S-9.

2. Pipe penetrations to be Type S-9.

D. Horizontal Traffic Joints:

1. Concrete paving, unit pavers to be Type S-11 or S-12.

E. High Temperature Joints over 400°F:

1. Exhaust pipes, flues, breech stacks to be Type S-7 or S-8.

F. Interior Caulking:

1. Typical narrow joint 1/4 inch or less at walls and adjacent components to be Type C-1, C-2.

2. Perimeter of doors, windows, access panels which adjoin concrete or masonry surfaces to be Type C-1, C-2.

3. Joints at masonry walls and columns, piers, concrete walls or exterior walls to be Type C-1, C-2.

4. Exposed isolation joints at top of full height walls to be Type C-1, C-2.

END OF SECTION
SECTION 08110

METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 Description
   A. Section includes hollow metal work doors and frames and removable transoms.

1.02 Related Sections
   A. Section 08710 – Door Hardware
   B. Section 09910 – Paints and Coatings

1.03 Submittals
   A. Submit product data for each type of product.
      1. Include construction details, material descriptions, core descriptions, fire resistance ratings, temperature rise ratings and finishes.
   B. Submit shop drawings including the following:
      1. Elevations of each door type.
      2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
      3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
      4. Locations of reinforcement and preparations for hardware.
      5. Details of each different wall opening condition.
      6. Details of anchorages, joints, field splices and connections.
      7. Details of accessories.
      8. Details of moldings, removable stops and glazing.
      9. Details of conduit and preparations for power, signal and control systems.
   C. Submit samples for initial selection for units with factory applied color finishes.
   D. Submit samples for verification:
      1. For each type of exposed finish required, prepared on samples of not less than 3 by 5 inches.
   E. Submit a schedule of hollow metal work prepared by or under the supervision of the supplier, using same reference numbers for details and openings as those on the Contract Drawings. Coordinate with final Door Hardware Schedule.
   F. Submit product test reports for each type of hollow metal door and frame assembly. Tests performed by a qualified testing agency.
G. Submit oversize construction certification for assemblies required to be fire rated and exceeding limitations of labeled assemblies.

H. Submit qualification data for the installer, the manufacturer and the acoustical testing agency.

I. Submit field quality control reports.

J. Submit sample warranty for the manufacturer's special warranties.

1.04 Quality Assurance

A. Applicable standards are specifications and standards of ANSI/SDI 250 (SDI 100).

B. Wind load performance requirements to meet the wind load requirements of Uniform Building Code. Deflection shall not exceed 1/175 of span.

C. An entity that employs installers and supervisors who are trained and approved by the manufacturer.

D. Obtain hollow metal work from single source from single manufacturer.

E. Verify actual dimensions of openings by field measurements before fabrication.

F. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI/SDI 111, Recommended Details for Standard Steel Doors, Frames, Accessories and Related Components.


3. ANSI/SDI A250.6, Recommended Practice for Hardware Reinforcing and Standard Steel Doors and Frames.


5. ANSI/SDI A250.10, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.

6. ANSI/SDI A250.11, Recommended Erection Instructions for Steel Frames.


8. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.


17. BHMA A156.115, Hardware Preparation in Steel Doors and Steel Frames.
18. NAAMM-HMMA 803, Door Components.
20. NFPA 80, Standard for Fire Doors and Other Opening Protectives.
22. NFPA 252, Fire Tests for Door Assemblies.
23. UL 10C, Positive Pressure Fire Tests of Door Assemblies.
24. UL 1784, Air Leakage Tests for Door Assemblies.

1.05 Delivery, Storage and Handling

A. Deliver hollow metal work palletized, packaged orcrated to provide protection during transit and Project site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to factory finished units.

B. Deliver welded frames with two (2) removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work vertically under cover at Project site with head up. Place on minimum 4 inch high wood blocking. Provide minimum 1/4 inch space between each stacked door to permit air circulation.

1.06 Definitions

A. Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.07 Coordination

A. Coordinate anchorage installation for hollow metal frames. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors. Deliver such items to Project site in time for installation.

1.08 Project Conditions

A. Verify actual dimensions of openings by field measurements before fabrication.
PART 2 - PRODUCTS

2.01 Manufacturers
   A. Manufacturers:
      1. Steelcraft.
      2. Cornell Ironworks.
      3. Curries.
      5. Or Approved Equal.
   B. Obtain hollow metal work from single source from single manufacturer.

2.02 Regulatory Requirement
   A. Fire rated assemblies to meet NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire protection ratings and temperature rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
      1. Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.03 Interior Doors and Frames
   A. Construct interior doors and frames to meet the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, clearances and as specified.
   B. Heavy duty doors to meet SDI A250.8, Level 2.
      1. Physical performance to meet Level B according to SDI A250.4, 18 gauge.
      2. Doors:
         a. Type as indicated in the Door and Frame Schedule.
         b. Thickness to be 1 3/4 inches.
         c. Face to be uncoated cold rolled steel sheet, minimum thickness of 0.042 inch.
         d. Edge construction to be model 2, Seamless.
         e. Core:
            1) Kraft paper honeycomb.
            2) Mineral board, vertical steel stiffener (for fire rated doors).
      3. Exposed finish to be factory primed. Refer to Section 09910 for finish system requirements.

2.04 Extra Heavy Duty Frames
   A. Frames:
      1. Materials to be uncoated steel sheet, minimum thickness of 0.053 inch, 16 gauge.
      2. Construction to be full profile welded.
2.05 Exterior Doors and Frames

A. Extra heavy duty doors to meet SDI A250.8, Level 3.

1. Physical performance to meet Level A according to SDI A250.4, 16 gauge.

2. Doors:
   a. Type as indicated in the Door and Frame Schedule.
   b. Thickness to be 1 3/4 inches.
   c. Face to be metallic coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 (ZF120) coating.
   d. Edge construction to be Model 2, seamless.
   e. Core to be mineral board, vertical steel stiffener.
      1) Provide doors fabricated with thermal resistance value (R-value) of not less than 2.1°F x h x sq. ft. /Btu when tested according to ASTM C 1363.

3. Exposed finish to be factory primed. Refer to Section 09910 for finish system requirements.

B. Maximum duty frames to meet SDI A250.8, Level 4.

1. Frames:
   a. Materials to be metallic coated steel sheet, minimum thickness of 0.067 inch, with minimum A40 coating, 14 gauge.
   b. Transom frames to be fabricated from same thickness material as adjacent door frame.
   c. Construction to be full profile welded.

2. Exposed finish to be factory primed. Refer to Section 09910 for finish system requirements.

2.06 Frame Anchors

A. Jamb Anchors:

1. Masonry type to be adjustable strap and stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.

2. Stud wall type to be designed to engage stud, welded to back of frames; not less than 0.042 inch thick.

3. Compression type for drywall slip-on frames to be adjustable compression anchors.

4. Post-installed expansion type for in-place concrete or masonry to be a minimum of 3/8 inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor anchors to be formed from same material as frames, minimum thickness of 0.042 inch, and as follows:
1. Monolithic concrete slabs to be clip type anchors, with two (2) holes to receive fasteners.

2. Separate topping concrete slabs to be adjustable type anchors with extension clips, allowing not less than 2 inch height adjustment. Terminate bottom of frames at finish floor surface.

2.07 Materials

A. Cold rolled steel sheet to meet ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot rolled steel sheet to meet ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting or surface defects; pickled and oiled.

C. Metallic coated steel sheet to meet ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame anchors to meet ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

   1. For anchors built into exterior walls, steel sheet to meet ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, bolts and fasteners to be hot dip galvanized according to ASTM A 153/A 153M.

F. Power actuated fasteners in concrete to be a fastener system of type suitable for application indicated, fabricated from corrosion resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Grout to meet ASTM C 476, except with a maximum slump of 4 inches as measured according to ASTM C 143/C 143M.

H. Mineral fiber insulation to meet ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame spread and smoke developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Bituminous coating to be cold applied asphalt mastic, compounded for 15 mil dry film thickness per coat. Provide inert type noncorrosive compound free of asbestos fibers, sulfur components and other deleterious impurities.

2.08 Fabrication

A. Fabricate hollow metal work to be rigid and free of defects, warp or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in the manufacturer’s plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow Metal Doors:

   1. Steel stiffened door cores to be a minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches on center. Fill spaces between stiffeners with glass or mineral fiber insulation.
2. Provide fire door cores as required to provide fire protection and temperature rise ratings indicated.

3. Vertical edges for single acting doors to have bevel edges 1/8 inch in 2 inches.

4. Close top edges of doors with flush closures of same material as face sheets.

5. Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.

6. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

C. Where hollow metal frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Provide transom bar frames as closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

2. Provide countersunk, flat or oval head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Weld guards to frame at back of hardware mortises in frames to be grouted.

4. Weld floor anchors to bottoms of jambs with at least four (4) spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

5. Provide number and spacing of jamb anchors as follows:
   a. Locate masonry type anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches on center, to match coursing, and as follows:
      1) Two (2) anchors per jamb up to 60 inches high.
      2) Three (3) anchors per jamb from 60 to 90 inches high.
      3) Four (4) anchors per jamb from 90 to 120 inches high.
      4) Four (4) anchors per jamb plus one (1) additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
   b. Locate stud wall type anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches on center and as follows:
      1) Three (3) anchors per jamb up to 60 inches high.
      2) Four (4) anchors per jamb from 60 to 90 inches high.
      3) Five (5) anchors per jamb from 90 to 96 inches high.
      4) Five (5) anchors per jamb plus one (1) additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
   c. Not less than two (2) compression type anchors in each frame.
   d. Locate post-installed expansion type anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches on center

6. Two (2) anchors per head for frames more than 42 inches wide and mounted in metal stud partitions.
7. Except on weather stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. For single door frames, drill stop in strike jamb to receive three (3) door silencers.
   b. For double door frames, drill stop in head jamb to receive two (2) door silencers.

8. Terminate stops 6 inches above finish floor with a 45 degree angle cut and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded steel filler plate, with welds ground smooth and flush with frame.

D. Fabricate concealed stiffeners and edge channels from either cold or hot rolled steel sheet.

E. Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling and tapping according to SDI A250.6, the Door Hardware Schedule and templates.
   1. Reinforce doors and frames to receive non-templated, mortised and surface mounted door hardware.
   2. Meet the applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow metal work for hardware.

F. Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.
   1. Provide fixed and removable stops and moldings welded on secure side of hollow metal work for single transom panels.
   2. Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
   4. Provide loose stops and moldings on inside of hollow metal work.
   5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.09 Steel Finishes

A. Clean, pretreat and apply the manufacturer’s standard primer.
   1. The manufacturer’s standard, fast-curing, lead and chromate free primer that meets SDI A250.10; recommended by the primer manufacturer for substrate; compatible with substrate and field applied coatings despite prolonged exposure.
   2. Refer to Section 09910 for color and gloss.

2.10 Accessories

A. Provide louvers for interior doors, where indicated, that meet SDI 111, with blades or baffles formed of 0.020 inch thick, cold rolled steel sheet set into 0.032 inch thick steel frame.
   1. Stationary sight-proof louvers constructed with inverted-V or inverted-Y blades.

B. Mullions and transom bars to join to adjacent members by welding or rigid mechanical anchors.
C. Grout guards to be formed from same material as frames, not less than 0.016 inch thick.

PART 3 - EXECUTION

3.01 Examination
A. Examine substrates, areas and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.
B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
C. Prepare written report, endorsed by the installer, listing conditions detrimental to performance of the work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation
A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling and dressing, as required to make repaired area smooth, flush and invisible on exposed faces.
B. Drill and tap doors and frames to receive non-templated, mortised and surface mounted door hardware.

3.03 Installation
A. Install hollow metal work plumb, rigid, properly aligned and securely fastened in place. Meet the Contract Drawing requirements and the manufacturer’s written instructions.
B. Install hollow metal frames for doors, transoms, sidelites, borrowed lites, and other openings of size and profile indicated. Meet SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   a. At fire rated openings, install frames according to NFPA 80.
   b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress and make splice smooth, flush and invisible on exposed faces.
   c. Install frames with removable stops located on secure side of opening.
   d. Install door silencers in frames before grouting.
   e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   f. Check plumb, square and twist of frames as walls are constructed. Shim as necessary to meet installation tolerances.
   g. Field apply bituminous coating to backs of frames that will be filled with grout containing anti-freezing agents.
2. Provide floor anchors for each jamb and mullion that extends to floor and secure with post-installed expansion anchors.
   a. Floor anchors may be set with power actuated fasteners instead of post-installed expansion anchors if so indicated and approved on shop drawings.

3. Solidly pack mineral fiber insulation inside frames for metal stud partitions.

4. Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Solidly fill space between frames and concrete with mineral-fiber insulation.

6. Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush and invisible on exposed faces.

7. Secure slip-on drywall frames in place according to the manufacturer's written instructions.

8. Adjust hollow metal door frames for squareness, alignment, twist and plumb to the following tolerances:
   a. Squareness to be plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment to be plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist to be plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines and perpendicular to plane of wall.
   d. Plumbness to be plus or minus 1/16 inch, measured at jambs at floor.

C. Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non Fire Rated Steel Doors:
   a. Provide 1/8 inch plus or minus 1/32 inch between door and frame jambs and head.
   b. Provide 1/8 inch to 1/4 inch plus or minus 1/32 inch between edges of pairs of doors.
   c. Provide 5/8 inch plus or minus 1/32 inch at bottom of door.
   d. Provide 1/16 inch to 1/8 inch plus or minus 1/32 inch between door face and stop.

2. Install fire rated doors with clearances according to NFPA 80.

3. Install smoke control doors and gaskets according to NFPA 105.

3.04 Adjusting and Cleaning

A. Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air drying, rust inhibitive primer for prime cost touchup.

D. Clean abraded areas and repair with galvanizing repair paint according to the manufacturer's written instructions for metallic coated surface touchup.
E. Clean abraded areas and repair with same material used for factory finish according to the manufacturer's written instructions for factory finish touchup.

F. Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION
SECTION 08710

DOOR HARDWARE

PART 1 - GENERAL

1.01 Description
A. Work of this Section includes all labor, materials, equipment and services necessary to furnish all the hardware as shown on the Contract Drawings and specified herein.

1.02 Related Sections
A. Section 08110 – Metal Doors and Frames

1.03 Submittals
A. Submit product data for each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles and finishes.
B. Submit shop drawings for electrified door hardware.
   1. Include diagrams for power, signal and control wiring.
   2. Include details of interface of electrified door hardware and building safety and security systems.
C. Submit samples for each exposed product in each finish specified, in the manufacturer's standard size.
   1. Tag samples with full product description to coordinate samples with door hardware schedule.
D. Submit samples for initial selection of each type of exposed finish.
E. Submit samples for verification of each type of exposed product, in each finish specified.
   1. Sample size to be full size units or minimum 2 inch by 4 inch samples for sheet and 4 inch long samples for other products.
      a. Full size samples will be returned to the General Contractor. Units that are acceptable and remain undamaged through submittal, review and field comparison process may, after final check of operation, be incorporated into the work, within limitations of keying requirements.
   2. Tag samples with full product description to coordinate samples with door hardware schedule.
F. Submit door hardware schedule prepared by or under the supervision of the installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames and related work to ensure proper size, thickness, hand, function and finish of door hardware.
   1. Submit door hardware schedule concurrent with submissions of product data, samples and shop drawings. Coordinate submission of door hardware schedule with the
scheduling requirements of other work to facilitate the fabrication of other work that is
critical in Contract construction schedule.

2. Use same scheduling sequence, format and use same door numbers as in door
   hardware schedule in the Contract Documents.

3. Include the following information:
   a. Identification number, location, hand, fire rating, size, and material of each door and frame.
   b. Locations of each door hardware set, cross referenced to the Contract Drawings on floor
      plans and to Door and Frame Schedule.
   c. Complete designations, including name and manufacturer, type, style, function, size, quantity,
      function and finish of each door hardware product.
   d. Description of electrified door hardware sequences of operation and interfaces with other
      building control systems.
   e. Fastenings and other installation information.
   f. Explanation of abbreviations, symbols and designations contained in door hardware
      schedule.
   g. Mounting locations for door hardware.
      1) List of related door devices specified in other Sections for each door and frame.

G. Submit keying schedule prepared by or under the supervision of the installer's Architectural
   Hardware Consultant, detailing SEPTA's final keying instructions for locks. Include schematic
   keying diagram and index each key set to unique door designations that are coordinated
   with the Contract Documents.

1.04 Quality Assurance

A. Hardware shall be suitable and adapted for its required use and shall fit its designated
   location. Should any hardware as shown, specified or required fail to meet the intended
   requirements or require modification to suit or fit the designated location, determine the
   correction or modification necessary and notify SEPTA in ample time to avoid delay in the
   manufacture and delivery of hardware.

B. Provide fire rated opening hardware to meet NFPA 80 requirements of authorities having
   jurisdiction.

C. The hardware supplier shall have been regularly engaged in the sale and distribution of
   hardware for Projects of comparable scope and size. The hardware supplier shall have an
   Architectural Hardware Consultant of the Door and Hardware Institute on staff who will be
   responsible for overseeing the scheduling, detailing, ordering, and coordinating of
   hardware, and shall be available for consultation with SEPTA, at no additional cost to SEPTA,
   during progress of construction. The hardware supplier shall be a direct factory authorized
   distributor for all finish hardware items being furnished in accordance with this
   Specification.

D. Meet the applicable provisions of the most recent issues of the following references:
   1. Americans with Disabilities Act (ADA).
   2. ANSI/SDI A250.8, Specifications for Standard Steel Doors and Frames.
5. BHMA A156.4, Door Controls - Closers.
6. BHMA 156.18, Continuous Hinges.
7. BHMA A156.13, Mortise Locks & Latches, Series 1000.
8. DHI, Door and Hardware Institute.
10. NAAMM, National Association of Architectural Metal Manufacturers.
11. NFPA 80, Standard for Fire Doors and Other Opening Protectives.
15. UL 10C, Positive Pressure Fire Tests for Door Assemblies.
16. WDI, Wood Door Institute.

1.05 Delivery, Storage and Handling

A. Inventory door hardware on receipt and provide secure lock up for door hardware delivered to Project site.
B. Tag each item or package separately with identification coordinated with the final Door Hardware Schedule, and include installation instructions, templates and necessary fasteners with each item or package.
C. Pack finish hardware in the manufacturer's containers, complete with trimmings, bolts, screws, washers, etc., as required for application. Each container shall bear a suitable label which shall state the quantity and kind of contents of said container, as well as identifying marks relating to the approved hardware schedule and its location in the Project.

1. Knobs, handles, pulls and other items of finish hardware with easily damaged finishes shall be individually wrapped before placing in containers and with sufficient sheet cloth or cotton backed paper which shall be adequately secured all as necessary to protect the finishes.
2. Finish hardware shall be delivered, as directed, to the building site or the factories of the various fabricators of metal or wood work to which such hardware is to be applied. Deliver hardware in the order required and in ample time to permit application at the building, or fabricators' shops, within the time required for the completion of the building.

1.06 Job Conditions

A. The hardware supplier shall assign a competent representative, acceptable to SEPTA, to be at the job site each time a major shipment of finish hardware is received. Such representative shall assist in "checking in" these shipments and shall secure a receipt covering the contents of each shipment. In addition, such representative shall be available for immediate call to the job site when, in the opinion of SEPTA, his presence is necessary.
B. Promptly following approval of the Door Hardware Schedule by SEPTA, furnish and deliver template information, to the fabricators, of items to which finish hardware is to be applied.

1. Such deliveries shall be made in ample time to avoid delays in such work of said fabricators. Provide drawings, schedules and detailed information to other trades as necessary for them to accommodate and prepare their work to receive the finish hardware.

C. Prior to the installation of any finish hardware, all parties and trades having responsibility to any of all of the openings for the job, shall meet in a pre-construction meeting, for instruction on the proper installation of finish hardware with the manufacturers’ representative.

1. Cooperate and coordinate work with that of other trades supplying materials or performing work in contact with, connecting to, underlying or overlaying the work of this Section.

2. Provide complete data of requirements for work of this Section to those other trades whose work is affected by or dependent upon the work of this Section.

3. Furnish all items to be built into other work in ample time to avoid delaying the progress of such work.

4. Examine all drawings covering the work of this Section and refer to all other drawings, including the Contract Drawings, which may affect the work of this Section or require coordination by this trade.

D. Verify all existing conditions in the field to ensure compatibility with hardware specified in the hardware sets herein. Any discrepancies between the existing field conditions and hardware specified shall be brought to the attention of SEPTA immediately. The hardware supplier shall not order any hardware until all discrepancies are rectified and SEPTA grants written approval.

PART 2 - PRODUCTS

2.01 General

A. Requirements for design, grade, function, finish, size and other distinctive qualities of each type of finish hardware are indicated herein. Products are identified by using appropriate hardware designation numbers.

2.02 Manufacturers

A. Provide hardware as indicated in hardware sets. Products other than those listed in the sets may be considered, provided that they are proven to be of equal quality and have equal performance to those products specified. See product description for each type of product for details on performance and quality requirements. SEPTA reserves the right to review and approve all proposed equivalents.

B. Provide additional hardware items required to complete the work in accordance with these Specifications and manufacturers’ instructions, including items inadvertently omitted from this Section. Note these items in the submittal for review.
2.03 Hanging Means

A. Stainless steel.

B. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives.

2. Acceptable Manufacturers:
   a. Markar.
   b. Stanley.
   c. Or Approved Equal.

C. Requirements:

1. Provide pin and barrel continuous hinges to meet BHMA A156.26, Grade 2.
2. Provide pin and barrel continuous hinges fabricated from 14 gauge, type 304 stainless steel.
3. Provide twin self-lubricated nylon bearings at each hinge knuckle, with 0.25 inch diameter stainless steel pin.
4. Provide hinges capable of supporting door weights up to 600 pounds, and successfully tested for one million five hundred thousand (1,500,000) cycles.
5. On fire rated doors, provide pin and barrel continuous hinges that are classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
   a. Provide pin and barrel continuous hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gauge to accommodate electric function of specified hardware.
   b. Install hinges with fasteners supplied by the manufacturer.
   c. Provide hinges with symmetrical hole pattern.

2.04 Locksets and Latchsets

A. Locksets:

1. All door hardware must be compatible with SEPTA's existing lock system and SEPTA's existing core key (BEST lock system).
2. Lock cases to be constructed with a protected leading edge and screw configuration that limits access to operating parts.
3. Lock cases are to be multi-functional that transform into different functions without opening the lock case.
4. Lock components to be manufactured of zinc dichromate plated steel. Manufacturers utilizing plastic parts, spacers and/or bushings are not acceptable.
5. Lock components to incorporate a spring loaded fusible link for Fire/Life Safety. Manufacturers utilizing gravity, fusible link are acceptable.
6. Latch bolts to have a standard 2 3/4 inch backset with a full 3/4 inch throw.
7. Latch bolts to be non-handed, field reversible without opening the lock case.
8. Latch bolts to be two (2) piece anti-friction, manufactured from stainless steel. Solid latch bolts and/or plastic anti-friction devices are not acceptable.

9. Cylinders to be secured by a cast stainless steel, dual retainer. Manufacturers utilizing screws and/or stamped retainers are not acceptable.

10. Manufacturers utilizing an exposed toggle on edge of door as “locked indicator” are not acceptable.

B. Lever Trim:

1. Lever assembly (external) to be one (1) piece design attached by threaded bushing. Lever assembly (internal) shall be attached by screwless shank. Lever attachment by common tools (allen nuts and/or set screws) are not acceptable.

2. Thru-bolt lever assemblies through the door for positive interlock. Manufacturers utilizing a through the door spindle for attachment are not acceptable.

3. Levers to have independent rotation in both directions.

4. Spring cages are to be incorporated into the lever assemblies.

5. Hub blocking plate to be solid, cast stainless steel. Manufacturers utilizing open hub designs are not acceptable.

6. Spindles to be independent, designed to “break-away” at a maximum of 75 psi torque.

C. Deadbolts:

1. Deadbolts to be 1 3/4 inch total length; have standard 1 inch throw with a minimum 3/4 inch internal engagement when fully extended.

2. Deadbolts to be constructed of stainless steel, incorporating a security roller pin with a minimum RC60 rating for surface hardness.

D. Strikes:

1. Strikes to be non-handed and bridged to ensure dead latching. Manufacturers utilizing fillers of any kind for dead-latch engagement are not acceptable.

2. Mounting tabs are to be automatic self-adjusting, vertically and horizontally for door bevel and strike alignment.

E. Lock series and design manufacturers, lever trim as specified in hardware sets.


2. Falcon M Series.

3. Sargent 8200 Series.

4. Or Approved Equal.

F. Certifications:

1. Provide locksets to meet BHMA A156.13, Series 1000, Operational Grade 1 and Security Grade 1 with all standard trims.

2. Provide locksets to meet UL 10C and NFPA 252 positive pressure requirements.
3. Provide locksets to meet ASTM F 476 Grade 40, UL Listed for locksets utilizing concealed cylinders.

2.05 Exit Devices

A. Exit devices shall be touch bar type, as specified in hardware sets.
   1. Furnish stainless steel touch bars on all exit devices.
   2. Touch bar and touch bar end caps shall overlap the mechanism case.
   3. Touch bar sub assembly shall be minimum 0.160 inch thick, with minimum 0.060 inch supports.
   4. Touch bar surface shall be minimum 2 1/4 inches high x 18 inches long for 36 inch doors, and minimum 2 1/4 inches high x 24 inches long for doors wider than 36 inches.
   5. Exit device touch bars shall be equipped with a fluid sound dampening feature.

B. Furnish exit devices, less bottom rod, on all cross corridor pairs of doors, where doors are for compartmentalization only.

C. Rim and mortise type devices shall have 3/4 inch throw latch bolt. Surface and concealed vertical rod devices shall have 5/8 inch throw latch bolts.
   1. Latch bolt security deadlocking shall be standard.

D. All fire doors shall receive devices UL listed fire exit hardware.

E. Furnish roller strikes, which interlock the door to the frame (499F) for all rim devices and surface vertical rod devices.

F. All internal springs shall be compression type.

G. Where lever trim is specified, levers shall match the balance of the Contract.
   1. Escutcheons of all lever trim shall be forged brass or bronze, with four (4) thru-bolts anchoring trim assembly to exit device chassis.
   2. Levers shall be solid forged brass or bronze.
   3. Lever return springs shall be compression type.
   4. Cylinders shall be recessed from face of escutcheon.

H. Lever trim shall be breakaway type. When rotational force of 35 ft.lbs. is applied, lever trim appears to break. Lever trim can be reset to normal function, without disassembly.
   1. Lever shall be protected by a shear pin, which will withstand a rotational force of 55 ft.lbs. before shearing, to prevent further damage to lever. Lever shall not separate from the escutcheon.

I. Furnish all necessary glass bead kits where exit device may interfere with raised glass beads on doors.

J. Certifications:
   1. Devices shall be Underwriters Laboratories™ listed for Panic Hardware (FVSR) SA163.
   2. Fire Devices shall be Underwriters Laboratories™ listed Fire Exit Hardware (GXHX) R4501, A Label.
3. Exit devices shall be certified by an independent testing lab for one million (1,000,000) cycles.

K. Exit device series and design manufacturers, exit devices with outside trim as specified in hardware sets.
   1. Von Duprin 98/99 Series.
   2. Falcon Series 25 Series.
   3. Sargent 80 Series.
   4. Or Approved Equal.

2.06 Closers

A. All surface closers shall exceed BHMA A156.4 Grade 1 requirements in all aspects as called for below. All closers shall have certification by an independent testing laboratory of ten million (10,000,000) cycles without failure.

B. Closer cylinders shall be cast iron. Closer pinions shall be dual heat treated. Pinion and piston shall be steel alloy. Piston diameter shall be minimum 1 1/2 inches.

C. Closers shall be barrier free with spring tension adjustable from size 1 to size 5.

D. Closers shall maintain control of the door in all conditions. Closers shall have three (3) non critical adjusting valves; latch, main and backcheck. Backcheck shall take affect at 45 (AVB) degrees of opening for parallel arm closers and 70 degrees for regular arm closers. Closers with pressure relief valves are not acceptable.

E. All closers shall have forged main arms. Forearms of parallel arm closers shall be forged. Parallel arm brackets shall be forged. All parallel arm joints shall have bronze bushings with minimum 5/8 inch diameter pins. Cylinders, arms, brackets and mounting plates shall be powder coated.

F. Provide all plates, brackets and special templates when needed for interface with particular header, door and wall conditions and neighboring hardware. Consult factory for special template (“ST” suffix to closer number) pricing.

G. All closers shall be installed so that closer bodies are positioned on room side of doors to and from corridors. Out swing doors shall have an Extra Heavy Duty Parallel Arm (EDA). Parallel arm shall be used on connecting doors between rooms.

H. All exterior closers shall have all weather fluid that does not require seasonal adjustment to control speed of door, and shall exhibit the same viscosity from minus 30°F to plus 120°F.

I. All closers shall have a powder coated aluminum finish on cylinder, arm and accessories. There shall be a full metal, powder coated cover.

J. Furnish all brackets, drop plates and any other necessary hardware required to insure proper installation.

K. All closers shall meet UL 10C requirements for positive pressure testing.

L. All closers shall be of one (1) manufacturer’s products. All closers shall be inspected after installation by a factory representative to insure proper adjustment and operation.

M. Closer Manufacturers:
1. LCN 4011/4111 series.
2. Falcon SC70 Series.
4. Or Approved Equal.

2.07 Door Stops
A. Unless otherwise noted, all door stops shall be wall mounted with concealed fasteners Ives WS407CCV/CVX series Or Approved Equal. Where wall stops will not function for the application, furnish floor mounted stops Ives FS436/438 series Or Approved Equal.

2.08 Overhead Stops
A. Stainless steel, non-plastic mechanisms and finished metal end caps. Provide field changeable hold open, friction and stop only functions. Coordinate templates for door and wall conditions and neighboring hardware. Furnish drop plates at locations where regular arm closer are used in conjunction with overhead stops. See hardware sets for specific model numbers.

2.09 Protection Plates
A. All kick plates and mop plates unless otherwise noted shall be 8 inches high by 2 inches Less Door Width (LDW), beveled three (3) sides by 0.050 inches thick.

2.10 Flush Bolts and Coordinators
A. Manual flush bolts to be Ives FB458/FB358 series, Or Approved Equal, furnished with DP2 dustproof strikes for all bottom bolts. Top bolts shall be furnished with proper extensions to allow for easy operation.
B. Self-latching flush bolts to be Ives FB51P/FB61P series, Or Approved Equal, furnished with DP2 dustproof strikes for all bottom bolts. Furnish wear plates as required.
C. Automatic flush bolts to be Ives FB31P/FB41P series, Or Approved Equal, furnished with DP2 dustproof strikes for all bottom bolts. Furnish wear plates as required.
D. Coordinators to be Ives COR series Or Approved Equal. Furnish all fillers, mounting brackets, carry bars and special cut outs for use with exit devices, as required. Finish shall be black.

2.11 Key Requirements
A. Final keying requirements to be determined by SEPTA. A meeting must take place between SEPTA, the end user, SEPTA's representative, and the hardware distributor prior to cylinders being ordered, to establish the keying requirements and required keyway.
B. Key system to tie into the existing interchangeable core key system. Coordinate with SEPTA Locksmith.
C. Provide Concealed Key Control (CKC) keyset symbol stamping on the side of each master keyed core. Provide visual key control for all operating and master keys.
D. Provide brass keyed alike temporary cores for construction keying plus ten (10) operating keys for all cylinders, interior and exterior.
E. Provide three (3) change keys for each differently keyed lock. Provide three (3) control keys for construction cores and three (3) control keys for permanent cores. Provide ten (10) copies of each level master key, grand master key, and/or great grand master key. Permanent keys and cores to be a secured shipment direct from point of origination to SEPTA. Provide bitting list, ship direct from point of origin to SEPTA upon Contract completion.

F. Provide a key control system including envelopes. Labels, tags with self-locking key clips, receipt forms, three (3) way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by the system manufacturer, with capacity for 150 percent of the number of locks required for the Contract.

1. Provide four (4) hinged panel type cabinet for wall mounting.

G. All door hardware must be compatible with SEPTA's existing lock system and SEPTA's existing core key (BEST lock system).

2.12 Weather Seals and Thresholds

A. Zero (0) as scheduled.

B. Perimeter seals shall be of compressible black neoprene material. Housing shall be solid aluminum stock. Furnish seals on three (3) sides of the opening. Coordinate the amount of material is required in each specified opening.

C. Seals shall be mechanically fastened to door frame.

D. Door sweeps shall be extruded aluminum and black neoprene sweep.

1. Fasten door sweeps with wood screws for wood doors and sheet metal screws for hollow metal and fiberglass reinforced doors.

2. Door sweep shall be 1 1/4 inches in overall height with a 1/2 inch high neoprene sweep.

3. Mount door sweep on the exterior side of the door, with the neoprene engaged with the threshold or finish floor.

E. Thresholds shall be extruded aluminum meeting ADA requirements. They shall not exceed 1/4 inch in height with a wall thickness of 0.125 inches unless specified otherwise. Coordinate templates for any and all hardware, which may require cutouts or slots within the threshold for the proper installation of that hardware.

1. Furnish threshold with non-slip epoxy abrasive bonded within the grooves of the threshold.

2. Thresholds shall extend a minimum of 1 inch past the exterior face of the door and have returned closed ends.

3. Set all thresholds in grout and seal with silicone caulk.

4. Fasten thresholds with expansion shield mounting at masonry substrate locations and wood screws at wood substrate locations.

PART 3 - EXECUTION
3.01 Acceptable Installers
   A. Factory trained and certified, and carries a factory issued card certifying that person is a "Certified Installer”.

3.02 Preparation
   A. Ensure that walls and frames are square and plumb before hardware installation.
   B. The installer shall notify SEPTA, in writing, of all unacceptable conditions that could affect the proper operation of the finish hardware.
   C. Locate hardware per ANSI/SDI A250.8 (SDI 100) and applicable building, fire, life safety, accessibility and security codes.
   D. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.
   E. Existing frames and doors scheduled to receive new hardware; carefully remove existing hardware and turn over to SEPTA. Patch and fill wood frames and doors with solid wood stock or dowel material before cutting for new hardware. Do not reuse existing screw holes; fill and re-pilot.

3.03 Installation
   A. Install hardware per the manufacturer's instructions and recommendations. Do not install surface mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation.
      1. Unless otherwise specified, locate all hardware in accordance with the recommended locations for builder's hardware for standard doors and frames as published by the Door and Hardware Institute.
      2. Install jamb applied gaskets before closers, overhead stops, rim strikes, etc. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.
      3. Unless otherwise specified or detailed, install thresholds with the bevel in vertical alignment with the outside door face. Notch and closely fit thresholds to frame profile. Set thresholds in full bed of sealant.
      4. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.
      5. Locate floor stops not more than 4 inches from the wall.
      6. Drill pilot holes for fasteners in wood doors and/or frames.
      7. Shim doors as required to maintain proper operating clearance between door and frame.
      8. Use only fasteners supplied by or approved by the manufacturer for each respective item of hardware.
      9. Lubricate and adjust existing hardware scheduled to remain. Carefully remove and give to SEPTA items not scheduled for reuse.
10. Where necessary, adjust doors and hardware as required to eliminate binding between strike and latchbolt. Doors should not rattle.

11. Install door closers on corridor side of lobby doors, room side of corridor doors and stair side of stairways.

12. Adjust spring power of door closers to insure exterior and fire rated doors will consistently close and latch doors under existing conditions. Adjust all other door closers to insure opening force does not exceed 5 pounds.

13. Adjust "sweep", "latch", and "back check" valves on all door closers to properly control door throughout the opening and closing cycle. Adjust total closing speed as required to meet all applicable state and local building codes.

14. Deliver to SEPTA one (1) complete set of installation and adjustment instructions, and tools as furnished with the hardware.

3.04 Quality Assurance

A. After installation has been completed, the hardware supplier and the manufacturers’ representative for locksets, door closers, exit devices and overhead stops shall check the Project and verify compliance with installation instructions, adjustment of all hardware items and proper application according to the approved hardware schedule. The hardware supplier shall submit a list of all hardware that has not been installed correctly.

B. After installation has been completed, the hardware supplier and the manufacturers’ representative shall meet with the SEPTA to explain the functions, uses, adjustment and maintenance of each item of hardware.

3.05 Adjusting and Cleaning

A. Adjust and check for proper operation and function. Replace units which cannot be adjusted to operate freely and smoothly.

B. At final completion, and when HVAC equipment is in operation, the installer shall make final adjustments to and verify proper operation of all door closers and other items of hardware. Lubricate moving parts with type lubrication recommended by the manufacturer.

C. All hardware shall be left clean and in good operation. Hardware found to be disfigured, defective or inoperative shall be repaired or replaced.

D. Wherever hardware installation is made more than one (1) month prior to acceptance or occupancy of space or area, return to work during week prior to acceptance or occupancy, and make final check and adjustment of hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors.

3.06 Extra Stock

A. See hardware sets for additional hardware. Additional hardware is to be delivered directly to SEPTA for maintenance purposes.

B. Extra screws shall be furnished to the Contractor for installation purposes. See hardware sets for a detailed listing of extra screws.
C. All extra hardware items, fasteners and special installation tools are to be turned over to SEPTA at completion of the Contract.

3.07 Demonstration
   A. Demonstrate electrical, electronic and pneumatic hardware systems, including adjustment and maintenance procedures.

3.08 Protection
   A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to substantial completion.
   B. Clean adjacent wall, frame and door surfaces soiled from installation/reinstallation process.

3.09 Schedule of Finish Hardware
   A. See Door Hardware Schedule on the Contract Drawings for hardware set assignments.
   B. Hardware groups to be determined.

END OF SECTION
THIS PAGE NOT USED
SECTION 09662

ELECTRICALLY INSULATED FLOOR COVERING

PART 1 - GENERAL

1.01 Description

A. This Section specifies requirements for electrically insulated floor covering.

B. The electrically insulated floor covering shall separate and insulate the traction gear from the substation floor and from ground. It shall be poured in place to the dimensions as shown on the Contract Drawings.

C. Each section shall be one (1) continuous pour with no joints or cracks. Joints or cracks in the finished covering shall require removal and reinstallation.

1.02 Submittals

A. Submit the following in accordance with Division 1.

B. Submit shop drawings:
   1. The manufacturer’s standard catalog cuts, material safety sheets, maintenance instructions, descriptive literature and diagrams, in 8 1/2 inch by 11 inch format, and in sufficient detail so as to clearly indicate compliance with all specified requirements and standards.

C. Submit certification:
   1. The manufacturer’s certification signed by the manufacturer certifying that the company meets the required qualifications. Upon request submit evidence of company’s experience.
   2. Product certification signed by the manufacturer certifying that the product meets the specification.

D. Submit five (5) certified copies of field tests, prior to shipment of products.

1.03 Quality Assurance

A. The completed installation shall meet the Contract Documents. The work shall also meet applicable provisions of the IEEE C2 and the NEC.

B. Electrically insulated floor covering shall be manufactured and tested under the control of Quality Assurance system that conforms to the requirements of ISO 9000.

C. The floor covering installation shall be in accordance with the manufacturer’s recommendations.

D. Each bidder for this Contract shall be pre-qualified and approved in writing by the material manufacturer.

E. Each bidder must have documented experience in the application of the type of system specified. The Contractor shall submit a list of Projects of similar size, scope and complexity.
F. Meet the applicable provisions of the most recent issues of the following references:

15. ISO 9001, Quality Management Systems - Requirements.
16. NFPA 70, National Electrical Code

1.04 Delivery, Storage and Handling

A. Deliver materials to site in the manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name, manufacturer, batch or lot number and date of manufacture.

B. Material should be delivered to job site and checked for completeness and shipping damage prior to job start.

C. Storage:

1. Store materials in accordance with the manufacturer’s written instructions.
2. Keep containers sealed until ready for use. Material should be stored in a dry, enclosed, protected area from the elements.
3. Do not subject material to excessive heat or freezing.
4. Shelf life to be established based on the manufacturer’s written recommendation for each material being used.
D. Protect materials during handling and application to prevent damage or contamination.
E. Condition materials for use accordingly to the manufacturer’s written instructions prior to application.
F. Record material lot number and quantity delivered to jobsite/storage.

1.05 Site Conditions
A. Do not install the work of this Section outside of the following environmental ranges with the manufacturers’ written acceptance.
   1. Precondition material for at least twenty-four (24) hours between 65°F to 75°F.
   2. Ambient temperature minimum/maximum to be 50°F/85°F.
   3. Substrate temperature minimum/maximum to be 50°F/85°F. Substrate temperature must be at least 5°F above measured dew point.
   4. Mixing and application attempted at material, ambient and/or substrate temperature conditions less than 65°F will result in a decrease in product workability and slower cure rates.
   5. The minimum relative ambient humidity to be 30 percent and the maximum relative ambient humidity to be 75 percent (during application and curing).
   6. Measure and confirm substrate moisture content, ambient relative humidity, ambient and surface temperature and dew point.
B. Maintain constant ambient room temperature of plus or minus 15°F with a minimum temperature of 50°F and maximum temperature of 85°F. Maintain constant ambient room temperature for forty-eight (48) hours before, during and after installation or until cured. Do not apply while ambient temperatures are rising.
C. Erect suitable barriers and post legible signs at points of entry to prevent traffic and trades from entering the work area during application and cure period of the floor.
D. Protection of finished floor from damage by subsequent trades shall be the responsibility of the Contractor.
E. Insure adequate ventilation and air flow.

1.06 Warranty
A. The manufacturer’s warranty covering the resinous flooring against defects in materials for one (1) year from date of installation.

PART 2 - PRODUCTS

2.01 Manufacturers
A. The manufacturer shall be certified under ISO 9001. All liquid materials, including primers, resins, curing agents, finish coats, and sealants are manufactured and tested under an ISO 9001 registered quality system.
B. The manufacturer shall be regularly engaged in production with documented experience in the actual production of the specified products.

C. Manufacturers:
   1. ESD Epoxy Electrostatic Control System.
   2. Sherwin Williams.
   3. PPG.
   4. Or Approved Equal.

D. Primer to be Sikafloor 161 applied between 8 – 10 mils.

E. Top coat to be Sikafloor 200 ESD applied at 16 mils

2.02 General Requirements

A. Furnish only materials that are new and of specified quality. Where Underwriters' Laboratories, Inc. have established standards for such materials furnish only materials bearing the UL label.

B. Electrically insulated floor covering shall be an epoxy material, consisting of two (2) semi-fluid components and shall contain no Portland cement.

C. The epoxy flooring shall be dense, resist thermal expansion and contraction, shall have a high electrical insulation resistance, and be dustless and skid proof.

D. The epoxy material shall adhere to clean dry concrete or metal surface and shall be suitable for application to a thickness of 1/4 inch or greater. The thickness of the epoxy floor material for this Contract shall be 1/2 inch.

E. The insulated floor covering shall be resistant to fire and acids, resist abrasion and impact and be suitable for industrial trucking. The floor covering shall not be affected by high or low ambient temperature after cure.

F. The epoxy coating shall meet the following:
   1. Primer:
      a. Pull-off strength to meet ASTM D 4541 and be > 400 psi (2.7 MPa) with 100 percent concrete failure.
      b. Shore D hardness to meet ASTM D 2240 and be 76 at seven (7) days.
      c. Solid content to be ~ 100% (by volume) / ~ 100% (by weight).
      d. VOC content to meet ASTM D 2369 and be ≤ 50 g/L.
      e. Permeability to meet ASTM E 96/E 96M and be 9.0 g/m² (twenty-four (24) hours / plus 75°F).
      f. Water absorption to meet ASTM D 570 and be 0.14 g/h - m².
      g. Viscosity (approximately) of components A + B to be 775 (SP2/100).
      h. Color to be gray as approved by SEPTA.
   2. Top Coat:
      a. Pull-off strength to meet ASTM D 4541 and be > 350 psi (2.4 MPa) with 100 percent concrete failure.
      b. VOC content to meet ASTM D 2369 and be ≤ 50 g/L.
c. Abrasion resistance to meet ASTM D 4060 and be 160 - 180 mgs (CS-17 Wheel, 1000 gm load, one thousand (1000) cycles).

d. Gloss (60°) to be 80 – 90.

e. Viscosity to be 300 - 650 cps. at 73° F.

f. Flexibility to meet ASTM D 522/D 522M and be 1/4 inch passes test.

PART 3 - EXECUTION

3.01 Examination

A. Examine surfaces to receive flooring system. Notify the Contractor, SEPTA and SEPTA’s representative if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected. Do not apply to substrate treatments for moisture, repair or leveling not of the same manufacturer.

B. Surface must be clean, sound and dry. Remove dust, laitance, grease, curing compounds bond inhibiting impregnations, waxes and any other contaminants. All projections, rough spots, etc. should be dressed off to achieve a level surface prior to the application.

C. Concrete substrate to have a minimum compressive strength of 3,500 psi at twenty-eight (28) days and a minimum of 215 psi in tension at time of application.

D. Substrate moisture:
   1. Measure and confirm substrate moisture content, ambient relative humidity, ambient and surface temperature and dew point.
   2. Confirm and record above values at least once every three (3) hours during installation or more frequently whenever conditions change (e.g. ambient temperature rise/fall, relative humidity increase/decrease, etc.).

E. Ensure the concrete substrate meets the minimum requirements of the flooring manufacturer.

F. Flooring system shall not be applied to sand cement setting beds. Sand cement beds shall be removed to structural concrete substrate and re-leveled/sloped as necessary to achieve grade and/or adequate drainage.

G. Flooring system shall not be applied to asphaltic or bitumen membranes, soft wood, aluminum, copper or fiberglass reinforced polyester/vinyl ester composites.

H. Application to glazed or vitrified brick and tile, structural wood, steel shall only be permitted with the manufacturer’s written recommendation.

3.02 Surface Preparation

A. Prepare the surface to receive flooring systems in accordance with the manufacturer’s written instructions.

B. Remove dirt, oil, grease, wax, laitance, curing compounds, water soluble concrete hardeners and other surface contaminants. Remove sealers, finishes and paints. Remove unsound concrete by appropriate mechanical means.
C. Concrete shall be cleaned and prepared to achieve laitance free and contaminant free, open textured surface by shot blasting or equivalent mechanical means (CSP level as per ICRI guidelines and the manufacturer’s written recommendation).

D. Chemical surface preparation (acid etching) is unacceptable and will void the manufacturer’s warranty.

E. Provide repair and treatment of control joints and surface cracks utilizing the manufacturer’s standard materials and installation details.

3.03 Application

A. Mix and apply material with strict adherence to the manufacturer’s written installation procedures and coverage rates.

B. Follow the manufacturer’s written recommendations on terminations and connections to walls, drains, doorways, columns and floor to floor transitions.

C. Do not apply while ambient and substrate temperatures are rising.

D. Apply resinous flooring with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform color, sheen and texture, all within limitations of materials and areas concerned.

E. Match colors and textures of approved samples.

F. Install cove base in accordance with the manufacturer’s written instructions.

3.04 Clean Up

A. Disposal of this product, solution and any by-products should at all times meet the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

B. Empty containers should be taken to an approved waste handling site for recycling or disposal.

3.05 Protection

A. Freshly applied material should be protected from dampness, condensation and water for at least seventy-two (72) hours.

B. Beware of air flow and changes in air flow. Introduction of dust, debris, and particles, etc. may result in surface imperfections and other defects.

C. Follow the manufacturer’s written recommendation with respect to cure, wait time and return to service.

3.06 Installation by Contractor

A. Installation shall be accomplished by the Contractor’s workmen with established skill in this type of work and shall conform to the Contract Documents.

B. The epoxy floor covering shall be applied to a minimum thickness of a 3/8 inches as one (1) piece level surface, free from cracks and joints.
C. Before installation, properly seal conduits to prevent the entrance of epoxy material into conduits. Apply masking to prevent the encapsulation of grounding conductors.

D. Where edge of the insulated floor meets the bare metal/concrete floor, epoxy material shall be tapered from full thickness to the level of the concrete floor over a length of 6 inches. Where the epoxy floor covering meets wall insulating panel, the floor covering shall completely fill any gap to a minimum thickness of 1/4 inch.

END OF SECTION
SECTION 09705

EPOXY RESIN FLOORING

PART 1 - GENERAL

1.01 Description
A. Furnish all labor, materials, tools and equipment required to perform the work of this Section as shown on the Contract Drawings and as specified herein.
   1. Application method is by metal, power or hand, troweled.

1.02 Related Sections
A. Section 03300 – Cast-In-Place Concrete
B. Section 03930 – Concrete Repair

1.03 Submittals
A. Submit product data for each type of product indicated. Include manufacturer's technical data, application instructions and recommendations for each resinous flooring component required.
B. Submit shop drawings for floor design and integral cove base, based on verified field conditions
C. Submit samples for verification.
   1. For each resinous flooring system required, minimum 6 inches square, applied to a rigid backing by the installer for this Contract.
   2. Samples of transitions for each system, color, and type, minimum 6 inches long, applied to a rigid backing by the installer for this Contract.
D. Submit product schedule using resinous flooring designations indicated in Article 2 in this Section and room designations indicated on the Contract Drawings in the product schedule. Schedule to be coordinated with Project specific staging and approved by the SEPTA Project Manager.
E. Submit installer certificates signed by manufacturer certifying that the installers meet the specified requirements.
F. Submit material certificates for each resinous flooring component, from manufacturer.
G. Submit material test reports for each resinous flooring system, by a qualified testing agency.
H. Submit maintenance data for resinous flooring to include in maintenance manuals.

1.04 Quality Assurance
A. Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Contract, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.
1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

2. The Contractor shall have completed Projects of similar size and complexity.

B. Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one (1) source from a single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Apply full thickness mockups on 48 inch square floor area selected by the SEPTA Project Manager.
   2. Include 48 inch length of integral cove base and the typical transition detail for flooring colors.
   3. Approved mockups may become part of the completed work if undisturbed at time of substantial completion.
   4. Sign off from the SEPTA Project Manager on texture for slip resistance must be complete before installation of flooring system.

D. Pre-installation Conference:
   1. The Contractor shall arrange a meeting not less than fifteen (15) days prior to starting work.
   2. Coordinate attendees with the SEPTA Project Manager.

E. Meet the applicable provisions of the most recent issues of the following references:
   1. ICC A117.1, Standard for Accessible and Usable Building and Facilities.

1.05 **Delivery, Storage and Handling**

A. Deliver materials in original packages and containers, with seals unbroken, bearing the manufacturer's label indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight or other detrimental effects.

C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.

1.06 **Project Conditions**

A. Meet the resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation and other conditions affecting resinous flooring application.

B. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than twenty-four (24) hours after application, unless the manufacturer recommends a longer period.

D. Concrete substrate shall be properly cured for a minimum of thirty (30) days. Refer to Article 3 in this Section for moisture test requirements of concrete substrate.

1.07 **Warranty**

A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of five (5) full years from date of installation, or provide a joint and several warranty signed on a single document by the material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of five (5) full years from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

**PART 2 - PRODUCTS**

2.01 **Resinous Flooring**

A. Subject to compliance with requirements, product that may be incorporated into the work include:

1. Meet with the troweled mortar base with broadcast topping. Liquid rich, slurry type systems will not be accepted, and will result in a disqualification from bid.

B. Manufactures:

1. Stonhard, Inc.; Stonshield HRI.
4. Or Approved Equal.

C. System Characteristics:
1. Color and pattern to be custom, as selected by SEPTA.
2. Wearing surface to be standard or medium texture. Texture must be in compliance with requirements noted within Article 2.01/E in this Section and approved by the SEPTA Project Manager.
3. Integral cove base to be as shown on Contract Drawings.
4. Overall system thickness to be nominal 1/4 inch.

D. System components to be the manufacturer's components that are compatible with each other and as follows:
1. Sealant for Metal and Expansion Joints:
   a. Material basis to be Stonhard Stonflex MP7, Or Approved Equal.
   b. Formulation description to be (2) two component polyurethane.
   c. Method to be saw cut resinous system and fill void with MP7 product.
   d. Number of coats to be (1) one.

2. Positive Side Vapor Barrier:
   a. Refer to Article 3.01 in this Section for use requirements of this product.
      1) Basis of design to be Stonhard Stonfill OP2, Or Approved Equal.

3. Primer:
   a. Material basis to be Stonhard Standard Primer, Or Approved Equal.
   b. Resin to be epoxy.
   c. Formulation description to be (2) two component, 100 percent solids.
   d. Application method to be squeegee and roller.
   e. Number of coats to be (1) one.

4. Mortar Base:
   a. Material design basis to be Stonclad GS, Or Approved Equal.
   b. Resin to be epoxy.
   c. Formulation description to be (3) three component, 100 percent solids.
   d. Application method to be metal trowel.
      1) Thickness of coats to be nominal 3/16 inch.
      2) Number of coats to be (1) one.
   e. Aggregates to be pigmented blended aggregate.

5. Undercoat:
   a. Material basis to be Stonshield undercoat, Or Approved Equal.
   b. Resin to be epoxy.
   c. Formulation description to be (2) two component, 100 percent solids, UV Stable.
   d. Type to be clear.
   e. Finish to be gloss.
f. Number of coats to be (1) one.

6. Broadcast Media:
   a. Material basis to be Stonshield quartz aggregate, Or Approved Equal.
   b. Type to be pigmented.
   c. Finish to be standard.
   d. Number of coats to be (1) one.
   e. Pattern to be tweed.

7. Sealer:
   a. Material basis to be Stonshield Sealer, Or Approved Equal.
   b. Resin to be epoxy.
   c. Formulation description to be (2) two component, 100 percent solids, UV Stable.
   d. Type to be clear.
   e. Finish to be gloss.
   f. Number of coats to be (1) one.
   g. Texture level to be standard or medium.
   h. Prep for seal coat to be light sanding and vacuum as required by the manufacturer.

8. Seal coat:
   a. Material basis to be Stonseal CF7 clear flat, Or Approved Equal.
   b. Resin to be aliphatic polyurethane.
   c. Formulation description to be (2) two component, waterborne, flat, aliphatic polyurethane that is chemical resistant and UV stable.
   d. Type to be clear.
   e. Finish to be gloss.
   f. Number of coats to be (1) one.

E. Slip Coefficient:
   1. Slip coefficient of friction shall be in compliance with ICC A117.1 requirements.
   2. Provide minimum wet static coefficient of friction of 0.8 for sloped surfaces and 0.6 flat surfaces.
   3. Final wearing surface to be approved by the SEPTA Project Manager.

F. Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
   1. Compressive strength to be 10,000 psi after seven (7) days per ASTM C 579.
   2. Tensile strength to be 2,000 psi per ASTM C 307.
   3. Flexural strength to be 4,300 psi per ASTM C 580.
   4. Water absorption to be < 1 percent per ASTM C 413.
   5. Impact resistance to be > 160 in. lbs. per ASTM D 2794.
   6. Flammability to be Class 1 per ASTM E 648.
   7. Hardness to be 85 to 90, Shore D per ASTM D 2240.
2.02 Accessory Materials
   
   A. Patching and fill material to be a resinous product of or approved by the resinous flooring manufacturer and recommended by the manufacturer for application indicated.

   B. Joint sealant to be the type recommended or produced by the resinous flooring manufacturer for type of service and joint condition indicated. Allowances should be included for Stonflex MP7 joint fill material (Or Approved Equal) and CT5 concrete crack treatment (Or Approved Equal).

PART 3 - EXECUTION

3.01 Preparation

   A. Prepare and clean substrates according to the resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry and neutral Ph substrate for resinous flooring application.

   B. Prepare metal substrates according to the resinous flooring manufacturer’s written instructions for substrate indicated.

   C. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form release agents, dust, dirt, grease, oil and other contaminants incompatible with resinous flooring.

   1. Mechanically prepare substrates as follows:
      a. Shot blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus and recirculates the shot by vacuum pickup.
      b. Meet the manufacturer's written instructions if they are more stringent.

   2. Repair damaged and deteriorated concrete according to the resinous flooring manufacturer’s written recommendations.

   3. Verify that concrete substrates are dry and moisture vapor emissions are within acceptable levels according to the manufacturer’s written instructions.
      a. Perform in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 85 percent.
      b. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture vapor emission rate of 7 pounds of water/1000 sq. ft. of slab in twenty-four (24) hours.
      c. Perform additional moisture tests recommended by the manufacturer. Proceed with application only after substrates pass testing.
      d. If tests result in high moisture content than a positive side vapor barrier shall be installed as required by the manufacturer.

   4. Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by the manufacturer. Proceed with application only after substrates pass testing.

   5. SEPTA to verify concrete substrate prior to application of resinous material.

   D. Mix components and prepare materials according to the resinous flooring manufacturer's written instructions.
E. Use patching and fill material to fill holes and depressions in substrates according to the manufacturer's written instructions.

F. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to the manufacturer's written recommendations. Allowances should be included for Stonflex MP7 joint fill material (Or Approved Equal) and CT5 concrete crack treatment (Or Approved Equal).

3.02 Application

A. Apply components of resinous flooring system according to the manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate and optimum intercoat adhesion.
   2. Cure resinous flooring components according to the manufacturer's written instructions. Prevent contamination during application and curing processes.
   3. At substrate expansion and isolation joints, provide joint in resinous flooring to meet the resinous flooring manufacturer's written recommendations.
      a. Apply joint sealant to meet the manufacturer's written recommendations.

B. Apply primer where required by resinous system, over prepared substrate at the manufacturer's recommended spreading rate.

C. Stonshield cove mortar (Or Approved Equal), apply cove base mix to wall surfaces before applying flooring. Apply according to the manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, of cove base. Round internal and external corners.

D. Refer to the Contract Documents for integral cover base.

E. Apply metal trowel single mortar coat in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, sand to remove trowel marks and roughness.

F. Remove any surface irregularities by lightly abrading and vacuuming the floor surface. Mix and apply undercoat with strict adherence to the manufacturer's installation procedures and coverage rates.

G. Immediately broadcast quartz silica aggregate into the undercoat using the manufacturer's specially designed spray caster. Strict adherence to the manufacturer's installation procedures and coverage rates is imperative.

H. Apply topcoat in number of coats indicated for flooring system and at spreading rates recommended in writing by the manufacturer.

3.03 Terminations

A. Chase edges to “lock” the flooring system into the concrete substrate along lines of termination.

B. Lap and seal the flooring system onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.
C. Continue flooring system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

D. Treat floor drains by chasing the flooring system to lock in place at point of termination.

E. Continue flooring system over curbs to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

3.04 Joints and Cracks

A. Treat control joints to bridge potential cracks and to maintain monolithic protection.

B. Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.

C. Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by the manufacturer for traffic conditions and chemical exposures to be encountered.

3.05 Field Quality Control

A. SEPTA Project Manager may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.

1. If test results show applied materials do not meet the specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to meet the requirements.

3.06 Cleaning, Protecting and Curing

A. Cure resinous flooring materials in compliance with the manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of eighteen (18) hours.

B. Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, meet the manufacturer's recommendations for protective materials and method of application. The Contractor is responsible for protection and cleaning of surfaces after final coats.

C. Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by the resinous flooring manufacturer.

END OF SECTION
SECTION 09910
PAINTS AND COATINGS

PART 1 - GENERAL

1.01 Description
A. Provide painting, as shown and scheduled per the Contract Drawings; including, but not limited to:
   1. Painting and surface preparation for interior and exterior finished surfaces.
   2. Priming of substrates.
   3. Refer to Section 09662 for coating concrete floor of the substations and switching stations.
   4. Refer to Section 09960 for sealing/painting catenary and gantry steel members.
   5. Refer to Section 09965 for graffiti resistant top coat to paint systems. Refer to the Contract Drawings for extent of application of graffiti resistant coating.

1.02 Related Sections
A. Section 01400 – Quality Requirements
B. Section 08110 – Metal Doors and Frames
C. Section 09662 – Electrically Insulated Floor Covering
D. Section 09960 – High Performance Coating
E. Section 09965 – Graffiti Resistant Coatings
F. Section 10200 – Louvers and Vents

1.03 Submittals
A. Submit the manufacturer's specifications, data and installation instructions for review.
B. Submit product list to cross reference coating system and locations of application areas. Use same designations indicated on the Contract Drawings and in schedules. Include color designations.
C. Submit samples:
   1. Submit specified colors for each surface finishing product.
   2. Field samples:
      a. In place, on material scheduled to be finished, illustrating coating color, texture and finish. Locate where directed; accepted sample may remain as part of the work.
      b. One (1) entire unit as scheduled to be finished.
D. Submit statement of VOC compliance with local regulations.
1.04 Quality Assurance

A. Refer to Section 01400.

B. Qualifications:
   1. Applicator to be specializing in performing the work of this Section with documented experience.
   2. Use only products in compliance with VOC content limits required by state and local regulations.

C. Meet the applicable provisions of the most recent issues of the following references:
   4. SEPTA System Safety Document #3001, Management of Lead Paint on SEPTA Property.
   5. SSPC-SP 1, Solvent Cleaning.
   6. SSPC-SP 2, Hand Tool Cleaning.
   7. SSPC-SP 3, Power Tool Cleaning.
   8. SSPC-SP 11, Power Tool Cleaning to Bare Metal.

1.05 Delivery, Storage and Handling

A. Delivery:
   1. Schedule delivery of materials at the site at such time as required for proper coordination of the work. Receive materials in the manufacturer’s unopened packages and bearing the manufacturer’s label.

B. Storage:
   1. Store materials in a dry and properly ventilated separate structure not less than 50 feet from any other structure on the site. Adequately protect from damage and exposure to the elements.
   2. Maintain a minimum temperature of 45°F and a maximum temperature of 90°F.
   3. Take necessary precautions to prevent fire; remove paint soiled rags and waste from building each day or store in metal containers with covers in the paint storage structure.

1.06 Warranty

A. Manufacturer’s Standard Warranty:
   1. Provide, in required form, for a period of five (5) years from date of final acceptance.
   2. Color and finish appearance shall remain unchanged throughout entire guarantee period.
1.07 Extra Material

A. Deliver 1 percent or a minimum of two (2) gallons of each color, type and surface texture of paint installed. Label each container with color, type, texture and room locations.

PART 2 - PRODUCTS

2.01 Materials

A. Manufacturer:
   1. Basis of Design is Sherwin Williams.
   2. Carboline Co.
   4. Or Approved Equal.

B. Container label to identify with the manufacturer's name, and include description of type of paint, brand name, lot number, and brand code and color designation.

C. Provide ready mixed products, except field catalyzed coatings. Provide accessory materials such as linseed oil, shellac, thinners, cleaners and other materials not specifically indicated but required to achieve finishes specified.
   1. Use only one (1) lot of paint for any individual element to be painted. Do not mix lots of paint.

D. Exterior:
   1. Composite Trim:
      a. One (1) coat Pro Industrial Pro-Cryl Universal Gray Primer B66-310.
      b. Two (2) coats Pro Industrial HP Acrylic, Semi-Gloss B66-650.

   2. Miscellaneous Metal Trim:
      a. One (1) coat Macropoxy 646-100 Fast Cure Epoxy, B58-620.
      b. Two (2) coats High Solids 100 Polyurethane B65-600.

   3. Various Slightly Rusted Substrates – Interior or Exterior:
      a. One (1) coat Kem Bond HS Universal Metal Primer B50AZ8.
      b. Two (2) coats Industrial Enamel High Solids Gloss B54 series.
      or
      c. One (1) coat Macropoxy 646-100, Fast Cure Epoxy B58-620.
      d. Two (2) coats High Solids Polyurethane 100 B65-600.

E. Interior:

   1. Ceiling or Curbs:
      a. Concrete:
         1) One (1) coat Loxon Concrete & Masonry Primer, A24.

F. Miscellaneous Cleaning and Refinishing Materials:
1. Fine grade Scotch-Brite pads (white and/or green type,) manufactured by 3M Co, St Paul MN, Or Approved Equal.
2. Very fine steel wool, clean and free of contaminants and corrosion.
3. Clean, soft, lint-less, cotton rags.

G. Solvent Cleaners and Thinners:
1. Xylene to be commercial manufacture.
2. White spirit to be commercial manufacture.
3. Odorless lacquer thinner to be commercial manufacture.
4. Denatured alcohol to be commercial manufacture.
5. Or Approved Equal.

2.02 Mixing
A. Mix paints at the factory; do not alter or reduce materials except as directed by the manufacturer.
B. See finish schedule on the Contract Drawings for colors.
C. Add fungicidal agent to paint per the manufacturer's recommendations. Add agent at the factory; clearly indicate on label that paint is mildew resistant.

PART 3 - EXECUTION

3.01 Preparation
A. Environmental Requirements:
1. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the manufacturer.
2. Temperature:
   a. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the manufacturer.
   b. Exterior paints to be applied at 40°F minimum during and for forty-eight (48) hours after application; do not apply when temperature is over 90°F, except in protected or shaded areas.
   c. Interior paints to be applied at 50°F for minimum of forty-eight (48) hours before, during and for forty-eight (48) hours after application.
3. Provide adequate ventilation of all interior spaces during application and curing of all painting products.
4. Provide minimum 80 foot candles measured at mid height of room. At exterior, measured at mid height of element to be painted.
B. Examination:
1. Examine conditions of surfaces in place before beginning work; report defects.
2. Test shop applied primer for compatibility with subsequent cover materials

3. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
   a. Concrete 12 percent.
   b. Fiber cement boards 12 percent.
   c. Masonry (clay and CMUs) 12 percent.
   d. Wood 15 percent.
   e. Portland cement plaster 12 percent.
   f. Gypsum board 12 percent.

4. Application of first coat of painting process constitutes acceptance of surface.

C. Protect adjacent surfaces not scheduled for paint finish from damage resulting from painting operations.

D. Steel/Metals Surface Preparation:
   1. Oil, grease, salts or other surface contaminations must first be removed by the methods outlined in SSPC-SP 1.
   2. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer, but not less than the following:
      a. SSPC-SP 2
      b. SSPC-SP 3
      c. SSPC-SP 11
   3. Dust conditions at the site shall be anticipated and such dust as may collect shall be removed before touch-up paint is applied.
   4. All flux, spatter, slag or laminations from welding or other sharp projections shall be ground smooth prior to cleaning.
   5. All areas cleaned on any day shall be coated on the same day. Any such areas not coated that are exposed overnight shall be lightly cleaned to remove any visible or invisible rust that may have formed.
   6. Remove or mask electrical plates, hardware, light fixture trim, escutcheons and fittings prior to preparing surfaces or finishing. Correct defects and clean surfaces that affect work of this Section. Remove existing coatings that exhibit loose surface conditions. Use shellac to seal marks, which may bleed through surface finishes.
   7. Remove mildew by scrubbing with solution of trisodium phosphate and bleach on impervious surfaces. Rinse with clean water and allow surface to dry.
   8. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather edges to make touch up patches inconspicuous. Clean surfaces with solvent to remove all oil, grease and other foreign matter. Prime bare steel surfaces.

3.02 Application
   A. Install in conformance with referenced standards, the manufacturer's written directions, as shown, and as specified.
1. Spray painting is not an acceptable method of application

B. Performance:

1. Apply each coat to uniform finish, slightly darker than preceding coat unless otherwise approved. Sand surfaces lightly between coats to achieve required finish. Vacuum clean surfaces free of loose particles; use tack cloth just prior to applying next coat. Allow applied coat to dry before next coat is applied.

3.03 Cleaning

A. Upon completion, remove masking materials, reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing, and thoroughly clean all exposed surfaces per the manufacturer’s instructions. Keep premises free from accumulation of waste and rubbish. At the completion of work remove surplus materials, rubbish and debris.

B. After detailed inspection of paint work, touch up or refinish abraded, stained, or otherwise disfigured work, as required by SEPTA.

C. Remove containers, rags and debris from the site; observe special care in control or disposal of flammable materials.

END OF SECTION
PART 1 - GENERAL

1.01 Description

A. Section includes surface preparation and the application of high performance coating systems for the following substrates:

1. Exterior Substrates:
   a. Galvanized steel members:
      1) Catenary steel.
      2) Gantry steel.

1.02 Submittals

A. Submit product data for each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

2. Indicate VOC content.

B. Submit samples for verification of each type of coating system and each color and gloss of topcoat indicated.

1. Submit samples on rigid backing, 8 inches square.

2. Apply coats on samples in steps to show each coat required for system.

3. Label each coat of each sample.

4. Label each sample for location and application area.

C. Submit product list to cross-reference to coating system and locations of application areas. Use same designations indicated on the Contract Drawings and in schedules. Include color designations.

D. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings to be 5 percent, but not less than 1 gallon of each material and color applied.

1.03 Quality Assurance

A. Apply mockups of each coating system indicated to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. SEPTA will select one (1) surface to represent surfaces and conditions for application of each coating system.
a. Provide samples of at least 100 square feet for floor surfaces.
b. SEPTA will designate other items or areas as required.

2. Final approval of color selections will be based on mockups.
a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by SEPTA at no added cost to SEPTA.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of substantial completion.

B. The manufacturer to have documented experience producing concrete coatings.

C. The installer to be a licensed installer experienced and trained in the use of specified products.

D. Concrete surface must be clean and dry with all stains, oil, grease, dust and dirt removed prior to application.

E. Meet the requirements of authorities having jurisdiction and applicable codes at the location of the Project.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
   3. SSPC-SP2, Hand Tool Cleaning.
   4. SSPC-SP 3, Power Tool Cleaning.
   5. SSPC-SP 11, Power Tool Cleaning to Bare Metal.
   6. SSPC-SP 11, Power Tool Cleaning to Bare Metal.

1.05 Delivery, Storage and Handling

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

1.06 Definitions

A. MPI Gloss Level 5 to be 35 to 70 units at 60 degrees to meet ASTM D 523.

B. MPI Gloss Level 6 to be 70 to 85 units at 60 degrees to meet ASTM D 523.

C. MPI Gloss Level 7 to be more than 85 units at 60 degrees to meet ASTM D 523.
1.07  **Field Conditions**

A. Apply coatings based on the manufacturers’ requirements or only when the temperature of surfaces to be coated and ambient air temperatures are between 50°F and 95°F.

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

C. Do not apply exterior coatings in snow, rain, fog or mist.

**PART 2 - PRODUCTS**

2.01  **Manufacturers**

A. Manufacturers:

1. Basis of design is Sherwin Williams Pro Industrial Water Based Acrolon 100 Polyurethane.

2. PPG.

3. Sika.

4. Tnemec.

5. Or Approved Equal.

2.02  **High Performance Coatings**

A. Products shall meet the MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by the manufacturer, based on testing and field experience.

2. For each coat in a paint system, products shall be recommended in writing by the topcoat manufacturers for use in paint system and on substrate indicated.

3. Products shall be of the same manufacturer for each coat in a coating system.

C. Colors to be clear.

**PART 3 - EXECUTION**

3.01  **Examination**

A. Examine substrates and conditions, with the applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the work.

B. Maximum moisture content of substrates when measured with an electronic moisture meter as follows:

1. Concrete to be 12 percent.
C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

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

3.02 Preparation

A. Meet the manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

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

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

D. Remove rust, loose mill scale, and shop primer if any on steel substrates. Clean using methods recommended in writing by the paint manufacturer but not less than the following:
   1. SSPC-SP 2.
   2. SSPC-SP 3.
   3. SSPC-SP 11.

3.03 Application

A. Apply high performance coatings according to the manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
   1. Spray painting is not an acceptable method of application.
   2. Use applicators and techniques suited for coating and substrate indicated.
   3. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
   4. Coat backsides of access panels, removable or hinged covers and similar hinged items to match exposed surfaces.
   5. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating or nomenclature plates.

B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color and appearance.
C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections. Produce sharp glass lines and color breaks.

3.04 Field Quality Control
A. Engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
1. The Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not meet the coating manufacturer's written recommendations, the Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that meets with the coating manufacturer's written recommendations.

3.05 Cleaning and Protection
A. At end of each workday, remove rubbish, empty cans, rags and other discarded materials from the Project site.
B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping or other methods. Do not scratch or damage adjacent finished surfaces.
C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by SEPTA, and leave in an undamaged condition.
D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

END OF SECTION
THIS PAGE NOT USED
SECTION 09965
GRAFFITI RESISTANT COATINGS

PART 1 - GENERAL

1.01 Description
A. Provide graffiti resistant coatings as shown and specified on the Contract Documents, including:
   1. All concrete and masonry stone construction that are exposed up to a maximum height of 10 feet above grade, including walls and curbs. This includes all new concrete and masonry, as well as any existing concrete or masonry walls and curbs that are affected by the scope of work.
   2. All structural steel members, supports, fasteners, etc. that are exposed up to a maximum of 10 feet above grade. This includes all new structural steel, as well as any existing steel that is affected by the scope of work.
B. Refer to Section 07190 for waterproofing sealer for brick.

1.02 Related Sections
A. Section 01300 – Submittals
B. Section 01400 – Quality Requirements
C. Section 03300 – Cast-in-Place Concrete
D. Section 05120 – Structural Steel
E. Section 07190 – Water Repellents
F. Section 07620 – Sheet Metal Flashing and Trim
G. Section 09910 – Paints and Coatings

1.03 Submittals
A. Refer to Contract Terms and Provisions, Section 01300.
B. Submit samples if specifically requested.
C. Submit documentation from the paint system manufacturer on the manufacturer’s letterhead stating each paint system and corresponding graffiti resistant coating are compatible.
D. Submit the manufacturer’s specifications, data and installation instructions for review.
E. Submit product list to cross reference coating system and locations of application areas. Use same designations indicated on the Contract Drawings and in schedules. Include color designations.
F. Submit the manufacturer's maintenance data instructions.
G. Submit the manufacturer’s standard warranty.
1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
   1. American Society of Testing Materials (ASTM), Materials and testing standards as identified throughout this Section.

B. The installer to be specialized in the work of this Section with documented experience installing coatings of similar size and scope.

C. Apply mockups on each type of substrate indicated and each finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Provide samples of at least 100 square feet for vertical and horizontal surfaces.
   2. SEPTA will designate other items or areas as required.
   3. Final approval of coating will be based on mockups.
   4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.
   5. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of substantial completion.

D. Graffiti resistant coating is required to be applied at all locations accessible to the public throughout the area of work that are within a minimum of 8 feet height of the finished floor. Graffiti resistant coating shall be applied to the full height and width of each substrate. If a portion of a masonry course is to receive graffiti resistant coating than the entire course shall receive the graffiti resistant coating.

1.05 Delivery, Storage and Handling

A. Schedule delivery of materials at the site at such time as required for proper coordination of the work. Receive materials in the manufacturer’s unopened packages and bearing the manufacturer’s label.

B. Store materials in a dry and well ventilated place, adequately protected from damage and exposure to the elements.
   1. Maintain a minimum temperature of 45°F and a maximum temperature of 90°F.
   2. Take necessary precautions to prevent fire; remove paint soiled rags and waste each day or store in metal containers with covers in the storage structure.

1.06 Warranty

A. Provide the manufacturer’s standard warranty, in required form, for a period of one (1) year from date of final acceptance by SEPTA.

1.07 Extra Material

A. Deliver 1 percent or a minimum of one (1) full container of specified coating.
PART 2 - PRODUCTS

2.01 Materials

A. Graffiti resistant coating on vertical unpainted surfaces (except brick or wood):
   1. Manufacturers:
      a. Sherwin Williams; 2K Waterbased Urethane Anti-Graffiti Coating, satin finish, one (1) coat.
      c. Tnemec Co., Inc.
      d. Or Approved Equal.
   2. Color to be clear.
   3. The manufacturer’s standard primer for surface to be treated.

B. Graffiti resistant coating on vertical painted surfaces (except wood):
   1. Manufacturers:
      a. Sherwin Williams; 2K Waterbased Urethane Anti-Graffiti Coating, semi-gloss finish, one (1) coat.
      b. Ecological Coatings; EC-1851 Primer, one (1) coat.
      c. Ecological Coatings; EC-1852 Two (2) Component Water-Based Clear Gloss Graffiti Resistant Coating, one (1) coat.
      d. Or Approved Equal.
   2. Approved equal product must dry clear with no milky or cloudy appearance and must be compatible with painted surface.
   3. Color to be clear.

2.02 Mixing

A. Mix resin components and pigments per the manufacturers’ instructions.

PART 3 - EXECUTION

3.01 Preparation

A. Do not apply when temperature is below 40°F.
B. Examine conditions of work in place before beginning work; report defects.
C. Protect adjacent surfaces not scheduled for graffiti resistant finish from damage resulting from coating operations.
D. Prepare surfaces in strict compliance with the manufacturer’s instructions.

3.02 Installation

A. Install in conformance with referenced standards, the manufacturer's written directions, as shown, and as specified.
B. Apply minimum two (2) coats; allow adequate drying time between coats.
C. Dry film thickness to be a minimum of 1-2 mils per coat; minimum 3 mils for two (2) coat application.

3.03 Cleaning

A. Keep premises free from accumulation of waste and rubbish. At the completion of work remove surplus materials, rubbish and debris.
SECTION 10200
LOUVERS AND VENTS

PART 1 - GENERAL

1.01 Description
A. Requirements for fixed louvers in walls.

1.02 Related Sections
A. Section 04200 – Unit Masonry
B. Section 05120 – Structural Steel
C. Section 05500 – Metal Fabrications
D. Section 07620 – Sheet Metal Flashing and Trim
E. Section 07900 – Joint Sealers
F. Section 09910 – Paints and Coatings

1.03 Submittals
A. Submit shop drawings showing material, finish, size of members, method of assembly, and installation and anchorage details. Show plans, elevations, sections, details, field measurements (if applicable), reinforcement, anchorages, attachment to other work and expansion provisions.
   1. Show frame profiles and blade profiles, angles and spacing.
   2. Show weep paths, gaskets, flashing, sealant and other means of preventing water intrusion.
   3. Show mullion profiles and locations.
B. Submit fabrication and installation details for metal louvers.
   1. Copies of the manufacturer's catalog cuts, specifications, load tables, dimension diagrams, anchor details, setting diagrams and templates, and the manufacturer's printed installation instructions, including paint products
   2. Installed products indicated to meet the performance requirements and design criteria, including analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.
C. Submit samples for verification of finishes for each type and color of finish, submit 12 inch long sections of extrusions or formed sections and 6 inch square sheets. Submit at least two (2) pieces for each color showing full range of color variations.
D. Submit printed louver catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
E. Submit product test reports based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by the manufacturer and
witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

F. Submit windborne debris impact resistance test reports.

1.04 Quality Assurance

A. A company designing, manufacturing and installing products of this Section which have performed in a satisfactory manner under comparable conditions.

B. Where louver performance requirements are specified, determine compliance in accordance with AMCA Standard 500.

C. Design louvers to safely withstand dead load and live loads prescribed by governing building code.

D. Meet the applicable provisions of the most recent issues of the following references:
   1. AAMA 511, Forensic Water Intrusion Testing.
   2. AAMA 611, Voluntary Specification for Anodized Architectural Aluminum.
   8. ASTM E 1886, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
   12. AWS D1.6, Structural Welding Code - Stainless Steel.
   14. Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA)

1.05 Delivery, Storage and Handling

A. Package so that products will not be damaged during shipping or storage.

B. Clearly label each package of contents. Label shall be on two (2) ends and one (1) face. Contents shall be labeled and coordinated with installation drawings.

C. Store and handle louvers, hardware and appurtenant items in strict compliance with the manufacturers’ instructions.
D. Protect units adequately against damage from the elements, construction activities and other hazards before, during and after construction.

E. Ship items to SEPTA's location as described in the purchase requisition.

1.06 Definitions

A. Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver is a louver with horizontal blades (i.e., the axes of the blades are horizontal).

C. Vertical Louver is a louver with vertical blades (i.e., the axes of the blades are vertical).

D. Drainable Blade Louver is a louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of the unit and away from the opening.

E. Wind Driven Rain Resistant Louver is a louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.07 Performance Requirements

A. Design louvers, including comprehensive engineering analysis by a Professional Engineer licensed in the Commonwealth of Pennsylvania, using structural and performance requirements and design criteria indicated.

B. Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Determine wind loads based on pressures as indicated on the Contract Drawings.

2. Determine wind loads based on a uniform pressure of 20 lbf/square feet acting inward or outward.

C. Louvers located within 30 feet of grade shall pass basic protection, large missile testing requirements in ASTM E 1996 for Wind Zone 2 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than louvers indicated for use on the Contract.

D. Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

E. Provide louvers meeting the requirements specified, as demonstrated by the testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

F. Allow for thermal movements from ambient and surface temperature changes.

1. Temperature change (range) is 120°F, ambient; 180°F, material surfaces.

1.08 Field Conditions
A. Verify actual dimensions of openings by field measurements before fabrication.

1.09 Warranty
A. Upon completion of the work and as a condition of its acceptance, deliver to SEPTA two (2) copies of the following “Warranty and Maintenance Agreement”, signed by the manufacturer and the installer of the work of this Section.

1. Upon execution of this document by SEPTA, the undersigned hereby propose and agree, for a period of two (2) years after substantial completion of the work, to make immediate repairs as required to stop leaks or correct defects in the work of this Section. Said repairs shall be made within twenty-four (24) hours of the receipt of a notice from SEPTA by telephone, telegram or letter. The undersigned further agree to make such repairs without reference to or consideration of the cause or nature of such leaks or defects.

2. The manufacturer shall warrant for a period of two (2) years that the wall system, including louvers and copings, materials and their finishes will be free from defects. The Contractor shall warrant for a period of two (2) years that the installation workmanship will be free from defects in materials and installation.

PART 2 - PRODUCTS

2.01 Manufacturers
A. Obtain louvers from single source from a single manufacturer where indicated to be of same type, design or factory applied finish.

B. Products of the following manufacturers, provided they meet the requirements of the Contract Documents, will be among those considered acceptable:

1. Exterior extruded aluminum louvers:
   a. Arrow United Industries.
   b. Pottorf PCI Industries.
   c. Ruskin Manufacturing Division/Tomkins Industries, Inc.
   d. Or Approved Equal.

2.02 Horizontal, Drainable Blade Louver
A. Coordinate depth with wall thickness.
B. Frame and blade nominal thickness to be not less than 0.080 inch.
C. Mullion type to be exposed.
D. Mark units with AMCA Certified Ratings Seal.

2.03 Materials
A. Aluminum:
   1. Aluminum extrusions to meet ASTM B 221, Alloy 6063 T6.
2. Aluminum sheet to meet ASTM B 209, Alloy 5005 with temper as required for forming, or as otherwise recommended by the metal producer for required finish.

B. Fasteners to be of same basic metal and alloy as fastened metal or 316 stainless steel, unless otherwise indicated. Do not use metals that are corrosive or incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Concealed fasteners shall be used to the greatest extent possible. Where used, exposed fasteners must be tamper proof.
   3. Finish exposed to view fastener heads to match adjacent surface.

C. Bituminous paint to be cold applied asphalt mastic to meet SSPC-Paint 12 except containing no asbestos fibers.

D. Anchors and Inserts:
   1. Refer to Section 05120 and Section 05500.
   2. Type, size and material required for type of loading and installation indicated. Use nonferrous metal or hot dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.

E. Finish
   1. Clear anodic finish to meet AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.04 Fabrication

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance

C. Head, sill and jamb sections shall have formed caulking slots to retain caulking. Head sections shall have exterior drip lip, sill sections and integral water stops. Furnish louvers with sill extension.
   1. Provide clearance or recesses as required to accommodate sealant between louver and adjacent construction.

D. Fabricate louver system to withstand the effects of loads and stresses from wind and normal thermal movement without experiencing permanent deformation of components including blades, frames and supports; noise or metal fatigue caused by blade rattle or flutter; or permanent damage to fasteners and anchors.

E. Louvers shall be equipped with bird screens and made to withstand a wind load of not less than 30 PSF. Mount screens in removable, rewirable frames of same material and finish as the louvers.

F. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500 and AMCA 511. The rating shall show a
water penetration of 0.20 ounces or less per square foot of free area at a free velocity of 800 feet per minute.

G. The louver system shall accommodate various performance criteria including pressure drop requirements, CFM requirements, static pressure drop, water infiltration, free area, and intake/exhaust velocities, etc. while maintaining a consistent exterior architectural line appearance. Louver blade spacing at all elevations shall be consistent regardless of these varying performance criteria. Provide louver profiles as indicated or where shown on the Contract Drawings.

H. Provide shop welded joints between framing components, and between framing components and fixed louver blades, unless otherwise indicated or where field assembly is unavoidable.

PART 3 - EXECUTION

3.01 Examination

A. Verify that substrates and openings to receive louvers are rigidly set, at proper lines and elevation, properly sized and ready to receive louvers.

B. Do not proceed with installation until conditions detrimental to proper installation have been corrected.

C. If substrate preparation is the responsibility of another installer, notify the SEPTA Project Manager of unsatisfactory preparation before proceeding.

3.02 Preparation

A. Coat contact surfaces of dissimilar metals with one (1) or more coats of bituminous paint.
   1. Aluminum, stainless steel and zinc are not considered dissimilar metals.

B. Apply one (1) 15 mil dry film thickness coat of bituminous isolation coating to metal surfaces, other than galvanized steel, which will be in contact with cementitious materials.

3.03 Installation

A. Locate and place louver units plumb, level and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.

E. Provide suitable means of anchorage acceptable to the manufacturer such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.

F. Anchor supports securely with allowance for necessary thermal movement and structural support.

G. Erect metalwork square, plumb, straight and true, accurately fitted, with tight joints and intersections.
H. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items that cannot be refinished in the field to the shop, make required alterations, and refinish entire unit, or provide new units.

I. Protect galvanized and nonferrous metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry or dissimilar metals.

J. Install concealed gaskets, flashings, joint fillers and insulation, as louver installation progresses, to make louver joints weather tight.

3.04 Adjusting and Cleaning

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Remove protective material from pre-finished surfaces immediately after installation.

C. Wash exposed surfaces using mild detergent; thoroughly clean inside corners. Thoroughly rinse surfaces and dry.

D. Remove excess sealant by moderate use of mineral spirits or other solvent recommended by the sealant manufacturer.

E. Touch up marred or abraded areas of finished elements. If satisfactory touch-up cannot be accomplished, remove and replace element.

END OF SECTION
THIS PAGE NOT USED
### TABLE OF CONTENTS

#### VOLUME 1

**SECTION 00010**

**DIVISION 1 - GENERAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>01010</td>
<td>Summary of Work</td>
</tr>
<tr>
<td>01025</td>
<td>Measurement and Payment</td>
</tr>
<tr>
<td>01045</td>
<td>Cutting and Patching</td>
</tr>
<tr>
<td>01050</td>
<td>Field Engineering</td>
</tr>
<tr>
<td>01060</td>
<td>Regulatory Requirements and Safety</td>
</tr>
<tr>
<td>01065</td>
<td>Railroad Safety Requirements</td>
</tr>
<tr>
<td>01100</td>
<td>Special Project Procedures</td>
</tr>
<tr>
<td>01200</td>
<td>Project Progress Meetings</td>
</tr>
<tr>
<td>01300</td>
<td>Submittals</td>
</tr>
<tr>
<td>01305</td>
<td>Requests for Information</td>
</tr>
<tr>
<td>01380</td>
<td>Construction Photographs</td>
</tr>
<tr>
<td>01400</td>
<td>Quality Requirements</td>
</tr>
<tr>
<td>01410</td>
<td>Testing and Inspection Services</td>
</tr>
<tr>
<td>01452</td>
<td>Contractor Quality Control – Traction Power Equipment</td>
</tr>
<tr>
<td>01500</td>
<td>Construction Facilities and Temporary Controls</td>
</tr>
<tr>
<td>01505</td>
<td>Mobilization and Demobilization</td>
</tr>
<tr>
<td>01525</td>
<td>Project Vehicle</td>
</tr>
<tr>
<td>01580</td>
<td>Project Identification Signs</td>
</tr>
<tr>
<td>01590</td>
<td>SEPTA Field Office</td>
</tr>
<tr>
<td>01600</td>
<td>Materials and Equipment</td>
</tr>
<tr>
<td>01612</td>
<td>Delivery, Storage and Handling – Traction Power Equipment</td>
</tr>
<tr>
<td>01700</td>
<td>Contract Closeout</td>
</tr>
<tr>
<td>01710</td>
<td>Final Cleaning</td>
</tr>
<tr>
<td>01720</td>
<td>Project AS-Built Documents</td>
</tr>
<tr>
<td>01752</td>
<td>Spare Parts and Maintenance Materials – Traction Power Equipment</td>
</tr>
<tr>
<td>01820</td>
<td>Demonstration and Training</td>
</tr>
<tr>
<td>01822</td>
<td>Demonstration and Training – Traction Power Equipment</td>
</tr>
<tr>
<td>01830</td>
<td>Operation and Maintenance Data</td>
</tr>
<tr>
<td>01832</td>
<td>Operations and Maintenance Manuals – Traction Power Equipment</td>
</tr>
</tbody>
</table>

**DIVISION 2 – SITE CONSTRUCTION**

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>02050</td>
<td>Demolition</td>
</tr>
<tr>
<td>02070</td>
<td>Selective Demolition</td>
</tr>
<tr>
<td>02080</td>
<td>Hazardous Material Abatement</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>02082</td>
<td>PCB Abatement</td>
</tr>
<tr>
<td>02083</td>
<td>Heavy Metals Abatement</td>
</tr>
<tr>
<td>02084</td>
<td>Oil and Lubricants Abatement</td>
</tr>
<tr>
<td>02110</td>
<td>Clearing and Grubbing</td>
</tr>
<tr>
<td>02160</td>
<td>Excavation Support and Protection</td>
</tr>
<tr>
<td>02205</td>
<td>Impacted Soil Management</td>
</tr>
<tr>
<td>02209</td>
<td>Geotextile Fabric</td>
</tr>
<tr>
<td>02220</td>
<td>Excavation, Backfill and Compaction</td>
</tr>
<tr>
<td>02230</td>
<td>Subbase</td>
</tr>
<tr>
<td>02270</td>
<td>Erosion and Sedimentation Control</td>
</tr>
<tr>
<td>02450</td>
<td>Oil Containment System</td>
</tr>
<tr>
<td>02520</td>
<td>Bituminous Concrete Paving</td>
</tr>
<tr>
<td>02534</td>
<td>Cast-In-Place Concrete Curb</td>
</tr>
<tr>
<td>02821</td>
<td>Chain Link Fences and Gates</td>
</tr>
<tr>
<td>02850</td>
<td>Drilled Caissons</td>
</tr>
</tbody>
</table>

**DIVISION 3 - CONCRETE**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03100</td>
<td>Concrete Forms</td>
</tr>
<tr>
<td>03200</td>
<td>Concrete Reinforcement</td>
</tr>
<tr>
<td>03300</td>
<td>Cast-in-Place Concrete</td>
</tr>
<tr>
<td>03400</td>
<td>Precast Concrete</td>
</tr>
<tr>
<td>03600</td>
<td>Grout</td>
</tr>
<tr>
<td>03930</td>
<td>Concrete Repair</td>
</tr>
</tbody>
</table>

**DIVISION 4 - MASONRY**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>04011</td>
<td>Masonry Cleaning</td>
</tr>
<tr>
<td>04012</td>
<td>Brick Masonry Repair</td>
</tr>
<tr>
<td>04200</td>
<td>Unit Masonry</td>
</tr>
</tbody>
</table>

**DIVISION 5 - METALS**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>05090</td>
<td>Metal Fasteners, Joining and Welding</td>
</tr>
<tr>
<td>05120</td>
<td>Structural Steel</td>
</tr>
<tr>
<td>05210</td>
<td>Steel Joists</td>
</tr>
<tr>
<td>05310</td>
<td>Steel Decking</td>
</tr>
<tr>
<td>05500</td>
<td>Metal Fabrications</td>
</tr>
<tr>
<td>05520</td>
<td>Hand Rails and Railings</td>
</tr>
<tr>
<td>05530</td>
<td>Steel Gratings</td>
</tr>
<tr>
<td>05610</td>
<td>Miscellaneous Metals</td>
</tr>
<tr>
<td>05900</td>
<td>Metal Restoration and Cleaning</td>
</tr>
</tbody>
</table>
DIVISION 6 – WOOD AND PLASTICS

06100  Rough Carpentry

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

07190  Water Repellents
07210  Building Insulation
07500  Membrane Roofing
07620  Sheet Metal Flashing and Trim
07720  Roof Accessories
07900  Joint Sealers

DIVISION 8 – DOORS AND WINDOWS

08110  Metal Doors and Frames
08710  Door Hardware

DIVISION 9 – FINISHES

09662  Electrically Insulated Floor Covering
09705  Epoxy Resin Flooring
09910  Paints and Coatings
09960  High Performance Coatings
09965  Graffiti Resistant Coatings

DIVISION 10 – SPECIALITIES

10200  Louvers and Vents

VOLUME 2

DIVISION 13 – SPECIAL CONSTRUCTION

13280  Asbestos Abatement
13285  Lead Paint Abatement
13700  Intrusion Alarm System
13850  Fire Alarm and Detection System

DIVISION 15 - MECHANICAL

15010  Basic Mechanical Requirements
15050  Basic Mechanical Materials and Methods
15060  Hangers and Supports
15062  Hangers and Supports for Plumbing Piping and Equipment
15075  Mechanical Identification
15080  Mechanical Insulation
15160  Storm Drainage Piping
15165  Storm Drainage Piping Specialties
15183  Duct Installation
15184  Refrigerant Piping
15412  Emergency Plumbing Fixtures
15700  Heating, Ventilation and Air Conditioning Equipment
15890  HVAC Ductwork
15935  Building System Controls
15940  Sequence of Operation
15950  Testing, Adjusting and Balancing

DIVISION 16 - ELECTRICAL

16010  Basic Electrical Requirements
16050  Basic Electrical Materials and Methods
16052  General Electrical Requirements – Traction Power Equipment
16060  Grounding and Bonding
16070  Hangers, Anchors and Supports
16075  Electrical Identification
16120  Conductors and Cables
16121  Medium Voltage Cable
16123  Building Wire and Cable
16129  Fiber Optic Cable
16130  Raceways and Boxes
16138  Duct Work and Electrical Manholes and Handholes
16140  Wiring Devices
16150  Wiring Connections
16210  Electric Utility Services
16240  Battery Equipment
16270  Distribution Transformers
16275  Installation of Traction Power Autotransformers
16290  Protective Devices and Instrument Transformers
16310  Transmission and Distribution
16331  Installation of Circuit Breakers
16335  Surge Protection
16411  Enclosed Switches
16413  Enclosed Transfer Switches
16421  Enclosed Motor Controllers
16440  Panelboards
16460  Low-Voltage Transformers
16500  Lightning
16700  Communications
16760  Fiber Optic Network
<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>16772</td>
<td>CCTV System</td>
</tr>
<tr>
<td>16791</td>
<td>Combined Relay and Control Switchboard</td>
</tr>
<tr>
<td>16826</td>
<td>Cable Trench System</td>
</tr>
<tr>
<td>16910</td>
<td>Electrical System Control SCADA, Remote Terminal Unit – Including HMI</td>
</tr>
<tr>
<td>16950</td>
<td>Testing</td>
</tr>
<tr>
<td>16952</td>
<td>Electrical Testing – Traction Power Equipment (RRD)</td>
</tr>
</tbody>
</table>
THIS PAGE LEFT BLANK
SECTION 13280
ASBESTOS ABATEMENT

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of the demolition, removal, and disposal of existing construction from the areas shown on the Contract Drawings; and, as required, to execute the work of this Contract including, but not necessarily limited to complete or partial demolition and removal of the following:
   1. Removal of suspect asbestos containing materials.

B. Asbestos containing materials may be located in building areas not accessed during sampling. All materials listed in the USEPA’s publication “Managing Asbestos in Place,” Appendix G, are suspect and shall require testing or special handling in accordance with this Section.

C. Removal of non-friable asbestos containing caulk and PACM roofing materials shall be performed in such a manner that the materials remain non-friable during the renovation. Roofing materials were not sampled and are presumed to be asbestos containing unless otherwise shown through laboratory testing. It is the Contractor’s responsibility to ensure that the materials are removed without rendering the material friable.

1.02 Related Sections

A. Section 01010 – Summary of Work.
B. Section 01045 – Cutting and Patching.
C. Section 01060 – Regulatory Requirements and Safety
D. Section 01065 – Railroad Safety Requirements
E. Section 01300 – Submittals
F. Section 02070 – Selective Demolition

1.03 Submittals

A. In accordance with Section 01300, submit the following for approval:
   1. Submit statements or drawings that indicate the means and methods that will be employed to remove the presumed roofing materials and other suspect materials. This should include the methods employed for adequately maintaining the non-friable conditions during the removal.
   2. The Contractor shall submit a letter from a permitted hazardous waste facility, stating that the facility has agreed to accept the waste generated by the work; is authorized to accept the waste under laws of the state of residence; has the required capacity to treat and dispose of the materials; and will provide or ensure the ultimate disposal method indicated on uniform hazardous waste manifest.
3. Submit a copy of any and all testing and reporting to SEPTA.

1.04 Quality Assurance

A. During the bid period, it is recommended to inspect and examine the construction site and existing construction to be removed and determine the type of renovation or demolition required or dismantlement procedure, physical conditions, and any contingency that could be encountered during the renovation or demolition procedures.

B. Conduct building demolition so SEPTA’s operations will not be disrupted.

1. Provide not less than seventy-two (72) hour notice to SEPTA of activities that will affect SEPTA’s operations.

2. Not later than ten (10) working days prior to commencing work, submit required written notification to the Pennsylvania Department of Environmental Protection, Pennsylvania Department of Labor and Industry, U.S. Environmental Protection Agency and local authorities having Contract jurisdiction. Provide copies of such notifications to SEPTA.

3. Maintain access to existing walkways, exits, and other adjacent occupied or used facilities. Do not close or obstruct walkways, exits, or other occupied or used facilities without written permission from the SEPTA Project Manager.

C. Consider the safety of the work, safety of the people, and property on and adjacent to the work site when determining equipment movement and use of materials and equipment on the work site. Meet the safety requirements specified in Sections 01060 and 01065. All work shall be undertaken in accordance with applicable federal, state and local regulations, standards, codes and guidelines.

1. Where the safety of persons is endangered within or adjacent to the area of renovation or demolition work, provide protection in accordance with requirements.

D. Arrange renovation or demolition schedule so as not to interfere with on-site operations. Do not unduly inconvenience SEPTA employees by demolition activities.

E. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

F. Storage or sale of removed items or materials on-site is not permitted.

G. Meet the applicable provisions of the most recent issues of the following references:

1. Codes and regulations of the jurisdictional authorities.


3. OSHA, Standards as applicable.

4. United States Environmental Protection Agency, Managing Asbestos in Place.


9. Commonwealth of Pennsylvania:
   c. Department of Labor and Industry, Worker and Community Right-To-Know Act 1984-159.
   d. Pennsylvania Department of Environmental Protection, Act 97, the Solid Waste Management Act of July 7, 1980.

**PART 2 - PRODUCTS**

**2.01 Not Used**

**PART 3 - EXECUTION**

**3.01 General Demolition**

A. Demolish indicated portions of existing building completely in accordance with Section 02070. Use methods required to complete the work within limitations of governing regulations and as follows:

1. Remove non-friable asbestos containing materials and presumed asbestos containing materials.

B. Control and prevent the spread of dust to occupied portions of the site and avoid creation of a nuisance in the surrounding area.

1. Use water mist and other suitable methods to limit spread of dust and dirt. Meet the governing environmental protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding and pollution.

C. Remove trash and debris daily unless otherwise directed by the SEPTA Project Manager and do not allow construction debris and waste materials to accumulate.

**3.02 Cleaning**

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building renovation or demolition activities. Return adjacent areas to the condition existing prior to commencement of renovation or demolition activities.

**END OF SECTION**
SECTION 13285

LEAD PAINT ABATEMENT

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of the renovation, removal and disposal of existing construction from the areas shown on the Contract Drawings; and, as required, to execute the work of this Contract including, but not necessarily limited to complete or partial renovation and removal of the following:

1. All work which disturbs surfaces that are coated with lead based paint must be performed in accordance with the Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulation (CFR) Part 1926.62, Lead Exposure in Construction; EPA 40 CFR Part 745 Lead; PA Law 291, No. 44 Lead Certification Act; and Montgomery County Regulations. In addition, all other applicable federal, state and local codes, rules and regulations must be adhered to by the Contractor.

2. The Contractor shall be aware that Lead Based Paint (LBP) has been identified within the proposed renovation project and must be familiar with the OSHA lead in construction standard and its requirements. In addition, all waste generated as part of the renovation Project should be tested in order to determine the classification of waste. The USEPA defines hazardous waste as waste containing the minimum concentration of a particular contaminant identified by the Toxicity Characteristic Leaching Procedure (TCLP). The USEPA regulatory level for lead (EPA Code: D008) is 5 parts per million (5 ppm).

B. The scope of work includes the testing and removal of lead based paint in each Contract that will be disturbed by the renovation and/or demolition.

1.02 Related Sections

A. Section 01010 – Summary of Work
B. Section 01045 – Cutting and Patching
C. Section 01300 – Submittals
D. Section 02070 – Selective Demolition

1.03 Submittals

A. In accordance with Section 01300, submit the following for approval:

1. Submit statements or drawings that indicate the means and methods that will be employed to remove the Lead Based Paint (LBP). This should include the methods employed for adequately removing and disposing of the LBP.

2. The Contractor shall submit a letter from a permitted hazardous waste facility, stating that the facility has agreed to accept the waste generated by the work; is authorized to accept the waste under laws of the State of residence; has the required capacity to treat and dispose of the materials; and will provide or ensure the ultimate disposal method indicated on uniform hazardous waste manifest.
3. Submit a copy of any and all testing and reporting to SEPTA.

1.04 Quality Assurance

A. During the bid period, it is recommended to inspect and examine the construction site and existing construction to be removed and determine the type of renovation or demolition required or dismantlement procedure, physical conditions, and any contingency that could be encountered during the renovation or demolition procedures.

B. Conduct building renovations or demolition so SEPTA’s operations will not be disrupted.
   1. Provide not less than seventy-two (72) hour notice to SEPTA of activities that will affect SEPTA’s operations.
   2. Provide notification of the LBP removal as necessary. Provide copies of such notifications to SEPTA.
   3. Maintain access to existing walkways, exits, and other adjacent occupied or used facilities. Do not close or obstruct walkways, exits, or other occupied or used facilities without written permission from the SEPTA Project Manager.

C. Consider the safety of the work, safety of the people, and property on and adjacent to the work site when determining equipment movement and use of materials and equipment on the work site. Meet the safety requirements. All work shall be undertaken in accordance with applicable federal, state and local regulations, standards, codes and guidelines.
   1. Where the safety of persons is endangered within or adjacent to the area of renovation or demolition work, provide protection in accordance with requirements.

D. Do not unduly inconvenience SEPTA employees by renovations or demolition activities.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Arrange renovation or demolition schedule so as not to interfere with on-site operations.

G. Protect against high and low temperatures and unfavorable environmental conditions in accordance with requirements of ACI 305R, 306R, and ACI 306.1.

H. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

I. Meet the applicable provisions of the most recent issues of the following references:
   5. OSHA Standards as applicable.
   7. 35 Penn. Stat. § 5901 to 5916.
8. Codes and Regulations of the jurisdictional authorities.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 General Demolition

A. Demolish indicated portions of existing buildings completely in accordance with Section 02070. Use methods required to complete the work within limitations of governing regulations and as follows:
   1. Remove and dispose of LBP. Additionally, wet, scrape, and stabilize loose and flaking paint.
   2. No grinding, torching, saw cutting, dry scraping or sanding is permitted during the removal process.

B. Control and prevent the spread of dust to occupied portions of the site and avoid creation of a nuisance in the surrounding areas.
   1. All surfaces shall be maintained free of accumulation of lead dust generated during renovation or demolition activities.
   2. If applicable, separate and deposit all lead waste, including sealing tape, plastic sheeting, mop heads, sponge filters, and disposable clothing in double polyethylene bags of at least 6 mils thick and seal each bag separately.
   3. No equipment, supplies or materials (except properly containerized waste materials) shall be removed from the Project work area unless such equipment, supplies, and/or materials have been cleaned free of lead debris.
   4. Air monitoring by certified lead inspectors shall be conducted during the removal process to ensure no high levels of airborne lead containing dust are created.

C. Remove trash and debris daily unless otherwise directed by the SEPTA Project Manager and do not allow construction debris and waste materials to accumulate.

3.02 Work Area Cleanup and Clearance

A. Clean up procedures shall utilize HEPA filtered vacuum systems and/or wet methods, such as mopping, wet wiping, shoveling of wet debris, etc. No dry sweeping of dust, particulate matter or debris is allowed during any stage of the work affecting lead coated surfaces.

B. Conduct periodic inspections.

C. At the end of the demolition Contract, have a certified person conduct a clearance examination and provide appropriate documentation or statements of LBP compliance.

3.03 Disposal of Demolished Materials

A. The Contractor shall conduct the Mass Balance TCLP Testing for all waste generated during the renovation or demolition of the components coated with detectable levels of lead.
B. All waste shall be kept drummed, secured, labeled and stored in a designated secured storage space on-site until test results categorize all waste to be hazardous or non-hazardous.

C. The lead based waste media or other debris must be stored in a manner that does not allow entry of any hazardous material into the environment. Leak proof drums or portable bins are generally acceptable. The containers must be kept out of flood plains or areas where run off may occur. Weather resistant labels using indelible ink warning of the potential hazard associated with the material must be placed on the containers. The containers must be keyed to the samples taken.

D. All waste, after being evaluated in accordance with the TCLP test, shall be disposed of in accordance with all applicable local, federal, state, and/or county regulations.

3.04 Cleaning

A. Clean adjacent structures and improvements of dust, dirt and debris caused by building renovation or demolition activities. Return adjacent areas to the condition existing prior to commencement of renovation or demolition activities.

END OF SECTION
SECTION 13700

INTRUSION ALARM SYSTEM

PART 1 - GENERAL

1.01 Description
   A. This Section covers the furnishing, installing and testing of an intrusion alarm system in the existing building.

1.02 Related Sections
   A. Section 01300 – Submittals
   B. Section 16950 – Testing

1.03 Submittals
   A. The Contractor shall submit the following in accordance with Section 01300.
   B. The Contractor shall submit wiring diagrams, data sheets, equipment ratings, layout, dimensions and finishes. Equipment submissions must include a minimum of the following:
      1. Complete descriptive data indicating UL listing for all system components.
      2. Copy of the device compatibility listing with the system product specification sheets.
      3. Drawings indicating the location of each device.
      4. Complete sequence of operations of the system.
      5. Complete system wiring diagrams for components capable of being connected to the system and interfaces to associated equipment.
      6. Zone and/or point listing.
   C. Submit user training course outline and copy of all instruction documentation.
   D. Submit Operational and Maintenance Data:
      1. Submit to SEPTA three (3) sets of the “as-built” drawings (full size 22 inches x 34 inches and at least one (1) must be a Mylar drawing) and an electronic file drawing. The drawings shall include the location of all devices, appliances, wiring sequences, wiring methods and connections of the system components. Devices shall also indicate the device address or zone as applicable. These drawings shall show the locations of raceways and the number and color codes of the conductors installed in the raceway.
      2. Submit to SEPTA three (3) sets of the zone and/or point listing.
      3. Submit to SEPTA a parts list for all components of the system. Include spare parts.
      4. Submit to SEPTA four (4) sets (all originals, no copies) of the operating and installation manuals for all system equipment.
      5. Submit to SEPTA two (2) copies of the database used to program (for listing, changes, general reprogramming, etc.) the site data. This database shall become the property of SEPTA.
6. Submit to SEPTA two (2) copies of the program record that records the system programming information.

1.04 Quality Assurance
A. Products for and the execution of, the work of this section shall satisfy the applicable requirements of the National Electrical Code, Regulations of Jurisdictional Authorities and the Occupational Safety and Health Act. Products shall satisfy the applicable requirements of ANSI, ASTM, IEEE, NEMA and UL.
B. Meet the applicable provisions of the most recent issues of the following references:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL Mercantile Burglary Listings, local grade A, police connect grade A, grade AA, central station grade B.

1.05 Design Requirements
A. Prior to installation, the Contractor shall obtain approval from SEPTA for the exact system that will be installed. This request for approval shall include product specification sheets and programming sequence of operation.
B. All equipment shall be approved by Underwriters Laboratories, Inc. for its intended purpose. All intrusion alarm equipment shall be listed for its intended purpose and compatibility listed to assure the integrity of the complete system.

1.06 Qualifications
A. The manufacturer shall be a company specializing in intrusion detection and alarm systems with sufficient previous experience to successfully manufacture the products indicated.
B. The installer shall be a company specializing in intrusion detection and alarm systems with sufficient previous experience to conduct satisfactorily the installation indicated.

1.07 Maintenance Service and Extra Material
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to SEPTA. Provide one (1) per contract unless otherwise noted.
   1. Four (4) sets of all keys to all control panels for each substation.
   2. One (1) fully operational control panel and keypad.
   3. Hardware for one (1) fully operational door.

PART 2 - PRODUCTS

2.01 Manufacturers
A. Manufacturers:
   1. Fire Burglary Instruments, Inc. (Pittway).
2. Ademco (Honeywell).
3. Radionics (Bosch).
4. Or Approved Equal.

2.02 Control Panel

A. Features:
1. Eight (8) Zone EEPROM control/communicator expandable to seventy-two (72) zones.
2. Commercial burglary panel.
3. Supervision of dual telephone lines and bell output.
4. Eight (8) zone hardwire capability.
5. Partitioning (up to eight (8) separate subsystems).
6. Sixty-four (64) User codes with seven (7) authorization levels.
8. Remote uploading/downloading and remote commands.
9. System log retains past one hundred and twenty-eight (128) events with option to automatically transmit log to remote or local printer.
10. Fuse-less design to eliminate unnecessary service calls.
11. Sheet metal enclosure with lock.
12. Status and alarm report through SEPTA approved SCADA system.

B. Programming:
1. Programmable locally through LCD keypads or remotely through PC downloading software.
2. Default lockout option to prevent hostile account takeovers.
3. Option to inhibit keypad programming.
4. Local programming secured through installer code.
5. EEPROM memory retains programmable features and current status.
6. Factory default characteristics that simplify installation.

C. Zones:
1. Eight (8) fully programmable EOL supervised hardwired zones on circuit board.
2. Expansion through plug in module:
   a. Eight (8) zone hardwire expander.
3. Zone programming flexibility including type and reporting characteristics.
4. Four (4) programmable keypad emergency conditions.
5. Programmable sixteen (16) character descriptors for each of the sixteen (16) zones.
6. Selectable sixteen (16) alarm types and eight (8) trouble types.
7. Programmable SCADA reporting and restore codes by zone.
8. Key switch capability through any zone.
9. Chime option by zone.
10. Pulse count option by zone.
11. Commands to view zone descriptions on LCD keypad.
12. Zone grouping capability that allows creation of groups within each partition for the purpose of bypassing and alarm transmission.

D. System Features:
1. Programmable dialer and bell lockout feature.
2. Accurate real time clock, time programmable by the installer or the authorized user.
3. Flexible system test function with programmable frequency (twelve (12) hours, twenty-four (24) hour or weekly transmission) and selectable time of day.
4. Two (2) programmable entry/exit delay times.
5. Status and alarm reports through SEPTA approved SCADA system.
6. Sounder ring back and bell test at arming options.
7. Auto-unbypass option.

E. Partitions:
1. Eight (8) partitions (subpanels) per control panel.
2. Zones and keypads are assigned to the desired partition.
3. User’s codes can be assigned to multiple partitions.
4. Partition descriptor, sixteen (16) characters, uniquely identifies each subsystem.
5. Multi-partition feature allows secure operation of the system through any keypad by authorized users.
6. Arm or disarm all partitions through a single keypad by the authorized user.
7. Authorized users can alter partition assignments through the keypad.

F. User Codes:
1. Sixty-four (64) user codes, with seven (7) authorization levels.
2. Four (4) digit or seven (7) digit user codes, system-wide option.
3. Programmable open/close ID’s for each user.
4. Programmable partition access by user, access to partitions.
5. Option to transmit O/C signals by user by partition.
6. Ambush code capability.
7. Arm or disarm all partitions through any keypad by authorized users.
8. Quick arm, bypass, forced arming commands available.
9. Arm only user code.
10. Trigger outputs (eight (8) voltage level triggers).

G. SCADA System Communications:
1. Transmission to two (2) separate CS telephone numbers.
2. Three (3) or four (4) digit account numbers.
3. Transmission formats include 10PPS, 20PPS, 40PPS 4x2, FBI Superfast, BFSK, ADEMCO express and point ID formats.
4. Pulse, touch tone or adaptive dialing (tone backed up by pulse).
5. Dial tone detection option.
6. The installer options for each of the remote command capabilities.

H. Keypads:
1. Up to eight (8) LCD keypads per system.
2. Backlit keypads.

I. Power Specifications:
1. Special watchdog circuitry insures integrity of microprocessor.
2. Battery backup with battery charger shall be provided within IDS enclosure.
3. Battery shall be sized for 24 hours.
4. Twenty-four (24) hour battery load test and continuous low battery monitoring.
5. Total control auxiliary power to be 12 VDC, regulated at 900 mA.
6. Keypad current to be 250 mA, maximum. Smoke current to be 150 mA maximum.
7. Auxiliary current to be 500 mA maximum if keypad and smoke power is used, or 900 mA maximum if keypad and smoke power is not used.
8. Alarm power to be 12 VDC, regulated at 2 Amps.

J. Remote Commands:
1. Answering Machine Detection (AMD) for secure communications with the alarm company without interruption to the premise telephone.
2. Programmable callback scheme prevents unauthorized access.
3. Remote downloading and uploading from the alarm company location.
4. Interactive programming sessions permit control panel to remain on-line with the downloading computer during remote communications.
5. Remotely arm, disarm, bypass, read system status and device control.

K. System Log:
1. Panel retains activity log (one hundred and twenty-eight (128) events max).
2. System log viewable locally at LCD keypad or from the alarm company.
3. Programmable transfer of system activity to a remote or local printer, automatically on either a daily, weekly or monthly basis.

L. Auxiliary Contacts:
   1. One (1) form-C alarm relay rated for a minimum of 5 amps at 28 VDC.
   2. One (1) form-C trouble relay rated for a minimum of 5 amps at 28 VDC.

M. Listings:
   1. UL mercantile burglary listings to be local grade A, police connect grade A, grade AA, central station grade B.

2.03 Keypads
   A. Zones to be determined by control panel.
   B. Type to be LCD (Liquid Crystal Display).
   C. Mounting to be surface or partial recess.
   D. Two (2) line by sixteen (16) character display for English zone descriptors and system status indications.
   E. Large supertwist backlit LCD display provides wide viewing angle and exceptional readability.
   F. Dedicated function keys to minimize keystrokes.
   G. Four (4) wire installation.

2.04 Motion Detectors
   A. Features:
      1. Selectable sensitivity.
      2. Look down zone.
      3. Sabotage resistant lens design.
      4. Tamper switch.
      5. White light immunity.
      6. Temperature compensation.
      7. Switchable range.
   B. Optimum Catch Performance:
      1. Provide adjustable sensitivity to match installation requirements, using a look down mirror provides for optimum detection pattern directly beneath the sensor. Provide a wide Fresnel lens for improved catch performance in a range of applications.
      2. Provide temperature compensation to allow for no loss of sensitivity as room temperature approaches body temperature.
   C. False Alarm Reduction:
1. The Fresnel lens allows optimum performance while reducing false alarms. Provide a carbon filled black bug guard to increase white light immunity.

2. Provide controls so the installers can adjust the sensitivity of the sensor to suit the environment; a "standard" setting for general security applications and a "harsh" setting for tough applications, such as rooms with many windows.

D. Sabotage Resistant Design:
   1. Provide a lens that wraps around a retainer, making it more stable and difficult to sabotage. Provide a sealed tamper switch that signals before any enclosure access is possible.

E. Mounting Flexibility:
   1. Provide a unit that easily mounts on walls or in corners for a full range of coverage.

F. Approvals/Listings:
   1. UL Listed.

G. Power Requirements:
   1. Current consumption to be 20mA at 12 VDC.
   2. Tamper switch to be rated 25mA at 24 VDC.
   3. Voltage operating range to be 10-14 VDC.

H. Alarm Relay:
   1. Form A (normally closed) to be rated 100mA at 24 VDC.

I. LED Enable:
   1. Enabled by cutting a jumper wire.

J. Operating Temperature:
   1. 32°F to 120°F.

K. Optics:
   1. Wide Fresnel lenses.
   2. Look down mirror/lens.

L. PIR Fields of View:
   1. Long range to be twenty-two (22).
   2. Intermediate to be six (6).
   3. Lower to be three (3).
   4. Look down to be (2).

M. Ranges:
   1. 50 feet x 70 feet.
   2. 32 feet x 50 feet.

N. PIR Sensitivity:
1. Jumper selectable (standard and harsh).

O. RF Immunity:
   1. 20 V/m at 10-1000 MHz.

P. White Light Immunity:
   1. 3,500 lux.

2.05 Door Contacts

A. High Security:
   1. Provide high security magnetic contacts with triple-biased reeds that are highly resistant to defeat by external magnets.
   2. Provide magnetic field tamper and pry tamper features.
   3. Provide contact and actuation magnet sets that have been factory compensated for the effects of steel.
   4. Form-C contact.
   5. Voltage to be 30V AC/DC maximum.
   6. Current to be 0.25A maximum.
   7. Power to be 3.0W maximum.
   8. To meet UL 634.
   9. 3-foot stainless steel armored cable.
   10. Manufacturers:
       a. Sentrol 2700 Series.
       b. Or Approved Equal.

2.06 Siren/Strobe

A. Indoor/Outdoor Self-contained Armored Siren/Strobe Combination:
   1. Indoor/outdoor, self-contained, 15-watt armored siren, consisting of a single tone that delivers a warble sound output, light weight rust proof aluminum die-cast housing, a 122dB output siren driver and dual action N/O (normally open) reed plunger switch for normally closed loop.
   2. Strobe to be 60,000 candlepower strobe with lens color of amber.

2.07 Intrusion Alarm Wire and Cable

A. Wire and cable shall be type and gauge recommended by the intrusion alarm equipment manufacturer.

B. All conductors shall be stranded.

C. Use 18 AWG minimum size conductors for alarm detection conductors.

D. Use 14 AWG minimum size conductors for signal circuit conductors.
PART 3 - EXECUTION

3.01 Installation

A. Installation shall be in accordance with the NFPA 70, local and state codes, as shown on the Contract Drawings, and as recommended by the major equipment manufacturer.

B. All wire and cable shall be installed in conduit, minimum size is 3/4 inch.

C. Provide all junction boxes, pull boxes or enclosures, other fittings and devices to accommodate the wiring system.

D. Wires shall be tagged at junction points and shall test free from grounds or crosses between conductors.

E. Wiring shall be color coded.

F. The wiring system shall be through-wired to the equipment. Pigtail type connections shall not be allowed.

G. Conductor splices shall be made on screw type terminal blocks; within terminal cabinets wire nuts shall not be used. Terminals within cabinets shall be properly labeled.

H. Final connections between control equipment and the wiring system shall be made under direct supervision of a representative of the equipment manufacturer.

I. Provide complete identification/labeling of all intrusion alarm devices and related components. Conduit (every 25 feet) and conduit boxes shall be identified by affixing waterproof and permanent decal with the words “SECURITY”. Conduits and boxes for power, communications, alarm, etc. for the intrusion alarm system shall be similarly identified. All devices shall be neatly, clearly, and permanently marked as to zone or point number.

J. Stamp or mark the date of installation on each battery.

K. Program control panel and other programmable devices and equipment. SEPTA shall receive an intrusion signal and the A/V strobe shall activate during the following scenarios. The system will report to SEPTA via the SCADA RTU connection. Regardless of signal type, the only intrusion signal SEPTA will receive shall indicate the system is in alarm. No other signals shall be sent such as arm/disarm, etc. SEPTA shall have the ability to silence the alarm from the remote viewing center.

1. If a door contact is broken and the code requirement is not fulfilled at the keypad within 60 seconds.

2. If a motion detector is activated while the system is in alarm mode.

L. Furnish and install, next to the control panel, a mounted frame with Plexiglas that is weatherproof, lockable and capable of posting changes. The frame shall contain an easily removable visual site plan that depicts the Contractor supplied “as-built” drawings. Further, the frame shall contain the Contractor supplied operator instructions for applicable basic system operations, including alarm acknowledgement, system reset and interpreting system output, such as LED’s and displays.
3.02 Field Quality Control
A. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the intrusion alarm equipment to technically supervise and participate in all of the adjustments and tests for the system.
B. Consult Section 16950 for requirements for field inspection and testing of intrusion alarm systems.
C. At the final inspection, demonstrate that the systems function properly in every respect.

3.03 Demonstration
A. Provide the service of a competent, factory trained engineer or technician authorized by the intrusion system manufacturer to perform system demonstration.
B. Provide instruction in the form of a formalized training course to the building personnel and security personnel. "Hands-on" demonstrations of the operation of the system shall be provided. The demonstration shall include a walking tour of the intrusion alarm system, briefly identifying and describing location, function, operation and maintenance of each item.
C. Provide one on one instruction for up to eight (8) students to individually qualify them in the system operation, fifteen (15) minutes dedicated per student.

END OF SECTION
SECTION 13850

FIRE ALARM AND DETECTION SYSTEM

PART 1 - GENERAL

1.01 Description
   A. This Section covers the furnishing, installing and testing of a fire alarm system in the substation building in accordance with NFPA 72.
   B. The Contractor shall provide a complete electrically operated, electrically supervised, addressable Class A, Style B, and Style Y, low voltage, non-coded, general evacuation fire alarm system as specified herein and as indicated on the Contract Drawings.

1.02 Related Sections
   A. Section 01300 – Submittals
   B. Section 16130 – Raceways and Boxes
   C. Section 16950 – Testing

1.03 Submittals
   A. The Contractor submittals shall meet both the requirements of Section 01300 and the documentation requirements of NFPA 72.
   B. The Contractor shall submit wiring diagrams, data sheets, equipment ratings, layout, dimensions and finishes. Equipment submissions must include a minimum of the following:
      1. Complete descriptive data indicating Underwriters' Laboratories, Inc. (UL) listing for all system components. A copy of the device compatibility listing shall be submitted with the system product specification sheets.
      2. Drawings indicating the location of each device.
      3. Complete sequence of operations of the system.
      4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
      5. Detail assembly and support requirements.
      6. Include voltage drop calculations for notification appliance circuits.
      7. Include battery sizing calculations.
      8. Include input/output matrix.
   C. Submit to SEPTA a copy of the manufacturer’s certification that the fire alarm system is non-proprietary; refer to Article 1.06/D in this Section.
D. Submit to SEPTA a copy of the Contractor's written statement stating that the system has been installed in accordance with approved plans and tested in accordance with the manufacturer's specifications and the appropriate NFPA requirements.

E. Submit to SEPTA a copy of the "Record of Completion" as defined in NFPA 72.

F. Submit to SEPTA a copy of the alarm certification and the permit submittal and approval.

G. Submit to SEPTA a copy of the record of alarm inspection, testing and certification (with certifying stamp and acceptance stamp from the authority having jurisdiction). This record must include the audibility record for each section, room, etc. of the facility.

H. Submit Operation and Maintenance Data:
   1. Submit to SEPTA three (3) sets of the “as built” drawings (full size 22 inches by 34 inches and at least one (1) must be a Mylar drawing) and an electronic file drawing. The drawings shall include the location of all devices, appliances, wiring sequences, wiring methods and connections of the system components. Devices shall also indicate the device address as applicable. These drawings shall show the locations of raceways and the number and color codes of the conductors installed in the raceway. These drawings shall include a description of the inputs and outputs to the fire alarm system. Ampere-hour and voltage drop calculations shall be included on the drawings.
   2. Submit to SEPTA (3) three sets of the point listing.
   3. Submit to SEPTA a parts list for all components of the system.
   4. Submit to SEPTA four (4) sets (all originals, no copies) of the operating and installation manuals for all system equipment.
   5. Submit to SEPTA two (2) copies of the database used to program (for listing, changes, general reprogramming, etc.) the site data. This database to become the property of SEPTA.
   6. Submit to SEPTA two (2) copies of the program record that records the system programming information.

I. Submit a course instruction outline and copy of all training materials for the demonstration class. Include the qualifications and resume of the instructor.

J. Submit AutoCAD files of the fire alarm system as-built drawings.

1.04 Quality Assurance

A. Meet the applicable provision of the most recent issues of the following references:
   1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NFPA 70, National Electrical Code (NEC).
   5. Local and State Building Codes.
   6. UL 38, Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems.
8. UL 268A, Smoke Detectors for Duct Application.
11. UL 864, Control Units and Accessories for Fire Alarm Systems.
12. UL 1971, Signaling Devices for the Hearing Impaired.
13. All requirements of the Authority Having Jurisdiction (AHJ).

1.05 Design Requirements

A. Prior to installation, the Contractor shall obtain approval from SEPTA for the exact system that will be installed. This request for approval shall include product specification sheets and a shop drawing.

B. All equipment shall be approved by UL for its intended purpose. All fire alarm equipment shall be listed for its intended purpose and compatibility listed to assure the integrity of the complete system.

C. Permanent room numbers (i.e. metal, wood or other permanent number device for each room, closet, etc. as provided by SEPTA/B&B) shall be utilized in the identification of areas/devices on the drawings and zone/point list and integrated into the control panel database.

D. All installations must be non-proprietary. For this purpose, non-proprietary is defined as equipment that can be readily monitored without losing zone or point addressability and type signal and maintained by any reputable Contractor regularly engaged in that business. Digital Alarm Communications Transmitter (DACT) must be programmable by any reputable Contractor regularly engaged in the fire alarm business. Further, replacement parts and system training must be readily available at a reasonable cost to whoever maintains the alarm equipment for SEPTA. This may include SEPTA personnel or a Third-Party Contractor. Technical support must be available upon request.

E. The system must be a turnkey system to SEPTA. This includes a complete and fully operation system with trouble, supervisory and alarm communications via the Remote Terminal Unit (RTU) to SEPTA and the SEPTA MMI (Maintenance Monitoring & Inspection) provider.

F. All fire alarm system locks and manual pull stations shall be keyed to the SEPTA CAT 30 key. The cost of the connection and all programming to Septa’s current Maintenance and Monitoring Company shall be paid by the contractor.

G. The Fire Alarm Control Panel (FACP) shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone for addressable initiation device circuits.

H. Spare Signaling Line Circuit (SLC) capacity shall be no less than 25 percent of the total device capacity of each SLC of the FACP.

I. The control panel must be a commercial fire (fire only – no combination fire and burglary) panel.
1.06 System Design and Performance Requirements

A. Components shall operate a system. Provide system manufacturer’s certification that all components provided have been tested as, and will operate as, a system.

B. Non-coded, addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical components, devices, and accessories to be listed and labeled as defined in the NEC, by a qualified testing agency, and marked for intended location and application.

F. Fire alarm signal shall initiate, but not limited to, the following actions:
   1. Continuously operate alarm notification appliances.
   2. Identify alarm and specific initiating device at the FACP.
   3. Transmit an alarm signal to the remote alarm receiving station via Digital Alarm Communications Transmitter (DACT) and/or Supervisory Control and Data Acquisition (SCADA).
   4. Unlock electric door locks in designated egress paths.
   5. Release fire and smoke doors held open by magnetic door holders.
   6. Activate alarm communication system.
   7. Record events in the system memory.
   8. Indicate device in alarm on the graphic annunciator.

G. System trouble signal initiation shall be by one (1) or more, but not limited to, the following devices and actions:
   1. Open circuits, shorts and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm initiating and supervisory signal initiating devices.
   3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface or Ethernet module.
   4. Loss of primary power at the FACP.
   5. Ground or a single break in internal circuits of the FACP.
   6. Abnormal AC voltage at the FACP.
   7. Break in standby battery circuitry.
   8. Failure of battery charging.
   9. Abnormal position of any switch at the FACP or annunciator.

H. System Supervisory Signal Actions:
   1. Initiate supervisory alarm notification.
   2. Identify specific device initiating the event at the FACP.
3. After a time-delay of two hundred (200) seconds, transmit a trouble or supervisory signal via DACT and/or SCADA to the remote receiving station.

1.07 Qualifications

A. The manufacturer shall be a company specializing in smoke detection and fire alarm systems with sufficient previous experience to successfully manufacture the products indicated.

B. The installer shall be a company specializing in smoke detection and fire alarm systems with sufficient previous experience to conduct satisfactorily the installation indicated.

PART 2 - PRODUCTS

2.01 Manufacturers

A. All equipment manufacturers must be non-proprietary. For this purpose, non-proprietary is defined as equipment that can be readily available to, and maintained by, any reputable Contractor regularly engaged in that business. The DACT must be programmable by any Contractor regularly engaged in the fire alarm business. Further, replacement parts and system training must be readily available at a reasonable cost to whomever maintains the fire alarm equipment for SEPTA. This may include SEPTA personnel or a Third-Party Contractor. Technical support must be available upon request.

1. Silent Knight, model 5820XL.
2. Or Approved Equal.

B. Smoke Detector Manufacturers:

1. Silent Knight, model SD505-APS.
2. Or Approved Equal:

C. Notification Appliance Manufacturers:

1. Silent Knight, Model 2251TB.
2. Or Approved Equal.

D. Manual Fire Alarm Station Manufacturers:

1. Silent Knight, Model SK-Pull-DA.
2. Or Approved Equal.

2.02 Fire Alarm Control Panel (FACP)

A. General Requirements for the FACP:

1. Field programmable, microprocessor based, modular, power limited design with electronic modules, meeting UL 864.
   a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read only memory, retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.
c. Provide communication between the FACP and remote circuit interface panels, annunciators and displays.
d. The FACP shall be listed for connection to a central station signaling system service.
e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum five hundred (500) event history log.

2. The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone for addressable initiation device circuits.

3. The FACP shall be listed for releasing service for addressable control circuits for operation of notification appliances and mechanical equipment.

B. Alphanumeric display and system controls to be arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and display to be liquid crystal type, eighty (80) characters, minimum.

2. Keypad to be arranged to permit entry and execution of programming, display and control commands.

C. Initiating Device, Notification Appliance and Signaling Line Circuits:

1. Pathway class designations to meet NFPA 72, Class A.

2. Pathway survivability to be Level 0.

3. Install no more than one hundred (100) addressable devices on each signaling line circuit.

4. Serial Interfaces:
   a. One (1) dedicated RS 485 port for SCADA operation using point identification DACT.
   b. One (1) RS 485 port for remote annunciators, Ethernet module or multi-interface module (printer port).
   c. One (1) USB port for PC configuration.
   d. One (1) RS 232 port for VESDA HLI connection.
   e. One (1) RS 232 port for voice evacuation interface.

D. Smoke Alarm Verification:

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.

2. Activate an approved "alarm verification" sequence at the FACP and detector.

3. Record events by the system printer.

4. Sound general alarm if the alarm is verified.

5. Cancel fire alarm control unit indication and system reset if the alarm is not verified.

E. Notification Appliance Circuit:
1. Audible appliances shall sound in a three (3) pulse temporal pattern, as defined in NFPA 72.

2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Remote Smoke Detector Sensitivity Adjustment:

1. Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time scheduled and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

G. Transmission to Remote Alarm Receiving Station:

1. Automatically transmit alarm, supervisory and trouble signals to a remote alarm station.

H. Primary Power:

1. 24 V DC obtained from 120 V AC service and a power supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24 V DC source.

2. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power supply module rating.

I. Secondary Power:

1. 24 V DC supply system with batteries, automatic battery charger and automatic transfer switch.

2. Batteries to be sealed lead calcium.

J. Instructions:

1. Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm and trouble conditions.

2.03 Remote Power Supply (If Required)

A. General:

1. Power supplies can be used as remotely mounted power supplies and battery chargers to power four (4) non-coded or coded Notification Appliance Circuits (NACs). The main FACP NAC(s) is connected to the remote power supply input circuit(s). When the control input circuit activates due to reverse polarity of the NAC from the FACP, the power supply will activate its NACs.

2. During the inactive or non-alarm state, the power supply supervises its NAC field wiring for short and open conditions. AC fail, battery, charger and ground fault troubles will also be monitored by the power supply. If an NAC or power supply fault is detected, the power supply normally closed trouble contact will open.
3. If an alarm condition occurs and the NAC is activated, the supervision is disabled and the NACs is no longer supervised. Supervision of other power supply faults such as low battery, AC loss, ground fault and battery charger trouble will continue and may be monitored via the trouble relay contacts.

B. Features:

1. Self-contained in a lockable cabinet.
2. 24 V DC remote power supply.
3. Outputs are completely power limited.
4. Two (2) optically isolated input/control circuits, compatible with 12 V DC and 24 V DC control panel NACs.
5. Four (4) output circuits:
   a. Fully filtered power.
   b. Four (4) 24 V DC Style Y (Class B) NACs.
   c. Optional ZNAC-4 Class A converter module for conversion to Style Z NACs.
   d. Alternatively, all four (4) circuits may be configured as 24 V DC power outputs.
   e. Output circuits may be configured as resettable or non-resettable.
6. NAC trouble Light Emitting Diode (LED) blinks to indicate the number of the circuit in trouble.
7. Maximum current available for any one (1) output circuit to be 3.0 amps.
8. Maximum total continuous current available to be 6.0 amps.
9. Maximum total short term current (one (1) hour maximum) to be 8.0 amps.
10. Integral supervised battery charger for lead acid batteries only.
11. Capable of charging 7.0 AH to 18.0 AH (Amp Hour) batteries.
12. Fully supervised power supply, battery and NACs.
13. Selectable strobe synchronization for NACs.
15. Fixed terminal blocks for field wiring capable of accepting No. 12 AWG through No. 22 AWG wire.
17. Power supply trouble form-C relay contacts (fail-safe).
18. Optional delay of AC loss reporting for eight (8) hours.
19. Auxiliary power output for Signal Line Circuit (SLC) modules (500 mA maximum) with optional reset for four (4) wire smoke detectors.
20. Mounting location for optional addressable control module.
2.04 Batteries

A. Battery shall have sufficient capacity to power the fire alarm system for not less than sixty (60) hours plus five (5) minutes of alarm upon a normal AC power failure.

B. The batteries shall be completely maintenance free. No liquids are required. Fluid level checks, refilling, spills and leakage shall not be required.

C. Batteries shall be of the type that only requires an annual charge and discharge tests as required by NFPA 72.

D. Batteries shall be located in dedicated battery enclosure(s). Batteries shall not be located in the FACP or remote power supply. Battery enclosure(s) shall be located below or to the side of the FACP.

2.05 System Components

A. Manual Fire Alarm Boxes:

1. Manual fire alarm boxes to meet UL 38. Boxes shall be finished in red with molded, raised letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   a. Double action mechanism requiring two (2) actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm or trouble) to the FACP.
   b. Station reset to be keyed to the SEPTA CAT 30 Key.
   c. Indoor gasketed protective shield to be factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery powered audible horn intended to discourage false alarm operation.
   d. Weatherproof protective shield to be factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm for manual station that do not include a horn.

B. System Smoke Detectors:

1. General Requirements for System Smoke Detectors:
   a. Meet UL 268; operating at 24 V DC, nominal.
   b. Detectors shall be two (2) wire type.
   c. Integral addressable module to be arranged to communicate detector status (normal, alarm or trouble) to the FACP.
   d. Detector and associated electronic components shall be mounted in a twist lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   e. Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   f. Integral visual indicating light to be LED type, indicating detector has operated.
   g. Unless otherwise indicated, detectors shall be digital addressable type, individually monitored at the FACP for calibration, sensitivity and alarm condition.
      1) Rate of rise temperature characteristic of combination smoke and heat detection units shall be selectable at the FACP for 15°F or 20°F per minute.
2) Fixed temperature sensing characteristic of combination smoke and heat detection units shall be independent of rate of rise sensing and shall be settable at the FACP to operate at 135°F or 155°F.

3) Number of settable levels in fire alarm control panel varies among manufacturers and between detector types. Indicate specific number of levels on drawings or in "Remarks" column of a detector schedule.

4) Multiple levels of detection sensitivity for each sensor.

5) Programmable sensitivity levels based on time of day.

2. Photoelectric Smoke Detectors:
   a. Detector address shall be accessible from the FACP unit and shall be able to identify the detector's location within the system and its sensitivity setting.

3. An operator at the FACP, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

4. Duct smoke detectors to be photoelectric type meeting U/L 268A.
   a. Detector address shall be accessible from the FACP and shall be able to identify the detector's location within the system and its sensitivity setting.
   b. An operator at the FACP, having the designated access level, shall be able to manually access the following for each detector:
      1) Primary status.
      2) Device type.
      3) Present average value.
      4) Present sensitivity selected.
      5) Sensor range (normal, dirty, etc.).
   c. Weatherproof duct housing enclosure to be NEMA 250, Type 4X; National Recognized Testing Laboratory (NRTL) listed for use with the supplied detector for smoke detection in HVAC system ducts.
   d. Number of settable levels in the FACP varies among manufacturers and between detector types. Indicate specific number of levels on drawings or in "Remarks" column of a detector schedule.
   e. Each sensor shall have multiple levels of detection sensitivity.
   f. Design and dimensions of sampling tubes to be as recommended by the manufacturer for specific duct size, air velocity and installation conditions where applied.
   g. Fully programmable relay rated to interrupt fan motor control circuit.

5. Heat Detectors:
   a. General Requirements for Heat Detectors:
      1) Meet UL 521.
      2) Temperature sensors shall test for and communicate the sensitivity range of the device.
   b. Heat detector, combination type to be actuated by either a fixed temperature of 135°F or a rate of rise that exceeds 15°F per minute unless otherwise indicated.
1) Adapter plate for outlet box mounting.
2) Integral addressable module to be arranged to communicate detector status (normal, alarm or trouble) to the FACP.

c. Heat detector, fixed temperature type to be actuated by temperature that exceeds a fixed temperature of 190°F.
   1) Adapter plate for outlet box mounting.
   2) Integral addressable module to be arranged to communicate detector status (normal, alarm or trouble) to the FACP.

C. Notification Application:

1. Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

2. Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
   a. Combination devices to be factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

3. Horns to be electric vibrating polarized type, 24 V DC; with provision for housing the operating mechanism behind a grille. Meet UL 464. Horns shall produce a sound pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

4. Visible notification appliances to be xenon strobe lights meeting UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1 inch high letters on the lens.
   a. Rated Light Output:
      1) 15/30/75/110 cd, selectable in the field.
   b. Wall mounted unless otherwise indicated.
   c. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   d. Flashing shall be in a temporal pattern, synchronized with other units.
   e. Strobe leads to be factory connected to screw terminals.
   f. Mounting faceplate to be factory finished, red.

D. Remote Annunciator:

1. Annunciator functions shall match those of the FACP for alarm, supervisory and trouble indications. Manual switching functions shall match those of the FACP, including acknowledging, silencing, resetting and testing.
   a. Mounting to be a surface cabinet, NEMA 250, Type 1.

2. Display type and functional performance to be an alphanumeric display and LED indicating lights shall match those of fire alarm control unit. Provide controls to acknowledge, silence, reset and test functions for alarm, supervisory and trouble signals.

E. Addressable Interface Device:

1. General:
a. Include address setting means on the module.
b. Store an internal identifying code for the FACP use to identify the module type.
c. Listed for controlling HVAC fan motor controllers.

2. Monitor module to be a microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

3. Integral Relay:
   a. Capable of providing a direct signal.
   b. Allow the control panel to switch the relay contacts on command.
   c. Have a minimum of two (2) normally open and two (2) normally closed contacts available for field wiring.

4. Control Module:
   a. Operate notification devices.
   b. Operate solenoids for use in sprinkler service.

F. Digital Alarm Communication:

1. Digital alarm communicator transmitter shall be acceptable to the remote central station.

2. Unit shall receive an alarm, supervisory, or trouble signal from the FACP and automatically capture one (1) telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than forty-five (45) seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

3. Local functions and display at the digital alarm communicator transmitter shall include the following:
   a. Verification that both telephone lines are available.
   b. Programming device.
   c. LED display.
   e. Communications failure with the central station or the FACP.

4. Digital data transmission shall include the following:
   a. Address of the alarm initiating device.
   b. Address of the supervisory signal.
   c. Address of the trouble initiating device.
   d. Loss of AC supply.
   e. Loss of power.
   f. Low battery.
   g. Abnormal test signal.
   h. Communication bus failure.
5. Secondary power to be an integral rechargeable battery and automatic charger.

6. Self-test to be conducted automatically every twenty-four (24) hours with report transmitted to central station.

G. System Printer (If Required):

1. Printer shall be listed and labeled as an integral part of fire alarm system.

H. Device Guards:

1. Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   a. Factory fabricated and furnished by the device manufacturer.
   b. Finish to be paint of color to match the protected device.

I. Relays:

1. Fire alarm relays remote to the FACP shall operate on supervised circuits utilizing polarity reversal and end of line resistor.

2. Relays shall be polarized and operate on 24 V DC.

3. Relay shall include a red status LED, on equals activated.

4. Contacts shall be Single Pole Double Throw (SPDT) (minimum) or Double Pole Double Throw (DPDT). Contact rating shall be sufficient for the controlled load.

5. Manufacturers:
   a. Space Age Electronics, Inc.
   b. Functional Devices, Inc.
   c. Air Product, Inc.
   d. Or Approved Equal.

2.06 Software Suite

A. The software suite is a tool for communicating with the FACP. The software allows the operator to program panels from a remote location or locally when directly connected to the panel. The software allows the operator to upload (receive) data from a panel to a PC. For example, the operator can upload event history from a panel so that the history can be sorted and viewed on screen or printed as a report. The operator can so upload programming changes that have been made at the installation site to a PC.

B. Features:

1. Compatible with the FACP.

2. Easily program panels from a remote location or on-site.

3. Upload panel account information to a PC.

4. Quick access to panel event history.

5. Forward and backward compatible with panel software.

6. Reduces the time it takes to reprogram an upgraded panel with the built-in translate option.
7. Free software upgrades downloadable from the manufacturer’s web site.

2.07 Fire Alarm Wire and Cable
   A. Wire and cable shall be type and gauge recommended by the fire alarm equipment manufacturer.
   B. All conductors shall be stranded.
   C. Use No. 16 AWG minimum size conductors for alarm detection SLC conductors.
   D. Use No. 14 AWG minimum size conductors for signal circuit NAC conductors.

PART 3 - EXECUTION

3.01 Installation
   A. Installation shall be in accordance with the NFPA 70, NFPA 72, local and state codes, as shown on the Contract Drawings and as recommended by the major equipment manufacturer.
   B. All wire and cable shall be installed in conduit, minimum size is 3/4 inch. All conduit shall meet Section 16130.
   C. Wires shall be tagged at junction points and shall test free from grounds or crosses between conductors.
   D. Wiring shall be color coded.
   E. Signaling line circuit shall be red and black. The red shall be the positive side of the line and the black shall be the negative side of the line.
   F. Horn/strobe and strobe notification application circuit shall be blue and white. Blue shall be positive and white shall be negative.
   G. The wiring system shall be through-wired the equipment. Pigtail type connections shall not be allowed.
   H. Conductor splices shall be made on screw type terminal blocks within terminal cabinets wire nuts shall not be used. Terminals within cabinets shall be properly labeled.
   I. Final connections between control equipment and the wiring system shall be made under direct supervision of a representative of the equipment manufacturer.
   J. Provide complete identification/labeling of all fire alarm devices and related components. Conduit (every 25 feet) and conduit boxes shall be identified by affixing waterproof and permanent decal with the words “Fire Alarm System” in white letters on a red background. Conduits and boxes for power, communications, alarm, etc. for the fire alarm system shall be similarly identified. All devices shall be neatly, clearly, and permanently marked as to zone or point number. End of line resistor locations shall be indicated on the alarm device, recorded on the as-built drawings and noted on the zone list.
   K. Smoke, heat and duct detectors shall not be installed until after the construction cleanup of all trades is complete and final.
L. Smoke, heat and duct detectors shall not be installed prior to the system programming and test period.

M. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

N. Manual pull stations shall be suitable for semi-flush mounting on standard single gang box, and shall be installed not less than 42 inches or more than 48 inches above the finished floor.

O. Mount strobes on the wall such that bottom of the lens is not less than 80 inches and the top of the lens is not greater than 96 inches above the finished floor, and the top of the lens is at least 6 inches below the ceiling. For low ceilings where these mounting heights cannot be met, mount strobe so the top of the lens is 6 inches below the ceiling.

P. Provide a readily visible remote indicator for smoke and heat detectors that are installed in locations that are not readily visible.

Q. Provide a readily visible remote test station for duct detectors that are installed in locations that are not readily visible/accessible.

R. Stamp or mark the date of installation on each battery.

S. Program control panel and other programmable devices and equipment.

T. Install, next to the control panel, a frame with plexiglas that is weatherproof, lockable and capable of posting changes. The frame shall contain an easily removable visual site plan that depicts the Contractor supplied “as-built” drawings. Further, the frame shall contain the Contractor supplied operator instructions for applicable basic system operations, including alarm acknowledgement, system reset, interpreting system output, such as LED’s and displays; operating the manual evacuation signaling and ancillary function controls.

U. After all actions affecting the alarm system are complete, install monitoring connection to SEPTA's Service Contractor of Record.

3.02 Field Quality Control

A. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

B. Consult Section 16950 for requirements for field inspection and testing of detection and alarm systems.

3.03 Manufacturer’s Field Services

A. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to:

1. Supervise the final connections between control equipment and the wiring system.

2. Technically supervise and participate during all of the adjustments and tests for the system.

3. At the final inspection, demonstrate that the systems function properly in every respect.
3.04 Demonstration

A. Provide instruction as required to the building personnel and fire and safety personnel. "Hands-on" demonstrations of the operation of the system shall be provided.

B. Provide a formal class to the location and facility managers on the operation of the system. Documentation and attendance rosters shall be provided to SEPTA.

C. Provide a separate overview briefing at a mutually agreed time. The briefing shall be provided to facilities managers, the SEPTA Fire Marshal and (SEPTA) IMOS Contract Services.

END OF SECTION
SECTION 15010

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 Description

A. This Section covers basic mechanical requirements specifically applicable to Division 15 Sections.

B. Specific work elements include permits, project staffing and coordination, record documents, commissioning of systems and instruction manuals for operation and maintenance.

C. The Mechanical Contractor is responsible to detail and construct the mechanical systems as part of the prefabricated building.

D. The Mechanical Contractor is tasked with making the final field adjustments and commissions the mechanical and HVAC systems indicated on the Contract Drawings.

1.02 Submittals

A. Organize each manual with index and thumb tab marker for each section of information including flow diagrams, maintenance instructions, operating instructions, parts listings and copies of other submittals indicated for inclusion; bind in 1 inch, three (3) ring vinyl covered binders with pockets to contain folded sheets, properly labeled on spine and face of binders.

B. Submit copies of shop drawings on all items of equipment and materials to be furnished and installed. Where same items, such as fixtures are involved; submit descriptive literature in a bound brochure form; individual piecemeal submittals shall not be accepted; fixture cuts (all types specified) shall be submitted at one (1) time.

C. Report before or at the time when shop drawings are submitted, any discrepancies or contradictions as applied to their instructions for each piece of equipment.

D. Submit the manufacturer's printed installation instructions for each piece of equipment.

E. Install, test, start and operate equipment as instructed by the manufacturer. Submit written evidence from the equipment manufacturer's that their equipment and systems have been installed strictly in accordance with the manufacturer's recommendation and properly aligned, adjusted and tested.

1.03 Quality Assurance

A. All items of work in Division 15 shall conform to all requirements of the latest edition of the International Mechanical Code as referenced by the PA Uniform Construction Code.

B. Meet the applicable provisions of the most recent issues of the following references:
   1. Associated General Contractor of America, Inc. (AGCA)
5. American Society Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE).
6. American Society of Mechanical Engineers (ASME).

C. All NFPA Codes referenced in these specifications shall be the latest editions of those codes in effect at the time of the bid.

D. All materials and equipment shall be produced in a plant of recognized reputation and regularly engaged in the production of equipments conforming to the specified standards. Materials and equipment shall be new, of makes and kinds specified herein, or as indicated on the Contract Drawings, without exceptions.

1.04 Job Conditions

A. Interferences:

1. Construct mechanical systems when and in a manner not to delay or interfere with other operations of work in the Project.

2. Construct and functionally test mechanical systems at the time of factory fabrication of the prefabricated building.

B. Electrical Interface:

1. Power, control and thermostat wiring, including final connections, from the electrical service devices to the electrical components of the apparatus shall be performed as work of Division 16.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION
SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 Description

A. This Section describes the work consisting of services and work of an administrative nature as well as general requirements concerning certain products and operations common to Division 15.

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Equipment nameplate data requirements.
5. Field painting, touchup painting and finishing.

1.02 Related Sections

A. Section 01300 – Submittals
B. Section 01305 – Requests for Information
C. Section 01400 – Quality Requirements
D. Section 13121 – Prefabricated Building
E. All other sections of Division 15.
F. Section 16010 – Basic Electrical Requirements
G. All auxiliary power related sections of Division 16 that power mechanical equipment.

1.03 Submittals

A. Submit product data applicable to items listed under Submittals in each Section of Division 15 and such items as may be scheduled on the Contract Drawings.

B. Include in submittals the manufacturer’s descriptive literature, product specifications, published details, performance or capacity rating schedules or charts, and installation instructions, as applicable to items under submittals in each Section of Division 15 and such items as may be scheduled on the Contract Drawings.

C. Submit shop drawings certified for construction by the manufacturers of various products, and approved by the Contractor, which includes location of electrical connections, wiring diagrams, anchor bolt layout, details indicating construction, materials of construction, diameter of shafting, dimensions, rated horsepower of motors, gear and bearing ratings, service factors, and the weights of principal parts and the completely assembled item. Shop drawings applicable to items listed under submittals in each Section of Division 15 and such items as may be scheduled on the Contract Drawings.
1.04 Quality Assurance

A. Meet the construction requirements of state, county and such other local political subdivision's specifications as may exceed the requirements of the codes, standards and approving bodies referenced herein.

B. Meet the requirements of the National Fire Protection Association (NFPA) Standards referenced in the various Specifications Sections, and as directly appropriate to the work and workmanship.

C. Meet the requirements for both the Underwriters' Laboratories, Inc. (UL) Listings, Labels, and Approvals and the National Electrical Manufacturers' Association's (NEMA) Stamps or Seals as applicable to electrical equipment or apparatus forming parts of the mechanical equipment.

D. Upon completion of work, and prior to final payment, furnish to SEPTA formal certification of final inspections from authorities having jurisdiction and secure required permits, if any, from such authorities. Additionally, prepare detailed diagrams and drawings, which may be required by those authorities having jurisdiction.

E. The term "Manufacturer" as used throughout the Division 15 specifications is understood to apply to a company of established reputation in the manufacture of the particular materials, equipment or apparatus from products of their own make, or products of others, and who assumes full responsibility for products used in said outfits which are not manufactured completely by them, and with replacement parts available.

F. Products used throughout the Division 15 specifications, and as indicated on the Contract Drawings, are those of companies having established reputations in the manufacture of the particular materials, equipment or apparatus specified. Such products may be of their own make, or products of others for which they assume full responsibility when used in said outfits (which are not manufactured completely by them) and with replacement parts available.

1. The manufacturer's names and model numbers are given for purpose of establishing a standard of quality, style, size and type and shall not be construed to exclude equipment or materials of other manufacturers.

G. Electrical Components:

1. The Contractor to provide all starters and disconnects as well as the wiring and conduit from the starters and disconnects to the mechanical equipment. Refer to Division 16 Specifications for requirements regarding conduit and wire.

2. Motor starters shall be minimum NEMA Size 1. Electrical enclosures to be NEMA 12 for indoor units and NEMA 4 for outdoor units unless otherwise specified or indicated on the Contract Drawings.

3. Starters shall be complete with two (2) sets of auxiliary contacts; one (1) set normally open; one (1) set normally closed.

H. Meet the applicable provisions of the most recent issues of the following references:

1. SSPC-SP 2, Hand Tool Cleaning.
1.05 Delivery, Storage and Handling

A. Deliver materials and equipment to the Project site in a clean condition with openings plugged or capped (or otherwise sealed by packaging) both during shipping and during temporary storage.

B. Delivered equipment crating and/or packaging shall clearly identify pick points or lift points. In the absence of crating or packaging, pick points or lift points must be identified on the equipment.

C. When unloading materials and equipment provide special lifting harness or apparatus as may be required by the manufacturer. Handle materials and equipment in accordance with the manufacturer's written instructions.

D. The Contractor shall determine the required equipment needed for unloading operations and have such equipment on site to perform unloading work on the date of equipment delivery.

E. Store materials and equipment, both on and off site, in accordance with the manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 Materials

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Dielectric Unions:
   a. Central Plastics Co.
   b. Epco Sales Inc.
   d. Watts Industries, Inc.
   e. Zurn Industries, Inc.
   f. Or Approved Equal.

2. Dielectric Flanges:
   a. Central Plastics Co.
   b. Epco Sales Inc.
   c. Watts Industries, Inc.
   d. Or Approved Equal.

3. Dielectric Flange Insulating Kits:
   a. Calpico, Inc.
   b. Central Plastics Co.
   c. Or Approved Equal.

4. Mechanical Sleeve Seals:
   a. Metraflex Co.
   b. Thunderline/Link-Seal.
   c. Or Approved Equal.
B. Dielectric Fittings:
   1. Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
   2. Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
   3. Insulating material shall be suitable for system fluid, pressure and temperature.
C. Mechanical Sleeves and Seals:
   1. Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

PART 3 - EXECUTION

3.01 Preparation
   A. The Contractor is responsible for installation of complete systems at the factory for prefabricated building, in accordance with Specification Section 13121.

3.02 Installation
   A. Painting and Finishes
      1. Factory Finishes and Field Painting:
         a. Painting of the materials, equipment, apparatus and items installed as work of this Contract will be factory painted with touch ups as indicated below. Refer to Division 9 for reference.
            1) Painting factory finished items will be required in the cases where the factory finish is damaged.
         b. The quality of the repaint work will be subject to SEPTA’s approval.
            1) Perform surface preparation of damaged areas in conformance with the latest edition of the Steel Structures Painting Council Standard SSPC-SP 2.
            2) Where a damaged area occurs on one (1) surface of an item having several surfaces, that entire surface where the damage occurs shall require repainting. The surface preparation for outside the damaged area shall consist of a light sanding to profile the existing paint.
         c. Apply paint in such a manner so that the finished appearance will match as nearly as possible the factory finish.
            1) Use paint material matching the composition of the factory applied products. When possible obtain touch up paint directly from the manufacturer to ensure paint is compatible and color matched.
         d. Meet the paint manufacturer’s label instruction for mixing, thinning, proper spreading rate, drying time and environmental limitations concerning application.

   END OF SECTION
SECTION 15060

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 Description
   A. This Section covers the minimum requirements for providing supports, anchors and seals for equipment that are included herein.

1.02 Submittals
   A. Submit product data in sufficient detail to show full compliance with the Contract Documents.
      1. Submit the manufacturer's product data for each product and material.
      2. Indicate the manufacturer, trade names, and model numbers, components, arrangement and accessories being provided.
      3. Submit applicable literature, catalog material or technical brochures.
      4. Submit material and equipment specifications, sizes, types, dimensions, weights, rated capacities and performance curves.
      5. Submit utility requirements for wiring and service connection data, motor sizes complete with electrical characteristics.
   B. Submit shop drawings to show full compliance with the Contract Documents:
      1. Submit dimensional data for rough in and installation instructions.
      2. Indicate typical layout including dimensions and utility connections.
   C. Submit quality assurance/control submittals:
      1. Design data.
      2. Test reports.
      3. Certificates.
      4. Manufacturer's instructions and field reports.

1.03 Quality Assurance
   A. Meet the applicable provisions of the most recent issues of the following references:
      1. American Concrete Institute (ACI).
      4. ASME B31.1, Power Piping.


12. MSS SP-69, Pipe Hangers and Supports - Selection and Application.


16. Underwriters’ Laboratories, Inc. (UL) and Factory Mutual (FM).

1.04 Design Requirements

A. Pipe hangers and supports to meet the requirements of ASME B31.1, MSS SP-58, MSS SP-69 and other requirements specified herein.

B. Design and size equipment suspension systems and base supports units based on installation instruction or information as obtained from the equipment manufacturers and other requirements as specified herein.

1.05 Warranty

A. All work and materials shall be warranted for one (1) year after acceptance by SEPTA.

B. Submit the manufacturer’s warranty and verify that forms are completed in SEPTA’s name and registered with the manufacturer.

C. Correct defective work within a one (1) year period after date of final acceptance.

PART 2 - PRODUCTS

2.01 Materials

A. Manufacturers:

1. The use of trade names on the Contract Drawings or other documents is to establish a basis of design, constructability and level of quality. It is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with contract requirements.

2. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

   a. B-Line Systems, Inc.
b. National Pipe Hanger Corp.
c. Unistrut Corp.
d. Hilti, Inc.
e. Or Approved Equal.

3. All indoor steel materials will be galvanized coated except those identified as stainless steel or copper plated. All outdoor steel materials or those exposed to outside conditions will be stainless steel.

B. Beam Clamps:
   1. For upper attachments on structural steel provide beam clamps of carbon steel ASTM A 36/A 36M or forged steel ASTM A 181/A 181M.
   2. Holes drilled in structural steel for hanger support rods will not be permitted.
   3. Provide clamps with hardened steel cup point set screw and locknut for anchoring in place.
   4. Base clamp size selection on required load being supported.

C. Hanger Rods
   2. Diameter of rods for piping system support to meet ASME B31.1.
      a. In no case shall hanger rods less than 3/8 inch diameter be provided for support of pipe sizes 2 inches and smaller, or less than 1/2 inch diameter rod for supporting pipe sizes 2 1/2 inch and larger.
   3. Size hanger rods for duct work systems to meet SMACNA standards.
   4. Size hanger rods for mechanical equipment support based on installation instructions as obtained from the equipment manufacturers.
      a. All thread hanger rods not permitted for equipment supports.

D. Auxiliary Steel:
   1. Provide auxiliary steel where support of piping systems and equipment is required between building structural elements. Provide light gauge and structural steel shapes to meet the requirements of ASTM A 36/A 36M.
   2. The Contractor shall have the option to use pre-engineered support systems of electro-galvanized steel products. MIXTURE OF SUPPORT SYSTEM MANUFACTURER’S PRODUCTS NOT PERMITTED.
   3. Where auxiliary steel is indicated as stainless steel, provide AISI Type 304 stainless steel in No. 1 Finish.

E. Vibration Isolators:
   1. Suspended application design, composed of either a steel spring and glass fiber isolator placed in series and encased in a welded steel bracket; or rubber in shear isolator placed in a welded steel bracket.
   2. Select isolators to provide 50 percent overload capacity with operating static deflections as recommended by the isolator manufacturer.
F. Sleeves and Seals:
   1. Seals and Plates:
      a. Wall seal to be hydrostatic modular compression link seal designed to seal opening between pipes and a through structure opening. Provide Link-Seal by Thunderline Corp., or approved equal. Caulking, mastic sealants, lead/oakum, continuous (solid) gaskets are not acceptable as equal.
      b. Wall and ceiling plates to be cast metal with integral set screw or similar anchoring screw. Hinged or split design plates may be provided.
      c. Provide chrome plated stamped steel hinged plate escutcheons to close pipe penetrations through structure interior in finished areas. Provide plates designed to lock on pipes using setscrews.
   2. Provide a factory pre-fabricated roof penetration seal system of materials acceptable to or by the existing roofing system membrane manufacturer.
      a. The pre-fabricated system design shall accommodate multiple pipes and conduits in a single fabricated curb and EPDM pipe portal unit.

2.02 Source Quality Control
   A. Factory tests:
      1. Provide factory certification.
   B. Performance Verification:
      1. Provide factory certification.

PART 3 - EXECUTION

3.01 Preparation
   A. Examine job site conditions prior to proceeding with work.

3.02 Installation
   A. General:
      1. Saddles and shields will be installed in accordance with industry standards or in accordance with the manufacturer's recommendations where applicable to prevent damage to insulation.
      2. Perforated strap iron and wire will under no circumstances be acceptable as hanger material.
      3. In corrosive conditions or wet areas, provide corrosion resistant supports.
   B. Spacing of Hangers and Supports:
      1. General:
         a. Space hangers and supports as stated herein and in ASME B31.1, MSS SP-58 and MSS SP-69, and as indicated on the Contract Drawings.
C. Equipment supports and penetrations seals for materials and equipment exposed to weather to be stainless steel fasteners for both exposed and concealed attachments in exterior locations.

D. Equipment Supports:
   1. Fabricate structural steel stands to suspend equipment from structure above or to support equipment above floor.

E. Seals and Plates Installation:
   1. Install wall and ceiling plates to close sleeve openings.
   2. Install escutcheons to close sleeve openings in finished areas.

3.03 Field Quality Control
   A. Protect installed work from subsequent construction activities.

END OF SECTION
THIS PAGE NOT USED
SECTION 15062

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 Description
   A. The Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. Section Includes:
      1. Metal pipe hangers and supports.

1.02 Related Sections
   A. Section 05500 – Metal Fabrications
   B. Section 09910 – Paints and Coatings

1.03 Submittals
   A. Submit product data for each type of product indicated.
   B. Submit shop drawings showing the fabrication and installation details and include calculations for the following; include product data for components:
      1. Trapeze pipe hangers.
      2. Metal framing systems.
      3. Fiberglass strut systems.
      4. Pipe stands.
      5. Equipment supports.
   C. Submit trapeze hanger analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.
      1. Detail fabrication and assembly of trapeze hangers.
      2. Calculate requirements for designing trapeze hangers.
   D. Submit welding certificates.

1.04 Quality Assurance
   A. Structural steel welding qualifications, qualify procedures and personnel according to AWS D1.1/D1.1M.
   B. Pipe welding qualifications, qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
   C. Meet the applicable provisions of the most recent issues of the following references:
5. AWS D1.1/D1.1M, Structural Welding Code - Steel.
6. MFMA-103, Guidelines for the use of Metal Framing.
8. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
10. SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel.

1.05 Definitions
   A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.06 Performance Requirements
   A. Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a Professional Engineer licensed in the Commonwealth of Pennsylvania, using performance requirements and design criteria indicated.
   B. Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
     1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents and test water.
     2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

PART 2 - PRODUCTS

2.01 Metal Pipe Hangers and Supports
   A. Carbon Steel Pipe Hangers and Supports:
      1. MSS SP-58, Types 1 through 58, factory fabricated components.
      2. Galvanized metallic coatings to be pre-galvanized or hot dipped.
      3. Nonmetallic coatings to be plastic coating, jacket or liner.
      4. Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
      5. Hanger rods to be continuous thread rod, nuts and washer made of stainless steel.
2.02 **Miscellaneous Materials**

A. Structural steel to meet ASTM A 36/A 36M, carbon steel plates, shapes and bars; black and galvanized.

B. Grout to meet ASTM C 1107/C 1107M, factory mixed and packaged, dry, hydraulic cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Non-staining, noncorrosive and nongaseous.
   2. Design mix to be 5000 psi, twenty-eight (28) day compressive strength.

**PART 3 - EXECUTION**

3.01 **Hangers and Support Installation**

A. Metal pipe hanger installation to meet MSS SP-69 and MSS SP-89. Install hangers, supports, clamps and attachments as required to properly support piping from the building structure.

3.02 **Painting**

A. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Meet the SSPC-PA 1 requirements for touching up field painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Cleaning and touchup painting of field welds, bolted connections and abraded areas of shop paint on miscellaneous metal are specified in Section 09910.

C. Clean welds, bolted connections and abraded areas and apply galvanizing repair paint to meet ASTM A 780/A 780M.

3.03 **Hangers and Support Schedule**

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Meet MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use stainless steel pipe hangers and stainless steel or corrosion resistant attachments for hostile environment applications.

E. Use copper plated pipe hangers and attachments for copper piping and tubing.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal hanger shield inserts for insulated piping and tubing.

H. Unless otherwise indicated and except as specified in piping system Sections, install the following vertical piping clamp types:
1. Use extension pipe or riser clamps (MSS Type 8) for support of pipe risers NPS 3/4 to NPS 24.

2. Use carbon or alloy steel riser clamps (MSS Type 42) for support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Unless otherwise indicated and except as specified in piping system Sections, install the following types of equipment for building attachments:

1. Use steel or malleable concrete inserts (MSS Type 18) for upper attachment to suspend pipe hangers from concrete ceiling.

2. Use top beam c-clamps (MSS Type 19) for under roof installations with bar joist construction, to attach to top flange of structural shape.

3. Use side beam or channel clamps (MSS Type 20) for attaching to bottom flange of beams, channels or angles.

4. Use center beam clamps (MSS Type 21) for attaching to center of bottom flange of beams.

5. Use welded beam attachments (MSS Type 22) for attaching to bottom of beams if loads are considerable and rod sizes are large.

6. Use c-clamps (MSS Type 23) for structural shapes.

7. Use top beam clamps (MSS Type 25) for top of beams if hanger rod is required tangent to flange edge.

8. Use steel beam clamps with eye nuts (MSS Type 28) for attaching to bottom of steel I-beams for heavy loads.

9. Use linked steel clamps with eye nuts (MSS Type 29) for attaching to bottom of steel I-beams for heavy loads, with link extensions.

10. Use malleable beam clamps with extension pieces (MSS Type 30) for attaching to structural steel.

11. Use welded steel brackets for support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31) to be 750 lb.
   b. Medium (MSS Type 32) to be 1500 lb.
   c. Heavy (MSS Type 33) to be 3000 lb.

12. Use side beam brackets (MSS Type 34) for sides of steel or wooden beams.

13. Use plate lugs (MSS Type 57) for attaching to steel beams if flexibility at beam is required.

14. Use horizontal travelers (MSS Type 58) for supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Unless otherwise indicated and except as specified in piping system Sections, install the following types of saddles and shields:

1. Use steel pipe covering protection saddles (MSS Type 39) to fill interior voids with insulation that matches adjoining insulation.
2. Use protection shields (MSS Type 40) of length recommended in writing by the manufacturer to prevent crushing insulation.

3. Use thermal hanger shield inserts for supporting insulated pipe.

K. Trapeze pipe hanger selections and applications that are not specified in piping system Sections to meet MSS SP-69.

L. Metal framing system selections and applications that are not specified in piping system Sections to meet MFMA-103.

M. Use powder actuated fasteners or mechanical expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION
THIS PAGE NOT USED
SECTION 15075
MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 Description
A. This Section covers the requirements of the following equipment to be furnished under this contract:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Labels.
   5. Lockout devices.

1.02 Submittals
A. Submit product data in the form of manufacturers catalog literature for each product required.
B. Submit shop drawings containing the list of wording, symbols, letter size and color coding for mechanical identification.
C. Submit two (2) samples of each type and size used on Contract.
D. Submit installation instructions and special procedures for installation.
E. Certify products meet or exceed specified requirements.
F. Record actual locations of tagged equipment; include tag numbers.

1.03 Quality Assurance
A. Meet NFPA 99 requirements for labeling and identification.
B. Maintain one (1) copy of each document on site.
C. Meet the applicable provisions of the most recent issues of the following references:
   1. American Society of Mechanical Engineers (ASME).

1.04 Qualifications
A. Company specializing in manufacturing products specified in this Section.
B. Company specializing in performing work of this Section.

PART 2 - PRODUCTS
2.01 Materials

A. Nameplates:
   1. Manufacturers:
      a. Craftmark Identification Systems Model.
      b. Safety Sign Company.
      c. Seton Identification Products.
      d. Or Approved Equal.
   2. Nameplates shall be of laminated three (3) layer plastic with engraved letters on light contrasting background color.

B. Tags:
   1. Plastic tags shall be laminated three (3) layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1 1/2 inches.
   2. Metal Tags shall be of brass, aluminum or stainless steel with stamped letters; tag size minimum 1 1/2 inches with finished edges. Mixing of types is not permitted.
   3. Information tags shall be of clear plastic with printed "Danger," "Caution" or "Warning" and message; size 3 1/4 inches x 5 5/8 inches with grommet and self-locking nylon ties.
   4. Provide a tag chart with typewritten letter size list of applied tags and location in anodized aluminum frame with plastic cover or plastic laminated. Provide a copy for reference in the operations and maintenance manual.

PART 3 - EXECUTION

3.01 Preparation

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 Installation

A. Install identifying devices after completion of coverings and painting.
B. Install plastic nameplates with corrosion resistant mechanical fasteners or adhesive.
C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
D. Install tags using corrosion resistant chain. Number tags consecutively by location.
E. Identify air handling units, pumps, heat transfer equipment, tanks and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
F. Identify control panels and major control components outside panels with plastic nameplates.
G. Identify air terminal units and radiator valves with numbered tags.
H. Tag automatic controls, instruments and relays.
I. Identify ductwork with plastic nameplates.
J. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure and at each obstruction.

END OF SECTION
THIS PAGE NOT USED
SECTION 15080

MECHANICAL INSULATION

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of the various insulation systems required in the Contract.

1.02 Related Sections
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Section 15060 – Hangers and Supports

1.03 Submittals
A. Submit the following product data:
   1. Pipe insulating materials.
   2. Duct insulating materials.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   9. Underwriters Laboratories Inc. (UL).
1.05 Delivery, Storage and Handling

A. Deliver insulation products to the site in unbroken shipping cartons bearing a label. Show on the label the list of contents and the appropriate ASTM, NFPA and UL flame and smoke hazard ratings as specified herein.

B. Deliver and store insulation products protected from the weather. Store insulation on the site elevated off wet and otherwise contaminating surfaces.

PART 2 - PRODUCTS

2.01 Materials

A. Pipe Insulation:

1. Flexible insulation (For pipe sizes 1/2 inch thru 5 inches) to be expanded, closed cell, elastomeric structure or unicellular polyolifin foam insulation manufactured to meet requirements of ASTM C 534/C 534M, Type I, in pre-slit or unslit tubing form.

a. Basic Physical Properties:

   1) Density to be 5 to 6 pounds per cubic foot.
   2) Thermal conductivity to be 0.28 BTUH or less per square foot per degree per inch at 75°F mean temperature when tested according to ASTM C 177.
   3) Water vapor permeability to be 0.10 perm-inch or less when tested according to ASTM E 96/E 96M.
   4) Fire rating not exceeding 25 flame spread and 50 smoke developed when tested according to ASTM E 84.
   5) Temperature limits to be minus 40°F to plus 220°F.

b. Provide the insulation manufacturer's companion joint making/sealing adhesive to make permanent insulation joints.

c. Insulate flexible fittings and valve bodies with sleeves of same insulation thickness used on adjacent piping and having an inside diameter large enough to fit over the insulation on adjacent piping.

d. Provide the manufacturer’s recommended weather resistant protective coating or finish for outdoor installations. Coating to be a water based latex enamel or similar sealer.

e. Manufacturers:

   2) Rubatex Corporation.
   3) Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Apply insulation on clean, dry surfaces only. Perform cleaning required for removal of construction debris, spills, etc.

B. Personnel protective equipment may be necessary when working with insulation materials. Refer to the manufacturer’s Material Safety Data Sheet (MSDS) for recommendations.
3.02 Installation

A. Install insulation continuous through structure penetration of surfaces being insulated.

B. Apply insulation on cold surfaces, where vapor barrier is integral with insulation in a continuous unbroken vapor seal. Adequately seal hanger, support and anchor penetrations of insulation.

C. Apply specified insulation adhesive, sealers and coatings at the manufacturer’s recommended minimum coverage per gallon.

D. Protect material from weather damage until weather protective jacket is applied.

E. Pipe Insulation:
   1. Apply insulation materials on piped services listed and in accordance with thicknesses listed in Article 2 in this Section or in the following paragraphs. Insulate fittings and valve bodies and in-line control devices, except gage and thermometer faces, setting or measuring scales integral with in-line devices and control handles.
   2. Install flexible insulation on piping according to the manufacturer’s instructions, using specified adhesive to seal both longitudinal and butt joints. Insulate in-line appurtenances to the same thickness as adjoining insulation.
      a. Install 1/2 inch thick insulation on the following piping:
         1) Domestic hot, cold, and tempered water and refrigerant piping.

3.03 Field Quality Control

A. Carefully inspect installed work of other trades in connection with insulating work and verify such work to be complete, including system or equipment testing, to such point where insulating work may begin.

END OF SECTION
THIS PAGE NOT USED
SECTION 15160

STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 Description
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Section includes:
   1. Pipe, tube and fittings.
   2. Specialty pipe fittings.
C. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm drainage piping to withstand 10 foot head of water.
D. Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.02 Related Sections
A. Section 15060 - Hangers and Supports
B. Section 15165 - Storm Drainage Piping Specialties

1.03 Submittals
A. Submit product data for each type of product indicated.
B. Submit field quality control reports.

1.04 Quality Assurance
A. Piping materials shall bear label, stamp or other markings of specified testing agency.
B. MEET NSF/ANSI 14 for plastic piping components. Include marking with "NSF drain" for plastic drain piping and "NSF sewer" for plastic sewer piping.
C. Meet the applicable provisions of the most recent issues of the following references:
   1. ASCE/SEI 7, Minimum Design loads for Buildings and Other Structures.
   2. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   3. ASME B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   5. ASME B16.23, Cast Copper Alloy Solder Joint Drainage Fittings: DMV.
   6. ASME B16.24, Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500.
7. ASME B16.29, Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DMV.
8. ASME B 18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
10. ASTM A 674, Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
23. ASTM D 2855, Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
27. AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
28. AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
30. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
31. MSS SP-123, Non-Ferrous Threaded and Solder Joint Unions for Use With Copper Water Tube.
32. NSF/ANSI 14, Plastics Piping System Components and Related Materials.

1.05 Project Condition

A. Do not interrupt service to facilities occupied by SEPTA or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify SEPTA Project Manager no fewer than two (2) days in advance of proposed interruption of storm drainage service.

2. Do not proceed with interruption of storm drainage service without the SEPTA Project Manager’s written permission.

PART 2 - PRODUCTS

2.01 Piping Materials

A. Meet the requirements in Article 3.10 in this Section for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations and pipe sizes.

2.02 Hubless, Cast Iron Soil Pipe and Fittings

A. Pipe and fittings to meet ASTM A 888 or CISPI 301.

B. Cast Iron, Hubless Piping Couplings:

1. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following or equal:
   a. MG Piping Products Company.
   b. Or Approved Equal.

2. Cast iron, hubless piping coupling to meet ASTM C 1277.

3. Two (2) piece ASTM A 48/A 48M, cast iron housing; stainless steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.03 Copper Tube and Fittings

A. Copper DWV tube to meet ASTM B 306, Type L, recommend using at least "M" wall thickness DWV, can be dented by hand. "L" wall type tube is preferred. Drainage tube, drawn temper.

B. Copper drainage fittings to meet ASME B16.23, cast copper fittings or ASME B16.29, wrought copper, solder joint fittings.
C. Hard copper tube to meet ASTM B 88, Type L, water tube, drawn temper.

D. Copper Pressure Fittings:
   1. Copper fittings to meet ASME B16.18, cast copper alloy fittings or ASME B16.22, wrought copper, solder joint fittings. Furnish wrought copper fittings if indicated.
   2. Copper unions to meet MSS SP-123, copper alloy, hexagonal stock body with ball-and-socket, metal-to-metal seating surfaces, and solder joint or threaded ends.

E. Copper flanges to meet ASME B16.24, Class 150, cast copper with solder joint end.
   1. Flange gasket materials to meet ASME B16.21, full face, flat, nonmetallic, asbestos free, 1/8 inch maximum thickness unless thickness or specific material is indicated.
   2. Flange bolts and nuts to meet ASME B18.2.1, carbon steel unless otherwise indicated.

F. Solder to meet ASTM B 32, lead free with ASTM B 813, water flushable flux.

2.04 Specialty Pipe Fittings

A. Transition Couplings:
   1. Fitting or device for joining piping with small differences in outside diameters or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting type transition couplings to be manufactured piping coupling or specified piping system fitting.

3. Unshielded, Non-Pressure Transition Couplings:
   a. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:
      2) Fernco Inc.
      3) Mission Rubber Company; a division of MCP Industries, Inc.
      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
      5) Or Approved Equal.
   b. Unshielded, non-pressure transition couplings to meet ASTM C 1173.
   c. Elastomeric, sleeve type, reducing or transition pattern. Include shear ring and corrosion resistant metal tension band and tightening mechanism on each end.
   d. Sleeve Materials:
      1) Cast iron soil pipe sleeve materials to meet ASTM C 564, rubber.
      2) Plastic pipe sleeve materials to meet ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-Pressure Transition Couplings:
   a. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:
      2) Mission Rubber Company; a division of MCP Industries, Inc.
3) Or Approved Equal.
   b. Shielded, non-pressure transition couplings to meet ASTM C 1460.
   c. Elastomeric or rubber sleeve with full length, corrosion resistant outer shield and corrosion resistant metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.01 Piping Installation
   A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
   B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
   D. Install piping to permit valve servicing.
   E. Install piping at indicated slopes.
   F. Install piping free of sags and bends.
   G. Install fittings for changes in direction and branch connections.
   H. Install piping to allow application of insulation.
   I. Make changes in direction for storm drainage piping using appropriate branches, bends and long sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
   J. Install storm drainage piping at the following minimum slopes unless otherwise indicated.
      1. Building storm drain to have a 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
      2. Horizontal storm drainage piping to have a 2 percent downward in direction of flow.
   K. Install cast iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
      1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
   L. Install steel piping according to applicable plumbing code.
   M. Install engineered controlled flow or siphonic drain specialties and storm drainage piping in locations indicated.
   N. Install underground, ductile iron, force main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust block supports at vertical and horizontal offsets.
1. Install encasement on piping according to ASTM A 674 or AWWA C105.

O. Install force mains at elevations indicated.

P. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force main piping. Meet the requirements for cleanouts specified in Section 15165.
   2. Install drains in storm drainage gravity flow piping. Meet the requirements for drains specified in Section 15165.

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings and floors. Meet the requirements for sleeves as per applicable codes.

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Meet the requirements for sleeve seals as per applicable codes.

T. Install escutcheons for piping penetrations of walls, ceilings and floors. Meet the requirements for escutcheons as per applicable codes.

3.02 Joint Construction

A. Join hubless, cast iron soil piping coupled joints according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.

B. Clean and dry plastic, non-pressure piping, solvent cemented joint surfaces. Join pipe and fittings according to the following:
   1. Meet ASTM F 402 for safe handling practice of cleaners, primers and solvent cements.
   2. Join ABS piping according to ASTM D 2235 and ASTM D 2661 appendixes.
   3. Join PVC piping according to ASTM D 2855 and ASTM D 2665 appendixes.

3.03 Specialty Pipe Fitting Installation

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in outer diameters.
   2. In drainage piping provide shielded, non-pressure transition couplings.
   3. In aboveground force main piping provide fitting type transition couplings.

3.04 Hanger and Support Installation

A. Meet the requirements for pipe hanger and support devices and installation specified in Section 15060.
   1. Install carbon steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install stainless steel or fiberglass pipe hangers for horizontal piping in corrosive environments.
3. Install carbon steel pipe support clamps for vertical piping in noncorrosive environments.

4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical piping to be MSS Type 8 or Type 42, clamps.

6. Individual, Straight, Horizontal Piping Runs:
   a. 100 feet and less to be MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 feet to be MSS Type 43, adjustable roller hangers.
   c. Longer than 100 feet if indicated to be MSS Type 49, spring cushion rolls.

7. Multiple, straight, horizontal piping runs 100 feet or longer to be MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of vertical piping to be DWV Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve and coupling.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one (1) size for double rod hangers, with 3/8 inch minimum rods.
E. Install hangers for cast iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1 1/2 and NPS 2 to be 60 inches with 3/8 inch rod.
   2. NPS 3 to be 60 inches with 1/2 inch rod.
   3. NPS 4 and NPS 5 to be 60 inches with 5/8 inch rod.
   4. Spacing for 10 foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast iron soil piping every 15 feet.
G. Support piping and tubing not listed above according to MSS SP-69 and the manufacturer's written instructions.

3.05 Connections
A. Contract Drawings indicate general arrangement of piping, fittings and specialties.
B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
C. Connect storm drainage piping to roof drains and storm drainage specialties.
   1. Meet the requirements for backwater valves, cleanouts and drains specified in Section 15165.
D. Connect force main piping to the following:
   1. Storm sewer to exterior force main.
   2. Sump pumps to sump pump discharge.
E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2 1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.06 Identification

A. During installation, notify authorities having jurisdiction at least twenty-four (24) hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unsealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10 foot head of water. From fifteen (15) minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

E. Test force main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Leave uncovered and unsealed new, altered, extended, or replaced force main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   2. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and
allow to stand for four (4) hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.07 Cleaning

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.08 Piping Schedule

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be the following:
   1. Hubless, cast iron soil pipe and fittings.

END OF SECTION
SECTION 15165

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 Description
A. Section includes:
   1. Roof drains.
   2. Through penetration fire stop assemblies.
   3. Flashing materials.

1.02 Related Sections
A. The Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Section 15160 - Storm Drainage Piping

1.03 Submittals
A. Submit product data for each type of product indicated.

1.04 Quality Assurance
A. Drainage piping specialties shall bear label, stamp or other markings of specified testing agency.
B. Meet the applicable provisions of the most recent issues of the following references:
   1. ASME A112.6.4, Roof, Deck, and Balcony Drains.
   5. ASTM B 152/B 152M, Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar.

PART 2 - PRODUCTS

2.01 Metal Roof Drains
A. Cast Iron, Small Sump, General Purpose Roof Drains:
1. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:
   b. Josam Company.
   c. Wade; a subsidiary of McWane Inc.
   d. Zurn Industries, LLC.
   e. Or Approved Equal.

2. Meet ASME A112.6.4, for general-purpose roof drains.

3. Body material to be cast iron.

4. Dimension of body to be nominal 9 inch diameter.

5. Combination flashing ring and gravel stop is required.

6. Outlet to be at the bottom.

7. Extension collars are required.

8. Underdeck clamp is required.

9. Expansion joint is required.

10. Dome material to be cast iron.

11. Wire mesh to be brass over dome.

12. Vandal proof dome is required.

2.02 Flashing Materials

A. Copper sheet to meet ASTM B 152/B 152M, 12 oz./square foot.

B. Zinc coated steel sheet to meet ASTM A 653/A 653M, with 0.20 percent copper content and 0.04 inch minimum thickness unless otherwise indicated. Include G90 hot dip galvanized, mill phosphatized finish for painting if indicated.

C. Elastic membrane sheet to meet ASTM D 4068, flexible, chlorinated polyethylene, 40 mil minimum thickness.

D. Fasteners to be metal compatible with material and substrate being fastened.

E. Metal accessories to be sheet metal strips, clamps, anchoring devices and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder to meet ASTM B 32, lead free alloy.

PART 3 - EXECUTION

3.01 Installation

A. Install roof drains at low points of roof areas according to the roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
C. Install through penetration fire stop assemblies in plastic conductors at concrete floor penetrations.
D. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.02 Connections
A. Meet the requirements for piping specified in Section 15160. Contract Drawings indicate general arrangement of piping, fittings and specialties.

3.03 Flashing Installation
A. Fabricate flashing from single piece of metal unless large pans, sumps or other drainage shapes are required. Join flashing according to the following if required:
   1. Solder joints of copper sheets.
B. Install sheet flashing on pipes, sleeves and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe flashing to be sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
   2. Sleeve flashing to be flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded specialty flashing to be flat sheet, with skirt or flange extending at least 8 inches around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Fabricate and install flashing and pans, sumps and other drainage shapes.

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

END OF SECTION
THIS PAGE NOT USED
SECTION 15183

DUCT INSULATION

PART 1 - GENERAL

1.01 Description
A. This Section covers the requirements of the following equipment to be furnished under this contract:
   1. Duct insulation.

1.02 Submittals
A. Submit product data in the form of manufacturers catalog literature for each product required.
B. Submit shop drawings containing the list of wording, symbols, letter size and color coding for mechanical identification.
C. Submit installation instructions and special procedures for installation.
D. Certify products meet or exceed specified requirements.
E. Record actual locations of tagged equipment; include tag numbers.

1.03 Quality Assurance
A. Meet NFPA 99 requirements for labeling and identification.
B. Maintain one (1) copy of each document on site.
C. Meet the applicable provisions of the most recent issues of the following references:
   1. American Society of Mechanical Engineers (ASME).


1.04 Qualifications
A. Company specializing in manufacturing products specified in this Section.
B. Company specializing in performing work of this Section.

PART 2 - PRODUCTS

2.01 Manufactures
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ductwork insulation:
      a. Certaineed.
      b. Schuller (Manville).
      c. Owens Corning.
      d. Or Approved Equal.

2.02 Equipment Insulation
A. Insulation for Equipment:
   1. Fire hazard classification:
      a. UL 723, ASTM E 84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 100.
   2. Provide minimum insulation thickness conforming to schedules or as shown on the Contract Drawings.

2.03 Ductwork Insulation
A. All ductwork insulation to be fiberglass.
B. Flexible Insulation:
   1. Scheduled thickness to be Schuller (Manville) Microlite or approved equal.
   2. Factory applied foil scrim vapor barrier facing.
   3. Average thermal conductivity not to exceed 0.27 (Btu-IN)/(HR-FT2-°F) at a mean temperature of 75°F (installed).
4. Minimum density to be 0.75 LB/CF.

5. Fire hazard classification:
   a. UL 723, ASTM E 84, NFPA 255.
   b. Flame spread not exceeding 25 and smoke developed not exceeding 100.

C. Semi-Rigid Insulation for Indoor Installation:
   1. Scheduled thickness to be Schuller (Manville) #814 SPIN-GLASS or approved equal.
   2. Factory applied vapor barrier facing white scrim foil.
   3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT2-°F) at a mean temperature of 75°F.
   4. Minimum density to be 3.0 LB/CF.
   5. Moisture adsorption:
      a. ASTM C 553.
      b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120°F and 96 percent relative humidity.

D. Semi-Rigid Insulation for Outdoor Installation:
   1. Surface with scheduled thickness of Schuller (Manville) 800 Series SPIN-GLASS #815 or approved equal.
   2. Factory applied foil scrim vapor barrier facing.
   3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT2-°F) at mean temperature of 75°F.
   4. Minimum density to be 3 LBS/CF.
   5. Fungi and bacteria resistance:
      a. ASTM C 665.
      b. Does not breed or promote growth.

E. Provide minimum insulation thickness conforming to schedule or as shown on the Contract Drawings.

F. Duct Interior Lining Board:
   1. Minimum noise reduction coefficients (NRC) is 0.45 when tested in accordance with ASTM C 423 on ASTM F 25/F 25M mounting.
   2. Fire Hazard Classification:
      a. UL 723, ASTM E 84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 100.
   3. Service Temperature:
      a. ASTM C 411.
      b. Cooling and heating ducts up to 200°F.
   4. Velocity Rating:
      a. ASTM C 1071.
      b. Maximum average air velocity is rated at 600 feet per minute.
5. Moisture Adsorption:
   a. ASTM C 553.
   b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120°F and 96 percent relative humidity.

6. Fungi and Bacteria Resistance:
   a. ASTM C 665.
   b. Does not breed or promote growth.

7. Size and Performance:
   a. ASTM C 518 and ASTM C 177.
   b. 1 inch thickness, long textile glass type fibers firmly bonded by thermosetting resin.
   c. At 75°F mean temperature, the k value, expressed as (Btu-IN)/(HR-FT2°F) does not exceed 0.27.

PART 3 - EXECUTION

3.01 Installation
   A. Install products in accordance with the manufacturer’s instructions.
   B. General:
      1. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
      2. Consider ductwork, piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.
         a. Consider ductwork, piping and equipment above ceilings as concealed.
      3. Provide release for insulation application after installation and testing is complete.
         a. Apply insulation on clean, dry surfaces after inspection.
      4. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
      5. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
         a. Provide vapor barrier (0.17 perm-inch; ASTM C 553) continuous and unbroken.
         b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.
      6. Apply specified adhesive, mastics and coatings at the manufacturer’s recommended coverage per unit volume.
   C. Install equipment per the manufacturer’s instructions.
   D. Ductwork Insulation:
      1. Flexible Insulation:
         a. Butt edges tightly.
            1) Secure insulation with Benjamin Foster 85-20 adhesive or approved equal applied in 6 inch strips on 12 inch centers and/or pins, applied on not more than 18 inch centers so that the insulation conforms to the duct surfaces uniformly and firmly.
b. Seal joints with facing overlap or 4 inch wide strips of like facing material adhered and stapled in place.
c. Properly seal any penetration in vapor barrier facing with Benjamin Foster 85-20 adhesive or approved equal.
d. Cut insulation slightly longer than the perimeter of the duct to ensure full thickness at corners.

2. Semi-Rigid Insulation and Duct Interior Lining Board:
   a. Impaling over pins.
      1) Apply insulation with edges butted.
      2) Apply insulation with mechanically welded fasteners to the duct and secured with speed clips.
      3) Clip pins off close to clip.
      4) Space pins as required to hold insulation firmly against duct surface but not less than one (1) pin per 1.5 square feet.
      5) Seal joints and speed clips with 3 inch wide strip of facing adhered with Benjamin Foster 85-20 adhesive or approved equal.
   b. If the welded pin method is impossible, secure insulation to the duct with Benjamin Foster 85-20 adhesive or approved equal.
      1) Cover the entire surface of duct with adhesive.
      2) Use corner metal angle to protect edge of insulation.
      3) Protect edge of insulation.
      4) Seal joints as above.

E. Install interior duct lining board as indicated above.
   1. Overall length shall be as indicated on the Contract Drawings or a minimum of 10 linear feet past any type of air supply fan.

3.02 Repair
   A. Whenever any factory applied insulation or job applied insulation is removed or damaged, replace with the same quality or material and workmanship.

3.03 Schedules
   A. Ductwork:
      1. Fiberglass.
### Table 15183 – Fiberglass Ductwork Locations and Insulation Requirements

<table>
<thead>
<tr>
<th>Duct Service</th>
<th>Insulation and Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside air and supply air downstream of heat recovery units, outside building</td>
<td>2 inch semi-rigid for outdoor installation</td>
</tr>
<tr>
<td>Outside air ducts, inside building</td>
<td>1 1/2 inch semi-rigid with vapor barrier</td>
</tr>
<tr>
<td>Supply air ducts, inside building</td>
<td>1 inch flexible with vapor barrier</td>
</tr>
<tr>
<td>Exhaust air ducts upstream of heat recovery units, inside building</td>
<td>1 1/2 inch semi-rigid</td>
</tr>
<tr>
<td>Exhaust air ducts upstream of heat recovery units, outside building</td>
<td>1 1/2 inch semi-rigid for outdoor installation</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 15184

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 Description

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

B. This Section includes refrigerant piping used for air conditioning applications.

C. Line test pressure for refrigerant R-134a.
   1. Suction lines for air conditioning applications to be 115 psig.
   2. Suction lines for heat pump applications to be 225 psig.
   3. Hot gas and liquid lines to be 225 psig.

D. Line test pressure for refrigerant R-410A.
   1. Suction lines for air conditioning applications to be 300 psig.
   2. Suction lines for heat pump applications to be 535 psig.
   3. Hot gas and liquid lines to be 535 psig.

1.02 Related Sections

A. Section 15060 - Hangers and Supports

B. Section 15075 - Mechanical Identification

C. Section 15120 - Sleeves and Sleeves Seals

1.03 Submittals

A. Submit product data for each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure regulating valves.

B. Submit shop drawings showing layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop drawing scale to be 1/4 inch equals 1 foot.
2. Refrigerant piping indicated on Contract Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Submit welding certificates.
D. Submit field quality control test reports.
E. Submit operation and maintenance data for refrigerant valves and piping specialties to include in maintenance manuals.

1.04 Quality Assurance
A. Qualify welding procedures and personnel according to applicable ASME Boiler and Pressure Vessel Code.
B. Meet the applicable provisions of the most recent issues of the following references:
   1. ARI 760, Performance Rating of Solenoid Valves for Use with Volatile Refrigerants.
   3. ASHRAE 34, Designation and Safety Classification of Refrigerants.
   10. AWS A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   11. Copper Development Association (CDA).
   12. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   13. UL 429, Electrically Operated Valves.

1.05 Product Storage and Handling
A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.06 Coordination
A. Coordinate size and location of roof curbs, equipment supports and roof penetrations.

PART 2 - PRODUCTS
2.01 Copper Tube and Fittings
A. Copper tube to meet ASTM B 88, Type K or L ASTM B 280, Type ACR.
B. Wrought copper fittings to meet ASME B16.22.
C. Wrought copper unions to meet ASME B16.22.
D. Solder filler metals to meet ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
E. Brazing filler metals to meet AWS A5.8.
F. Flexible Connectors:
   1. Body to be tin bronze bellows with woven, flexible, tinned bronze wire reinforced protective jacket.
   2. End connections to be socket ends.
   3. Offset performance to be capable of minimum 3/4 inch misalignment in minimum 7 inch long assembly.
   4. Pressure rating to be factory tested at minimum 500 psig.
   5. Maximum operating temperature to be 250°F.

2.02 Valves and Specialties
A. Service Valves:
   1. Body to be forged brass with brass cap including key end to remove core.
   2. Core to be removable ball type check valve with stainless steel spring.
   3. Seat to be polytetrafluoroethylene.
   4. End connections copper spring.
   5. Working pressure rating to be 500 psig.

B. Solenoid Valves:
   1. Meet ARI 760 and UL 429; listed and labeled by an NRTL.
   2. Body and bonnet to be plated steel.
   3. Solenoid tube, plunger, closing spring and seat orifice to be stainless steel.
   4. Seat to be polytetrafluoroethylene.
   5. End connections to be threaded.
   6. Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2 inch conduit adapter, and 208 VAC coil.
   7. Working pressure rating to be 400 psig.
   8. Maximum operating temperature to be 240°F.

C. Safety Relief Valves:
1. Meet ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Body and bonnet to be ductile iron and steel, with neoprene O-ring seal.
3. Piston, closing spring and seat insert to be stainless steel.
4. Seat disc to be polytetrafluoroethylene.
5. End connections to be threaded.
6. Working pressure rating to be 400 psig.
7. Maximum operating temperature to be 240°F.

2.03 Refrigerants
A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Atofina Chemicals, Inc.
   2. DuPont Company; Fluorochemicals Div.
   3. Honeywell, Inc.; Genetron Refrigerants.
   4. INEOS Fluor Americas LLC.
B. Meet ASHRAE 34, R-134a Tetrafluoroethane.
C. Meet ASHRAE 34, R-410A Pentafluoroethane/Difluoromethane

PART 3 - EXECUTION

3.01 Piping Applications for Refrigerant R-134a
A. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR, annealed temper tubing and wrought copper fittings with brazed or soldered joints.
B. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR K L, drawn temper tubing and wrought copper fittings with soldered joints.
C. Safety relief valve discharge piping to be copper, Type ACR K L, drawn temper tubing and wrought copper fittings with soldered joints.
D. Safety Relief Valve Discharge Piping:
   1. NPS 1 1/2 and smaller to be copper, Type ACR, annealed temper tubing and wrought copper fittings with brazed or soldered joints.
   2. NPS 1 1/2 and smaller to be copper, Type ACR L, drawn temper tubing and wrought copper fittings with brazed or soldered joints.

3.02 Piping Applications for Refrigerant R-410A
A. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR L, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.
B. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

C. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR K L, drawn temper tubing and wrought copper fittings with 95-5 tin antimony soldered joints.

D. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR K L, drawn temper tubing and wrought copper fittings with Alloy HB soldered joints.

E. Hot gas and liquid lines, and suction lines for heat pump applications:
   1. NPS 5/8 and smaller to be copper, Type ACR K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.
   2. NPS 3/4 to NPS 1 to be copper, Type K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.
   3. NPS 1 1/4 and smaller to be copper, Type ACR K, drawn temper tubing and wrought copper fittings with 95-5 tin antimony soldered joints.
   4. NPS 1 1/2 to NPS 2 to be copper, Type ACR K, drawn temper tubing and wrought copper fittings with Alloy HB soldered joints.

F. Safety relief valve discharge piping to be copper, Type K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

G. Safety Relief Valve Discharge Piping:
   1. NPS 5/8 and smaller to be copper, Type ACR K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.
   2. NPS 3/4 to NPS 1 and smaller to be copper, Type K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.
   3. NPS 1 1/4 and smaller to be copper, Type ACR K, drawn temper tubing and wrought copper fittings with 95-5 tin antimony soldered joints.
   4. NPS 1 1/2 to NPS 2 to be copper, Type ACR K, drawn temper tubing and wrought copper fittings with Alloy HB soldered joints.

3.03 Valve and Specialty Applications

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety relief valve discharge line to outside according to ASHRAE 15.
F. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

G. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot gas bypass valves.
   4. Compressor.

H. Install receivers sized to accommodate pump down charge.

I. Install flexible connectors at compressors.

3.04 Piping Installation

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on shop drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels, if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:
1. Install horizontal hot gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Section 15075.

R. Install sleeves for piping penetrations of walls, ceilings and floors. Meet the requirements for sleeves specified in Section 15120.

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Meet the requirements for sleeve seals specified in Section 15120.

T. Install escutcheons for piping penetrations of walls, ceilings and floors. Meet the requirements for escutcheons as per applicable codes.

3.05 Pipe Joint Construction

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Construct soldered joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Construct brazed joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

   1. Use Type BcuP, copper phosphorus alloy for joining copper socket fittings with copper pipe.

3.06 Hangers and Supports

A. Hanger, support, and anchor products are specified in Section 15060.

B. Install the following pipe attachments:

   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Copper clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

   1. NPS 1/2 to have a maximum span, 60 inches; minimum rod size, 3/8 inch.
2. NPS 5/8 to have a maximum span, 60 inches; minimum rod size, 3/8 inch.
3. NPS 1 to have a maximum span, 72 inches; minimum rod size, 3/8 inch.
4. NPS 1 1/4 to have a maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1 1/2 to have a maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2 to have a maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2 1/2 to have a maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3 to have a maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4 to have a maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 2 to have a maximum span, 10 feet; minimum rod size, 3/8 inch.
   2. NPS 2 1/2 to have a maximum span, 11 feet; minimum rod size, 3/8 inch.
   3. NPS 3 to have a maximum span, 12 feet; minimum rod size, 3/8 inch.
   4. NPS 4 to have a maximum span, 14 feet; minimum rod size, 1/2 inch.

E. Support multi-floor vertical runs at least at each floor.

3.07 Field Quality Control

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Meet ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high and low-pressure side piping of each system separately at not less than the pressures indicated in Article 1.01.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.08 System Charging

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for twelve (12) hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter dryer core in charging line.
3.09 Adjusting

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set point temperature of air conditioning or chilled water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to the manufacturer’s written instructions:
   1. Verify that compressor oil level is correct.
   2. Open compressor suction and discharge valves.
   3. Open refrigerant valves except bypass valves that are used for other purposes.
   4. Check open compressor motor alignment and verify lubrication for motors and bearings.

END OF SECTION
THIS PAGE NOT USED
SECTION 15412

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 Description
   A. Section includes:
      1. Eyewash equipment.

1.02 Related Sections
   A. The Contract Drawings and general provisions of the Contract, including General and
      Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. Section 15075 – Mechanical Identification

1.03 Submittals
   A. Submit product data for each type of product indicated. Include flow rates and capacities,
      furnished specialties and accessories.
   B. Submit shop drawings including diagram power, signal and control wiring.
   C. Submit product certificates of performance testing specified in Article 2.02 in this Section.
   D. Submit field quality control test reports.
   E. Submit operation and maintenance data for emergency plumbing fixtures to include in
      operation and maintenance manuals.
   F. Furnish extra materials that match products installed and that are packaged with protective
      covering for storage and identified with labels describing contents.
      1. Provide a separate lot of flushing fluid solution equal to at least 200 percent of amount
         of solution installed for each self-contained unit.

1.04 Quality Assurance
   A. Electrical components, devices and accessories to be listed and labeled as defined in NFPA
      70, by a qualified testing agency, and marked for intended location and application.
   B. Meet the applicable provisions of the most recent issues of the following references:
      1. ANSI Z358.1, Emergency Eyewash and Shower Equipment.
      4. NFPA 70, National Electrical Code (NEC).
1.05 Definitions
A. Accessible Fixture is an emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
B. Self-Contained Emergency Plumbing Fixture is a fixture with flushing fluid solution supply.

1.06 Maintenance Material Submittals
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushing Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.01 Eyewash Equipment
A. Standard, Self-Contained Eyewash Units:
   1. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:
      a. Fend-all.
      b. Or Approved Equal.
   2. Capacity to be not less than 0.4 gallons per minute for at least fifteen (15) minutes.
   3. Gravity tank to be 7 gallon, plastic and suitable for shelf mounting.
   4. Flushing fluid to be medically acceptable solution manufactured and labeled according to applicable regulations.
   5. Actuator to be pull down front panel.
   6. Spray heads to be protected, two (2) mounted on tank.

2.02 Source Quality Control
A. Certify performance of emergency plumbing fixtures by an independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.01 Examination
A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Identification
A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water tempering equipment. Meet the requirements for identification materials specified in Section 15075.
3.03 Field Quality Control

A. After plumbing connections have been made, test for compliance with requirements for mechanical component testing. Verify ability to achieve indicated capacities.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. After electrical circuitry has been energized, start units to confirm proper unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.04 Adjusting

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION
SECTION 15700

HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements of heating, ventilating and air conditioning equipment and associated elements.

B. Air conditioning, heating and ventilation systems for switchgear area, battery room and communication room shall have the capacity to operate under the following conditions:

1. Outside Temperature:
   a. Summer dry bulb to be 104°F and wet bulb to be 78°F.
   b. Winter dry bulb to be minus 10°F.

2. Inside Temperature:
   a. Switchgear Area:
      1) Summer dry bulb to be 80°F.
      2) Winter dry bulb to be 68°F.
   b. Battery Room:
      1) Summer dry bulb to be 80°F.
      2) Winter dry bulb to be 68°F.
   c. Communications Room:
      1) Summer dry bulb to be 80°F.
      2) Winter dry bulb to be 68°F.

1.02 Submittals

A. Submit product data for the following equipment:
   1. Split system air conditioning units.
   2. Exhaust fans.
   3. Propeller unit heaters.
   4. Energy recovery ventilators.

1.03 Quality Assurance

A. Electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Meet the applicable provisions of the most recent issues of the following references:
   2. AMCA 204, Balance Quality and Vibration Levels for Fans.
4. ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI Approved).
5. ASHRAE 62.1, Ventilation for Acceptable Indoor Air Quality (ANSI Approved).
8. ISO 9001, Quality Management Systems - Requirements.
9. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
10. NEMA MG 1, Motors and Generators.
11. NFPA 70, National Electrical Code (NEC).
13. UL 705, Power Ventilators.
14. UL 823, Electric Heaters for Use in Hazardous (Classified) Locations.
15. UL 2021, Fixed and Location-Dedicated Electric Room Heaters.

1.04 Operation and Maintenance Data

A. The manufacturers of the products specified herein shall include complete instructions with their products giving directions for replacing renewable parts of their products as well as instructions for cleaning the finished surfaces of such products.

PART 2 - PRODUCTS

2.01 Indoor Units

A. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:
   1. Friedrich.
   3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
   4. Or Approved Equal.

B. Wall Mounted, Evaporator Fan Components:
   1. Cabinet to be enameled steel with removable panels on front and ends in color selected by SEPTA and discharge drain pans with drain connection.
   2. Refrigerant coil to be copper tube, with mechanically bonded aluminum fins and thermal expansion valve to meet ARI 210/240.
   3. Electric coil to be helical nickel chrome, resistance wire heating elements; with refractory ceramic support bushings, automatic reset thermal cutout, built-in magnetic contactors, manual reset thermal cutout, airflow proving device and one (1) time fuses in thermal box for overcurrent protection.
4. Fans to be direct drive, centrifugal.

5. Fan Motors:
   a. Meet NEMA designation, temperature rating, service factor, enclosure type and efficiency requirements specified in Division 15 Sections.
   b. Multitaped, multispeed with internal thermal protection and permanent lubrication.
   c. Enclosure type to be total enclosed, fan cooled.
   d. NEMA Premium ™ efficient motors as defined in NEMA MG 1.
   e. Controllers, electrical devices, and wiring to meet the requirements for electrical devices and connections specified in Division 16 Sections.
   f. Mount unit mounted disconnect switches on exterior of units.

6. Surfaces in contact with the airstream to meet the requirements in ASHRAE 62.1.

7. Condensate Drain Pans:
   a. Fabricated with 1 percent slope in at least two (2) planes to collect condensate from cooling coils (including coil piping connections, coil headers and return bends) and humidifiers, and to direct water toward drain connection.
      1) Extend drain pan downstream from leaving face to meet ASHRAE 62.1.
   b. Single wall, stainless steel sheet.
   c. Drain connection to be located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
   d. Pan top surface coating to be asphaltic waterproofing compound.

8. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Meet NFPA 90A.
      2) Minimum arrestance and MERV to meet ASHRAE 52.2.
      3) Filter holding frames to be arranged for flat orientation, with access on both sides of unit. Filters shall be removable from one (1) side or lifted out.

9. Disposable Panel Filters:
   1) Factory fabricated, viscous coated, flat panel type.
   2) Thickness to be 1 inch.
   3) Merv 5 according to ASHRAE 52.2.
   4) Media to be interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
   5) Frame to be flame resistant cardboard.

2.02 Outdoor Units

A. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:
   1. Friedrich.
   3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
   4. Or Approved Equal.
B. Air Cooled, Compressor Condenser Components:

1. Casing to be steel, finished with baked enamel in color selected by SEPTA, with removable panels for access to controls, weep holes for water drainage and mounting holes in base. Provide brass service valves, fittings and gage ports on exterior of casing.

2. Compressor to be hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal and current sensitive overload devices, start capacitor, relay and contactor.
   a. Compressor to be scroll type.
   b. Two (2) speed compressor motor with manual reset high pressure switch and automatic reset low pressure switch.
   c. LEED Credit EA 4 awards a single point if all HVAC&R equipment has HCFC free refrigerants. R-407C and R-410A are HCFC-free refrigerants.
   d. Refrigerant charge to be R-407C or R-410A.
   e. Refrigerant coil to be copper tube, with mechanically bonded aluminum fins and liquid sub-cooler to meet ARI 210/240.

3. Heat pumps to have reversing valve and low temperature air cutoff thermostat.

4. Fans to be aluminum propeller type, directly connected to motor.

5. Motor to be permanently lubricated, with integral thermal overload protection.

6. The low ambient kit permits cooling operation down to 15°F.

2.03 Accessories

A. Thermostat to be wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. Twenty-four (24) hour time control of system stop and start.
3. Liquid crystal display indicating temperature, set point temperature, time setting, operating mode and fan speed.
4. Fan speed selection including auto setting.

B. Automatic reset timer to prevent rapid cycling of compressor.

C. Refrigerant line kits to be soft annealed copper suction and liquid lines factory cleaned, dried, pressurized and sealed; factory insulated suction line with flared fittings at both ends.

D. Provide drain hose for condensate.

E. Wiremold 4000 to enclose refrigerant and condensate piping where exposed to view in normally occupied spaces.

2.04 Louvered Exhaust Fan

A. Description:

1. Fan shall be wall mounted, belt or direct driven, propeller exhaust fan.

B. Certifications:
1. Fan shall be listed by Underwriters Laboratories UL 705.

C. Construction:
   1. The fan shall be of bolted construction utilizing corrosion resistant fasteners.
   2. The motor, bearings and drives shall be mounted on a welded tubular steel power assembly.
   3. The power assembly shall be rigidly secured to the fan housing.
   4. The fan housing shall include a minimum 14 gauge base with integral spun venture and continuously welded curb cap corners.
   5. Unit shall bear an engraved aluminum nameplate.
   6. Nameplate shall indicate design CFM, static pressure and maximum fan RPM.

D. Coating:
   1. All un-galvanized steel fan components shall have an electrostatically applied, baked polyester powder coating.
   2. Paint must exceed one thousand (1,000) hour salt spray under ASTM B 117 test method.

E. Propeller:
   1. Propeller shall be extruded aluminum airfoil design with cast aluminum hub.
   2. The blade pitch shall be factory set and locked using set screws and roll pin.
   3. The hub shall be keyed and securely attached to the shaft utilizing two (2) set screws or a taper lock bushing.
   4. Propeller shall be balanced in accordance with AMCA 204.

F. Motor:
   1. Motor shall be heavy duty type with permanently lubricated sealed ball bearing and furnished at the specified voltage, phase and enclosure.

G. Bearings:
   1. Bearings shall be designed and individually tested specifically for use in air handling applications.
   2. Construction shall be heavy duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of two hundred thousand (200,000) hours at maximum cataloged operating speed.

H. Belts and Drives:
   1. Belts shall be oil and heat resistant, non-static type.
   2. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.
   3. Drives shall be sized for 150 percent of the installed motor horsepower.
   4. The variable pitch motor must be factory set to the specified RPM.

I. Capacity:
1. As scheduled.

2.05 Fan Forced Wall Heaters

A. Meet UL 2021 and UL 823.

B. Subject to compliance with the requirements, provide products by one (1) of the following manufacturers:
   1. Qmark.
   4. Or Approved Equal.

C. Description:
   1. Assembly including casting, coil, fan and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.

D. Housing:
   1. Finish shall be baked enamel.
   2. Airstream surface in contact with the airstream shall meet the requirements in ASHRAE 62.1.
   3. Louver shall be adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

E. Electrical Resistance Heating Coil:
   1. Nickel chromium heating wire, free from expansion noise and 60 Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion resistant metallic sheath with fins no closer than 0.16 inch.
   2. Element end shall be enclosed in terminal box.
   3. Fin surface temperature shall not exceed 550° F at any point during normal operation.

F. Fan and Motor:
   1. Fan to be propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
   2. Motor to be permanently lubricated, multi-speed.

G. Controls:
   1. Wall mounted thermostat.

H. Size and capacity as scheduled on the Contract Drawings.

2.06 Energy Recovery Ventilators

A. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:
   1. Greenheck, Inc.
2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. Vemar CES Inc.
4. Or Approved Equal.

B. Surfaces in contact with the airstream to meet requirements in ASHRAE 62.1.

C. Housing to be the manufacturer’s standard construction with corrosion protection coating and exterior finish, hinged access door or removable panels, with neoprene gaskets or inspection and access to internal parts, minimum 1 inch thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection and lifting lugs.

D. Enthalpy wheel certified to AHRI 1060.

E. Supply and exhaust fans to be forward curved, centrifugal.
   1. Motor and drive to be direct driven or belt driven with adjustable sheaves, motor mounted on adjustable base.
   2. Motor sizes to be as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Disposable Panel Filters:
   1. Meet NFPA 90 A.
   2. Filter holding frames to be arranged for flat or any orientation, with access doors on both sides of unit. Filters shall be removable from one (1) side or lift out from access plenum.
   3. Factory fabricated, viscous coated, flat panel type.
   4. Thickness to be 1 inch.
   5. Minimum arrestance to be 80, according to ASHRAE 52.2.
   6. Minimum Merv 5, according to ASHRAE 52.2.
   7. Media to be interlaced glass fibers sprayed with nonflammable adhesive.

G. Fabricated units to have space within housing for piping and electrical conduits. Wire motors and controls are only external connections are required during installation.
   1. Indoor enclosure to be NEMA 250, Type 12 enclosure contains relays, starters and terminal strip.
   2. Include non-fused disconnect switches.

H. Accessories:
   1. Isolation dampers to be opposed blade, galvanized steel, aluminum or extruded aluminum dampers with cadmium plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized steel, aluminum or extruded aluminum frame with operating rods connected with a common linkage and electric damper operator factory wired. Blades shall have gaskets and edge seals, and shall be mechanically fastened to operating rod.
   2. Duct flanges.
3. Rubber-in-shear isolator for ceiling mounted units.

PART 3 - EXECUTION

3.01 Examination
A. Examine areas and conditions, with the installer present, for compliance with requirements for installation tolerance and other conditions affecting performance of the work.
B. Examine casting insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged or mold damaged.
C. Examine roughing-in for electrical services to verify actual locations of connection before installation.
D. Proceed with installation only after unsatisfactory conditions has been corrected.

3.02 Installation
A. Install units level and plumb.
B. Install evaporator fan components using the manufacturer's standard mounting devices securely fastened to building structure.
C. Install compressor condenser components on equipment supports. Anchor unit to supports with removable, cadmium plated fasteners.
D. Install and connect pre-charged refrigerant tubing to component's quick connect fittings. Install tubing to allow access to unit.
E. Suspend units from structural steel support frame using threaded steel rods and spring hangers.
F. Install units with clearances for service and maintenance.
G. Install new filters at completion of equipment installation and before testing, adjusting and balancing.
H. Pipe drains from drain pans to the nearest floor drain using ASTM B 88, Type L, drawing temper copper water tubing with soldered joints, same size as condensate drain connections.

3.03 Connections
A. Where piping is installed adjacent to unit, allow space for service and maintenance of units.

3.04 Field Quality Control
A. Engaged a factory authorized service representative to inspect, test and adjacent components, assemblies and equipment installations, including connections.
B. Perform Tests and Inspections:
   1. Engage a factory authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
C. Tests and Inspections:
   1. After installation, charge system and test for leaks. Repair leaks and retest units until no leaks exist.
   2. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Remove and replace malfunctioning units and retest as specified above.
E. Prepare test and inspection reports.
F. Connect piping to units mounted on vibration isolators with flexible connectors.
G. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

3.05 Equipment Start-Up
A. Engage a factory authorized service representative to perform startup service.
   1. Complete installation and startup checks according to the manufacturer's written instructions.
B. The Contractor shall provide factory supervision for his start-up of equipment. Factory supervision shall include inspection of the equipment and refrigeration system prior to the start-up.
C. The Contractor shall perform equipment start-up and insure its proper operation prior to acceptance of work.

3.06 Demonstration
A. Engage a factory authorized service representative to train SEPTA maintenance personnel to adjust, operate and maintain units.

END OF SECTION
SECTION 15890

HVAC DUCTWORK

PART 1 - GENERAL

1.01 Description
A. This Section covers the requirements of the following equipment to be furnished under this contract:
   1. Ductwork and associated equipment.

1.02 Submittals
A. Submit product data in the form of manufacturers catalog literature for each product required.
B. Submit shop drawings containing the list of wording, symbols, letter size and color coding for equipment.
C. Submit installation instructions and special procedures for installation.
D. Certify products meet or exceed specified requirements.

1.03 Quality Assurance
A. Maintain one (1) copy of each document on site.
B. Meet the applicable provisions of the most recent issues of the following references:
   1. American Society of Mechanical Engineers (ASME).
   3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.04 Qualifications
A. Company specializing in manufacturing products specified in this Section.
B. Company specializing in performing work of the Section.

PART 2 - PRODUCTS

2.01 Manufactures
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Transverse Joints (Factory Fabricated Aluminum):
      a. Ductmate Industries, Inc.
      b. Or approved Equal.
   2. Fiberglass Ductwork:
      a. Peabody Spunstrand.
b. Ceilcote.
c. Or Approved Equal.

3. Flexible Ducts:
   a. Thermaflex.
   b. Condu-flex.
   c. Glass-flex.
   d. Or Approved Equal.

4. Turning Vanes:
   a. Barber-Colman.
   b. Titus.
   c. Tuttle and Bailey.
   d. Or Approved Equal.

5. Flexible Duct Connections:
   a. Vent Fabrics.
   b. American Warming.
   c. Or Approved Equal.

6. Flexible Connector Thrust Restraint:
   a. Mason WB.
   b. Or Approved Equal.

7. Access Doors in Ductwork:
   a. Vent Fabrics.
   b. American Warming.
   c. Or Approved Equal.

8. Ceiling Diffusers:
   a. Anemostat.
   b. Carnes.
   c. Titus.
   d. Or Approved Equal.

9. Grilles and Registers:
   a. Anemostat.
   b. Carnes.
   c. Titus.
   d. Or Approved Equal.

10. Air Filters:
    b. Farr.
    c. Continental.
    d. Or Approved Equal.

11. Manual (Volume) Dampers:
    a. Air Balance.
b. Ruskin.
c. American Warming.
d. Or Approved Equal.

12. Duct Sealers:
   a. Chicago Mastic.
   b. 3M Co.
   c. Permatex.
   d. Benjamin Foster.
   e. Or Approved Equal.

13. Temperature Control and Automatic Dampers:
   a. Air Balance.
   b. Ruskin.
   c. American Warming.
   d. Or Approved Equal.

14. Louvers:
   a. Ruskin.
   b. Air Balance.
   c. American Warming.
   d. Or Approved Equal.

2.02 Components

A. Duct and Fittings (Metallic):
   1. Materials to be 3003 H-14 aluminum alloy.

   2. Fabrication:
      a. Minimum sheet material thickness:
         1) Ducts with largest side or diameter to 30 inches to be 0.05 Inches thick.
         2) Ducts with largest side or diameter greater than 30 inches to be 0.08 inches thick.
      b. Utilize SMACNA HVAC Duct Construction Standards for minimum of 2 inch water gauge static
         pressure for the minimum sheet material thickness specified herein.
         1) Heavier gauge sheet material may be used with associated reinforcement as an
            alternate to minimum thickness specified.
         2) Lighter gauge sheet material with associated reinforcement shall not be used as an
            alternate to minimum thickness specified.
      c. Continuously weld seams on factory assembled units.
      d. Transverse joints (Alternate A):
         1) SMACNA T-22 companion flange.
         2) Gasketed.
         3) Rigidity class:
            a) Ducts with largest side or diameter to 30 inches to be SMACNA Class H (2 1/2 inch x
               2 1/2 inch x 3/16 inch angles).
      e. Transverse joints (Alternate B):
         1) Materials and fabrication:
a) Angles to be aluminum.
   i. Ductmate 35 or approved equal.

b) Corners to be aluminum.
   i. Ductmate DC 35 or approved equal.

c) Snap cleats to be aluminized or stainless steel.

d) Gaskets to be closed cell neoprene.

e) Bolts to be stainless steel.

f) Sheet metal screws to be self-drilling stainless steel with unthreaded section under head.

2) Fabrication:
   a) Rigidity class to be SMACNA Class H.
   b) 3/8 inch diameter x 1 inch bolts.

B. Supports and Hangers:

1. Materials:
   a. Support angles to be stainless steel.
   b. Hanger rods to be stainless steel.
   c. Anchors to be stainless steel wedge type.

2. Fabrication
   a. Trapeze type units.

C. Turning Vanes:

1. Materials to be same as duct.

2. Fabrication:
   a. Fabricate double vane units.
   b. Pressure drop through elbows to be a maximum 20 percent of velocity pressure.

D. Flexible Connections:


2. Fabrication to withstand 4.5 inch water column, positive and negative pressure.

E. Access Doors:

1. Materials:
   a. Inner panel, out panel and frame to be same as duct.
   b. Gaskets to be closed cell neoprene.
   c. Insulation to be 1 pound density fiberglass.
   d. Hinges to be stainless steel.
   e. Latches:
      1) Aluminum zinc alloy.
      2) Outside lever handle.
      3) Adjustable spacer.
      4) Beveled inside flange.
      5) Studs:
         a) Minimum 3/8 inch diameter stud for doors up to 24 inches wide x 48 inches high.
b) Minimum 1/2 inch diameter stud for doors larger than 24 inches x 48 inches.

2. Fabrication:
   a. Provide four (4) side continuous gaskets.
   b. Utilize continuous piano hinges.
   c. Latches required.
      1) One (1) 12 inches in any direction.
      2) Two (2) up to 18 inches x 18 inches.
      3) Two (2) with inside handles up to 24 inches x 48 inches.
      4) Three (2) with inside handles up to 24 inches x 72 inches.
      5) Minimum door size to be 12 inches x 12 inches.

F. Diffusers:
   1. Materials:
      a. Body to be extruded aluminum.
      b. Ceiling diffuser gaskets to be sponge rubber.
   2. Fabrication:
      a. Round or rectangular with removable core.
      b. Key operated opposed blade damper mounted in neck except where indicated on the Contract Drawings to be omitted.
      c. Finish:
         1) Aluminum.

G. Volume Dampers and Flow Equalizers for Round Neck Diffusers:
   1. Material to be aluminum.
   2. Fabrication:
      a. Design for neck velocity of 2500 feet per minute.
      b. Center rod operator accessible through diffuser without removing diffuser.
      c. Furnish with screws, duct collars, transitions and air pattern deflectors as required.

H. Air Grille and Register Assembly:
   1. Materials:
      a. Assembly to be extruded aluminum.
      b. Gaskets to be sponge rubber.
   2. Fabrication:
      a. Supply registers to be two (2) sets individually adjustable louvers.
      b. Exhaust and return registers to have 45 degrees deflection front blades.
      c. Dampers to be key operated opposed blade.
      d. Screw, duct collars and transitions as required.

I. Temperature Control, Automatic and Manually (Volume) Operated Dampers:
   1. Material:
      a. Body to be 6063 T5 aluminum.
      b. Seal blade edge to be extruded vinyl.
2. Fabrication:
   a. Frame thickness to be 0.125 inches minimum.
   b. Blades:
      1) Two (2) position damper to be parallel blade.
      2) Mixing and volume damper to be opposed blade.
      3) Airfoil shape.
      4) Maximum 6 inch width.
   c. Linkage to be concealed in the frame.
   d. Axles to be 1/2 inch plated steel hex.
   e. Bearings to be molded synthetic.
   f. Seals:
      1) Jamb to be flexible compression type.
   g. Control shaft to be removable, 1/2 inch diameter.
   h. Air leakage (4 square foot damper) at 4 inch water gauge pressure to be 99 CFM maximum.
   i. Provide outboard support for operator linkage where damper motor is to be installed outside of duct.
   j. Provide stainless steel locking quadrants for manual (volume) dampers.
   k. Provide fold out operator mounting bracket where damper motor is to be installed on face of damper or inside duct.
   l. Finish to be 215 R1 anodized.

PART 3 - EXECUTION

3.01 Installation

A. Metal Ductwork:
   1. Install with longitudinal seams sealed for zero (0) leakage.
      a. Welded seams may be used upon acceptance of welded seam samples by SEPTA.
   2. Install gaskets at each transverse joint and fasten sections together with bolts.
      a. Tighten for zero (0) leakage.
   3. Install supports and hangers with anchors in accordance with SMACNA HVAC Duct Construction Standards.
   4. Install turning vanes in square elbows:
      a. Unsupported vane length not to exceed 48 inches.
      b. Position vanes at proper angle to meet specified pressure drop.
   5. Install flexible connections at fans:
      a. Locate as close as possible to fan.
      b. Allow 1 inch of slack to prevent vibration transmission.
      c. Install thrust restraints across connectors.
   6. Install access doors where indicated on the Contract Drawings and at smoke and fire damper in accordance with NFPA requirements.
   7. Volume extractors:
a. Install at supply register, grilles, diffusers and supply branch connections from ducts.
b. Provide branch duct extensions into main duct above and below extractor when branch duct is narrower than main duct.

B. Diffusers:
   1. Install where shown on the Contract Drawings of size and capacities scheduled on the Contract Drawings.
   2. Install anodized diffusers in exposed duct work.

C. Air Grille and Register Assemblies:
   1. Install where shown on the Contract Drawings of size and capacities scheduled on the Contract Drawings.
   2. Install prime painted grilles and registers in areas where duct work is concealed.
      a. Field paint to match adjacent surface finish.

END OF SECTION
SECTION 15935

BUILDING SYSTEM CONTROLS

PART 1 - GENERAL

1.01 Description
   A. This Section covers the requirements for the following items:
      1. HVAC control panels.
      2. Thermostats.
      3. Gas detection.
   B. Provide conduit and electrical wiring for complete system.

1.02 Submittals
   A. Submit shop drawings indicating operating data, system drawings, wiring diagrams and
      written detailed operational description of sequences.
   B. Submit product description and engineering data for each control system component,
      including sizing. Submit data for each system component.
   C. Record actual locations of controls including thermostats remotely located from equipment.
   D. Submit operation and maintenance data and include the following:
      1. Systems descriptions, set points, and controls settings and adjustments.
      2. Inspection period, cleaning methods, recommended cleaning materials and calibration
tolrances.
      3. Interconnection wiring diagrams of completed field installed systems with identified and
      numbered system components and devices.

1.03 Quality Assurance
   A. Products requiring electrical connection shall be listed and classified by Underwriters
      Laboratories Inc. as suitable for the purpose specified and indicated.
   B. Meet the applicable provisions of the most recent issues of the following references:
      1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      2. NEMA DC 3, Residential Controls - Electrical Wall-Mounted Room Thermostats.

1.04 Performance Requirements
   A. Furnish the manufacturer's maintenance services on control system for one (1) year from
      date of substantial completion.

PART 2 - PRODUCTS
2.01 Manufacturers
   A. Manufacturers:
      1. Honeywell Inc.
      2. Johnson Control.
      3. Siemens.
      4. Specific Systems.
      5. Or Approved Equal.

2.02 HVAC Control Panels
   A. Unitized cabinet type for each system under automatic control with relays and controls
      mounted in cabinet. Provide as required for system operation, temperature indicators,
      pressure gages, pilot lights, push buttons and switches flush on cabinet panel face.
   B. NEMA 250 general purpose utility enclosures with enameled finished face panel.
   C. Furnish common keying for every panel.
   D. Systems requiring control panels include:
      1. Ventilation Fans:
         a. Controls to include auto manual switches for each fan.
         b. Operating status indicating light.
         c. High/low speed indicating light.
         d. Power available indicating light.

2.03 Thermostats
   A. Manufacturers:
      1. Honeywell Inc.
      2. Johnson Control.
      3. Siemens.
      4. Specific Systems.
      5. Or Approved Equal.
   B. Electric Line Voltage Room Thermostats:
      1. Type to be NEMA DC 3, with setback/setup temperature control.
      2. Covers to be locking with concealed set point.

2.04 Gas Detection
   A. Gas Detection and Control System:
      1. Manufacturers:
         a. MSA.
         b. INTEC Controls.
c. Vulcan.
d. Sensidyne.
e. Or Approved Equal.

2. Gas detection control panel to be microprocessor based control panel with programmable relays.
   a. Control panel capable of receiving 0-20mA analog signals.
   b. Programmable relays as required to achieve the control sequence.
   c. Panel capable of low, medium and alarm level control conditions.
   d. LCD display with backlight.
   e. Provide alarm input into SCADA system to indicate a high hydrogen level in the battery room.

3. Hydrogen (H2):
   a. NEMA 4X sensor enclosure.
   b. Built in heater.

PART 3 - EXECUTION

3.01 Preparation
   A. Verify power supply is available to panels.
   B. Verify field end devices and wiring is installed prior to installation proceeding.

3.02 Installation
   A. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.
   B. Install panels and other hardware in position on permanent walls not subject to excessive vibration.
   C. Install thermostats and gas sensors and other exposed control sensors at locations as indicated on the Contract Drawings. Coordinate with room components before installation. Align mounting height with light switches.
   D. Install guards on all wall mounted thermostats.
   E. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
   F. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
   G. All wiring shall be installed in conduit.
   H. Refer to Division 16 specifications for wire and conduit material requirements.

END OF SECTION
SECTION 15940

SEQUENCE OF OPERATION

PART 1 - GENERAL

1.01 Description
A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation and the intended sequence are specified in this Section. Equipment, devices and system components required for control systems are specified in other Sections.
B. Section includes sequence of operation for:
   1. Electrical rooms ventilation cooling.
   2. Electric duct heater.
   3. Unit heaters.
   4. Exhaust fans.

1.02 Related Sections
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Division 16 - Electrical
C. Section 15935 - Building Systems Controls
D. Section 15950 - Testing, Adjusting and Balancing

1.03 Submittals
A. Submit shop drawings indicating mechanical system controlled and control system components.
B. Label with settings, adjustable range of control and limits.
C. Submit written description of control sequence.
D. Submit flow diagrams for each control system, graphically depicting control logic.
E. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
F. Submit project record documents recording actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Application

A. Electrical Room Ventilation:
   1. The ventilation system will operate from the control panel with an On-Auto-Off switch.
      a. On position – The fans will operate in the high speed setting.
      b. Auto position – The fans will run on low speed continuously, on rise in space temperatures above an adjustable temperature set point (adjustable) initially set to 95°F; the fan will index to high speed for the supply and exhaust fan. On a drop in temperature below the system set point, return the supply and exhaust fans to the low speed operating set point for normal electrical room ventilation.
      c. Off position – The fans will be de-energized.
   2. Indicating lights will be provided to indicate the operating status and fan speed.

B. Electric Duct Heater:
   1. An airflow switch will be provided to ensure adequate airflow prior to energizing the electric duct heater.
   2. On a drop in supply air temperature below the discharge air temperature sensor set point (adjustable); initially set to 55°F; the first stage of electric heat will energize to maintain leaving air temperature at 55°F. Upon a further drop in temperature additional stages of heat will energize as required to maintain discharge air temperature set point.
   3. A three (3) hour (minimum) override timer will be provided with a second thermostat when the override timer is actuated the space temperature will be controlled by the local space thermostat to help raise the space temperature. When the timer is over the system will return to the controlling duct discharge temperature.

C. Electric Unit Heaters:
   1. A unit mounted thermostat shall cycle the fan and electric heating element to maintain an adjustable space temperature set point (adjustable) of 55°F.

D. Exhaust Fans:
   1. Battery Room:
      a. The battery room ventilation will be activated based on hydrogen levels located within the space. The space hydrogen sensor will monitor levels and energize the fan to maintain space hydrogen levels below the set point (adjustable) initially set to 1 percent. Upon levels returning below the set point the fan will de-energize
      1) Provide indicating lights at the room entrance to indicate the fan is energized with a manual on switch to energize the fan from outside the room prior to entering the battery room.
      2) Provide a signal to the SCADA system to indicate operation of the fan and indication that the high level alarm is activated.
2. General Ventilation for Toilet room and Support Facilities:
   a. The general ventilation system will operate continuously to ventilate the associated spaces.

E. Hydrocarbon Detection:
   1. Hydrocarbon detection system will provide a means of detecting hydrocarbons in the oil stop valve basin and provide an alarm to the SCADA system to indicate the presence of oil from the transformer pad.

END OF SECTION
SECTION 15950
TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 Description
A. This Section covers the requirements for testing, adjusting and balancing HVAC systems to produce design objectives, including the following:
   1. Balancing airflow within distribution systems, including mains, branches and terminals to indicated quantities according to specified tolerances.
   2. Adjusting total HVAC systems to provide indicated quantities.
   4. Setting quantitative performance of HVAC equipment.
   5. Verifying that automatic control devices are functioning properly.
   7. Reporting results of the activities and procedures specified in this Section.

1.02 Submittals
A. Submit two (2) copies of the certified testing, adjusting and balancing reports prepared as specified in this Section on approved forms certified by the testing, adjusting and balancing agent.

1.03 Quality Assurance
A. Engage a testing, adjusting and balancing agent certified by either AABC or NEBB.
B. Certify the testing, adjusting and balancing field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting and balancing reports.
   2. Certify that the testing, adjusting and balancing team complied with the approved testing, adjusting and balancing plan and the procedures specified and referenced in this specification.
C. Use standard forms from AABC's "National Standards for Testing, Adjusting and Balancing."
D. Meet the applicable provisions of the most recent issues of the following references:
   2. Associated Air Balance Council (AABC).
   4. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
1.04 Performance Requirements

A. Coordinate the efforts of the factory authorized service representatives for systems and equipment, the HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting and balancing activities.

B. Provide seven (7) days advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.05 Warranty

A. Provide one (1) year warranty under which period the Contractor will return to site and make adjustments as required by SEPTA.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Preparation

A. Examine contract documents to become familiar with project requirements and to discover conditions in the systems designs that may preclude proper testing, adjusting and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.

2. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings and manual volume dampers are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting and commissioning specified in individual Specification Sections have been performed.

D. Examine system and equipment test reports.

E. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

F. Examine air handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight and equipment with functioning controls is ready for operation.

G. Examine equipment for installation and for properly operating safety interlocks and controls.
H. Examine automatic temperature system components to verify the following:
   1. Dampers, valves and other controlled devices operate by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
   4. Thermostats are located to avoid adverse effects of sunlight, drafts and cold walls.
   5. Sensors are located to sense only the intended conditions.
   6. Sequence of operation for control modes is according to the Contract Documents.
   7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
   8. Interlocked systems are operating.
   9. Changeover from heating to cooling mode occurs automatically.

I. Report deficiencies discovered before and during performance of testing, adjusting and balancing procedures.

J. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

K. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Automatic temperature control systems are operational.
   3. Equipment and duct access doors are securely closed.
   4. Dampers are open.
   5. Ceilings are installed in critical areas where air pattern adjustments are required and access to balancing devices is provided.
   6. Windows and doors can be closed so design conditions for system operations can be met.

3.02 Execution

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC or NEBB national standards and this Section.

B. Cut insulation, ducts, pipes and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Contract.

C. Fundamental Air System Balancing Procedures:
1. Prepare test reports for both fans and outlets. Obtain the manufacturer’s outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

2. Prepare schematic diagrams of systems’ "as-built" duct layouts.

3. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

4. Check the airflow patterns from the outside air louvers and dampers and the return and exhaust air dampers, through the supply fan discharge and mixing dampers.

5. Locate start-stop and disconnect switches, electrical interlocks and motor starters.

6. Verify that motor starters are equipped with properly sized thermal protection.

7. Check dampers for proper position to achieve desired airflow path.

8. Check for airflow blockages.

9. Check condensate drains for proper connections and functioning.

10. Check for proper sealing of air handling unit components.

D. Constant Volume Air System Balancing:

1. The procedures in this Article apply to constant volume supply, return and exhaust air systems. Additional procedures are required for variable air volume, multi-zone, dual duct, induction unit supply air systems and process exhaust air systems. These additional procedures are specified in other Articles in this Specification.

2. Adjust fans to deliver total design airflows within the maximum allowable RPM listed by the fan manufacturer.
   a. Measure fan static pressures to determine actual static pressure as follows:
      1) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      2) Measure static pressure directly at the fan outlet or through the flexible connection.
      3) Measure inlet static pressure of single inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   b. Measure static pressure across each air handling unit component.
      1) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
   c. Measure static pressures entering and leaving other devices such as heating duct coils under final balanced conditions.
   d. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
   e. Adjust fan speed higher or lower than design with the approval of SEPTA. Make required adjustments to pulley sizes, motor sizes and electrical connections to accommodate fan speed changes.
   f. Do not make fan speed adjustments that result in motor overload. Consult the equipment manufacturers about fan speed safety factors. Modulate dampers and measure fan motor
amperage to ensure no overload will occur. Measure amperage under all normal operating modes of operation to determine the maximum required brake horsepower.

3. Adjust volume dampers for main duct, sub main ducts and major branch ducts to design airflows within specified tolerances.
   a. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      1) Where sufficient space in sub mains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   b. Re-measure each sub main and branch duct after all have been adjusted. Continue to adjust sub mains and branch ducts to design airflows within specified tolerances.

4. Measure terminal outlets and inlets without making adjustments.
   a. Measure terminal outlets using a direct reading hood or the outlet manufacturer's written instructions and calculating factors.

5. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than the dampers at the air terminals.

E. Motors
   1. Test at final balanced conditions and record the following data for motors 1/2 horsepower and larger:
      a. Manufacturer, model and serial numbers.
      b. Motor horsepower rating.
      c. Motor RPM.
      d. Efficiency rating if high efficiency motor.
      e. Nameplate and measured voltage, each phase.
      f. Nameplate and measured amperage, each phase.
      g. Starter thermal protection element rating.

F. Heat Transfer Coil:
   1. Measure the following data for each electric heating coil:
      a. Nameplate data.
      b. Airflow.
      c. Entering and leaving air temperatures at full load.
      d. Voltage and amperage input of each phase at full load and at each incremental stage.
      e. Calculated kW at full load.
      f. Fuse or circuit breaker rating for overload protection.

G. Temperature Testing:
   1. During testing, adjusting and balancing, report need for adjustment in temperature regulation within the automatic temperature control system.
   2. Measure indoor wet and dry bulb temperatures every other hour for a period of two (2) successive eight (8) hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
3. Measure outside air, wet and dry bulb temperatures.

H. Temperature Control Verification:
1. Verify that controllers are calibrated and commissioned.
2. Check transmitter and controller locations and note conditions that would adversely affect control functions.
3. Record controller settings and note variances between set points and actual measurements.
4. Verify operation of limiting controllers (i.e., high and low temperature controllers).
5. Verify free travel and proper operation of control devices such as damper and valve operators.
6. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow. Note the speed of response to input changes.
7. Confirm interaction of electrically operated switch transducers.
8. Confirm interaction of interlock and lockout systems.
9. Verify main control supply air pressure and observe compressor and dryer operations.
10. Record voltages of power supply and controller output; determine if the system operates on a grounded or ungrounded power supply.
11. Note operation of electric actuators using spring return for proper fail safe operations.

I. Reports:
1. Typewritten or computer printout in letter quality font, on standard bond paper, in three (3) ring binder, tabulated and divided into sections by tested and balanced systems.
2. Include a certification sheet in front of binder signed and sealed by the certified testing and Balancing Engineer.
   a. Include a list of the instruments used for procedures along with proof of calibration.
3. In addition to the certified field report data, include the following in the final report:
   a. Fan curves.
   b. The manufacturers' test data.
   c. Field test reports prepared by the system and equipment installers.
   d. Other information relative to equipment performance, but do not include approved shop drawings and product data.
4. In addition to the form titles and entries, include the following data in the final report, as applicable:
   a. Title page.
   b. Name and address of testing, adjusting and balancing agent.
   c. Project name.
   d. Project location.
   e. Contractor’s name and address.
   f. Report date.
g. Signature of testing, adjusting and balancing agent who certifies the report.

h. Summary of contents, including the following:
   1) Design versus final performance.
   2) Notable characteristics of systems.
   3) Description of system operation sequence if it varies from the Contract Documents.

i. Nomenclature sheets for each item of equipment.

j. Notes to explain why certain final data in the body of reports vary from design values.

k. Test conditions for fans and pump performance forms, including the following:
   1) Settings for outside, return and exhaust air dampers.
   2) Conditions of filters.
   3) Cooling coil, wet and dry bulb conditions.
   4) Fan drive settings, including settings and percentage of maximum pitch diameter.
   5) Other system operating conditions that affect performance.

5. Apparatus coil test reports to include the following:
   a. Coil Data:
      1) System identification.
      2) Location.
      3) Coil type.
      4) Number of rows.
      5) Fin spacing in fins per inch.
      6) Make and model number.
      7) Face area in square feet.
      8) Tube and fin materials.
      9) Circuiting arrangement.

   b. Test Data:
      1) Airflow rate in CFM.
      2) Average face velocity in feet per minute.
      3) Air pressure drop in inches water gauge.
      4) Outside air, wet and dry bulb temperatures in °F.
      5) Entering air, wet and dry bulb temperatures in °F.
      6) Leaving air, wet and dry bulb temperatures in °F.

6. Fan test reports for the supply, return and exhaust fans, including the following:
   a. Fan Data:
      1) System identification.
      2) Location.
      3) Make and type.
      4) Model number and size.
      5) Manufacturer’s serial number.
      6) Arrangement and class.
      7) Sheave make, size in inches and bore.
      8) Sheave dimensions, center-to-center and amount of adjustments in inches.

   b. Motor Data:
1) Make and frame type and size.
2) Horsepower and RPM.
3) Volts, phase and hertz.
4) Full load amperage and service factor.
5) Sheave make, size in inches and bore.
6) Sheave dimensions, center-to-center and amount of adjustments in inches.
7) Number of belts, make and size.

   c. Test Data:
      1) Total airflow rate in CFM.
      2) Total system static pressure in inches water gauge.
      3) Fan RPM.
      4) Discharge static pressure in inches water gauge.
      5) Suction static pressure in inches water gauge.

3.03 Tolerances

   A. Set HVAC system airflow and water flow rates within the following tolerances:
      1. Supply, return and exhaust fans to be plus 10 to minus 10 percent.
      2. Air outlets and inlets to be plus 10 to minus 10 percent.

   END OF SECTION
PART 1 - GENERAL

1.01 Description

A. This Section addresses the parts of the power system electrical work that involve the following:

1. Interfaces and integration with other trades.
2. Submittals.
3. Quality assurance.
4. Manufacturer and equipment selection.
5. Reports.
6. Visit to site.
7. Fuse database.

1.02 Related Sections

A. All requirements that are described in Division 1.
B. Section 01010 – Summary of Work
C. Section 01300 – Submittals
D. Section 01400 – Quality Requirements
E. Section 01600 – Materials and Equipment
F. Section 01612 – Delivery, Storage and Handling - Traction Power Equipment
G. Section 16060 – Grounding and Bonding
H. Section 16075 – Electrical Identification
I. Section 16123 – Building Wire and Cable
J. Section 16130 – Raceway and Boxes
K. Section 16140 – Wiring Devices
L. Section 16240 – Battery Equipment
M. Section 16440 – Panelboards
N. Section 16500 – Lighting
O. Section 16772 – CCTV System
P. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit - Including HMI
Q. Section 16950 – Testing
R. Section 16952 – Electrical Testing - Traction Power Equipment (RRD)
1.03 Contract Documents

A. Design Modifications:
   1. Perform design modifications only with prior written approval from SEPTA.

B. Intent of Contract Drawings:
   1. The Contract Drawings do not indicate all fittings, hardware or appurtenances required for a complete operating installation.
   2. Wiring diagrams are not intended to indicate the exact course of raceways or exact location of outlets. Raceway locations are subject to revision as may be necessary at the time of installation. Location of undimensioned features is subject to SEPTA's approval.
   3. One-line diagrams, feeder diagrams and riser diagrams are schematic and do not show physical arrangement of equipment.

1.04 Delivery, Storage and Handling

A. Refer to Sections 01600 and 01612.

1.05 Protection during Storage

A. Provide protection of products against loss and damage.

B. Protect products from the effects of weather. Prior to installation, store items in clean, dry, indoor locations. Take all precautions as recommended by the manufacturer of the equipment. Store items subject to corrosion and items containing insulation, such as conductors, in a clean, dry, heated, indoor location.

C. Following installation, protect products from corrosion, dust, dirt, physical damage and the effects of moisture.

1.06 AS-Built Drawings

A. Keep records of all site modifications to produce accurate as-built drawings for submission to SEPTA. Include information of the work by others.

1.07 Submittals

A. Submit manufacturer's descriptive literature, product specifications, published details, performance/capacity rating schedules or charts and installation instructions, as specified in Section 01300 and as augmented by each Section of Division 16.

B. Submit shop drawings:
   1. Approve and submit shop drawings certified for construction by product manufacturers as follows:
      a. The shop drawings applicable to items listed under submittals in each Section of Division 16; and such items as may be scheduled or noted on the Contract Drawings.
      b. Include the associated Installation and Maintenance manuals (I & M) for the respective equipment with shop drawing submittals.
2. Include (as applicable) anchor bolt layouts; details indicating construction and materials of construction; dimensions; equipment, and weights of principal parts and the completely assembled item.

C. Review each submittal for completeness and for compliance with the Contract Requirements including the Contract Specifications and approved Contractor Detailed Design Drawings and Specifications. Failure to comply, even though the submittal is based on the manufacturer and equipment specified, will result in an immediate rejection of the submittal.

1.08 Quality Assurance

A. Provide the services of a Power System Integrator (PSI) and assume complete responsibility for the work that is performed by the PSI.

B. Meet the building and electrical code requirements of state, county, township or other political subdivisions, which exceed the requirements of national codes, standards and approving bodies. Modify the electrical work to be in conformity with such laws, ordinances, rules and regulations without additional expense to SEPTA.

C. Upon completion of work, and prior to final payment, furnish formal certification of final inspections to SEPTA from authorities having jurisdiction and secure required permits or certificates from such authorities. Additionally, prepare detailed diagrams and drawings, which may be required by those authorities having jurisdiction.

D. Products as specified in these Specifications and as indicated on the Contract Drawings are those of companies having established reputations in the manufacture of the particular materials, equipment or apparatus specified. Provide products from the manufacturers that are either of their own make, or products of others, for which the manufacturer assumes full responsibility. Replacement parts shall be available for them.

E. Provide UL Listed products whenever comparable, products of like design, function and appearance have been submitted to UL and have received the UL Label. Provide products labeled for the specific use intended and the location where it will be installed. Provide and include evidence or proof of UL listings by respective references on product data or shop drawing document submittals. Provide UL listing cards, where such information is not otherwise evident or obvious on the submittal documents.

F. Have the work inspected by an authorized inspection agency for compliance with National Electrical Code (NEC) and obtain certificates of approval, acceptance and compliance with code regulations. Work shall not be deemed complete until such certificates have been delivered to SEPTA for review.

G. Meet the applicable provisions of the most recent issues of the following references:

3. NFPA 70, National Electrical Code (NEC).
4. National Electrical Installation Standards (NEIS) developed by the National Electrical Contractors’ Association (NECA).
1.09 **Interfaces and Integration with Other Trades**

A. This Section provides supplemental requirements and responsibilities for performing the work as described herein and in the other Sections, in order to achieve the following goals:

1. The requirement of a single point of responsibility for the selection of equipment, materials, compatibility and interface with other elements of the integrated system.

2. System interfaces and integration.

3. Interface with Other Trades:
   a. Assume responsibility to identify all interface requirements with the all the trades required for performing work under this Contract so that all aspects of the work are correctly sized and located. While not exhausting all the possible interfaces, the following are the kinds of interfaces to be considered:
      1) Locations of electrical equipment pads.
      2) New cable trenches.
      3) Existing underground objects.
      4) Water, drainage and sewer utility piping.
      5) Assume responsibility to coordinate the installation of all equipment with the existing and new ground grid, including grounding tail locations in equipment pads and/or floors.

B. Coordinate the communication system work with SEPTA’s Signals and Communications group, through the SEPTA Project Manager. The coordination shall include the work of routing communication cables to/from the control room and SCADA system interface cabinet.

1.10 **Manufacturer and Equipment Selection**

A. The names of the manufacturers who are known to have products similar to the products specified in these Specifications are listed in the Specification. It is the Contractor’s responsibility to ensure that the product that is selected from these manufacturers meet the detailed requirements contained in these specifications.

B. The decision of SEPTA regarding whether the product meets the Specification requirements is final and binding on the Contractor. If the Contractor decides to offer products from other than those named, it shall in such cases be accepted Approved-Equal if, to the best of SEPTA's knowledge, information and belief, the products are approximately equal in physical size, strength, arrangement, durability, usefulness, suitability, performance and convenience for the purpose intended.

C. SEPTA is the sole judge of the qualifications of such products and determines all questions regarding the conformation of any products with the specified products. If such products are acceptable to SEPTA but differ significantly from those in the Specifications, to the extent that their proper incorporation into the work requires changes to the structural mechanical, electrical, instrumentation, or any other changes of whatsoever nature, the Contractor shall assume responsibility to accept the full cost for such changes. SEPTA shall judge the qualifications of such products and determine all questions regarding the conformation of any products with the specified products based on the Contractor’s submittals.
1.11 Reports

A. Certified Test Reports:

1. Where certified test reports are required by the Contract Documents, they will meet the following requirements:
   a. Before delivery of materials for which certified test reports are required, submit certified copies of the reports of tests required in reference publications or specified within the Contract Documents for approval to SEPTA. Perform the testing in an approved independent laboratory. If testing was performed in the manufacturer's own testing laboratory, the credentials of its test lab and procedures must be submitted to SEPTA's Project Manager who may approve the testing lab as a certified alternate to an independent testing lab. Accompany test reports with a notarized certificate from the manufacturer or supplier certifying that the tested material meets the specified requirements and is the same design, type, quality, manufacturer and make as that proposed to be supplied.
   b. At the option of the SEPTA Project Manager, or where specified, furnish, in lieu of the specified tests and other tests required in the various reference documents, a certificate of compliance from the manufacturer. The certificate must state that the manufacturer has performed the required tests; that products to be supplied meet the test requirements; that products tested were of the same design, type, quality, and manufacturer and make as those proposed to be supplied. The intent of this requirement is to permit, as approved by the SEPTA Project Manager, the manufacturer to provide certified test reports for non-production related tests that were performed on equipment having the same configuration, capacities and characteristics.

1.12 Visit to Site

A. Prior to submitting a bid, visit the proposed construction site and become familiar with the existing facilities and conditions.

B. Immediately inform SEPTA's Project Manager of anything found that is incorrectly represented or not represented on the Contract Drawings, or is not specified within the Specifications.

C. Failure to meet the above shall not be just cause for additional payment should conflicting or non-represented conditions be encountered during construction.

1.13 Fuse Database

A. Develop a database which tabulates all fuses utilized in the substations and switching stations for all installed equipment.

B. Obtain actual fuse requirements for each assembly, sub-assembly or component of electrical equipment in the Contract that contains fuses for overcurrent protection. Submit a comprehensive fuse schedule identifying the respective equipment, the fuse designation within equipment, the fuse manufacturer, the fuse type, the fuse ampere rating, the fuse voltage rating, the fuse family class and its associated AIC rating.

PART 2 - PRODUCTS
2.01 Not Used

PART 3 - EXECUTION

3.01 General

A. Locate and install all equipment to be readily accessible for operation and maintenance. Septa reserves the right to require minor changes in location of raceways or equipment without incurring any additional costs or charges.

B. Install raceway stub-ups in accordance with field conditions and equipment shop drawings.

C. Locate wall switches, outlets and lighting to suit field conditions.

D. Install equipment using procedures defined in NECA standard of installation.

E. Energize any space heaters in equipment or provide temporary heat during storage and until such time the equipment is finally commissioned.

F. Cap raceway runs with seals manufactured by the raceway manufacturer.

G. Keep openings in boxes or equipment closed during construction.

3.02 Power System Integrator (PSI)

A. Appoint a Power System Integrator (PSI) with significant prior experience in the specification, selection, startup, and commissioning of complete medium voltage power systems that are controlled and protected by automated controls and multi-function relays. Refer to Section 01010 for additional requirements.

B. Require that the PSI, who is under the Contractor’s supervision, shall be responsible for the following work in addition to all other matters related to their responsibilities:

1. Short circuit analysis, protective relay coordination study and arc flash study.
2. Equipment selection and options (including accessories), relay calibrations and settings of relays and software programming of all relays.
3. Substation or switching station equipment SCADA network system (equipment, transducers, terminations and remote terminal unit (RTU) interconnecting operation, including master SCADA hardware and software revisions if required), including the creation and preparation of all SCADA databases.
4. The interconnection of the SCADA RTU and all substation or switching station SCADA/communication networks and interfaces.
5. Communication system installation, equipment, material and testing requirements to connect into SEPTA's existing fiber-optic communication system.
6. Supervision/oversight of the battery system and all components.
7. Commissioning tests (both factory and substation or switching station equipment and system).
8. Training of SEPTA personnel as further described in other Sections of Division 13 and Division 16.
3.03 Interfaces with Other Contracts

A. Interferences:
   1. Perform construction activities in a manner not to delay or interfere with other operations of work in the Contract.
   2. Prior to performing electrical installations, coordinate the work with the other work either being performed or planned at the location, especially in congested areas.
   3. In the event that interferences develop, the decision of the SEPTA Project Manager will be final and no additional compensation will be allowed for relocation of either existing electrical installation or the new installation.

B. Scheduling:
   1. Schedule electrical work, unless otherwise indicated in accordance with the requirements of Section 01400.
   2. Provide coordination and agreement of work schedule. Start no work in an area without approval from SEPTA.
   3. Coordinate the work in such manner as not to interfere or conflict with the performance of work by SEPTA's employees, or the obligations and duties of its maintenance personnel during the normal operating hours.

END OF SECTION
SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 Description

A. Requirements for the basic materials and methods of installation of electrical systems, which include the following materials and systems:

1. Metal framing system (including metal framing material, fittings and related accessories) also known as strut system.
   a. Provide all metal framing material, fittings and related accessories to support the equipment, conduits and cables as shown on the Contract Drawings.
   b. Provide all labor, supervision, engineering and fabrication required for installation of the metal framing systems.

2. Cable tray systems.

3. Cable (vertical support) strain relief grips, bus drops and conduit risers when cable end is not available.

4. Cable fire proofing tape system.

5. Floor and wall sleeves.


7. Concrete inserts.

8. Anchors.


10. Padlocks for various traction power and auxiliary power equipment.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 16120 – Conductors and Cables

C. Section 16130 – Raceways and Boxes

D. Section 16240 – Battery Equipment

E. Section 16310 – Transmission and Distribution

F. Section 16440 – Panelboards

G. Section 16500 – Lighting

1.03 Submittals

A. Submit the proposed manufacturers with model or catalog numbers, identifying the materials and equipment proposed.
B. Submit brochures, catalog cuts, or shop drawings for materials and equipment as designated on the returned list of materials.

C. Submit samples of any materials for review by SEPTA's Project Manager. Samples shall be sent to the Project site and stored by the Contractor.

D. Submit certification from the manufacturers verifying that the equipment furnished conforms to the specified requirements.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:


4. ASTM A 370, Standard Test Methods and Definition for Mechanical Testing of Steel Products.


7. NEMA FG 1, Fiberglass Cable Tray Systems.

8. NFPA 70, National Electrical Code (NEC).

B. Inspection of Materials:

1. Inspection of the material will be made at the point of delivery. However, SEPTA's Project Manager reserves the right to make any tests or inspection that he may deem necessary at the Contractor's plant.

2. In the event inspection is made at the plant, grant SEPTA's Project Manager, and/or representative, free entry at all times while work under this Specification is being performed, to all parts of the plant that concern the manufacture of the pertinent material/equipment.

3. Render all assistance to satisfy SEPTA's Project Manager that the material/equipment is being furnished in accordance with this Specification.

4. Assume the responsibility to impose these conditions upon in Contracts with the equipment manufacturer.

5. In all cases, notify SEPTA's Project Manager when the finished material/equipment is ready for shipment in order that plant inspection of the material/equipment may be made if desired.

C. The construction code requirements of state, county, city, utility companies or other political subdivision, which exceed the requirements of the NEC, shall be met and complied
with. Modify the electrical work to be in conformity with such laws, ordinances, rules and regulations.

D. Use electrical materials, which are new, UL listed, meet UL requirements and bear the UL label. In lieu of the UL listing, or where standards have not been established by UL and label service or certification service is not available, material and equipment shall meet the requirements of a recognized national testing laboratory, such as one (1) of the following laboratories:
   1. ETL Testing Laboratories, Inc.
   2. MET Electrical Testing Company, Inc.
   3. SGS U.S. Testing Company, Inc.

E. Perform work of this Section in accordance with requirements of the NEC applicable to basic electrical materials and as modified by this Specification.

F. Have the work inspected by an authorized electrical inspection agency for compliance with the NEC and obtain certificates of approval, acceptance and compliance with code regulations. Work shall not be deemed complete until such certificates have been delivered to SEPTA’s Project Manager for review.

1.05 Operational and Maintenance Data

A. Furnish SEPTA's Project Manager with one (1) set of final drawings, in reproducible form and on CD-ROM disk in AutoCAD format, of the material and equipment supplied under this agreement, in their accepted, as-built form.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Metal Framing Systems:
   1. The following metal framing system manufacturers are approved for use on this Contract:
      a. Unistrut Buffalo-P1000 Series.
      b. Versabar Corporation.
      c. Cooper B-Line.
      d. Or Approved Equal.
   2. Material:
      a. All Metal framing system components that are in unheated spaces, shall be fabricated from structural grade steel that is hot dipped galvanized, meeting ASTM A 1011/A 1011M and A 123/A 123M.
      b. All metal framing system components that are installed outdoors, shall be fabricated from structural grade stainless steel meeting ASTM A 480/A 480M and A 276/A 276M.
      c. Cables shall be supported using Unistrut, Porce-A-Clamp (thermoplastic elastomer insulator) with stainless steel clamps and hardware or approved equal.

B. Cable Trays:
1. **Cable Trays for AC Circuits and/or Control Cables:**
   a. Cable trays shall be steel, hot dip galvanized meeting ASTM A 123/A 123M after fabrication, with continuous ventilated punched bottom.
   b. Minimum tray widths shall be 18 inches. Tray depth shall be selected to limit the initial fill to 50 percent of the allowable fill, as defined in the NEC. Inside depth shall be 4 inches minimum.
   c. All connectors, accessories and supports shall be supplied to provide a complete system.
   d. Upper flanges shall be rolled out and downward.
   e. Minimum radius of elbows, crosses, tees, et al shall be as required for the minimum bending radius of the largest diameter cable installed.
   f. Cable tray connections shall be solid plates, with multiple bolts on each rail. Total resistance of a connection, when made in accordance with the manufacturer’s requirements, shall not exceed the resistance of 2 feet of side rail.
   g. Cable trays shall be as manufactured by the companies listed below:  
      1) Husky-Burndy.
      2) T.J. Cope.
      3) PW. Industries.
      4) Or Approved Equal.
   h. All wiring on cable trays shall be multi-conductor jacketed up through 500 kcmil and shall be of the same insulation level.
   i. Where cable tray is mounted from the ceiling, a metal framing system shall be used. A single rod mounted system will not be accepted.

C. **Cable Strain Relief Grips:**
   1. Select appropriate type cable strain relief grips for the application and be fully aware of the breaking strength, safety and technical data regarding the product.
   2. Provide support of AC cables in vertical conduit drops.
   3. Cable strain relief grips shall be manufactured by the companies listed below:  
      a. Hubbell Kellems.
      b. Daniel Woodhead.
      c. Ericson.
      d. Or Approved Equal.

D. **Sleeves:**
   1. Sleeves shall be rigid galvanized steel tubing. Extend sleeves through floor or 2 inches above the finished floor and 2 inches below ceilings.
   2. Seal conduits penetrating walls below grade with a waterproof, modular, mechanical expansion seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and wall opening. Assume responsibility for the sizing of links and wall sleeve. Seal conduits in fire rated walls with fire seals of the same rating as wall composition.
      a. Fire retardant sealant shall be asbestos free; UL classified and meet ASTM E 814. Forming and backing material installed with the sealant shall be bulk ceramic fiber or rigid fiberboard rated for 2300°F.
3. For slabs above grade, plastic core form block outs may be used to form sleeve opening where exposed in electrical closets and other areas not subject to flooding.

E. Anchors:

1. Bolts, Nuts Washers and Screws:
   a. Less than 3/8 inch trade size to be stainless steel.
   b. Over 3/8 inch trade size to be galvanized.

2. For Hollow Masonry:
   a. Toggle type bolts.
   b. Epoxy bolt or stud.

3. For Steel Work:
   a. Either machine screws, welded threaded studs or spring tensioned clamps.

F. Inserts:

1. Channel Inserts:
   a. Not lighter than 12 gauge carbon steel hot dip galvanized after fabrication.
   b. Not smaller than 1 1/2 inches by 1 1/2 inches, and have 13/32 inch by 3 inch slots on 4 inch centers.
   c. Pullout load rating shall be not less than 1,500 pounds per linear foot uniformly distributed.
   d. Inserts embedded in concrete shall have solid base plate with concrete anchors welded to base plate and coated with cold applied zinc rich paint.

2. Spot inserts:
   a. Rated 800 pounds.
   b. Carbon steel galvanized after fabrication.
   c. Safety factor of five (5).
   d. Covered to prevent concrete from filling insert.

G. Beam Clamps:

1. Shall be galvanized steel, with tapped holes in base and face for bolts or hanger rods.

H. Duct Water-Tight Cable Plugs:

1. Cable watertight cable seals shall be as manufactured by the companies listed below:
   a. Jack Moon, Inc.
   b. OZ Gedney.
   c. Or Approved Equal.

I. Padlocks (If required by SEPTA):

1. Padlocks shall have 2 inch wide solid brass body with 1 inch brass shackle clearance, 3/8 inch shackle diameter. Each padlock shall be keyed differently and each provided with two (2) keys.

2. Manufacturer:
   b. Or Approved Equal.
3. Provide a durable key box, wall mounting type, with hinged doors to organize the keys. Provide as a minimum, one hundred (100) assignment key hangers.

4. Upon request by the SEPTA Project Manager, provide padlocks for the following equipment:
   a. Interrupter switch and ground switch operating mechanism handles.
   b. Grounding switches operating mechanism handles.
   c. Vacuum switch doors.
   d. Vacuum switch operator handles (These padlocks are not key interlock mechanisms, which are separate and unique).
   e. Auxiliary power transformer enclosure doors.
   f. SCADA remote terminal unit.
   g. SCADA interface cubicle.

PART 3 - EXECUTION

3.01 Preparation
   A. Transmit submittals and deliverables required by this Section.
   B. Furnish products as indicated on the Contract Drawings.
   C. Ensure substrates are in suitable condition to receive the work of this Section.
   D. Review the Contract Drawings and Specifications thoroughly in preparation for installation of the materials and equipment. Materials shall be procured and stored, and planned for use in a manner that minimizes waste and substitutions and maximizes installation efficiency and quality of the end product.
   E. Determine the exact location of all equipment within the space assignments designated on the drawings. The right to make any reasonable change in location of equipment, before installation, is reserved by SEPTA's Project Manager.
   F. Design and install all electrical equipment and apparatus that may require periodic maintenance and operation in a manner that provides accessibility and arrangement.
   G. Examine all Contract and Reference Drawings, to verify and properly coordinate the placement of conduits and outlets; check all drawings including mechanical drawings, equipment drawings and shop drawings, for apparatus that must be connected.

3.02 Installation, Application and Execution
   A. Cable Trays:
      1. Cable trays shall be supported by metal framing systems.
      2. Maximum distance between tray supports shall be 8 feet.
      3. Supports for tray fittings shall be located as follows:
         a. Horizontal straight sections to be within 2 feet of splices.
         b. Vertical straight sections to be every 8 feet.
         c. Horizontal elbows to be at the midpoint of the arc.
         d. Horizontal tees to be within 2 feet of each opening.
e. Horizontal crosses to be within 2 feet of each opening and diagonally under the cross for 2 feet and 3 feet radii fittings.

f. Vertical elbows to be at each end.

g. Dropout at end of runs to be under the fitting.

4. Trays shall be ruggedly clamped in place at every support. Sliding glide clamps may be used in horizontal runs, where provision for thermal expansion is required. Sloping and vertical trays shall be through bolted or positively anchored to the support by means other than friction, so as to support the specified design load. Make provisions to allow tray supports to accommodate thermal expansion of the tray system.

5. Wherever possible maintain a minimum vertical clearance of four 4 from the top of all trays to the underside of beams, ceilings, ducts, piping and other obstructions, and 4 feet 3 inches from bottom of tray to switchgear and clearance of 12 inches shall be maintained from the top of the bottom tray to the bottom of the top tray.

6. All tray runs shall be marked with the tray numbers at both ends and every 25 feet. Marking shall be high black letters stenciled in a visible location on the outside of the tray side channel.

7. The following partial list is intended to serve as an example of the kinds of equipment that shall be supported using metal framing systems:

   a. Automatic transfer switches, disconnect switches, panel boards, battery chargers, bus ducts, light fixtures, conduits, pull boxes, splice boxes, cable strain relief grips and exposed cables run along the wall, or ceiling, interrupter switches and related operating mechanisms

B. Anchors:

   1. Holes for anchors placed in pre-stressed and post-tensioned concrete shall be made so as not to weaken tendons or tensioning wires.

C. Beam Clamps:

   1. Beam clamps may be used for support of raceways, enclosures, panelboards or equipment where attached to/from fixed steel supports or structures.

   2. Beam clamps fastened to steel supports not horizontal or vertical shall be provided with a swing connector.

   3. Beam clamps fastened to structures in a horizontal position (where bolt is horizontal) shall not be used for support of equipment exceeding 10 pounds.

END OF SECTION
THIS PAGE NOT USED
SECTION 16052

GENERAL ELECTRICAL REQUIREMENTS – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Provide equipment for rehabilitation of Bethayer's, Neshaminy Falls and Yardley traction power substations located on SEPTA’s Regional System West Trenton Line.

B. The equipment shall be generally similar and interchangeable across the three (3) substations.

C. Provide all traction power equipment to withstand the specified project conditions and be capable of operation without impairment at the specified performance levels. This shall include performing electrical studies identified herein.

D. Design the substation to be capable of working via local control in the event of failure of SCADA, communication link, local area network or the bay modules.

E. Advise SEPTA if there are any additional conditions to which the equipment may be sensitive.

F. Provide all equipment with minimum functional life expectancy of thirty (30) years.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control -Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling -Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials -Traction Power Equipment

E. Section 01832 – Operations and Maintenance Manuals -Traction Power Equipment

F. Section 09910 – Paints and Coatings

G. Section 16060 – Grounding and Bonding

H. Section 16075 – Electrical Identification

I. Section 16290 – Protective Devices and Instrument Transformers

J. Section 16310 – Transmission and Distribution

K. Section 16335 – Surge Protection

L. Section 16952 – Electrical Testing -Traction Power Equipment (RRD)

1.03 Submittals

A. Submit documentation indicating compliance with the required standards and codes and these specifications.

B. Bring any item of non-compliance with this Specification or with the required standards and codes to the immediate attention of SEPTA.
C. Submit traction power system studies as specified herein.

1.04 Quality Assurance

A. Meet applicable provisions of the most recent issues of the following references:
   1. Aluminum Association of America (AAA).
   3. American Institute of Steel Construction (AISC).
   7. American Society of Mechanical Engineers (ASME).
  11. Industrial Fasteners Institute (IFI).
  14. Insulated Cable Engineers Association (ICEA).
  15. National Electrical Contractors Association (NECA).
  18. NFPA 70, National Electrical Code (NEC).
  20. Occupational Safety and Health Administration (OSHA).
  21. Society of Automotive Engineers (SAE).
  22. Underwriters Laboratories (UL).

B. Perform the work in accordance with the relevant Federal Specifications (FS), Military Specifications (MIL) and Military Standards (MS) where specified.

C. A partial list of applicable standards is provided in each equipment section of the Technical Specifications. Identify and consult all applicable industry standards as well as local, state and utility codes and practices.

D. Provide all systems in accordance with the most stringent applicable industry standard, code or practice and requirement.

1.05 Project Conditions and Performance Requirements

A. Indoor Climatic Conditions:
1. Design all indoor equipment to be suitable for operation in industrial environment throughout temperature range of 10°F to 100°F and 90 percent relative humidity.

B. Outdoor Climatic Conditions:

1. The outdoor climatic conditions existing in the Project locale are shown in Table 16052-1.

<table>
<thead>
<tr>
<th>Table 16052-1 Outdoor Climatic Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climatic Condition</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Temperature (°F)</td>
</tr>
<tr>
<td>Ice Thickness (Inches)</td>
</tr>
<tr>
<td>Twenty-Four (24) Hour Rainfall (Inches)</td>
</tr>
<tr>
<td>Humidity (%)</td>
</tr>
<tr>
<td>Wind Speed (MPH)</td>
</tr>
</tbody>
</table>

C. Altitude:

1. The altitude of the Project site does not exceed 3,300 feet.

D. Seismic Conditions:

1. Provide electrical equipment and material suitable for Seismic Use Group II, Seismic Design Category C, Site Class D, as defined by the IBC.

E. Operating Environment:

1. 12 kV Trolley Circuit Breakers and Associated Equipment:
   a. The 12 kV trolley circuit breakers and its associated equipment will be installed outdoors. The breaker controls and relays shall be installed in the substation control room.
   b. The equipment will not be exposed to damaging fumes, vapor steam, salt air, oil vapors, excessive dust, and abnormal vibration or tilting.

2. 24 kV Feeder Circuit Breakers and Associated Equipment:
   a. The 24 kV feeder circuit breakers and its associated equipment will be installed outdoors. The breaker controls and relays shall be installed in the substation control room.
   b. The equipment will not be exposed to damaging fumes, vapor steam, salt air, oil vapors, excessive dust, and abnormal vibration or tilting.

3. Autotransformers and Autotransformer (46 kV) Circuit Breakers and Associated Equipment:
   a. The autotransformers and autotransformer circuit breakers and its associated equipment will be installed outdoors. The breaker controls and relays shall be installed in the substation control room.
   b. The equipment will not be exposed to damaging fumes, vapor steam, salt air, oil vapors, excessive dust, and abnormal vibration or tilting.

F. Operating Conditions:

1. The following operating conditions of voltage and frequency can occur simultaneously:
a. Voltage to be 110% of rated value due to rolling stock regeneration.

b. Frequency to be 95% of rated value.

c. The traction power system is subject to rapidly fluctuating load currents as trains accelerate, decelerate and encounter gradients. The fluctuating load results in axial and radial pulsating forces in the substation equipment.

d. The traction power system is subject to a high occurrence of short circuits. The short circuits occur as follows:
   1) Between the overhead 12 kV trolley and ground or rail.
   2) Between the overhead 24 kV feeder and ground or rail.
   3) Between the overhead 24 kV feeder and the overhead 12 kV trolley.

2. The traction power system operates with a significant content of harmonics caused by power electronic equipment switching. The harmonics consist of two (2) parts:

a. Harmonics generated by the traction load. The traction load consists of number of multi-car trains operating simultaneously on the system. The propulsion system of the existing cars is thyristor controlled. The new fleet of the cars expected to be procured by SEPTA over next several years will have propulsion system based on integrated gate bipolar thyristors (IGBTs).

b. Harmonics generated by the static frequency converters (SFCs). The existing SFC's are thyristor controlled cyclo-converters connected in twelve-pulse arrangement. SEPTA plans to replace the frequency converters in the near future. Coordinate with SEPTA for the details of the new static frequency converters.

c. The SFC manufacturer, ABB, performed extensive studies of the system harmonics and their results are shown in Table 16052-2. The Table shows the overall system harmonics when one (1) SFC is operating at 100% rated power and at 200% rated power.

d. Since SEPTA could operate three (3) SFCs in parallel, the Contractor shall design all substation equipment for operation with three (3) units. For operation of three (3) SFCs in parallel, the system harmonic current shall be assumed to increase proportionally.

3. Relays, meters, bay modules, and PLCs used shall be immunized against the electromagnetic interference normally associated with the medium voltage electrical substations or switching stations.

4. Continuous and Overload Rating of the SFCs:

a. Design all equipment to be fully compatible with the continuous and overload ratings of the existing and future SFCs.

b. Each existing SFC is rated as follows:
   1) 100 percent rated power of 15 MVA continuously, followed by
   2) 120 percent of rated power for one (1) hour, followed by
   3) 160 percent of rated power for five (5) minutes, and followed by
   4) 200 percent of rated power for thirty (30) seconds.
Table 16052-2 Harmonic Content of the Power System Currents for One (1) SFC

<table>
<thead>
<tr>
<th>Harmonic</th>
<th>Frequency (Hz)</th>
<th>Current Harmonics at Converter Load</th>
<th>15MVA</th>
<th>30MVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(A)</td>
<td>% of Fundamental</td>
<td>(A)</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
<td>1,456</td>
<td>Fundamental</td>
<td>2,686</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
<td>269</td>
<td>18.48</td>
<td>367</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
<td>444</td>
<td>30.49</td>
<td>633</td>
</tr>
<tr>
<td>7</td>
<td>175</td>
<td>100</td>
<td>6.87</td>
<td>144</td>
</tr>
<tr>
<td>9</td>
<td>225</td>
<td>41.7</td>
<td>2.86</td>
<td>52.8</td>
</tr>
<tr>
<td>9.6</td>
<td>240</td>
<td>5.6</td>
<td>0.38</td>
<td>11.1</td>
</tr>
<tr>
<td>11</td>
<td>275</td>
<td>16.7</td>
<td>1.15</td>
<td>44.5</td>
</tr>
<tr>
<td>11.6</td>
<td>290</td>
<td>5.6</td>
<td>0.38</td>
<td>11.1</td>
</tr>
<tr>
<td>13</td>
<td>325</td>
<td>8.8</td>
<td>0.60</td>
<td>33.32</td>
</tr>
<tr>
<td>13.6</td>
<td>340</td>
<td>5.6</td>
<td>0.38</td>
<td>11.1</td>
</tr>
<tr>
<td>15</td>
<td>375</td>
<td>5.6</td>
<td>0.38</td>
<td>27.8</td>
</tr>
<tr>
<td>15.6</td>
<td>390</td>
<td>19.4</td>
<td>1.33</td>
<td>50.0</td>
</tr>
<tr>
<td>17</td>
<td>425</td>
<td>5.6</td>
<td>0.38</td>
<td>8.3</td>
</tr>
<tr>
<td>17.6</td>
<td>440</td>
<td>36.1</td>
<td>2.48</td>
<td>61.1</td>
</tr>
<tr>
<td>19</td>
<td>475</td>
<td>5.6</td>
<td>0.38</td>
<td>5.6</td>
</tr>
<tr>
<td>19.6</td>
<td>490</td>
<td>63.9</td>
<td>4.39</td>
<td>80.6</td>
</tr>
<tr>
<td>21</td>
<td>525</td>
<td>5.6</td>
<td>0.38</td>
<td>5.6</td>
</tr>
<tr>
<td>21.6</td>
<td>540</td>
<td>75.0</td>
<td>5.15</td>
<td>55.6</td>
</tr>
<tr>
<td>23</td>
<td>575</td>
<td>5.6</td>
<td>0.38</td>
<td>2.8</td>
</tr>
<tr>
<td>23.6</td>
<td>590</td>
<td>33.3</td>
<td>2.29</td>
<td>41.7</td>
</tr>
<tr>
<td>25.6</td>
<td>640</td>
<td>5.6</td>
<td>0.38</td>
<td>5.6</td>
</tr>
<tr>
<td>27.6</td>
<td>690</td>
<td>19.4</td>
<td>1.33</td>
<td>5.6</td>
</tr>
<tr>
<td>29.6</td>
<td>740</td>
<td>2.8</td>
<td>0.19</td>
<td>11.1</td>
</tr>
<tr>
<td>31.6</td>
<td>790</td>
<td>16.7</td>
<td>1.15</td>
<td>5.6</td>
</tr>
<tr>
<td>33.6</td>
<td>840</td>
<td>33.3</td>
<td>2.29</td>
<td>5.6</td>
</tr>
<tr>
<td>35.6</td>
<td>890</td>
<td>30.6</td>
<td>2.10</td>
<td>5.6</td>
</tr>
<tr>
<td>37.6</td>
<td>940</td>
<td>19.4</td>
<td>1.33</td>
<td>5.6</td>
</tr>
</tbody>
</table>

PART 2 - PRODUCTS

2.01 Services Required

A. Scope:

1. This Contract includes rehabilitation of existing Bethayres, Neshaminy Falls and Yardley Traction Power Substations supplying power to the West Trenton Line. Refer to Section 01010.

2. The Contract includes the Contractor performing the detailed engineering and design required for performing the specified overhaul of the substation by replacing the

Construction Contract No. 1  16052-5  General Electrical Requirements – TP Equipment
obsolete equipment with the new equipment specified in these specifications and relocating as shown on the Contract Drawings.

3. The Contract Documents, including this Technical Specification and the related Preliminary Drawings outlining the scope, define the responsibilities of the Contractor to design, manufacture, factory test, deliver, install, field test, commission and bring into revenue service the equipment specified herein.

B. Work included:

1. Contractor shall perform detailed engineering and design, prepare drawings and documents required to procure materials, manufacture, test in the factory, deliver, install, test in the field, commission and bring into revenue service all components necessary for implementation of the overhaul of Bethayres, Neshaminy Falls and Yardley Traction Power Substations.

2. The overhauling of the substation shall be performed in phases keeping the substation in revenue operation at all times during execution of this Contract. The staging developed in the Contract Drawings facilitates the change out of equipment progressively such that the substation shall always be energized and operational at all times. Brief outages of the complete substation will be allowed for removal and replacement of some equipment which, due to location, require a total substation outage.

3. Perform all work described in the Contract Documents.

4. Verify field conditions by performing detailed field survey of existing conditions and take them into consideration in the performance of the detailed engineering and design required to be done under this Contract.

5. Submit detailed engineering calculations and drawings for SEPTA approval prior to commencing any field work.

2.02 Complexity of the Project

A. The traction power work included in this Contract is very complex and requires a high degree of coordination between the suppliers, the Prime Contractors and SEPTA. It is expected that the required electrical equipment will be procured from multiple manufacturers. The Contractor shall be required to integrate all equipment into one fully functional, complete and operable system.

B. Control of the facility shall be by state-of-the-art automated system using microprocessor based control relays, bay modules, gate computer, internal fiber optic cable network and fiber optic cable connection to SEPTA's SCADA system.

C. Multiple levels of testing shall be required, including design and production tests at the manufacturer's plants, tests in specialized laboratories and field tests at the site.

2.03 Traction Power System Studies

A. Perform the following studies as specified herein. Use industry accepted software with prior approval of SEPTA for all studies.

1. Short Circuit Study:
a. Perform a short circuit study on the relevant part of the system.

b. Previous studies, that are available, will be provided to assist the Contractor in developing a complete model of the system as required by the software to be utilized. Include in the model the static frequency converters at Wayne Junction and all 24 kV feeder and 12 kV trolley circuits. Develop the impedances of the circuits.

c. Short circuit capability of each existing static frequency converter is as follows. Coordinate with SEPTA for the short circuit capability of the proposed static frequency converters.

1) 4,000 A trolley to ground for two (2) seconds. During the next three (3) seconds, the current is reduced to 2,500 A. The converter trips after five (5) seconds, if the voltage is sufficiently low.

d. Perform the study for both substation autotransformers in service and for one (1) autotransformer out of service for the following conditions:

1) Feeder to trolley fault.
2) Feeder to ground fault.
3) Trolley to ground fault.

e. Produce graphical results showing the system configuration and indicating the following results:

1) Short circuit current in each feeder circuit.
2) Short circuit current in each trolley circuit.
3) Short circuit current in each autotransformer winding.
4) Total short circuit current at the fault.

2. Arc flash Hazard Study:

a. Perform arc flash hazard study for the substation circuit breakers based on the short circuit study.

b. Base the study on the short circuit current magnitude determined in the short circuit study and current duration of 0.5 seconds. Provide calculated incident energy at various distances from the equipment and identify the calculated flash protection boundaries.

c. Include in the study, requirements of OSHA 29 CFR, NFPA 70E, NEC and IEEE 1584. Provide recommendation on Personnel Protection Equipment (PPE) and appropriate labeling of equipment.

3. Protective Relay Study:

a. Perform protective relay study based on the short circuit study using the single line diagram developed by the Contractor as part of the detailed design.

b. Based on the existing relay settings, develop the relay setting philosophy and provide relay settings calculations for each 24 kV feeder circuit, 12 kV trolley circuit and the two (2) autotransformers.

c. Summarize the relay settings in tabular form.

d. Indicate the following for each circuit:

1) Equipment.
2) Protected circuit.
3) Relay function.
4) Relay manufacturer.
5) Relay type.
6) Nominal voltage.
7) Nominal current.
8) Nominal frequency.
9) Line length.
10) Line impedance.

e. Indicate the following for each relay:
   1) Relay element.
   2) Function.
   3) Designation.
   4) Setting.
   5) Units.
   6) CT ratio.
   7) PT ratio.

f. For autotransformer time overcurrent and instantaneous relay elements provide time versus current plot with cable/transformer damage characteristics and inrush current point clearly shown.

4. Substation Ground Grid Design Study:
   a. Perform substation ground grid design study based on the earth resistivity measurements obtained from the Contractor. The study shall form the basis of the ground grid design to meet IEEE requirements.

5. Perform a lightning shielding study. The study shall determine the need for additional shielding which shall be provided.

6. Performance of the Studies:
   a. All studies shall be performed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.
   b. Provide a comprehensive report for each study, including the following:
      1) Purpose.
      2) Theoretical background.
      3) Design parameters.
      4) Design procedures.
      5) Calculation procedures.
      6) Technical analyses and calculations.
      7) Result evaluations.
      8) Conclusions and recommendations.
      9) Appendices, including:
         a) Collected raw data.
         b) Software input and output data.
         c) Detailed calculations.

   B. All studies shall be signed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

2.04 Traction Power System Equipment Design

A. Contractor shall provide final and detail design for the traction power equipment. The Contractor shall submit 60 percent and 90 percent complete detailed design documents for SEPTA’s review and comments prior to submitting 100 percent completed documents for
approval. The Contractor shall comply with SEPTA comments on all the submittals or provide a justification for their design satisfactory to SEPTA.

B. The following equipment has been ordered by SEPTA. The design shall be prepared utilizing this equipment. Other equipment must be compatible with this equipment while meeting other specified requirements.

1. 24 V feeder circuit breakers.
2. 12 kV trolley circuit breakers.
3. 46 kV, two (2) pole autotransformer circuit breakers.
4. 5 MVA autotransformers.

C. Provide detailed design justification for the following equipment:

1. Protective relaying, local and remote controls, and local and remote metering including SCADA RTU.
2. Relay and control board.
3. Disconnect switches.
4. Current transformers, potential transformers and surge protection equipment. Use copper or copper alloy connectors and copper cables associated with these components. Use of aluminum cables or connectors is not allowed.

D. All primary and secondary wiring shall utilize copper conductors. Use of aluminum conductors is not permitted.

E. Include all calculations, technical data, shop drawings and other documentation as specified.

F. Fully interface all design work with the required civil and structural work on the Contract.

2.05 Intent of Contract Documents

A. The intent of the Contract Documents is to provide the scope of work in the Contract and provide necessary data and direction for the Contractor to perform the detailed design for construction.

B. The Contract documents do not indicate all fittings, hardware or appurtenances required for a complete operating installation.

C. The Contract Documents provide suggested construction phases to be followed in order to keep the substation in revenue operation during the execution of this Contract. This is not intended as a step by step procedure to be followed by the Contractor. The Contractor shall verify after performing the detailed field survey and engineering and design, and develop a detailed step by step phasing plan which can be implemented safely and without problems. The Contractor's detailed plan shall meet the SEPTA criteria for safety, working clearance and approval.

D. It is the responsibility of the Contractor to perform the work meeting the criteria laid down in the Contract Documents to the full satisfaction of SEPTA without additional protection or compensation.
2.06 Work Modification and Approval

A. All design, manufacture, delivery, installation and testing, as well as ancillary work on the Contract shall be subject to approval by SEPTA.

B. Perform any modifications to the SEPTA approved plan only with prior written approval from SEPTA.

C. No approval shall relieve the Contractor from meeting the requirements of the Contract Documents.

2.07 Contractor’s Responsibilities

A. The Contractor shall be fully responsible for all labor, labor supervision and materials required for design, manufacture, delivery, installation, testing and commissioning of the system.

B. The Contractor shall be fully responsible for coordination with other Contractors and agencies, compliance with the city, state and other agency requirements required for design, manufacture, delivery, installation, testing and commissioning of the system. The Contractor shall apply for, pay for, and obtain all permits and licenses required for execution of the work and placing the substation into revenue service in phases according to the requirements of those Contract Documents.

C. The Contractor shall provide services of a full time Electrical Engineer, licensed in the Commonwealth of Pennsylvania and experienced in traction power systems equipment and design, to coordinate the design of various traction power equipment with each other, with other disciplines, sign and seal shop drawings before submitting to SEPTA, and to coordinate compliance with the specified standards and all applicable, federal, state, city and local rules and regulations. The Power System Integrator (PSI) and the Traction Power Integrator (TPI) specified in Section 01010 can serve this requirement provided the person is full time on this Contract.

D. Submit resume of the Engineer to SEPTA for approval before the award of the Contract.

E. The Contractor shall have a design firm on its team to complete the 50% design to 100% and sign & seal the drawings. Contractor shall submit the resumes of the key personnel of the design team to SEPTA for approval.

F. The Contractor shall be responsible to bring the entire substation into full revenue operation to the full satisfaction of SEPTA after completion of all the contract work.

G. The Contractor shall be fully responsible for proper and safe disposal of all demolition and installation spoils in accordance with the applicable laws, regulations and procedures.

H. Insure all material and equipment against all liabilities up to the time of final system acceptance by SEPTA. Hold SEPTA harmless against any claim or suit resulting from equipment and materials disposal, manufacture, storage, shipping, installation, testing and commissioning of the substation equipment.

2.08 Products, Materials and Equipment

A. Provide only new and unused products, materials and equipment as approved by SEPTA.
B. Provide products, materials and equipment that are standard products of manufacturers regularly engaged in the production of such products, materials and equipment to the extent feasible except for provision of additional features that are required per these Specifications. Provide the manufacturer’s latest standard design that conforms to the Contract Documents.

C. Provide products, materials and equipment listed and labeled by an electrical safety testing laboratory acceptable to SEPTA where available and that meets the Specification requirements.

D. Where two (2) or more units of the same class of product, material or equipment are required, provide products from a single manufacturer. Incidental component parts of equipment are not required to be the products of the same manufacturer.

E. Where finish of products, materials and equipment is referenced or stated, provide the finish exactly as shown or specified. Where no finish or color is listed, provide the manufacturer’s standard finish, suitable for the environment intended and as approved by SEPTA.

F. Provide all products, materials and equipment designed to ensure satisfactory operation and operational life in the environmental conditions of the Project locale.

G. All materials and equipment are subject to inspection by SEPTA at any time.

H. Correct or replace at no additional cost to SEPTA any products, materials and equipment not in accordance with the Contract Documents or found to be deficient or defective.

PART 3 - EXECUTION

3.01 General Requirements during Manufacture

A. Perform all phases of equipment manufacture by qualified and experienced personnel using proper tools and equipment under competent supervision.

B. Manufacture and install all equipment to withstand and be capable of operation without impairment at the specified performance levels at the specified Contract conditions.

C. Select all equipment and hardware, including seals, elastomers and lubricants, suitable for the specified Contract conditions. Use only products and materials free of asbestos and other potentially harmful substances.

D. Procure materials and manufacture equipment and components based on the Contract Specifications and the Contractor’s final designs approved by SEPTA. Provide only service proven components, equipment and materials that are standard products of manufacturers regularly engaged in the production of such components, equipment and materials.

E. For equipment manufacture and fabrication use materials of the highest possible quality. Provide high grade workmanship conforming in all respects to the best manufacturing practices for electrification system equipment.

F. Locate and install all equipment to be readily accessible for operation and maintenance. SEPTA reserves the right to require minor changes in location of raceways or equipment for operational flexibility. The Contractor shall implement these changes at no additional cost to SEPTA.
G. All system components shall be capable of being maintained without impairment resulting from natural or induced environmental conditions within which SEPTA will operate the system.

H. Provide insides of all enclosures free of burrs and sharp edges.

I. Insure that no equipment is damaged during manufacture and factory testing and SEPTA will be the sole judge of whether the equipment can be repaired/reconditioned or new equipment will have to be manufactured if such damages do happen.

3.02 General Requirements during Installation

A. After obtaining from SEPTA Substation Maintenance categorical permission in writing to disconnect and remove each piece of equipment to be removed under this Contract, test and ensure that the equipment are de-energized prior to proceeding with the removal.

B. After removal and disposal of the equipment, per stage, per the governing codes, rules and regulations, proceed with the site clean-up meeting the environmental regulations.

C. Perform all civil and structural work including transformer foundations, pads for the breakers, underground conduit and duct bank installation.

D. Install all electrical equipment.

E. Install disconnect switches and surge arresters.

F. Install all cables and perform all necessary connections.

G. Install feeder and trolley connections.

H. Ground all traction power equipment.

I. Provide fully operational facility.

J. Perform all phases of equipment installation by qualified, licensed and experienced personnel using proper tools and equipment under competent supervision.

K. Insure that no equipment is damaged during shipment, storage, installation and field testing.

L. As required, install raceway stub-ups in accordance with field conditions and equipment shop drawings. Cap raceway runs with seals manufactured by the raceway manufacturer.

M. Securely fasten in place and protect all equipment and raceways against earthquakes.

N. Keep openings in boxes or equipment closed during construction.

O. Install equipment using procedures defined in NECA Standard of Installation.

P. Energize any space heaters in equipment or provide temporary heat.

Q. Construction progress and workmanship quality is subject to inspection by SEPTA at any time.

R. Correct any work not in accordance with the Contract Documents and the Contractor's detailed design drawings or found to be deficient or defective at no additional cost to SEPTA.
3.03 Protection of Products during Construction
A. Provide protection of products against loss or damage.
B. Protect all products from the effects of weather. Prior to installation, store products in clean, dry, indoor locations.
C. Store items subject to corrosion and items containing insulation, such as conductors, in a clean, dry, heated, indoor location.
D. Following installation, protect products from corrosion, dust, dirt, physical damage and the effects of moisture.
E. Ensure that operating portion of the substation is unaffected by the construction activities and safety of the workers is fully taken care of.

3.04 Equipment Installation
A. The Contractor shall develop detailed installation procedure with detailed step by step methods for all the work including general requirements for Installation specified above and included in the scope of Contract and submit the installation procedure to SEPTA for approval prior to commencement of any field work.
B. The procedure shall clearly show that the substation will be in revenue operation during the entire period of construction under this Contract. Without the approved installation procedure, the Contractor will not be allowed to perform any field work.
C. Any substation de-energization must be approved by SEPTA. Coordinate with SEPTA for the details of advance request.

3.05 Testing
A. Factory Testing:
   1. Perform comprehensive tests of all components and equipment during the manufacturing process and upon its completion.
   2. Perform all factory design and production tests as specified in the individual equipment sections in accordance with specified standards.
   3. All test reports shall be submitted to the SEPTA Project Manager for review and approval.
   4. Do not proceed with the production of equipment until satisfactory completion of design tests and approval by SEPTA.
B. Field Testing:
   1. Perform system installation inspection upon completion of all installation work for each phase.
   2. Perform field testing prior to system energization and tests following system energization as specified in Section 16952.

END OF SECTION
THIS PAGE NOT USED
SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 Description

A. This Section covers requirements for the design, furnishing, installing and testing the grounding and bonding of indoor and outdoor electrical equipment, manholes, handholes, pull boxes, junction boxes, fences, metallic structures, enclosures and overhead distribution system take off structures and gantries.

B. Measure the soil resistivity at each substation and perform a ground grid design study. Refer Section 16052. Design supplemental ground grid in accordance with IEEE 80. Calculate step and touch potentials and ground grid resistance to remote earth.

C. Excavate to the level of existing grid.

D. Install new ground grid, new ground rods, new ground meshes, new grounding wires, new grounding pigtails, new personal safety mats, new ground busbars, new grounding lugs and fittings.

E. Ground all equipment and structures as specified and bond the new ground grid to the existing ground grid.

F. Provide additional clean low resistance backfill, as specified herein.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 02220 – Excavating, Backfilling and Compacting

C. Section 05090 – Metal Fasteners, Joining and Welding

D. Section 16050 – Basic Electrical Material and Methods

E. Section 16052 – General Electrical Requirements - Traction Power Equipment

F. Section 16120 – Conductors and Cables

G. Section 16952 – Electrical Testing - Traction Power Equipment (RRD)

1.03 Submittals

A. Meet the submittal requirements of the general electrical work section and the general provisions.

B. Submit the following documents and samples for the SEPTA review and approval:

1. Ground grid calculations and grounding plan. Include the location of pigtails for connection to the equipment, steel structures, fence and existing ground grid.

2. Description of exothermic welding process.

3. Description of jointing process.
4. Test Procedures:
   a. Test procedure for measuring ground grid resistance.
   b. Test procedure for measuring electrical continuity of the grounding system.

5. Test Reports:
   a. Ground grid resistance.
   b. Results of electrical continuity measurements.

6. Product Data:
   a. Grounding conductors and pigtails.
   b. Ground rods.
   c. Mesh and personal safety mats.
   d. Ground busbars.
   e. Connectors, compression joints, lugs and fittings.
   f. Exothermic welding molds, weld metal and electronic ignitor.
   g. A test report demonstrating that the ignitor meets standard requirements for electromagnetic and electrostatic compatibility, including radiated emissions and electrostatic discharge.

7. Shop Drawings:
   a. Ground grid layout.
   b. Location plan of ground rods, connectors and pigtails. Assume responsibility for provision of all ground rods, connectors and pigtails.

8. Submit a sample of each type of mechanical and compression connectors proposed, along with a description of its intended use.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM B 3, Standard Specification for Soft or Annealed Copper Wire.
11. UL 44, Thermoset-Insulated Wires and Cables.
12. UL 83, Thermoplastic-Insulated Wires and Cables.
13. UL 467, Grounding and Bounding Equipment.
14. UL 486A/B, Wire Connectors.
15. UL 486C, Splicing Wire Connectors.
17. UL 486E, Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
18. UL 506, Specialty Transformers.

1.05 System Requirements
A. Provide a complete grounding and bonding system including all grounding electrodes, electrode conductors, equipment grounding conductors, bonding jumpers, grounding bushings, connections and other materials that may be required.
B. All raceway, cable tray and non-current carrying metal equipment and enclosures shall be continuous and bonded to the grounding system.
C. The grounding and bonding system shall be as indicated on the Contract Documents and shall meet the requirements of NEC Article 250.
D. The grounding system shall provide a resistance to earth not exceeding the design value or five (5) ohms, whichever is less.

PART 2 - PRODUCTS

2.01 Basic Grounding Materials
A. Grounding Conductors:
   1. Use class B stranded, No. 4/0 AWG minimum, annealed copper conductors, meeting ASTM B 3 for the ground grid and for all non-flexible grounding connections.
   2. Use braided copper conductors, No. 4/0 AWG minimum, for all pigtails and flexible grounding connections.
   3. All connections shall be capable of carrying the rated short circuit current.
   4. Aluminum conductors are prohibited.
   5. Use of splices is allowed only with prior approval from SEPTA.
B. Insulated conductors to meet the requirements for 600 V system grounding. Provide green insulation for conductors No. 2 AWG and smaller, and black insulation with green taped ends for conductors larger than No. 2 AWG.
C. Use steel ground rods copper clad by the molten weld casting process. Use 3/4 inch diameter, 10 foot or 20 foot long rods. Achieve this length by UL approved splicing or welding of two (2) 10 foot or four (40) 5 foot ground rods. The Contractor to determine ground rod length based on field conditions.
D. Busbars for grounding shall be minimum 2 inch x 1/4 inch meeting ASTM B 187/B 187M, 98 percent conductivity copper, minimum.

E. Ground Mesh:
   1. Provide 2 foot x 2 foot cell, 8 feet x 8 feet total size, No. 6 AWG solid copper conductor meshes for grounding the grid at corners.
   2. Provide 2 foot x 2 foot, 4 foot wide mesh rolls, No. 6 AWG solid copper conductors, for fence grounding.

F. Personal Safety Mats:
   1. Provide 3 foot x 4 foot personal safety wire mats prefabricated with No. 4 AWG solid copper conductors spaced 6 inches apart.
   2. Provide mats with center wire suitable for connection to ground grid pigtail.

G. Provide polymer concrete ground grid access well with cover.

H. Accessories:
   1. Lugs:
      a. Select suitable lugs for attaching grounding conductors to equipment or metallic surfaces.
      b. Use UL listed NEMA two (2) hole, compression type lugs manufactured of tin plated or silver plated copper. Exothermically weld or install the lugs with a hydraulic tool.
   2. Use stainless steel or silicon bronze bolts and braided, flexible tin plated copper jumpers.

2.02 Exothermic Welding Materials

A. Molds:
   1. Use synthetic graphite material molds capable of withstanding high temperatures generated during the welding process.
   2. Use molds bearing permanent marking indicating the name of manufacturer, type and size of welding mixture compatible with the welding process, and the size of cable or bus connection.
   3. Select molds furnished with safety information, connection preparation and welding procedure.

B. Weld Metal:
   1. Use weld metal consisting of copper oxide.
   2. Weld metal packages shall identify the type of weld metal and the metals to be connected.

C. Electronic Ignitor:
   1. Provide rugged and water resistant ignitor meeting the requirements of UL 506, IEC 61000 series of standards.
   2. Provide the ignitor with a high intensity LED indicator viewable in sunlight. Provide the unit with an overvoltage protection.
3. Provide field replaceable, No. 18 AWG, one hundred and forty-two (142) strand, individually insulated, copper leads.

2.03 Manufacturers

A. Manufacturers:
   1. Harger.
   2. Erico.
   3. Thermoweld.
   4. Burndy.
   5. Thomas and Betts.
   6. Ilsco.
   7. Ideal Industries.
   8. Or Approved Equal.

PART 3 - EXECUTION

3.01 Site Work

A. Excavation:
   1. Clear the substation or switching station site. Excavate to the existing ground grid and prepare subgrade by leveling and compacting soil. Should rock be encountered, over excavate.
   2. Allow for equipment footings, foundations, slabs and transformer oil containment system.

B. Ground Grid Installation:
   1. Construct the grounding grid per the approved design using copper conductors arranged to form a mesh.
   2. Following installation of ground grid conductors, ground rods and pigtails, notify SEPTA prior to backfilling the ground grid. Place no backfill, concrete or asphalt until inspection by SEPTA is completed and the grounding installation is approved.
   3. Install ground rods, ground meshes, grounding wires, grounding pigtails, grounding lugs and fittings. Weld exothermically all underground wire cross, tee, pigtail and ground rod connections.
   4. Install three (3) 2 foot x 2 foot cells, 8 feet x 8 feet total size, No. 6 AWG solid copper conductor meshes at each ground grid corner. Weld the meshes to the ground grid.
   5. Bond the new grid to the existing ground grid.

C. Backfilling:
   1. Provide 12 inches minimum of clean low resistance compacted soil, free from debris and rocks, on top of the ground grid conductors.
2. The backfill shall be a mixture of surface soils and loam with limited amount of sand and gravel such that the resistivity does not exceed one hundred (100) ohm-meters. Compact the backfill.

3. Protect grounding conductors, ground rods, pigtails and fittings from damage at all times during installation and backfilling by isolation from other construction activities. Avoid driving of any kind of vehicle over grounding conductors, ground rods and pigtails.

D. Crushed Rock:

1. Following installation of equipment foundations, equipment footings, provide 4 inch depth, minimum, layer of crushed stone or pebbles within the station areas not covered by concrete and asphalt.

2. Extend the layer of crushed stone or pebbles 6 feet, minimum, beyond the station fence. Contractor to determine final distance based on field conditions and site locations.

3.02 General Grounding Requirements

A. Provide all grounding as required by this Specification and shown on the Contract Drawings.

B. Weld all ground grid connections exothermically, including tees, crosses, pig tail connections and ground rod connections. Compression or mechanical connections underground are prohibited.

C. Prior to welding to exposed structural steel, remove epoxy coating from the steel at the location of grounding conductor connection. Following completion of the weld, reapply epoxy coating to exposed surfaces of the steel.

D. Compression type or mechanical connections may be used in dry, above grade locations with the approval of SEPTA. Attach lugs to items being grounded with stainless steel or silicon bronze bolting hardware.

E. Protect grounding conductors from physical and environmental damage. Wherever possible, enclose grounding and bonding conductors in non-metallic raceways. Where conductors are required to be exposed, support grounding conductors by corrosion resistant metallic hardware at 4 foot intervals or less.

F. Use bi-metallic strips and oxide inhibiting compound for all mechanical connections where copper to aluminum or copper to steel connections are made. Abrade all contact surfaces prior to application of the inhibiting compound and before attachment of the bolted connection. Apply the compound to all copper, aluminum and steel parts.

G. Make all grounding and bonding connections by continuous grounding conductors via shortest possible route and without splices, or unnecessary bends and kinks in the conductors.

3.03 Exothermic Welding

A. Clean and dry the surfaces to be welded. Wire brush or file the points of contact to clean bare metal surfaces.

B. Use suitable welding cartridges and molds for the type of weld performed. Perform welding in accordance with the manufacturer's recommendations. Discard worn or damaged molds.
C. Place powdered welding metal in the mold along with the conductors to be welded. Ignite the powder to produce molten copper to weld the conductors to each other or to a surface.

D. After welds have been completed and cooled, brush slag from the weld area and thoroughly clean the joint.

E. Where exothermic grounding connections made between copper wire and steel surfaces are direct buried, coat the connection with a Coal Tar Epoxy (CTE) coating per before backfilling. Also, coat the entire area of the steel surface disturbed by the exothermic welding.

F. Where exothermic welds are made to a galvanized surface, remove the galvanizing and expose a clean surface by grinding wheel. After welding, touch up the steel surface with zinc rich primer.

G. Test all welds by striking with a two (2) pound steel hammer. Replace any defective welds.

3.04 Perimeter Fence Grounding Installation

A. Install one (1) No. 4/0 AWG bare copper grounding conductor along the entire perimeter of the fence, on the inside of the fence, at a depth of 2 1/2 feet below grade, except in the area where the fence crosses the ground grid as shown on the Contract Drawings.

B. Install 2 foot x 2 foot cell, 4 feet wide rolls, No. 6 AWG solid copper conductor mesh 6 inches below grade, around the inside and outside of the entire perimeter of the fence, except in the area where the fence crosses the ground grid.

C. Provide a ground on the top rail of the perimeter fence at every vertical post via #2 stranded copper conductor. The conductor shall also be connected to the mesh.

3.05 Personal Safety Mat Installation

A. Install personal safety mat 6 inches below grade at all locations where an operator is likely to stand while operating a disconnect switch or circuit breaker. Move the location of the safety mats if the location of the operating handles of the switches is changed.

3.06 Ground Rod Installation

A. Install ground rods as shown on the Contract Drawings. Install ground rods in line with top of the grid.

B. If extensive rock formation is encountered, inform SEPTA and obtain direction to relocate the ground rods or provide supplemental ground rods. Supplemental ground rods are those needed in addition to the grounding system as shown on the Contract Drawings to make the grounding system conform to the design calculations.

C. Connect ground rods to grid conductors using exothermic welding.

3.07 Ground Grid Access Well Installation

A. Install one (1) ground rod in the well to enable measurement of the ground grid resistivity.

B. Weld the ground rod to the ground grid.
3.08 Pigtail Installation

A. Provide flexible conductor pigtails required for the following connections:
   1. Ground grid to substation or switching station indoor and outdoor electrical equipment.
   2. Ground grid to ground busbars.
   3. Ground grid to personal safety mats.
   4. Grounding conductor to fence grounding mesh.
   5. Grounding conductor or ground grid to fence posts and fence mesh.

B. Install “pigtails” as shown on the Contract Drawings. Protect all pigtail conductors with stubbed-up conduits.

C. Install pigtails of the following minimum lengths:
   1. Roof mounted equipment pigtail to be 45 feet long measured from the foundation stubbed-up grounding conduit.
   2. Perimeter fence pigtail to be 5 feet long measured from the grounding wire.
   3. All other equipment pigtails to be 15 feet long measured from the foundation stubbed-up grounding conduit.

D. Coordinate pigtail stub up location with the Contractor to ensure that all equipment is grounded as specified.

E. Indoor and Outdoor Equipment:
   1. Provide minimum of two (2) pigtails from ground grid to each grounding busbar.

F. Electrical Equipment Yard Fence Pigtails:
   1. Install pigtails from ground grid to enable the following:
      a. Grounding of each fence corner post.
      b. Grounding of each fence gate post.
      c. Grounding every fence third post.
      d. Grounding of the fence mesh between grounded posts.

G. Perimeter Fence Pigtails:
   1. Location of fence within the area of ground grid:
      a. Install pigtails from ground grid to enable the following:
         1) Grounding of each fence gate post.
         2) Grounding every fence third post.
         3) Grounding of the fence mesh between grounded posts.
   2. Location of fence outside of the area of ground grid:
      a. Install pigtails from grounding conductor to the inside and outside mesh every 8 feet.
      b. Install pigtails from the grounding conductor to enable the following:
         1) Grounding of each fence corner post.
         2) Grounding of each fence gate post.
         3) Grounding every fence third post.
4) Grounding of the fence mesh between grounded posts.

3.09 Perimeter Fence Grounding Installation
A. At each end of the fence mesh, weld the grounding conductor and the inside and outside meshes to the ground grid.
B. Weld the inside and outside meshes to the pigtails welded to the grounding conductor.
C. Connect the pigtails from the ground mat and grounding conductor to the fence poles and fence meshes as shown on the Contract Drawings.
D. Ground the corner posts, every third post, gate posts and the fence mesh to the pigtails connected to the ground grid or the ground wire.
E. Ground the fence gates to the fence posts with soft braided copper conductor as shown on the Contract Drawings.
F. Bond each entrance gate post located at street elevation to the corner fence post at the substation or switching station elevation.
G. Bond the barbed wire to every corner posts, every third post and gate posts.

3.10 Personal Safety Mats Installation
A. Weld the personal safety mats to the pigtails.

3.11 Substation or Switching Station Ground Bus
A. Provide substation or switching station ground busbar mounted on the gantry, as shown on the Contract Drawings, for connection of the following equipment:
   1. Transformer and autotransformer neutrals.
   2. Traction power return conductors.
   4. Neutrals of service transformer and potential transformers.
B. Support the ground bus on steel structure at 4 foot intervals by standoff insulators.

3.12 Autotransformer Grounding
A. Ground each autotransformer tank at two (2) diagonally opposite corners to the grounding busbar.
B. Connect each autotransformer neutral to the rail return bus.
C. Solidly connect the rail return bus directly to the substation grounding grid by two (2) pigtails in addition to the ground bus.

3.13 Raceway Bonding and Grounding
A. Bond all metallic raceways together to provide a continuous metallic electrical path to ground. Bond metallic raceways to other raceway components using insulated grounding bushings. Connect grounding bushings to the grounding system using conductors sized in compliance with NEC.
B. All metal conduits, raceways, pull boxes and cable shields shall be bonded and connected to the ground bus.

C. Install grounding conductors in non-metallic raceway systems in accordance with the NEC.

3.14 Disconnect Switch and Arrester Grounding

A. Disconnect Switch:
   1. Connect disconnect switch support structure to the gantry ground bus.
   2. Connect the grounding switch to the gantry ground bus.
   3. Connect the disconnect switch operating handles to the support structure with flexible braided conductors.

B. Surge Arrester:
   1. Connect each surge arrester to the gantry ground bus.

3.15 Control Room Grounding

A. Provide ground bus inside the control rooms around the entire perimeter.

B. Solidly connect the control room ground bus to the substation or switching station ground bus at each corner of the room.

C. Solidly connect all equipment enclosures, compartments, cases, doors and panels directly to the ground bus of the control room.

3.16 Electrical Yard Fence Grounding

A. Ground the corner posts, every third post, gate posts and the fence mesh to the pigtails connected to the ground grid.

B. Ground the fence gates to the fence posts with soft braided copper conductor as shown on the Contract Drawings.

3.17 Tests

A. Perform grounding tests of the completed ground system.

B. Measure the substation or switching station ground grid resistance before foundation installation. If the measured resistance is higher than the design value or five (5) ohms, install additional ground rods to bring the resistance down to the design value or lower.
SECTION 16070
HANGERS, ANCHORS AND SUPPORTS

PART 1 - GENERAL

1.01 Description
A. This Section covers hangers, anchors and supports as specified herein for use in substations.
B. Types of hangers, supports, anchors and seals in this Section include the following:
   1. Hanger rod attachments.
   2. Building attachments.
   4. Anchors.
C. Supports, anchors and seals furnished as a part of factory fabricated equipment are specified as part of the equipment assembly in other sections of this specification.

1.02 Related Sections
A. Section 01300 – Submittals

1.03 Submittals
A. Shop drawings and manufacturer’s literature shall be submitted in accordance with Section 01300.
B. Submit catalog cuts, specifications, installation instructions and dimensioned drawings for each type of support, anchor and seal.

1.04 Quality Assurance
A. Products shall be provided which are Underwriter Laboratories listed and Factory Mutual approved.
B. Meet the applicable provisions of the most recent issues of the following references:
   2. MFMA-4, Metal Framing Standards Publication.

PART 2 - PRODUCTS

2.01 Hanger Rod Attachments
A. Except as otherwise indicated, factory fabricated hanger rod attachments shall be provided in compliance with MSS SP-58. Only one (1) type by one (1) manufacturer shall be used for each service. Size of hanger rod attachments shall be selected to suit hanger rods.
B. Steel turnbuckles to be MSS Type 13.
C. Steel clevises to be MSS Type 14.
D. Swivel turnbuckles to be MSS Type 15.
E. Malleable iron sockets to be MSS Type 16.
F. Steel weld-less eye nuts to be MSS Type 17.

2.02 Building Attachments

A. Building attachments shall be coordinated with the prefabricated building design.
B. Steel strut shall be galvanized steel type channel, 1 5/8 inch or larger on a side, complete with spring nuts, clips, conduit clamps, bolts and accessory fittings.

2.03 Manufacturers of Hangers and Supports

A. Subject to compliance with requirements, hangers and supports shall be provided from one (1) of the following manufacturers:
2. Carpenter and Patterson, Inc.
3. Elcen Metal Products Co.
6. ITT Grinnell Corp.
7. Or Approved Equal.

2.04 Miscellaneous Materials

A. Metal framing products to meet MFMA-4.
B. Steel plates, shapes and bars to meet ASTM A 36/A 36M.

PART 3 - EXECUTION

3.01 Preparation

A. Installation of hangers, supports and anchors shall proceed only after required building structural work has been completed in areas where the work is to be installed. All inadequacies shall be corrected at no additional cost to SEPTA.

B. Prior to installation of hangers, supports, anchors and associated work, the Contractor shall meet at Project site with the installer of each component of associated work, inspection and testing agency representatives and the installers of other work requiring coordination with work of this Section and SEPTA for the purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.
3.02 Installation of Building Attachments
   A. Building attachments shall be installed at required locations on structural steel for proper equipment support. Additional building attachments shall be installed where support is required for additional concentrated loads.
   B. Note variation on prefabricated building as-built drawings.

3.03 Installation of Hangers and Supports
   A. Hangers and supports shall be installed complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated, hangers and supports shall be installed of same type and style as installed for adjacent similar equipment.
   B. Adjust supports to allow adequate clearances between equipment.

END OF SECTION
THIS PAGE NOT USED
SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 Description
A. Provide electrical equipment identifications consisting of the following:
   1. Nameplates.
   2. Labels.
   3. Identification signs.
   4. Warning signs.

1.02 Related Sections
A. All requirements that are described in Division 1.
B. Section 01452 – Contractor Quality Control - Traction Power Equipment
C. Section 01612 – Delivery, Storage and Handling - Traction Power Equipment
D. Section 01752 – Spare Parts and Maintenance Manual Traction Power Equipment
E. Section 01822 – Demonstration and Training - Traction Power Equipment
F. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment
G. Section 05090 – Metal Fasteners, Joining and Welding
H. Section 09910 – Paints and Coatings
I. Section 16050 – Basic Electrical Materials and Methods
J. Section 16060 – Grounding and Bonding
K. Section 16240 – Battery Equipment
L. Section 16290 – Protective Devices and Instrument Transformers
M. Section 16310 – Transmission and Distribution
N. Section 16335 – Surge Protection
O. Section 16440 – Panelboards
P. Section 16791 – Combined Relay and Control Switchboard
Q. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit - Including HMI
R. Section 16952 – Electrical Testing - Traction Power Equipment (RRD)

1.03 Submittals
A. Submit the following documents to the SEPTA Project Manager for review and approval:
   1. Tabulation of all equipment that require nameplates.
2. Drawings of all nameplates.
3. Text of all labels and signs.
4. System for numbering control wires and cables.
5. System for numbering of terminal blocks.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Nameplates:
   1. Provide all major items of equipment, such as autotransformers, circuit breakers, and relay and control panels with permanent nameplates identifying the equipment, relevant parameters, manufacturer and other appropriate information such as serial numbers.
   2. Design the nameplates in accordance with applicable IEEE, ANSI and NEMA standards.

B. Labels:
   1. Provide equipment cubicles and wall mounted equipment with black lamicoid labels. Provide primary equipment description using white lettering 2 inches high and secondary description using lettering 3/4 inch high.
   2. Identify all external and internal devices mounted on enclosure doors and panels, such as protective relays, auxiliary relays, control switches, instruments, transducers, indicating lights, test blocks, terminal blocks and fuse blocks with engraved labels. Securely attach labels in the vicinity of the device.
   3. Provide control wires and cables with identification numbers.
   4. Provide terminal blocks with identification numbers.

C. Identification Signs:
   1. Provide the following equipment identification signs, as appropriate:
      a. Autotransformer No.
      b. 46KV autotransformer circuit breaker No.
      c. 24 KV feeder circuit breaker No.
      d. 12 KV trolley circuit breaker No.
      e. 24 KV feeder circuit breaker control and relay panel No.
      f. 12 kV trolley circuit breaker control and relay panel No.
      g. Panelboards.
      h. Cables at all termination points including those in the manholes or handholes.
      i. Control wires at all termination points.
   2. Provide identification signs for the following additional facilities and equipment:
      a. Switchboard cubicles.
      b. Panelboards.
      c. Transformers.
d. Remote Terminal Unit (RTU) and SCADA interface cabinet.
e. Battery equipment.
f. Communication equipment.
g. Disconnect switch and grounding switches and their operating rods at ground level.

D. Warning Signs:

1. Provide graffiti resistant, stain resistant and airborne pollutant resistant signs. Select easily cleanable signs with high resistance to abrasion, bleach cleaning agents and fading due to UV radiation present in sunlight.

2. Provide "Danger High Voltage & Arc Flash Hazard" warning signs of size not less than 12 inches x 12 inches, at following locations as a minimum:
   a. Outdoor circuit breakers.
   b. Switchyard fence.
   c. Protective mesh on building roof, if applicable.
   d. Around the entire perimeter of each substation or switching station.

3. Provide a sample of each warning sign for review and approval by SEPTA.

PART 3 - EXECUTION

3.01 Preparation

A. Clean all surfaces in preparation for attaching the nameplate.
B. After drilling tap holes, clean off all metal filings and oil residue.

3.02 Installation, Application and Execution

A. Attach all nameplates, labels and signs with non-corrosive screws.
B. Color code 600 Volt and below power conductors as indicated in Table 16075-1.

<table>
<thead>
<tr>
<th>Phase</th>
<th>208/120 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Black</td>
</tr>
<tr>
<td>B</td>
<td>Red</td>
</tr>
<tr>
<td>C</td>
<td>Blue</td>
</tr>
<tr>
<td>N</td>
<td>White</td>
</tr>
<tr>
<td>EGC</td>
<td>Green</td>
</tr>
</tbody>
</table>

C. Color code communications cables as indicated by industry standards.

END OF SECTION
THIS PAGE NOT USED
SECTION 16120

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of material and labor for furnishing, installing, connecting, energizing, testing, cleaning and protecting communications cable and accessories, none of which can be replaced by smaller or lesser current-carrying-capacity product than that which is being removed.

1.02 Related Sections

A. Section 01600 – Materials and Equipment
B. Section 16060 – Grounding and Bonding
C. Section 16075 – Electrical Identification
D. Section 16950 – Testing

1.03 Submittals

A. Submit with all product data evidence of testing agency/quality verification, listing and labeling either by printed mark on the data or by a separate listing card. If not available, provide from the product manufacturer a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.

B. Submit product data for the following products; indicate clearly the Contract specific usage of each product:
   1. Conductors and cables, along with installation details and the detailed conduit and cable schedules.
   2. Termination and splices.

C. Tensions Calculations:
   1. Submit cable pulling calculations for all underground runs. Calculations shall include both pull load and tensions, along with safety factors, for all cables.
   2. Design conduits runs so as not to exceed tension limits of the manufacturer.

D. Record actual installed lengths and locations, both concealed and exposed work, on the record drawings.

E. Submit record drawings, product data, and installation and maintenance instructions for project closeout.
1.04 Quality Assurance

A. Unless products meeting the requirements of nationally recognized testing laboratories are not readily available for a category of products, provide products that are listed and labeled by Underwriters Laboratory (UL), or certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory (ETL).

B. All work to meet the regulatory requirements of all state and local codes and requirements.

C. Install work under the supervision of skilled licensed electricians.

D. Meet the applicable provisions of the most recent issues of the following references:
   1. ANSI/TIA 568C: Commercial Building Telecommunications Cabling Standards
   2. ASQC C1, Specification of General Requirements for a Quality Program.
   3. ASTM B 3, Standard Specification for Soft or annealed copper wire
   5. ASTM B 33, Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
   11. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
   12. NEMA WC 26, Binational Wire and Cable Packaging Standard.
   13. NFPA 70, National Electrical Code (NEC).
   15. UL 13 - Power-Limited Circuit cables
   16. UL 83, Thermoplastic-Insulated Wires and Cables
   17. Telecordia GR-20: Generic Requirements for Optical Fiber and Optical Fiber cable
   18. ANSI/TIA 568 C.3 Fiber Cabling Component Standard

1.05 Delivery, Storage and Handling

A. Delivery, store and handle materials and products in strict compliance with manufacturer's instructions and industry standards
B. Protect items from damage during delivery, storage and handling in accordance with Section 01600.

C. Test and inspect cable upon receipt to ensure cables are not damaged during delivery.

D. Packaging of wire and cable to meet NEMA WC 26.

1.06 Qualifications

A. Fire specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

1.07 Field Samples

A. Provide one (1) 36 inch long sample of each type of wire to be used.

PART 2 - PRODUCTS

2.01 General Requirements for Single-Conductor and Multi-Conductor Communication cable

A. Rated voltage: 600 Volts

B. Conductors

1. ASTM B3 or B8 annealed copper

2. Size 10 AWG and smaller: Solid or Class B or Class C Stranded copper

3. Size 8 AWG and larger: Class B Stranded copper

C. Insulation shall be cross-linked polyethylene (XLPE) insulated cable

D. Cable UL-Listed as follows

1. Non-metallic-sheathed cable: Type TC, suitable for wet and dry locations

2. Metallic sheathed cable: Type MC, suit for wet and dry locations.

E. Provide twenty-five (25) pair No. 19 AWG and fifty (50) pair No. 22 AWG communication cable suitable for outside plant cable in duct banks and through manholes.

F. Provide two (2) and twenty-five (25) pair No. 22 AWG communication cable for indoor/outdoor cable in the prefabricated building. Use sun resistance, flame-retardant, dual-rated, insulation labeled as Gasoline and Oil Resistant II.

G. Provide four (4) pair UTP cable per Article 2.02 in this Section.

H. Provide outside plant cable with gel flooded core for protection outside element blocking compound, filling the air space between the insulated conductors.

I. Outside and inside plant cable shall be provided with an overall 0.005 inch thick corrugated solid copper tape shield applied longitudinally with overlap to provide 100 percent electrical shielding coverage.

J. Each outside plant cable shall be provided with an outer jacket of black UV resistance, low density, high molecular weight virgin polyethylene, compounded to withstand sunlight, temperature variations and other environmental conditions, as well as installation handling
without damage. Jacketed cable shall be rated for a combination of aerial, lashed, in conduit or underground duct or direct burial applications.

K. Each inside plant cable shall be provided with a light grey jacket of the standard type produced by the manufacturer for telephone applications, except UTP Ethernet cable.

L. Imprint the jacket with the date of manufacture, wire type and the manufacturer’s name.

M. Wire and cable manufactured more than twelve (12) months before delivery to the job site shall not be used.

N. Manufacturers:
   1. Clifford of Vermont, Inc.
   2. Okonite
   3. Or Approved Equal.

2.02 Unshielded Twisted Pair (UTP) Data Cable

A. Provide inside plant cable which meets the following:
   1. Cable fabricated using solid No. 24 AWG un-coated copper conductors with polyethylene insulation, color coded conductor insulation and overall PVC jacket.
   2. Unshielded cable with controlled dielectric properties for Ethernet category 5E of better.
   3. UL listed with a blue jacket.
   4. Dry (Not flooded).
   5. Manufacturers:
      a. Belden Corporation.
      b. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Inspect conduits, junction boxes and manholes for cleanliness, lack of burrs, alignment and completeness. Correct deficiencies before proceeding.

B. Ensure that grounding fittings are installed at places called for in Section 16060.

C. Swab conduits with a nylon bush and steel mandrel.

D. Ascertain that pulling calculations have been made and are available for long runs and pulls indicated in this Section. Ascertain that a means of controlling pulling tension is installed on mechanical assist devices for pulling cable.

E. Pre-lubricate conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.

3.02 Installation

A. General:
1. Install all wiring outside of equipment in conduit. For the SCADA indications for disconnect switches at structures, make control cable splices from larger count to smaller count cables within a sealed splice/pull box within the manholes adjacent to the structures.

2. Do not perform wiring work until other work that might cause damage to the wires, cables or conduits has been completed. Take the necessary precautions to prevent the accumulation of water, dirt or other foreign material in the conduits during the execution of the work.

B. Cable Pulling:

1. Meet the manufacturer’s recommendations for the inspection, handling, storage temperature conditioning prior to installation, bending and training limits, pulling limits and calculation parameters for installation of all cable. Use quadrant blocks located properly along the cable run. Remove from the job site and replace all cables that were subjected to excessive bending and tension and all cables that are cracked or have damaged or nicked outer jackets.

2. Pull cables down grade with the feed-in point at the manhole, handholes or buildings of the highest elevation. Flexible cable feeds shall be used to convey cables through the manhole opening and into the duct runs. Lubricate all cables during pulling with lubricants specifically recommended by the cable manufacturer.

3. Limit cable pulling tensions to the maximum pulling tensions recommended by the cable manufacturer. Use dynamometer to measure pulling tensions on all runs pulled with mechanical assistance and for all runs where calculations are required to be submitted. If pulling tension is exceeded during pulling, cables shall be removed and marked as defective and not reused.

4. Install cables in manholes along the wall providing the longest route to the maximum spare cable lengths. Form cables to closely parallel walls so as not to interfere with duct entrances. Support cable on brackets and insulators at a maximum of 2 feet apart. Lubricants must be used and must be approved by the cable manufacturer.

C. Wiring Identification:

1. Color code wires and cables as specified in Section 16075.

2. Identify all control wiring and wire numbers corresponding to record drawings.

D. Wire and Cable Splices:

1. Splices between termination points are prohibited without prior written authorization of the SEPTA Project Manager. The intent of this Section is to prohibit intermediate splices unless they are explicitly shown on the Contract Drawings.

3.03 Field Quality Control

A. Conduct verification field tests prior to energizing cables or utilizing fibers prior to final tests specified in Section 16950.
SECTION 16121
MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.01 Description

A. This Section specifies furnishing, installing, testing and terminating of medium voltage traction power, single conductor shielded power cable.

1. Shielded medium voltage traction power cables that are suitable for use in wet or dry locations in conduit, underground duct system and aerial installation. The cable shall be rated 105°C for normal operation, 140°C for emergency overload operation and 250°C for short circuit conditions. The following cables are required:

a. 1/C – 25 kV shielded cable (150 kV BIL), for connection between SEPTA’s 12 kV, 25 Hz, trolley feeder and 12 kV circuit breaker.

b. 1/C – 46 kV shielded cable (250 kV BIL), for connection between SEPTA’s 24 kV, 25 Hz, traction power feeder and 24 kV feeder circuit breaker.

c. 1/C – 69 kV, shielded cable is an acceptable substitute for the 46 kV shielded cable if manufacturing small quantities is an issue. If 69 kV shielded cable is provided, furnish and install terminations appropriate for the cable construction and 46 kV (250 kV BIL).

2. Provide all accessories and terminations.

B. This Section specifies furnishing, installing, testing and terminating of 1/C – 25 Hz, 2 kV rail return circuit traction power cables.

1. Underground in duct bank and as direct burial from the rail return cabinet in the substation or switching station to impedance bonds in between rails of track.

2. Underground in duct bank from the rail return cabinet to a splice point with existing rail return cables.

C. The Contractor to provide new medium voltage cables to match what presently exists at each substation or switching station location.

1.02 Related Sections

A. Section 01300 – Submittals

1.03 Submittals

A. The Contractor shall submit the following shop drawings and data for the SEPTA Project Manager’s review in accordance with Section 01300:

1. Submit shop drawings, catalog cuts and other forms of descriptive data delineating the construction of the cables specified herein.

2. Submit certified dimensioned cable cross section diagram, maximum recommended pulling tension and cable weight.

3. Submit installation and test instructions.

4. Submit special storage instructions, if applicable.
5. Submit recommended pulling lubricants, compatible with the jacket and semiconducting shield materials.

6. Submit pulling calculations for all cables whose total run exceed 300 feet, or have exceeded 270 degrees in total pulling angle, for review by SEPTA's Project Manager.

7. Submit recommended termination materials and procedures.

8. The Contractor shall submit five (5) certified copies of test reports of all the tests conducted at the factory and in the field for the SEPTA Project Manager's approval. Test reports shall be submitted to SEPTA within two (2) weeks after completion of tests. In case of "Factory Tests", test reports shall include original data, detailed calculation of test data to arrive at the results and interpretation of results. Test reports shall contain the characteristics, curves, etc. where required for interpretation of results. Authorization to ship will not in any way relieve the Contractor of this responsibility under this Contract.

9. Submit certificate certifying that the cables meet the requirements specified herein, meet the standards designated herein and that the cables have been tested as specified herein.

10. Following Contract award, the Contractor shall submit the following technical data for each cable specified in this Specification for approval of the SEPTA Project Manager. The characteristics of the cable shall be fully explained by providing the following information:
   a. Conductor stranding.
   b. Conductor material.
   c. Conductor coating.
   d. Insulation material.
   e. Insulation thickness in mils.
   f. Shielding:
      1) Conductor in mils.
      2) Insulation (non-metallic) in mils.
      3) Insulation (metallic) in mils.
   g. Maximum Copper Temperature:
      1) Continuous in °C.
      2) Emergency in °C.
      3) Short circuit in °C.
   h. Minimum installation temperature in °C.
   i. Jacket material in °C.
   j. Jacket thickness (nominal) in mils.
   k. Physical Requirements:
      1) Tensile strength of the insulation and jacket in psi.
      2) Elongation at rupture (Set) of the insulation and jacket in percent.
   l. Aging Requirements:
      1) After air oven (indicate condition) of the insulation and jacket.
         a) Tensile strength, change in unaged value, of the insulation and jacket in percent.
b) Elongation at rupture, change in unaged value, of the insulation and jacket in percent.

2) After oil immersion test (indicate conditions) of the jacket only.
   a) Tensile strength of unaged value of the jacket only in percent.
   b) Elongation at rupture of unaged value on the jacket only in percent.

m. Accelerated Water Absorption:
   1) Electrical method increase in capacitance:
      a) One (1) to fourteen (14) days in percent.
      b) Seven (7) to fourteen (14) days in percent.
   2) Gravimetric method water absorption in mg/in.

n. Electrical Requirements (Insulation):
   1) AC voltage test in kV/min.
   2) DC voltage test in kV/min.
   3) Insulation resistance (minimum) in megohms.

o. Cable outside diameter (nominal) in inches.

p. Allowable minimum bending radius in inches.

q. Allowable pulling tension in pounds.

r. Allowable side wall pressure in psi.

s. Reel Data:
   1) Diameter in inches.
   2) Width in inches.
   3) Drum diameter in inches.
   4) Tare weight in pounds.
   5) Arbor diameter in inches.

t. Ampacities:
   1) Cable in ducts, one (1) or two (2) cables per duct per the duct bank drawing sections,
      earth temperature 20°C, RHO = 90, conductor temperature 90°C.
      a) Three (3) cables per duct bank:
         i. 100 percent load factor in amperes.
         ii. 50 percent load factor in amperes.
         iii. 30 percent load factor in amperes.
      b) Six (6) cables per duct bank:
         i. 100 percent load factor in amperes.
         ii. 50 percent load factor in amperes.
         iii. 30 percent load factor in amperes.

u. Electrical Characteristics (Indicate Conditions):
   1) Resistance in ohms/1000 feet.
   2) Reactance (inductive) in ohms/1000 feet.
   3) Impedance in ohms/1000 feet.

v. Cable weight in pounds/1000 feet.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
1. AEIC CS8, Specification for Extruded Dielectric, Shielded Power Cables Rated 5 Through 46 kV.
2. ASME NQA-1, Quality Assurance Requirements for Nuclear Facility Applications.
5. ASTM B 496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
15. ICEA S-97-682, Utility Shielded Power Cables Rated 5 Through 46 kV.
18. IEEE 386, IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
19. IEEE 404, IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rates 2.5 kV to 500 kV.
20. NFPA 70, National Electrical Code (NEC).
22. UL 44, Thermoset-Insulated Wires and Cables.
23. UL 1072, Medium-Voltage Power Cables.
24. UL 1581, Electrical Wires, Cables, and Flexible Cords.

B. Furnish and install medium voltage power cables having a performance record demonstrating a minimum of twenty (20) years successful operating experience in utility and industrial power cable applications.

1.05 Delivery, Storage and Handling

A. Ship cable in reels, suitable covered to protect the cable from injury during shipment. Ship only one (1) length of cable on a reel. Seal, secure and protect cable ends from injury. Make both cable ends available for testing, unless cable size or reel construction precludes that possibility.

B. Suitably store cables to protect them from injury.

PART 2 - PRODUCTS

2.01 Description

A. Conductors covered by this Section are intended for use on alternating current, 1 phase, 25 Hz distribution system operating at 12 kV and 24 kV, and subjected to such additional strains of potential as may occur on the account of switching and operation of a traction power catenary system. The 3 phase voltage classes below are equivalent to what is required for the 1 phase application mentioned above. Cables furnished shall be constructed in accordance with the following requirements:

1. 25 kV and 46 kV, No. 4/0 AWG thru 1000 kcmil, single conductor, shielded cable (NEMA WC 74)(For 12kV and 24kV Circuits):
   a. The conductor shall be annealed after stranding, uncoated, soft copper wire, Class B, stranded, compact round per ASTM B 496.
   b. Conductors shall meet the electrical resistance requirements of ICEA S-93-639.
   c. An extruded layer of semiconducting ethylene propylene rubber thermosetting compound that is compatible with the insulation thermosetting compound, will be applied directly over the conductor and have a volume resistivity not in excess of 10 ohm-meters at 105°C and minimum elongation of 100 percent after an air oven test at 120°C.
   d. The conductor shield shall be in intimate contact with the strands and shall be clean stripping from the conductor and inseparably bonded to the overlying insulation.
   e. Conductor Insulation:
      1) Ethylene-propylene rubber, 133 percent insulation level, Class III per ICEA S-93-639.
      2) The insulation shall be triple tandem extruded, with the conductor and insulation screens and passed through a continuous vulcanization tube in a single pass to prevent inter-surface contamination. Three (3) separate inline extruder heads shall perform the extrusion process.
      3) Physical Properties:
         a) Original:
            i. Tensile strength to be 700 psi minimum.
            ii. Elongation percentage to be 300 minimum.
         b) After Aging – Air Oven Test (One Hundred and Sixty-Eight (168) Hours at 121°C):
            i. Tensile strength (percent of original) to be 75 minimum.
            ii. Elongation (percent of original) to be 75 minimum.
c) After Aging – Air Pressure Test (80 psi for forty (40) hours at 127°C):
   i. Tensile strength (percent of original) to be 75 minimum.
   ii. Elongation (percent of original) to be 75 minimum.

4) Electrical Properties:
   a) Insulation resistance constant (K) at 15.6°C to be 20,000 minimum.
   b) SIC at 75°C to be 3.5 maximum.
   c) Power factor at 75°C – percentage to be 2.5 maximum.
   d) Stability factor after fourteen (14) days to be 1.0 maximum.

5) Moisture Resistance:
   a) Mechanical moisture absorption to be 5.0 mg per square inch maximum.
   b) Maximum Percent Change in SIC (75°C Water):
      i. One (1) to fourteen (14) days to be 4.0 maximum.
      ii. Seven (7) to fourteen (14) days to be 2.0 maximum.

6) Ozone Resistance:
   a) 0.030 percent concentration at room temperature to have no cracks after twenty-four (24) hours of exposure.
   b) 0.005 percent concentration at 125°C to have no cracks after twenty-four (24) hours of exposure.

7) Cold Bend:
   a) No cracks at minus 40°C.

8) Corona Level:
   a) The corona level test must be made on completed shielded single conductor cable on long length factory reels. Certified test reports shall be submitted only for cut lengths although the actual values reported are those for the completed long lengths.
   b) The corona values to meet the maximum discharge in Pico-Coulombs (PC) specified in Table 16121-1 with a detection sensitivity of 5 PC and using the method specified in the referenced AEIC specification.

9) Insulation Color:
   a) The insulation shall be orange color, so that semi-conducting material on the insulation can be visually detected.

f. Insulation Shield (Screen):
   1) The insulation shield shall be an extruded semi-conducting all EPR compound verifiable with infrared spectrometry with a volume resistivity not in excess of the maximum acceptable values when tested in accordance with AEIC CS8 requirements. The screen shall be clean stripping from the insulation with a force of between 4 – 24 pounds on a 1/2 inch wide strip when tested in accordance with AEIC CS8.
   2) The insulation shall be completely shielded with a layer of semi-conducting extruded ethylene propylene rubber compatible with the insulation and have an average thickness of 30 mils. It shall be in intimate contact with the insulation. The legend “semi-conducting shielding, remove before splicing” shall be printed in white indelible non-conducting ink along with entire surface.

   g. The cable shield shall consist of a metallic shield over the semi-conducting shield. The insulation semi-conducting metallic shield shall be flat copper strap. The shield straps shall be designed utilizing 0.02 inch x 0.175 inch flat straps helically applied in sufficient numbers to meet the fault requirements of Table 16121-1. 5 mil copper tape shield is acceptable for the 60 kV rated shielded cable since the tape shield is capable of handling fault current.
h. Include a marker tape along the core. It shall show the name of the manufacturer, the year in which the cable was manufactured, conductor size, and consecutive serial number for identification purposes; all to appear at intervals of approximately 1 foot, so that this information can be obtained without destroying more than 1 foot of cable.

i. A non-metallic high temperature jacket of cross link polyolefin shall be extruded over the sheath. The minimum jacket thickness shall be in accordance with ICEA S-93-639. The jacket shall be rated as low smoke, zero halogen material.

j. Print on cable over its jacket at regular intervals of no more than 36 inches, showing the manufacturer, date of manufacture, voltage, conductor size, type and thickness of the insulation.

k. Furnish cable with approved stress cone indoor terminations and suitable outdoor synthetic terminations. Quantity of stress cone terminations shall be adequate for all terminations indicated on the Contract Drawings plus 10 percent spare terminations.

l. Provide on the outside end of each length of cable a pulling-in eye. Hermetically seal both ends of every length of cable before leaving the factory and make accessible on the reel for testing.

m. Furnish a manufacturer’s guarantee stating that the cable supplied under these Specifications is of first class material and workmanship throughout and in lieu of other claims against it, agrees to replace any length of cable filing during normal and proper use, within two (2) years of date of placing in service, which shows defects of material or workmanship, provided in each case that immediate written notice of such failure is given to the manufacturer and he is given all reasonable opportunity to inspect such failure.

n. The date of lacing in service is to be interpreted as the date on which operating voltage was first applied, but in no case shall it be interpreted to be later than six (6) months after the shipment of the cable from the factory.

o. The completed cable will be inspected by SEPTA at the time of delivery. In case of any doubt arising as to the intent or meaning of these Specifications, the decision of SEPTA shall be final and binding on the Contractor.

p. Reel dimensions shall not exceed 72 inches in height and 48 inches in width.

Table 16121-1 Cable Ratings or Components

<table>
<thead>
<tr>
<th>Cable Rating or Component</th>
<th>12 kV Trolley</th>
<th>24 kV Trolley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation Voltage Rating</td>
<td>25 kV</td>
<td>46 kV</td>
</tr>
<tr>
<td>Basic Impulse Level</td>
<td>150 kV</td>
<td>250 kV</td>
</tr>
<tr>
<td>Withstand Voltage</td>
<td>800 V/mil</td>
<td>800 V/mil</td>
</tr>
<tr>
<td>Insulation Thickness (Minimum/Maximum)</td>
<td>Refer to ICEA S-93-639.</td>
<td>330/375 mils</td>
</tr>
<tr>
<td>Metallic Shielding</td>
<td>Flat Straps</td>
<td>Flat Straps</td>
</tr>
<tr>
<td>Jacket (mils)</td>
<td>ICEA S-93-639</td>
<td>ICEA S-93-639</td>
</tr>
<tr>
<td>Fault Current Phase-to-Ground</td>
<td>7 kA</td>
<td>17.063 kA</td>
</tr>
<tr>
<td>Ground Fault Clearing Time</td>
<td>2 Cycles</td>
<td>2 Cycles</td>
</tr>
<tr>
<td>AC Factory Test Voltage</td>
<td>69 kV</td>
<td>116 kV</td>
</tr>
</tbody>
</table>

2. 2 kV, 500 kcmil, single conductor non-shielded power cable (NEMA WC 70)(For Rail Return Circuits):
a. Conductors shall be annealed, uncoated and Class C stranded copper, meeting the requirements of ASTM B 3.
b. The jacket material to meet the requirements of AREMA Signal Manual and rated for direct burial installation, in addition to being placed in conduit or underground duct.
c. The assembled cable shall be chemical and oil resistant, flame resistant, suitable to resisting vibrations of nearby train operations and have resistance to mechanical abuse.
d. The temperature ratings shall be 90°C on a continuous basis, 130°C degrees for emergency overload and 300°C for short circuits.

2.02 General Requirements

A. Cables that will be used on 12 kV and 24 kV, 25 Hz power systems shall be manufactured to the following requirements:

1. Furnish cable that is single conductor and UL listed.
2. All shielded cables shall be installed without splices, termination to termination.
3. The cable shall be suitable for use for power distribution feeders, indoors or outdoors, in wet or dry locations, as open runs of cable, in cable tray, in conduit, ducts or aerial cable. The cable shall be sunlight resistant.
4. The insulation shall be triple tandem extruded with the conductor and insulation screens.
5. The cable shall be insulated with an ozone resistant and discharge resistant, flexible, thermoset Ethylene Propylene Rubber (EPR) dielectric and meet or exceed the references listed in Article 1.04 in this Section.
6. Medium voltage cables shall be rated 105°C for continuous normal operation, 140°C for emergency overload operation and 250°C for short circuit conditions. Cables shall be suitable for emergency overload operation that may occur for periods up to one thousand five hundred (1500) hours cumulative during the life of the cable.

2.03 Fire Proofing

A. The Contractor shall furnish and install a form of arc and fire protection tape for all cables to be manufactured by the following:

1. 3M Scotch 77 Fire and Arc Proofing Tape with an overwrap of Scotch 69 Glass Cloth Electrical Tape.
2. Or Approved Equal.

2.04 Cable Duct Lubricant

A. Furnish high performance cable pulling lubricant specifically developed for compatibility with low smoke/zero halogen jacketed cables. The lubricant properties shall include slow drying, thin slippery film residue that remains for two (2) or more months after use, not flame sustaining, stringy gel that clings to cables and temperature stable with no flash point.

B. Cable lubricant shall be capable of being hand or pump applied, and cleaned away with water.

C. Provide cable lubricant as manufactured by the following:
1. American Polywater types LZ or WLZ.
2. Or Approved Equal.

2.05 Manufacturers

A. Medium Voltage Cable Assemblies:

1. Select a cable manufacturer who is regularly engaged in the production of similar wire and cable. Provide products from one (1) of the following manufacturers:
   a. The Okonite Company.
   b. Kerite Cable.
   c. BICC.
   d. Or Approved Equal.

B. Terminations for Medium Voltage Cable:

1. Terminations (Outdoor) of 25 kV rated cable shall be as manufactured by one (1) of the following:
   b. 3M.
   c. Or Approved Equal.

2. Terminations (Outdoor) of 46 kV rated cable shall be as manufactured by one (1) of the following:
   a. Tyco Raychem (EHVT series).
   b. 3M.
   c. Or Approved Equal.

3. Terminations of 25 kV rated cable for Gas Insulated Switchgear (GIS) shall be as manufactured by one (1) of the following:
   a. Pfisterer Connex (Type S2).
   b. Or Approved Equal.

PART 3 - EXECUTION

3.01 Installation

A. General:

1. Cable shall not be pulled until conduits have been cleaned and swabbed, and are free from obstructions.

2. Pull, install and protect cables as follows:
   a. Use factory installed compression type pulling eyes for all pulls except as otherwise specified.
   b. Seal all cable ends before pulling into ducts. The ends of a cable when cut shall not be left with the insulation exposed to moisture unless splice is to done immediately.
   c. Strip reels of all nails in outside edges of reel heads before pulling of cable. Conveniently locate reels for feeding cable into the duct or conduit without excessive binding or possible injury to cable by abrasion. Reels shall be jacked to clear ground level by at least 6 inches before pulling of cable.
d. Attached pulling ropes to cables with ball bearing swivels to prevent twisting of cable during pulling.

e. Pull cable into ducts and conduits under moderate tension. The manufacturer’s recommended maximum pulling tensions shall not be exceeded. Any lubricant used shall not have a deleterious effect on the conductor insulation.

f. Station sufficient personnel between the reel and the duct entrance during pulling operations to inspect, control and direct the passage of cable. Equip duct mouth with a form of bell end to prevent chafing of the cable while being inserted.

g. Minimum bending radii as measured to inside surface of the cables shall not be less than those recommended by the manufacturers, and not less than 23 inches for 25 kV and 46kV power cables, whichever is greater.

h. Lubricate cables with the cable manufacturer approved material which shall be placed into the duct prior to the installation of the pulling rope.

i. Do not allow cable to chafe on the ground, pull boxes or any sharp surfaces during pulling. Provide timbers and flexible cable pulling tubes to guide and protect the cable, where necessary.

j. All cables installed shall be continuous from terminal to terminal.

k. Mark all cables with printed numbers on cable tags at all terminal points. Refer to the Contract Drawings for numbering of cables.

l. Install cables as shown on the Contract Drawings. Provide supports, conduit and other hardware as required. All ferrous hardware shall be hot dip galvanized.

3. Handle cable reels carefully to avoid injury to persons or cables. Control movement of reels on loading skids or sloping grades by use of a snub line or wedge. Always block reels after positioning.

4. When a cable is cut, seal the ends properly. Cut bank cable ends which have been exposed to the weather, a minimum of 1 foot and properly seal. If this seal is broken, repair it immediately. One (1) of the two (2) following methods shall be used for sealing rubber or thermoplastic cable ends. In both cases, clean the cable jacket and buff so that all cable wax, pulling compounds and contaminations are removed from the surface.

a. For the first method the end shall then be sealed with epoxy resin using a procedure which shall be approved by SEPTA.

b. For the second method a combination of rubber and vinyl tape may be used to provide a seal. The end shall first be sealed with high voltage electrical tape and then overwrapped with vinyl electrical tape.

B. Terminations:

1. Make 2 kV, 25 kV and 46 kV cable terminations in strict accordance with the manufacturer’s instructions unless otherwise directed by the SEPTA Project Manager.

2. Terminations of power cables shall be made at the equipment as shown. It is of the utmost importance that perfect electrical contact be secured at the points of connection of each cable. All connections shall have a conductivity and insulation resistance at least equal to that of the cable.

3. Splicers shall have a minimum of five (5) years of experience in splicing and terminating medium voltage power cables of the type and size(s) involved under similar conditions. Prior to making of a termination, the Contractor shall submit to the SEPTA Project
Manager, for approval, the name of each individual who will perform this type of work including the background of each such individual on similar previous Projects.

4. Each supplier shall be certified by the SEPTA Project Manager. SEPTA may request the splicer to make a test termination in the presence of the SEPTA Project Manager before the approval is granted.

3.02 Tests

A. General:

1. The Contractor shall provide all instruments, materials and labor required for tests specified herein.

2. The Contractor shall formulate overall test program of the equipment and installation which shall include but not be limited to the tests specified in this Section to ensure equipment and material compliance with the relevant standards, this Specification, and satisfactory and reliable performance in actual intended operation.

3. Tests at the factory shall include but not be limited to:
   a. Tests listed in this Section.
   b. The manufacturer’s standard tests.
   c. Tests as per relevant NEMA, IEEE and ANSI standards not included in the manufacturer’s standard tests.
   d. Any other tests to ensure satisfactory performance of the product.

4. Tests and checkouts in the field shall include but not be limited to the following:
   a. Tests as listed in this Section.
   b. Tests as per relevant NEMA, IEEE and ANSI standards not include in these Specifications.
   c. Any other tests to ensure satisfactory performance of cable and installation.

B. Conditions of Tests:

1. Prior to testing of any cable and the installation, the following conditions shall be fulfilled by the Contractor:
   a. The Contractor shall have in his possession approved shop drawings.
   b. The Contractor shall have submitted testing procedure for SEPTA’s Project Manager approval at least forty-five (45) days in advance of the testing.
   c. For factory tests, a minimum of four (4) weeks advance notification shall be given to the SEPTA Project Manager on the schedule date of tests to enable him to witness the tests. Field tests shall be scheduled in consultation with the SEPTA Project Manager.

C. Witnessing Tests:

1. The SEPTA Project Manager will (at his option) witness complete or partial testing on all the cable and installation unless a waiver is granted for witnessing factory tests, in which case test reports of the product for which the waiver was granted shall be submitted for review to obtain clearance for packing and shipping. Waiver of witnessing factory tests on any cable shall not be construed as a waiver for all future supplies either of the same type or different cable.

D. Responsibility:
1. The Contractor shall assume full responsibility during the factory and field testing of all cable and installation provided by him. Should there be any loss or damage to such cable or installation as a result of these tests, the Contractor shall be fully responsible for replacing the damaged cable. Replacement of damaged cable shall include all costs, including, but not limited to, removal of damaged cable, furnishing of, transportation of, and installation of replacement cable.

E. Rejection and Retesting:

1. Failure of cable or termination to withstand tests or to meet ratings shall be sufficient grounds for rejection of the item tested.

2. Any cable or splice rejected shall be retested in the presence of the SEPTA Project Manager after rectification. If the modifications or changes are such as to affect any of the drawings, diagrams, or any other document submitted and accepted by SEPTA, revised drawings or diagrams, etc., shall be obtained before changes or modifications are made on the installation. Modifications or changes which do not warrant revision of any drawing shall be furnished to the SEPTA Project Manager along with notice of retesting.

3. If it is not possible to rectify rejected cable, new cable shall be manufactured and requirements of drawings and design calculations of original item shall be applicable for the new items.

F. Factory Tests:

1. Ethylene Propylene Insulated Cable:
   a. The manufacturer shall conduct all applicable factory tests specified in the referenced standard.
   b. The manufacturer shall furnish test certificates for each reel of cable for approval.

G. Field Tests:

1. General:
   a. All tests shall be successfully completed to show that the installation meets the Specification requirements before final acceptance. The Contractor shall perform the specified tests on all cable installed under this Contract.
   b. Tests and checkouts shall be conducted in accordance with the approved test procedure specified in this Section, the NEC and applicable standards and specifications of ANSI, NEMA, IEEE, AEIC, etc.
   c. Field tests are required for all cable.
   d. The Contractor shall provide properly qualified personnel who shall be responsible for supervising, coordinating, and performing all electrical field testing and checking work, and who will maintain a written record of all tests conducted.
   e. Testing and checkouts shall be performed in the presence of SEPTA.
   f. The Contractor shall furnish four (4) copies of all test results to SEPTA. Result sheets shall include date of test, personnel involved, items tested, type of tests and test data. Test certificate shall show the type and ratings of test instruments used and details of their calibration including dates of their first calibration.
   g. Any equipment or cable damaged due to improper test procedure or test apparatus handling shall be replaced or restored to original condition by the Contractor at his expense.
h. Safety devices including but not limited to rubber gloves and blankets, screens and barriers, danger signs, padlocks, etc., shall be used to protect and warn all personnel in the vicinity of the tests.

2. Power Cable Field Tests:
   a. Procedure:
      1) All single conductor cables shall be tested as specified herein. The object of these tests is to ascertain the following:
         a) Dielectric strength of the cable insulation has not been impaired during installation.
         b) Cable splices and terminations are made properly.
         c) Integrity of the cable system prior to energization.
      2) The tests shall include, but not be limited to, the following:
         a) Continuity tests.
         b) Insulation resistance tests.
         c) High potential direct current test.
      3) The test or tests shall be carried out under the supervision of a competent, qualified and trained technician in the presence of the SEPTA Project Manager. All the technicians involved in the testing shall be fully aware of the detailed test procedures and hazards involved in the high potential direct current testing.
      4) For high potential tests, the area around the ends of the cable under test shall be roped off and warning signs posted. A guard shall be posted at each end for the duration of the tests to prevent unauthorized people entering the test area.
      5) Prior to testing, the Contractor shall submit for approval a detailed step by step testing procedure, the list of personnel involved and the make and model number and details of the instruments he intends to use. Written approval of the procedure, personnel and instruments must be obtained before commencement of testing of any cable. Approval of the procedure does not in any way relieve the Contractor from his responsibility with regard to safety of personnel, equipment and property.
      6) The factory test voltages specified herein for high potential direct current testing shall be in accordance with ICEA S-97-682 for the single conductor EPR insulated cable, for the voltage and insulation levels of the cables included.
   b. Installation Tests/Acceptance Tests:
      1) After installation of the entire length of cable run and completing all terminations, the Contractor shall perform the below listed tests on each cable circuit.
      2) To preclude damage to equipment and devices, all equipment normally connected to the power circuit shall be disconnected from the cable to be tested.
         a) Continuity test shall be performed to prove the continuity of the conductor. Immediately after the test, both ends of the cable shall be tagged with cable identification number.
         b) Phasing test shall be performed to establish the phase identification of the cable for the purpose of phasing. This test shall be done at both ends of a length of installed cable.
         c) Insulation resistance test shall be performed to determine the cable insulation resistance to ground and between the conductors in the case of the 2 phase cables. A total of three (3) measurements are required for each circuit; one (1) from conductor-to-conductor and two (2) from conductor-to-sheath.
      3) Test shall be conducted with a 2500 volt, motor operated megger. Each measurement shall be held until each reading reaches a constant value for five (5) minutes. Megger
test values of insulation resistance obtained shall not be less than 5 Megaohms. The Contractor shall bring to the attention of the SEPTA Project Manager similar readings which are unequal with the variations of 25 percent or more.

4) The Contractor shall also record the temperature, humidity, duration of test and voltage for each test.

5) High potential test shall be performed only after the insulation resistance test has been successfully completed.

a) Before conducting the high potential direct current test, the Contractor shall make sure that the following requirements are complied with:

i. *Equipment and the shields, ground wire of nearby insulated conductors not under test and the ground stick are all securely tied to the manhole or substation/switching station grounding system.*

ii. *The insulated conductor under test must have a safe clearance from adjacent grounded conductors, insulation shield and surrounding metal objects. A 1/4 inch clearance for every 1000 volts of DC test voltage is regarded as a safe distance.*

iii. *High voltage test gloves are worn by each participant.*

iv. *The test voltages meet the recommendations of the cable manufacturer and the splice kits and termination manufacturers.*

v. *Danger signs and sentries are posted at all critical points along the entire cable route under test.*

vi. *The operator’s manual for particular test set being used has been read and understood.*

vii. *All safety precautions have been observed at the testing end and at the far end of the cable.*

b) Each insulated conductor in a conduit shall be tested separately while grounding test equipment and all conductors not under test, with metallic shield or ground wires to the manhole or substation/switching station ground. The test equipment shall be supplied from a stable, constant voltage source having a maximum variation of the voltage of plus/minus 5 percent. Preferably, a motor driven alternator shall be used for the supply. The output voltage of the test set must be filtered, regulated and spike free. The following test procedure shall be followed:

i. *Ground each conductor to be tested with ground stick before test. Connect test lead to conductor that is to be tested. Then, remove ground stick from conductor to be tested; conduct test. Upon completion of testing that conductor, allow voltage to decay to approximately 5 kV before re-applying ground. Follow above procedure for each conductor being tested.*

ii. *Apply the direct current test voltage between the conductor and the grounded sheath slowly in equal steps (in steps of 5 to 7 percent of full test voltage) until the designated voltage is reached. The rate of voltage acceleration shall be consistent under each step.*

iii. *Allow sufficient time after each step for the leakage current to stabilize.*

iv. *Record total leakage current in micro-amperes after each step. The same length of time shall be allowed after each step for the total current to stabilize before taking readings.*

v. *The equivalent DC test voltage shall be 80 percent of the AC factory test voltage. Maintain the test voltage after it has reached the specified value for fifteen (15) minutes.*

vi. *Record total current values in micro-amperes at one (1) minute intervals for the duration of the test.*
vii. Set the test voltage control to zero (0) at the end of the test period. Allow the residual voltage on the circuit to decay to approximately 5 kV before applying manual grounds.

viii. The tested conductors should remain grounded for at least thirty (30) minutes after completion of the test.

c) Failure of the initial leakage current to decrease, or any increase in the leakage current at any time during the test shall be presumed to be indicative of a cable defect and the test shall be continued until cable failure occurs.

c. Proof Tests:

1) The SEPTA Project Manager reserves the right to have the Contractor proof test the cable installed under this Contract any time during the warranty period of the Contract work or at any time during the performance of this Contract.

2) The proof test shall consist of a high potential direct current test as described above with the test voltage specified to the Contractor at the time of the test; the test voltage is to be applied and maintained for a period of five (5) minutes.

3) The Contractor shall include in his bid proposal the cost of performing a total of two (2) proof tests (per cable tested). The cost of performing the tests shall include all labor for isolation of cable to be tested and for performing the work according to the instructions and direct supervision of the SEPTA Project Manager. The SEPTA Project Manager will arrange for isolation of the cable from the electrical equipment inside the substations or switching stations.

4) Any defects found as a result of the high potential proof test shall be corrected by the Contractor or at no expense to SEPTA.

5) After successful completion of the proof test, the Contractor shall provide all material, labor and equipment to reestablish the integrity of the installed cable to its original status which prevailed before the cable was isolated for testing.

d. Any cables found defective during the testing shall be replaced with new cables by the Contractor. Rectification of defects of any cable shall be done only with specific approval of the SEPTA Project Manager.

END OF SECTION
THIS PAGE NOT USED
SECTION 16123
BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of material and labor for furnishing, installing, connecting, energizing, testing, cleaning and protecting building wire and cable, and accessories.

1.02 Related Sections
A. Section 01600 – Materials and Equipment
B. Section 16060 – Grounding and Bonding
C. Section 16075 – Electrical Identification
D. Section 16130 – Raceways and Boxes
E. Section 16950 – Testing

1.03 Submittals
A. Submit with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. If not available, provide from the product manufacturer a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA.

B. Submit product data for the following products; indicate clearly the Contract specific usage of each product:
   1. Wires and cables.
   2. Lugs and connectors.
   4. Tapes and pulling lubricant.

C. Tension Calculations:
   1. Submit cable pulling calculations for all underground power runs. Calculations shall include both pull load and tensions, along with safety factors, for all cables.
   2. Design conduit runs so as not to exceed tension limits of the manufacturer. Provide additional pulling points as required to limit the tension.

D. Record actual installed elevation and locations of feeders, both concealed and exposed work, on the record drawings.

E. Submit record drawings, product data, and installation and maintenance instructions for Project closeout.
1.04  Quality Assurance

A. Unless products meeting the requirements of nationally recognized testing laboratories are not readily available for a category of products, provide products that are listed and labeled by Underwriters Laboratory (UL), approved by Factory Mutual (FM) or certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory (ETL).

B. All work shall meet the regulatory requirements of all state and local codes and requirements.

C. Install work under supervision of skilled licensed electricians.

D. Meet the applicable provisions of the most recent issues of the following references:
   2. CSA FT-1, Vertical Flame Test.
   5. NEMA WC 26, Binational Wire and Cable Packaging Standard.
   6. NFPA 70, National Electrical Code (NEC).
   7. UL 44, Rubber-Insulated Wires and Cables.
   8. UL 1277, Electrical Power and Control Tray Cables with Optional-Fiber Members.
   9. UL 1569, Metal-Clad Cables.
  10. UL 1581, Electrical Wires, Cables, and Flexible Cords.

1.05  Delivery, Storage and Handling

A. Protect items from damage during delivery, storage and handling in accordance with Section 01600.

B. Packaging of wire and cable shall meet NEMA WC 26.

1.06  Qualifications

A. Firm specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

1.07  Field Samples

A. Provide one (1) 36 inch long sample of each type of wire to be used.

PART 2 - PRODUCTS

2.01  Low Voltage Copper Building Wire

A. UL listed conductors of 98 percent conductivity copper with type THHN/THWN insulation rated 600 volts.
B. Provide conductors of proper size and ampacity ratings according to NEC Article 310.

C. Minimum Conductor Size:
   1. No. 12 AWG in power and branch feeder circuits.
   2. No. 14 AWG in control circuits.
   3. No. 14 AWG in alarm and status circuits.

D. Except for control wires or where otherwise indicated on the Contract Drawings, do not exceed four (4) conductors (three (3) phase conductors and one (1) neutral) plus one (1) ground in raceways or conduits.

E. All conductors in all sizes shall be stranded copper.

F. ROMEX and BX cable and aluminum conductors are not permitted for use in this Contract.

G. Imprint insulated conductors with the date of manufacture, wire type and the manufacturer’s name. Wire and cable manufactured more than twelve (12) months before delivery to the job site shall not be used.

H. Manufacturers:
   1. Cablec Continental Co.
   2. Rome Cable Corp.
   3. Okonite Co.
   4. Southwire Co.
   5. Or Approved Equal.

2.02 Shielded Instrumentation Cable (2/C Cable)

A. Provide cable which meets the following:
   1. Cable fabricated using stranded (19 x 29 AWG) tin coated copper conductors with polyethylene insulation, color coded conductor insulation and overall PVC jacket.
   2. Cable 100 percent shielded, utilizing aluminum polyester foil, incorporating No. 18 AWG stranded tinned copper drain wire.
   3. Cable shall be NEC Class CL2 and passing the CSA Vertical Flame Test FT-1.
   4. Cable UL (recognized) Style 20253 having a 600 volt insulation and 90°C temperature rating, two (2) conductor, twisted pair, No. 16 AWG.
   5. Manufacturers:
      a. Belden Corporation.
      b. Or Approved Equal.

2.03 Wire and Cable Connections

A. Grounding to meet Section 16060.

B. For equipment connections using service wires and cables, and wires larger than No. 6 AWG, provide connectors approved by the equipment manufacturer and of the types specified
below. For all other types of connections provide connectors of one (1) of the types specified below:

1. Split bolt connectors or compression type connectors to be UL Listed connectors for making parallel or butt splices of stranded copper wire. Use companion preformed plastic insulating covers or tape insulation meeting the NEC requirements.

2. Mechanical compression connectors to be compact high copper bronze or brass alloy, two (2) hole, capable of being installed with one (1) wrench with two (2) clamping bolts, single conductor, or multiple conductor, brass or bronze bolts. Plated steel screws are unacceptable. Provide silicon bronze fasteners for bolting connectors to connections.

3. Crimped compression connectors to be two (2) hole crimped connectors of high conductivity seamless electrolytic wrought copper, electrolytically tin plated, with two (2) holes, color coded to match dies. Provide adequate area for conduction of the flowing current. Provide tooling to crimp connectors from the same manufacturer as connectors.

C. Control wiring connections to be crimped nylon insulated ring terminals for all connections at terminal boards and nylon insulated butt splices with insulation grip. When more than two (2) control wires are to be joined provide junction boxes with terminal boards as specified in Section 16130.

D. Instrumentation Cable Connector:

1. Provide companion type connectors for instrumentation cable and for the equipment being furnished under this Contract.

2. Where providing cable to equipment controllers/enclosures furnished under other sections of this Contract, connectors provided with furnished equipment.

3. Terminate wiring as required for proper installation.

4. Manufacturers:
   a. Thomas & Betts Corp.
   b. AMP Inc.
   c. Ilsco Corp.
   d. Buchanan Construction Products.
   e. Or Approved Equal.

E. Provide one (1) of the following types of connectors for other conductors:

1. Any of the types listed for larger wire.

2. Screw terminals, crimped compression terminals to be nylon insulated crimped terminals with copper barrels for making terminal connections of stranded copper wire to screw terminals.

3. Wire nuts to be pre-insulated, UL Listed, hand or tool installed, solder-less connectors of the spring lock type or compression type for making splices of solid copper wire. Wire nuts for site lighting shall be of the type intended for use in wet locations and shall be pre-filled with a waterproofing compound by the manufacturer.

4. Screw lock connectors are for making terminal connections of solid copper wire.
5. Manufacturers:
   a. Thomas & Betts Corp.
   b. AMP Inc.
   c. Ilsco Corp.
   d. Burndy.
   e. Or Approved Equal.

2.04 Tape
A. Arc proofing tape to be Scotch 77.
B. Vinyl insulating tape to be Scotch 33+, black.
C. Rubber splicing tape to be Scotch 1 30C.
D. Grounding braid to be Scotch 25.
E. Heat shrinking to be Amp HST1125.
F. Manufacturers:
   1. 3M, Scotch.
   2. Plymouth.
   3. Permacel.
   4. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation
A. Inspect all conduits, junction boxes, electrical vaults and handholes for cleanliness, lack of burrs, conduits alignment, completeness and correct deficiencies.
B. Ensure that two (2) locknuts are installed on all conduits without threaded hubs, that bushings are installed in all conduits with wires larger than No. 10 AWG, that grounding bushings and fittings are installed at all places called for in Section 16060.
C. Check that proper sized boxes are installed. Boxes and conduit fittings must meet the NEC for bending requirements.
D. Swab all conduits with a nylon bush and steel mandrel.
E. Ascertain that pulling calculations have been made and are available for long runs and pulls as indicated in this Section. Ascertain that a means of controlling pulling tension is installed on mechanical assist devices for pulling cable.
F. Pre-lubricate all conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.

3.02 Installation
A. General:
   1. Install all wiring outside of equipment in conduit.
2. Do not perform wiring until work which might cause damage to the wires, cables or conduits has been completed. Take the necessary precautions to prevent the accumulation of water, dirt or other foreign material in the conduits during the execution of the work.

3. Make wire and cable splices in outlet or junction boxes per the NEC, and install such boxes in accessible locations.

B. Include a green equipment ground conductor with all runs; wire type and size as specified in Section 16060.

C. Neutral Conductors:
   1. Provide separate neutral conductors for all branch circuits except as follows:
      a. Common neutrals may be used for circuits from three (3) adjacent single pole circuit breakers or poles of the same multi-pole circuit breaker in 3 phase wye connected panelboards.

   2. Provide separate neutrals for each single phase and each multi-phase feeder.
   3. Size each neutral to the same size as the largest phase conductor.

D. Cable Pulling:
   1. Meet the manufacturer’s recommendations for the inspection, handling, storage, temperature conditioning prior to installation, bending and training limits, pulling limits and calculation parameters for installation of all cable. Use quadrant blocks located properly along the cable run. Remove from the job site and replace all cables that were subjected to excessive bending and tension and all cables that are cracked or have damaged or nicked outer jackets.

   2. Pull cables down grade with the feed-in point at the manhole, handholes or buildings of the highest elevation. Flexible cable feeds shall be used to convey cables through the manhole opening and into the duct runs. Cable lubricant shall be soapstone, graphite or talc for rubber or plastic jacketed cables.

   3. Lubricate all cables during pulling with lubricants specifically recommended by the cable manufacturer.

   4. Limit cable pulling tensions to the maximum pulling tensions recommended by the cable manufacturer. Use dynameter to measure pulling tensions on all runs pulled with mechanical assistance and for all runs where calculations are required to be submitted. If pulling tension is exceeding during pulling, cables shall be removed and marked and not reused.

   5. Install cables in manholes along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls so as not to interfere with duct entrances. Support cable on brackets and insulators spaced at a maximum of 2 feet apart. Lubricants must be used and must be approved by the cable manufacturer.

E. Wiring Identification:
   1. Color code wires and cables as specified in Section 16075.

   2. Identify all control wiring with wire numbers corresponding to the record drawings.
3. Identify all power wiring by circuit and panelboard, switchboard and motor control center number.

F. Cable Terminating:

1. Protect termination of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials. Terminations shall be made using materials and methods as indicated or specified herein or as designated by the written instruction of the cable manufacturer and the termination kit manufacturer.

G. Wire and Cable Splices:

1. Splice cables only in accessible location. Install all service and feeder conductors from end to end without splice. Install all motor conductors from starter to motor without splice.

2. Protect termination of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials. Terminations shall be made using materials and methods as indicated or specified herein or as designated by the written instruction of the cable manufacturer and the termination kit manufacturer.

3. Locate splices in underground systems in accessible locations with manhole entrances above the one hundred (100) year flood elevation. Make below grade splices using a compression connector on the conductor. Insulate and waterproof below grade splices by methods suitable for continuous submersion in water using either method that follows:
   a. Gravity poured method to employ materials and equipment contained in an approved commercial splicing kit with a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare and pour the resin mix into the mold.
   b. Cast type splice insulation to employ materials and equipment contained in an approved commercial splicing kit employing a thermosetting epoxy resin insulating material applied by a gravity poured method or by a pressure injected method. Fix cables in place to not be moved until the splicing materials have completely set.

3.03 Field Quality Control

A. Field test prior to energizing wire and cable as specified in Section 16950.

END OF SECTION
THIS PAGE NOT USED
SECTION 16129

FIBER OPTIC CABLE

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for providing (furnishing and installing) fiber optic cable.

B. Cabling shall be installed in such a manner so that SEPTA's normal day-to-day operations are not affected and that interruptions to SEPTA's normal workday activities are kept to a minimum.

C. Work along the right of way of this Section may require track outages that must be performed during the hours of 12:00 AM and 4:00 AM.

1.02 Related Sections

A. Section 01300 – Submittals
B. Section 16760 – Fiber Optic Network
C. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI
D. Section 16950 – Testing

1.03 Submittals

A. Submit proof of the manufacturer's certification, within ten (10) business days of the Contract Award, that you or your subcontractor is manufacturer-certified to install the specified cabling systems. Certify that warranty is a minimum of five (5) years.

B. Submit for approval to SEPTA's Project Manager, sets of catalog cut sheets for all materials to be used in this installation, in accordance with Section 01300. Each cut sheet shall be identified with the manufacturer’s name, part number, acquisition lead time and date of submittal. SEPTA will not be responsible for any materials ordered prior to SEPTA’s approval for the cut sheet item in question.

C. Failure to provide a complete cut sheet submittal for a specific item will result in rejection. Upon rejection, resubmit the specified documentation for re-approval.

D. Submit cut sheet submittals in a timely manner to permit proper consideration and approval. Coordinate the timing of each submission to assure adequate lead time for procuring items required by this Contract and inform SEPTA's Project Manager of any time constraints concerning submittal approvals that are critical to the completion of the Contract. Delays attributable to rejected cut sheet submittals shall not serve as a basis for extending time for Contract completion.

E. After an item has been approved, changes in make, manufacturer or part number shall not be permitted, unless:

1. Satisfactory written evidence is presented, and approved by SEPTA, that the manufacturer cannot make the scheduled delivery date of an approved item; or
2. Other conditions become apparent indicating approval of the item to be substituted will be in the best interest of SEPTA.

F. Submit a cable and outlet identification plan and an interconnection block diagram to SEPTA’s Project Manager for approval before final cable and faceplate labels are installed.

G. Submit pulling calculations (tensions and side wall pressure).

H. Submit field monitored pulling tension forces measured during actual installation of the cable.

I. As part of the “as-built” submission, submit copies of the completed test results (in accordance with Section 01300) within fifteen (15) working days of test completion, in both electronic and printed format. The submission shall include copies of the print outs of all cables tested.

J. Submit copies of the marked-up “as-built” drawing(s) to SEPTA’s Project Manager within fifteen (15) working days of completion of the work (or each stage of the work). As a minimum, annotate on a clean set of prints, the following information:

1. The approximate routing of cabling installed.

2. Other pertinent information, such as actual pulled lengths, concerning the performance of the work regarding “as-built” conditions that will provide a more accurate set of drawings.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:


2. NFPA 70, National Electric Code (NEC).


4. TIA/EIA 568-B.3, Optical Fiber Cabling Components Standard.

5. TIA/EIA 569-A, Commercial Building Standards for Telecommunications Pathways and Spaces.

1.05 Performance Requirements

A. Work shall be performed in a professional manner, using practices of good craftsmanship.

B. Provide cables with the specified connectors affixed using the tools specified by the manufacturer.

C. Terminate cables using the tools specified by the manufacturer.

D. Remove trash, debris, spent reels and all other refuse related to this installation, daily.

1.06 Qualifications

A. Provide the services of personnel having at least five (5) years of experience in the installation and termination of single mode optical fiber.
1.07 Operation and Maintenance Data
   A. Develop and submit:
      1. Certified factory test reports.
      2. Pulling calculations.
      3. Certified detailed field test reports that verify the total db losses.
      4. As-built documents with maintenance guide.

1.08 Warranty
   A. Provide the standard warranty with a five (5) year minimum term as indicated in this Section.

1.09 System Acceptance
   A. Final acceptance will be made by SEPTA upon satisfactory completion of the work. Additionally, SEPTA’s acceptance is based upon the submission and approval of all test records, cable run summaries and as-built drawings.
   B. The work will not be considered complete until:
      1. It has been inspected and accepted by SEPTA.
      2. All discrepancies have been resolved.
      3. All test records, cable run summaries and as-built documentation have been received.

PART 2 - PRODUCTS

2.01 General
   A. Items not listed in this Section or shown on the Contract Drawings, but necessary for the complete and proper performance of the work as specified, shall be considered part of the work. Verify exact types and quantities of all materials with SEPTA before purchase.

2.02 Outside Plant Fiber Optic Cable
   A. Provide Single Mode Fiber (SMF) for outside plant operations that can be applied in underground duct, in aerial duct and lashed to an aerial messenger wire as offered by the following manufacturers:
      1. Superior Essex (Series F1), single flex tube all dielectric.
      2. Or Approved Equal.
   B. Fiber and cable characteristics for cable to be supplied are as follows:
      1. Fiber count to be twenty-four (24), unless shown otherwise on the Contract Drawings.
      2. Nominal diameter to be 0.47 inches.
      3. Minimum bending radius to be 9.5 inches.
      4. Outer construction consisting of:
         a. Rigid dielectric outer strength members imbedded just under a UV resistant jacket.
b. Rip cords to remove outer jacket.
c. A dielectric water blocking strength member layer over a single gel-filled tube.
d. Surrounding the core tube with up to eight (8) fiber bundles of twelve (12) fibers, each.

5. The inner construction of the cable shall be a loose tube design, highly flexible and dry, with individual Type 3, reduced water peak, single mode fibers.

2.03 Inside Plant Fiber Optic Cable
A. Provide inside plant fiber optic cable compatible with the equipment specified in Section 16910.

2.04 Cable Terminations
A. Provide terminations as per Section 16760.

PART 3 - EXECUTION

3.01 General
A. Do not exceed the recommended pulling tension of the cable manufacturer. Assume responsibility to pay all costs associated with the replacement of any cable that exhibits evidence of cuts, crimps, severe abrasions and damage due to exceeding the manufacturer’s specified pulling tension.
B. Install, dress and terminate cabling in a professional manner, using practices of good craftsmanship.
C. Place all new sleeves and penetrations required for successful cable installation.

3.02 Cable Termination
A. Each element of the specified fiber optic cabling installed shall be connectorized using the specified SC connectors, and shall be mounted into the specified fiber optic patch panels and SC insert panels.
B. Furnish and install all termination equipment according to the manufacturer’s instructions, using the required tooling and materials.

3.03 Floor and Wall Penetrations, Fire Stops
A. Refer to Section 16910.

3.04 Installation in Duct Banks and on Aerial Structures
A. In the duct bank manholes, apply a wrap of fireproofing tape and mastic between the entry points into the manhole. Install fire stop material at each duct entry point. The intent is to provide protection to vital fiber optic cables passing through manholes where unrelated C&S and ET cables may cause a fire.

3.05 Splices
A. SEPTA intends that outside plant cabling shall be installed in one (1) continuous run between termination locations. No splices will be permitted.
B. Install inside plant fiber optic cable without splicing between terminations at SCADA equipment or between outside plant to inside plant splice panels and SCADA equipment (i.e. no splices between termination points shown on a final fiber plant block diagram).

3.06 Damage

A. Any cuts, abrasions, burns, stretched segments and/or other damage that will be detrimental to the performance of that cable shall be cause for replacement of that entire segment of cable.

B. Incidental damage to cables and connectors shall be corrected at the Contractor’s expense before testing and final acceptance of cables.

3.07 Cable Labeling and Identification

A. Submit a cable and outlet identification plan to SEPTA for approval before final cable labels are installed.

B. Each cable, patch panel port and termination block position shall be labeled individually with a unique cable number, using machine printed labels.

C. Each outlet shall be labeled individually with a unique identification number, using machine printed labels.

D. Cable labels that are cut off during the installation process shall be replaced with new labels after final dress and termination in such a position that permits the label to be easily read.

3.08 Testing

A. Factory and field testing shall be performed in accordance with the requirements of Section 16950.

END OF SECTION
THIS PAGE NOT USED
SECTION 16130

RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements for the following conduits and ducts:
   1. Metal conduits.
   2. Non-metallic conduits.
   3. Metallic pull boxes and splice boxes.

1.02 Related Sections

A. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI
B. Section 16950 – Testing

1.03 Submittals

A. Submit catalog cuts of proposed conduits.
B. Submit drawings and catalog cuts of proposed pull and splice boxes.
C. Submit pull and splice box size calculations and/or diagrams.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
   1. ANSI C80.1, American National Standard for Electric Rigid Steel Conduit (ERSC).
   3. ASTM D 150, Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation.


15. NRMA TC 14 Reinforced Thermosetting Resin Conduit and Fitting Series.


17. UL 1, Flexible Metal Conduit.

18. UL 6, Electrical Rigid Metal Conduit - Steel.


20. UL 514B, Conduit, Tubing and Cable Fittings.

21. UL 1684, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Non-Metallic Conduit:

1. Polyvinyl Chloride Conduit (PVC):
   a. Provide PVC conduit from the following manufacturers:
      1)  T & B (Carlon).
      2)  Cantex.
      3)  National Pipe & Plastic.
      4)  Or Approved Equal.
   b. Concrete encased conduit to be UL listed, PVC plastic conduit meeting ASTM D 1785.
   c. Direct burial (sand encased) conduit to be UL listed, type 80 PVC meeting ASTM D 1785.

B. Flexible Metal Conduit (FMC):

1. Flexible metal conduit shall be galvanized steel meeting UL 1.

2. Connectors shall be of the twist-in, insertion type with insulated throats.

3. FMC shall only be installed in heated spaces.

C. Flexible Conduit:

1. Liquid tight flexible metal conduit shall consist of continuous lengths of wound and interlocked galvanized steel, over which is an extruded polyvinyl chloride covering.

2. Provide liquid tight flexible metal conduit from the following manufacturers:
   a. Anamet Canada Inc. (Anaconda) Type UA/CSA.
   b. Electro-Flex Type LA.
c. Or Approved Equal.

3. Connectors for liquid tight flexible metal conduit shall be of the throated insulated type and shall be provided with a bonding locknut.

4. Liquid tight flexible metal conduit shall be PVC jacketed steel core. Liquid tight flexible metal conduits less than 1 1/2 inches in diameter shall have continuous copper bonding conductor between convolutions and be approved for grounding. Conduit sizes 1 1/2 inch and larger shall be provided with separate grounding conductor.

D. Rigid Metallic Conduit (RGS):

1. Do not use RGS conduit, conduit bends and fittings for the installation of traction power cables.

2. Provide conduits fabricated of mild steel piping, galvanized or electro-plated inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating. Each conduit shall bear the UL label, shall be defect free, furnished in 10 foot lengths minimum, threaded both ends, one (1) end fitting with a coupling and of the following types:
   a. Galvanized Rigid Steel (RGS) conduit and fittings to meet the requirements of NEC for materials and uses.

3. Connectors and coupling shall be threaded galvanized malleable iron or steel.

4. Locknuts shall be of the type with sharp edges that bite into enclosure where connected.

5. Bushings shall be brown or black, high temperature type, lay-in grounding type, unless indicated otherwise.

6. Rigid Steel Conduit and Fittings:
   a. Hot dip galvanized inside and out, with threads galvanized after cutting, meeting UL 6 and ANSI C80.1.
   b. Rigid steel conduit and fittings shall be such as manufactured by the following:
      1) Allied Tube and Conduit.
      2) Or Approved Equal.

E. Rigid Non-Metallic Conduit:

1. PVC Electrical Conduit and Fittings:
   a. Non-metallic conduit and conduit fittings shall be as follows:
      1) All underground conduits shall be PVC, (with transition to FRE type conduit when the conduit continues exposed, above grade).
      2) Conduit and fittings shall be encased in concrete and shall be thin wall type EB.
      3) Metallic ties shall not be used when constructing embedded conduit system. Concrete encased conduits shall be assembled utilizing plastic base and intermediate spacers to provide a minimum spacing of 7 inches between centerlines of parallel conduits.
   b. Furnish UL listed material in accordance with the NEC for underground use.

2. Glass Fiber Reinforced Thermosetting Resin Conduit (RTRC) Electrical Conduit and Fittings:
   a. Refer to Table 16130-1 thru 16130-4 physical properties of RTRC electrical conduit and fittings.
### Table 16130-1 Physical Properties of RTRC Electrical Conduit and Fittings

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>1.94 g/cubic cm</td>
<td>ASTM D 792</td>
</tr>
<tr>
<td>Barcol Hardness</td>
<td>54 + 2</td>
<td>ASTM D 2583</td>
</tr>
<tr>
<td>Glass Content</td>
<td>68% + 3%</td>
<td>-</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>&lt; 1%</td>
<td>ASTM D 570</td>
</tr>
<tr>
<td>Color</td>
<td>Black</td>
<td>-</td>
</tr>
<tr>
<td>Application</td>
<td>Above Ground</td>
<td>-</td>
</tr>
<tr>
<td>Coefficient of Friction (PVC Jacket)</td>
<td>0.385 + .06</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 16130-2 Electrical Properties of RTRC Electrical Conduit and Fittings

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric Strength</td>
<td>500 volts/mil</td>
<td>ASTM D 149</td>
</tr>
<tr>
<td>Dielectric Breakdown Voltage</td>
<td>29.7 kV</td>
<td>ASTM D 149</td>
</tr>
<tr>
<td>Dissipation Factor</td>
<td>0.5%</td>
<td>ASTM D 150</td>
</tr>
</tbody>
</table>

### Table 16130-3 Thermal Properties of RTRC Electrical Conduit and Fittings

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient of Thermal Expansion</td>
<td>1.37 E-5 in./in./°F</td>
<td>ASTM D 696</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>2 BTU.in/ft2.h.°F</td>
<td>-</td>
</tr>
<tr>
<td>Flammability</td>
<td>HB</td>
<td>UL 94</td>
</tr>
<tr>
<td>Heat Deflection Temperature</td>
<td>312°F</td>
<td>ASTM D 648</td>
</tr>
<tr>
<td>Flame Retardant</td>
<td>Satisfactory</td>
<td>UL 1684 Sect. 5.12</td>
</tr>
</tbody>
</table>

### Table 16130-4 Mechanical Properties of RTRC Electrical Conduit and Fittings

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>&gt;=9000 psi</td>
<td>ASTM D 2105</td>
</tr>
<tr>
<td>Elasticity Modulus</td>
<td>1.3 E + 6 psi</td>
<td>ASTM D 2105</td>
</tr>
<tr>
<td>Resin</td>
<td>Epoxy</td>
<td>-</td>
</tr>
<tr>
<td>Glass</td>
<td>E-Glass</td>
<td>-</td>
</tr>
<tr>
<td>Toxicity</td>
<td>No chlorine or trace halogens</td>
<td>-</td>
</tr>
</tbody>
</table>

b. Use RTRC conduit and fittings that meet the requirements of NEMA TC 14, Type HW.

c. Manufactured from pure, high grade, filament wound fiberglass epoxy having the following properties as a minimum:

1. Longitudinal tensile strength to be 7,000 psi when tested per ASTM D 2105.
2. Axial compressive strength to be 12,000 psi when tested per ASTM D 695.
3. Ultimate elongation to be 2 percent when tested per ASTM D 2105.
4. Modules of elasticity in tension to be 1,250,000 psi when tested per ASTM D 2105.
5) Modules of elasticity in bending to be 1,250,000 psi when tested per ASTM D 790.
6) Thermal conductivity to be 2.0 BTU/Hr./Sq. Ft./°F/Inch.
7) Coefficient of linear thermal expansion to be 1.25 x 10-5 inch/inch/°F.
8) Specific gravity to be 1.94.
9) Temperature range to be minus 65°F to plus 300°F.
10) Dielectric strength to be 500 volts/mil when tested per ASTM D 348.
11) Dissipation factor to be 0.5 percent average at room temperature when tested per ASTM D 348.

d. RTRC conduit in 4 inch size and larger to be heavy wall thickness of 0.096 inches, minimum, and rated for impact resistance (vandal resistant).

e. Conduit and fittings (watertight) shall be such as manufactured by the following:
   1) Champion.
   2) FRE Composites Inc.
   3) Or Approved Equal.

F. Miscellaneous Fittings:
   1. Expansion and deflection fittings to be concrete tight and weatherproof with ground continuity, shall allow 4 inch movement and 3/4 inch or 30 degrees of deflection from normal, and shall have factory installed packing ring and pressure ring designed to exclude moisture.
   2. Hub fittings to have nylon insulated throat.
   3. Through wall and floor seals to be insulating and watertight type.
   4. Elbows:
      a. Radius not less than twelve (12) times the conductor diameters but in all instances, the cable manufacturer’s requirements shall supersede this paragraph.
      b. Fittings for conduits and outlet boxes to meet UL 514B.

G. Accessories:
   1. Conduit pull lines to be polypropylene, 1/4 inch, tensile strength not less than 1,000 pounds.
   2. Conduit thread compound to be lead free, corrosion resistant, anti-seize, conductive.
   3. Conduit sealant to be silicon foam manufactured by the following:
      a. Chase Technology Corp.’s PR855.
      b. Or Approved Equal.
   4. Galvanize repair coating to be cold liquid type.

H. Pull and Splice Boxes:
   1. Metal Pull and Splice Boxes:
      a. Metal Boxes that are to be installed in heated or unheated spaces shall be extra duty hot dipped galvanized steel. All boxes shall be sized in accordance with the NEC.
         1) Provide grounding means in each metal box.
      b. Boxes shall have metal covers to meet the NEC.
PART 3 - EXECUTION

3.01 General
   A. Do not exceed the recommended pulling tension of the cable manufacturer. Assume responsibility to pay all costs associated with the replacement of any cable that exhibits evidence of cuts, crimps, severe abrasions and damage due to exceeding the manufacturer’s specified pulling tension.
   B. Install, dress and terminate cabling in a professional manner, using practices of good craftsmanship.
   C. Place all new sleeves and penetrations required for successful cable installation.

3.02 Cable Termination
   A. Each element of the specified fiber optic cabling installed shall be connectorized using the specified SC connectors, and shall be mounted into the specified fiber optic patch panels and SC insert panels.
   B. Furnish and install all termination equipment according to the manufacturer’s instructions, using the required tooling and materials.

3.03 Floor and Wall Penetrations, Fire Stops
   A. Refer to Section 16910.

3.04 Installation in Duct Banks and on Aerial Structures
   A. In the duct bank manholes, apply a wrap of fireproofing tape and mastic between the entry points into the manhole. Install fire stop material at each duct entry point. The intent is to provide protection to vital fiber optic cables passing through manholes where unrelated C&S and ET cables may cause a fire.

3.05 Splices
   A. SEPTA intends that outside plant cabling shall be installed in one (1) continuous run between termination locations. No splices will be permitted.
   B. Install inside plant fiber optic cable without splicing between terminations at SCADA equipment or between outside plant to inside plant splice panels and SCADA equipment (i.e. no splices between termination points shown on a final fiber plant block diagram).

3.06 Damage
   A. Any cuts, abrasions, burns, stretched segments, and/or other damage that will be detrimental to the performance of that cable shall be cause for replacement of that entire segment of cable.
   B. Incidental damage to cables and connectors shall be corrected at the Contractor’s expense before testing and final acceptance of cables.
3.07 Cable Labeling and Identification

A. Submit a cable and outlet identification plan to SEPTA for approval before final cable labels are installed.

B. Each cable, patch panel port and termination block position shall be labeled individually with a unique cable number, using machine printed labels.

C. The cables shall be labeled at all terminations, junction boxes, pull boxes, manholes and hand holes.

D. Each outlet shall be labeled individually with a unique identification number, using machine printed labels.

E. Cable labels that are cut off during the installation process shall be replaced with new labels after final dress and termination in such a position that permits the label to be easily read.

3.08 Testing

A. Factory and field testing shall be performed in accordance with the requirements of Section 16950.

END OF SECTION
THIS PAGE NOT USED
SECTION 16138

DUCTWORK AND ELECTRICAL MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.01 Description
   A. This Section specifies furnishing and installing new buried conduits, handholes and manholes for electrical and communication cables. Also included is furnishing and installing precast cable trench box with tops flush with top of grade.
   B. The Contractor is also required to remove cables from to-be-abandoned communications and signal duct bank after they have been severed by SEPTA.

1.02 Related Sections
   A. Section 01720 – Project As-Built Documents
   B. Section 02220 – Excavation, Backfill and Compaction
   C. Section 16075 – Electrical Identification
   D. Section 16130 – Raceways and Boxes

1.03 Submittals
   A. Submit data sheets for each specified product.
   B. Submit mix design for each specified concrete mix.
   C. Submit shop drawings:
      1. Manholes:
         a. Drawings for each cast-in-place manhole with details of reinforcing, covers, frames and other appurtenances.
         b. Drawings for each size configuration of precast manhole and pullbox with details of joints, covers, frames and other appurtenances.
         c. Diagrams showing dimensioned locations for openings and knockout panels for duct penetrations of manhole walls.
      2. Underground duct accessories and joints.
   D. Submit working drawings:
      1. Location plan, arrangement and profile of manholes.
      2. Location plan, arrangement, profile of duct bank, number, size and type of ducts.
      3. Plan of existing utilities and the proposed locations of manholes and ducts.
   E. Submit loading design calculations for handholes and manholes, to demonstrate compliance with required load bearing capacity, as certified by a Professional Engineer licensed in the Commonwealth of Pennsylvania
1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. AASHTO M199, Standard Specification for Precast Reinforced Concrete Manhole Sections.
2. AASHTO H20, Wheel Loading.
3. ACI 304, Measuring, Mixing, Transporting, and Placing Concrete.
4. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
8. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
24. FS FF-S-325, Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry).
25. FS WW-C-581, Conduit, Metal, Rigid, and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Steel, Zinc Coated.
27. MIL-C-82052, Coating Compound, Waterproofing, Mineral-Filled, Solvent-Type, Asphalt-Base.
28. NEMA TC-2, Electrical Polyvinyl Chloride (PVC) Conduit.
29. NFPA 70, National Electrical Code (NEC).
30. Occupational Safety and Health Administration (OSHA).
31. UL 514B, Conduit, Tubing and Cable Fittings.
32. UL 651A, Type EB and a Rigid PVC Conduit and HDPE Conduit.

**B. Inspection of the material/equipment will be made at the point of delivery. However, SEPTA’s Project Manager reserves the right to make any tests or inspection that he may deem necessary at the Contractor’s plant.**

1. In the event inspection is made at the plant, grant SEPTA’s Project Manager and/or Representative free entry at all times while work under this Specification is being performed, to all parts of the plant that concern the manufacture of the pertinent material/equipment. Make available all facilities to satisfy SEPTA’s Project Manager that the material/equipment is being furnished in accordance with this Section.

2. If the Contractor is not the manufacturer of the material/equipment, it shall impose these conditions in its Contract with the manufacturer. In all cases, notify SEPTA’s Project Manager when the finished material/equipment is ready for shipment in order that plant inspection of the material/equipment may be made if desired.

**PART 2 - PRODUCTS**

**2.01 Materials and Equipment**

**A. Duct Bank:**

1. Electrical duct and fittings to meet the requirements of Section 16130.

2. Traction power medium voltage cables and communication and signaling duct banks require non-metallic duct.

3. Provide spacers as recommended by the conduit manufacturer.

4. Pull line to be 5/8 inch nylon or polyester type braided tape with markings at 1 foot intervals.

**B. Manholes, Handholes and Pull Boxes:**

1. Provide chimneys, frames and covers, cable pulling irons, cable racks, cable rack supports, ground rods, ground cable, and sump for each new or modified manhole.
2. Design manholes and handholes for AASHTO requirements for H20 loading on top and design for E-80 soil surcharge loading on the sidewalls. Meet the type and shape and inside dimensions indicated on the Contract Drawings.

3. Manholes and handholes constructed of precast concrete.
   a. Precast concrete to meet ASTM C 478.
      1) Manholes to include lifting rings, ladder, lids, pulling eyes, sump, and seal or sealant for sealing joints between sections; include precast extensions where required.
      2) Handholes to be the same format as for manholes except no ladder is required.

4. Pull Boxes Constructed of Polymer Concrete:
   a. Polymer concrete to meet ASTM C 579.
   b. Lid strength to meet ASTM C 857.
   c. Loading to be select based upon exposure to vehicular traffic. Heavy duty industrial type is minimum acceptable loading.
   d. Manufacturers:
      1) Carson Industries.
      2) Synertech Molded Products.
      3) Or Approved Equal.
   e. Lid to have “SEPTA” cast or embedded in center.
   f. Bolt-on lids having stainless steel fasteners.

5. Provide hole in floor for ground rod.

6. Cable pulling irons to be fabricated of plain steel reinforcement bar, ASTM A 615/A 615M, Grade 400 (60). Hot dip galvanized after fabrication, ASTM A 123/A 123M, and nylon encapsulated.

7. Provide cable support assemblies consisting of the following:
   a. Concrete inserts of size, number and spacing as required to accommodate cable racks.
   b. Cable racks to be non-metallic polyester or nylon stanchions, arms or saddles as manufactured by the following:
      1) Unistrut.
      2) Or Approved Equal.
   c. Cable rack fasteners to be stainless steel.
   d. Cable rack ties to be electrical grade black nylon cable ties, 1/4 inch minimum width.

8. Frames and Covers:
   a. Round frames and covers to be cast iron, ASTM A 48/A 48M, Class 35; with SEPTA logo. Covers shall be lockable and keys to SEPTA's Master Key System. Draw bar type system using a padlock is acceptable.

9. Provide 12 inch diameter drains with strainer tops set flush with the floor. Alternatively, provide a pervious concrete floor system.

C. Precast Concrete Manholes and Handholes:

1. Cable Racks:
   a. Provide UL listed, channel shaped racks and accessories including arms, saddle racks and slings to meet cable requirements.
b. Provide wall brackets and support brackets fabricated from, non-metallic, electrical insulating, fiberglass reinforced epoxy structural resin.
c. Support brackets shall be of a removable type.
d. Provide only stainless steel expansion anchors meeting Federal Specification FF-S-325 Group II, Type 4 and Class 1. Provide galvanized threaded bolts.

D. Expansion Couplings:
1. Rigid type, have minimum 4 inch travel distance with either gasket or O-ring meeting ASTM D 2000, Grade 2, Type FE and as follows:
   a. PVC to meet UL 514B.

E. Tags:
1. Refer to Section 16075 for requirements.

F. Underground Warning Tape:
1. Tape shall be printed polyethylene material, 4 mils minimum thickness with minimum 1 inch high lettering, over coated graphics to read, "CAUTION-BURIED ELECTRIC LINE" for electric lines, colored red.

G. Cable Trench:
1. Provide a precast concrete underground utility trench system for electrical cabling.
2. Design precast components to meet the requirements stated in ASTM C 857, ASTM C 858 and ACI 318.
3. Cement shall meet ASTM C 150/C 150M.
4. Fine and coarse aggregates shall meet ASTM C 33/C 33M.
6. Steel reinforcing bars shall meet ASTM A 615/A 615M.
7. Steel reinforcing wires shall meet ASTM A 1064/A 1064M.
8. Steel reinforcing welded wire mats shall meet ASTM A 1064/A 1064M.
9. Batching, mixing and placing of concrete shall meet ACI 304. All materials shall be pre-weighed prior to mixing.
10. Concrete shall obtain a minimum compressive strength of 5,000 psi at twenty-eight (28) days of age.
11. Furnish trench system consisting of precast concrete U-shaped bases and removable covers.
12. Design trench system to support at least 200 pounds per square foot live load for pedestrian traffic or 9,000# G.V.W. for pickup trucks and light duty utility vehicles.
13. Furnish trench with an interior clear cross sectional area of 20 inches wide x 15 inches deep. The trench will be approximately 26 inches wide x 19 inches deep overall including cover.
14. The precast U-shaped bases for the trench will be furnished in standard 10 foot lengths, except that special lengths will be furnished where required by the layout on the drawings. The U-shaped bases will be solid bottom.

15. Furnish precast trench covers in lightweight sections, sized to permit removal be a single person.

16. Furnish product as manufactured by the following:
   a. Trenwa, Inc.
   b. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation
   A. Transmit submittals and deliverables required by this section.
   B. Furnish products as indicated. Note that risers at each OCS (catenary) structure are to be glass fiber Reinforced Thermosetting-Resin (RTRC) that are impact rated (vandal resistant) grade conduit.
   C. Ensure substrates are in suitable condition to receive the work of this Section.
   D. Coordinate to provide the following:
      1. Ducts shall be flush with the vault walls using bell end fittings as required by the Contract Drawings.
      2. All duct openings shall be provided with water tight cable seals of the proper size and configuration for the cables.
      3. All unused duct openings shall be provided with blank watertight seals.
      4. Substrate Preparation for Manhole Installation:
         a. When excavation for manholes and duct banks has reached the required depth, the bottoms shall be graded smooth. Where rock, soft spots, or sharp edged materials are encountered, the bottom shall be excavated an additional 3 inches, then filled and tamped level to the proper grade with bedding material. Excavate trenches, and determine elevations and directions of pitch of underground ducts to provide the cover or invert as shown on the Contract Drawings.
         b. Tamp the bottom of trenches firm and even. Do not allow the cover for underground duct banks to be less than 36 inches below the top of the rail tie when run under the track and not less than 36 inches below the final grade when not the under track.
   E. Provide excavation, dewatering, treatment of water as required, temporary shoring, backfill, manholes, forms, miscellaneous steel, reinforced concrete and compaction associated with the duct banks, in accordance with Section 02220.
   F. Provide ducts, fittings and spacers, including setting in place. Coordinate the layouts and associated materials of the duct bank.
   G. Thoroughly review the Contract Drawings and Specifications in preparation for installation of the materials and equipment. Procure, store and plan for use all materials in a manner, which minimizes waste and substitutions, and maximizes installation efficiency and quality of the end product.
H. Examine all Contract and Reference Drawings, to verify and properly coordinate the work. Check all relevant drawings including civil, mechanical, structural, architectural, electrical and shop drawings.

3.02 Installation of Ducts

A. Verify locations, distance levels and other conditions in the field prior to the commencement of installation of work. Significant deviations shall be brought to the attention of SEPTA upon discovery.

B. Duct Installation:

1. Encase the ducts in steel reinforced concrete in the configuration that is shown on the Contract Drawings.

2. Lay the duct in the trench in the designed formation using SEPTA approved duct spacers. Place duct spacers every 60 inches and staggered. Connect duct spacers. In rock excavations, assemble the duct bank on a protective course of a minimum of 3 inches of clean sand. Stagger joints 6 inches minimum, both in vertical and horizontal runs. No two (2) joints shall be within 6 inches of each other in any plane. Lay straight ducts as straight in alignment as possible with a minimum permissible offset of 3 inches in a 50 foot length. Install all bends so that they are tangent at the point of joining.

3. When changes in the formation of a bank of ducts within a duct run are necessary, install the transition in as straight an alignment as possible.

4. Repairs to ducts are prohibited. Remove and replace all individual broken, cracked, chipped or impaired lengths of duct with new ducts.

5. After the duct is in place with the proper spacing and joints made up tight, firmly anchor the run in position. Make flush the end of the duct bell with the inner surface of the manhole, substation and/or switching station cable vault, where applicable.

6. Where necessary, support the sides of the trench excavations for ducts by suitable sheeting or shoring. Where the duct is close to the main or running track, brace the sides of trench excavation, except in rock or shale, to prevent slipping or settlement of the roadbed. No bracing within 10 feet of the nearest rail shall extend above the top of rail, or be attached in any way to the rails or ties.

7. Remove all obstructions, such as rocks, concrete and pipes (which extend into the trench and which would prevent the proper formation of the duct and manholes) unless such projections are part of a permanent structure. If they are part of a permanent structure, notify SEPTA’s Project Manager for further instructions.

8. Arrange the work in the vicinity of the tracks so that any excavation, laying of the ducts and backfilling will proceed in one (1) continuous operation to the maximum extent possible. The intent is to keep the trench open for the least possible time and only to such an extent as is considered necessary for the economical and practical construction of the work. Do not leave open trenches unattended or unprotected. Trenches must be closed up at the end of each workday or suitably covered and roped off with appropriate warning flags or markers.

9. Pass a flexible duct rodding device through the completed duct run to check for continuity and cleanliness. Following the duct rodding, draw a test mandrel, with an
outside diameter 1/4 inch smaller than the inside diameter of the duct, through to test bore and alignment. If difficulty is encountered in passage of the duct rodding device, draw a series of wire brushes through the duct, once in each direction using a trailing line. Use wire brushes 1/8 inch smaller than the diameter of the duct. If the correct size cannot be passed through on the initial attempt, the operation must be repeated until accomplished as specified.

10. When the duct is partially or fully obstructed with mud, dirt or gravel, all attempts must be made to clear the obstruction.

11. After the ducts have been wire brush cleaned, pull nylon cord in and leave in each duct, including all spare ducts. Leave at least 24 inches of nylon cord extended beyond each duct end.

12. Broken, cracked, chipped or impaired lengths of conduit will not be acceptable.

C. Constructing Concrete Encased 40/80 PVC Duct Bank:

1. Use 80 PVC conduit under tracks and 40/80 PVC conduit elsewhere.

2. The concrete encasement surrounding the duct bank shall provide at least 3 inches of cover on all sides of the duct bank and no less than 2 inches minimum cover over steel reinforcement.

3. Lay conduits using spacers to provide tier spacing shown on the Contract Drawings. Locate spacers at a maximum center spacing of 4 feet.

4. Construct duct lines to slope downward towards manholes with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished be long sweep bends having a minimum radius of curvature of 25 feet unless otherwise indicated; sweep bend may be made up of one (1) or more curved or straight sections or combinations. Manufactured bends shall have a minimum radius of 24 inches or the minimum cable manufacturer bending radius, whichever is greater.

5. Conduits shall terminate in end bells where duct lines enter underground structures. Stagger joints of the conduits by rows and layers to provide a duct line having maximum strength. During construction, protect partially completed duct lines from debris such as mud, sand and dirt by inserting plugs in the open ends of the conduits.

6. Properly place concrete around conduits to assure complete encasement without voids. Finish off with a mechanical vibrator. Where concrete encased duct lines connect to underground structures, construct a flared section adjacent to the manhole to provide shear strength. Construct the underground structure to provide for keying the concrete envelope of the duct line into the wall of the structure.

7. Wherever a construction joint is necessary in a duct line, fit concrete envelope of a partially complete duct line with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one (1) number 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two (2) number 3 bars, spaced approximately 1 foot apart, all around.

8. Prior to backfilling, temporarily close ends of conduits with plugs.
9. In the presence of the SEPTA’s Project Manager, prove conduit clear and clean by one (1) of the following methods:
   a. Rodding and pulling approved test mandrel from structure to structure.
   b. Blowing approved device from structure to structure with compressed air.

10. Install and leave approved pull tape in each conduit.

D. Existing Direct Buried Ducts:

   1. Bring to the attention of SEPTA’s Project Manager, details about existing buried ducts or cables encountered during excavation. If such existing installations are determined to be abandoned, cut off and remove the materials. Protect all remaining duct and cable so as not to interfere with construction.

   2. At certain locations, existing ducts and cables are buried beneath tracks and along the right-of-way. Extreme care must be exercised when excavating. Repair any damaged ducts or cables, as a result of work performed during excavation.

   3. In temporarily open trench areas, furnish and install reflective signs, flags or warning tape to warn of an open trench. Submit protection materials and method of installation to SEPTA’s Project Manager for review. Cover all open trenches in an approved manner upon completion of each day’s work.

   4. Provide backfill material that is clean, free of large stones, cinders and ashes. Provide backfill free of stone greater than 1 inch that is to be placed within 12 inches of the duct.

   5. Place all backfill material placed in layers not exceeding 12 inches in depth and compact by hand tamping backfill that is placed within 18 inches above the duct. Machine tamp the balance of the backfill material.

   6. In rock areas, where the duct trench bottoms cannot be kept clear of stone, place a 3 inch minimum cushion of sand prior to duct installation.

3.03 Construction of Manholes and Handholes

   A. Install precast underground structures as specified below.

   B. Excavate in accordance with Section 02220.

   C. Provide for location of duct entrances and windows to facilitate cable racking; build duct formation into walls of the structure and seal flush around opening.

   D. Install frame and cover, adjusting to finished grade.

   E. Place ground rod.

   F. When installing sections of precast manholes, prevent damage to joint seals.

   G. Coat exterior surfaces of structures with a cold applied, fibrous asphalt damp proofing meeting Military Specification MIL-C-82052, or approved equal, applied to a minimum thickness of 3/32 inch.

3.04 New Duct into Existing Manholes

   A. Inspect manhole to ensure that work will not damage existing cables/conduit.
B. After exposing manhole side wall, core bore wall to accommodate new duct.
C. Clean and roughen manhole wall surface around new entry to facilitate a good bond with new concrete duct bank. This seal shall be water tight.
D. Repair any damage to interior wall and fill in and seal flush around all new ducts.

3.05 Demolition of Abandoned Cables, Conduit and Manholes
A. The Contractor shall remove abandoned cables as per the Contract Drawings.
   1. Prior to any work, ascertain that all cables are dead by having SEPTA sever the cables.
B. The Contractor shall then remove the abandoned ducts in their entirety and the abandoned manholes. Refer to the Contract Drawings for the extends of the selective demolition.
C. After removal, the Contractor shall backfill and compact as per Section 02220.

3.06 Cleanup
A. Remove debris from conduits, manholes and handholes and ensure complete installation is left in neat and finished condition.

3.07 Clearing and Cleaning of Existing Duct Banks that Remain
A. Survey the impacted manholes and on-site duct bank system and remove all abandoned and dead cables from manhole to manhole.
B. Clear existing spare ducts.
C. After removal of any existing cables, pull or fish wires, mandrel each duct for its entirety then thoroughly clean with a pull brush.
D. Place new pull tape in each duct after clearing.
E. Plug duct ends.
F. Where ducts cannot be cleared, the Contractor shall attempt to clear the ducts using a pneumatic type system. If the ducts still cannot be cleared, report all findings to SEPTA’s Project Manager.
G. After cable removal and clearing of the ducts, the Contractor shall remove all rubbish and debris and broom clean surveyed manholes. Power washing will not be permitted.
H. Maintain a “job set” of inspection forms in accordance with Specification Section 01720.

3.08 New Cable Trench
A. Set precast trench sections so that the top is flush with final grade, i.e. flush with the aggregate surface within the substation or switching station yard.
B. Core drill solid bottoms to allow conduits to sweep up and into the trench. Grout the annular opening prior to pulling cable.
C. Install solid end caps to keep vermin, dirt and debris out of trench.
D. Broom clean trench way before cable installation.
END OF SECTION
SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 Description

A. The work of this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning, and protecting wiring devices and cover plates.

1.02 Related Sections

A. Section 01400 – Quality Requirements
B. Section 13121 – Prefabricated Building
C. Section 16060 – Grounding and Bonding
D. Section 16075 – Electrical Identification
E. Section 16123 – Building Wire and Cable
F. Section 16130 – Raceways and Boxes
G. Section 16950 – Testing

1.03 Submittals

A. Submit all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.

B. Submit product data:
   1. List of all products and accessories.
   2. Catalog cuts of all products and accessories to be furnished and installed.

C. Submit product data, and installation and maintenance instructions for Contract closeout.

1.04 Quality Assurance

A. All quality control work to meet Section 01400.

B. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) unless products meeting the requirements of these testing laboratories are not readily available, or unless standards do not exist for the products. Provide products that are for the location installed and listed and labeled or approved for the voltages and currents applied for the applications the items are intended.

C. Perform all electrical work under the supervision of a licensed electrician.

D. Meet the applicable provisions of the most recent issues of the following references:
   1. American Iron and Steel Institute (AISI).
2. NEMA WD 1, General Color Requirements for Wiring Devices.
3. NEMA WD 6, American National Standard for Wiring Devices - Dimensional Requirements.
4. NFPA 70, National Electrical Code (NEC).
5. UL 20, General-Use Snap Switches.
6. UL 231, Power Outlets.
7. UL 498, Attachment Plugs and Receptacles.
8. UL 943, Ground Fault Circuit-Interrupters.
9. UL 1681, Standard for Wiring Device Configurations.

1.05 Delivery, Storage and Handling
A. Deliver product to the Contractor responsible for providing the prefabricated building per Section 13121.

PART 2 - PRODUCTS
2.01 Switches and Receptacles
A. Provide UL listed specification grade switches meeting NEMA WD 1 and WD 6; and UL listed specification grade receptacles meeting NEMA WD 1 and WD 6 for voltage and current indicated. Provide switches and receptacles with screw terminals. A mixture of manufacturers’ products is not permitted.
B. Toggle handle snap switches to be 20 amp, single pole, 3 way or 4 way as indicated, quiet design.
   1. Control switches, Single Pole Double Throw (SPDT) with center OFF and maintained contacts or SPDT with center OFF and momentary contacts to be of the same basic type, construction and rating as specified above for toggle handle snap switches. See the Contract Drawings for additional information.
C. Standard Face Design Receptacles:
   1. Industrial specification grade to be duplex, 125 volts AC, 20 amperes, 2 pole, 3 wire, grounding.
D. Ground Fault Circuit Interrupter (GFCI) Receptacles:
   1. Industrial specification grade to be duplex, 125 volts AC, 20 amperes, 2 pole, 3 wire, grounding, UL 943, solid state circuitry.
E. Manufacturers:
   1. Hubbell.
   2. Pass & Seymour.
   3. Or Approved Equal.
2.02 Wall Plates

A. Provide a wall plate for each switch, receptacle and special purpose outlet. Do not use sectional gang plates. Use multi-gang outlet plates for multi-gang boxes. Use wall plates of AISI 302 stainless steel (0.040 inches thick) with satin finish.

B. Use wall plates for pushbutton and buzzer outlets that have openings to suit the pushbuttons and buzzers. Use plates having the same finish mentioned above.

C. Provide wet location device covers for use at locations subject to wet or rain conditions. Provide receptacles covers marked “Suitable for Wet Locations While In Use”.

D. Use 316 stainless steel type screws for the installation of wiring devices and wall plates.

E. Manufacturers:
   1. Hubbell.
   2. Pass & Seymour.
   3. Appleton.
   5. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Inspect area to insure all surfaces are concrete foundation for completeness, correct number, type and location of anchors, size and levelness. Check for spalled concrete, honeycombs and other concrete defects.

B. Check pull and junction box for correct type, size and location.
   1. Flush boxes should be plumb and level to 1/8 inches and flush or protrude no more than 1/16 inch from the finish surface.
   2. Surface mounted boxes should be plumb and level to 1/16 inch.
   3. Size of box should meet the NEC.
   4. Check wiring pigtails for sufficient length to re-terminate wiring twice and leave 6 inches of slack within the box.

C. Check ground wires for correct type, size and location.

D. Correct any and all defects.

E. Remove any over sprayed paint from interior of boxes and from wiring.

F. Clean interior of box of dirt and debris.

3.02 Installation

A. Install equipment under supervision of skilled electricians and in accordance with the manufacturer's printed installation instructions.
B. Where two (2) or more switches or receptacles are shown on the Contract Drawings at the same location, they shall be ganged and covered with one (1) coverplate.

C. Use stainless steel hardware in all locations.

D. Adjust final switch and devices to be plumb and level and wall plates of flush boxes to be set flush to wall.

E. Unless otherwise specifically instructed, locate mounting heights from finished floor to centerline of devices.
   1. Lighting control switches to be 48 inches to centerline of switch above finished floor and on strike side of door, unless indicated otherwise on the Contract Drawings. Mount switches in tandem where not possible to mount side-by-side with a common device plate.
   2. Duplex convenience outlets to be mounted 18 inches to centerline of outlet above finished floor, unless indicated otherwise on the Contract Drawings.

F. Ground all devices to meet Section 16060.

G. Make up all connections to devices to meet Sections 16123.

H. Provide outlet boxes and supports to meet Sections 16130.

I. Identify all devices to meet Section 16075.

J. Protection:
   1. Mask all items during painting operation.
   2. Protect items against damage during other work.

### 3.03 Field Quality Control

A. Inspect all boxes for proper operation and visual appearance and mounting height.

B. Test receptacles per Section 16950.

**END OF SECTION**
SECTION 16150

WIRING CONNECTIONS

PART 1 - GENERAL

1.01 Description
A. This Section covers equipment wiring requirements and responsibilities.

1.02 Electrical Interface
A. This Section is provided for clarification of the responsibilities of the Contractor with regard to the connection of equipment provided under other Contracts.

B. Unless specifically indicated otherwise, the Contractor is responsible for connecting electrical products. The Contractor also furnishes and installs mechanical products as part of the prefabricated building.

1. Tie-ins to existing active SEPTA circuits will be by SEPTA.

PART 2 - PRODUCTS

2.01 Materials and Equipment
1. Basic electrical materials required for the work to be included in this Section are as specified in other Sections.

PART 3 - EXECUTION

3.01 Installation
A. Electrical materials being installed for the connection of equipment shall be installed as specified in the applicable sections and as indicated on approved shop drawings.

B. Equipment Wiring:
1. Mechanical Equipment:
   a. The Contractor provides power supply wiring as specified in Section 01011.
   b. The Contractor provides motor starters, control devices and interconnection wiring and conduit, including final connections, between control panels, control devices, motor starters, equipment, and disconnect switch or junction box as required for an operational system.
   c. The Contractor provides final connections between fire alarm control relays and air handling equipment.

END OF SECTION
THIS PAGE NOT USED
SECTION 16210

ELECTRIC UTILITY SERVICES

PART 1 - GENERAL

1.01 Description
A. This Section specifies the supply of electrical services from PECO UTILITY and describes the equipment and service installation requirements.
B. The following equipment assemblies are to be furnished and installed as an independent distribution circuit as indicated on Contract Drawings to supply auxiliary power at 60 Hz.
   1. Outdoor service entrance switchgear.
   2. Utility metering for a new service drop.
   3. Underground and overhead distribution circuit from the PECO transformer to the meter, then switchgear, then to the disconnect switch at the prefabricated building.

1.02 Related Sections
A. Section 16950 – Testing

1.03 Submittals
A. Submit plan, elevations and details of the routing of distribution circuits between PECO Point-Of-Connection (POC) and the auxiliary power disconnect switch in the substation or switching station.
B. Submit electrical inspection certification to demonstrate that the work meets the local code requirements and the requirements of PECO.
C. Submit arc flash hazard study.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. NFPA 70, National Electrical Code (NEC).
B. Provide the services of an electrical inspection agency (that is recognized by authority having jurisdiction) to review the submittals and inspect the finished equipment and construction of the 60 Hz electric services outside the substation or switching station yard.
C. PECO service requirements.

PART 2 - PRODUCTS

2.01 Service Meter Box
A. Refer to PECO requirements.
2.02 Non-Walk-In Outdoor Switchgear

A. Manufacturers:
   1. Eaton (Cutler-Hammer).
   2. Penn Panel.
   3. Or Approved Equal.

B. Ratings:
   1. 208/120 VAC, 600 V class.
   2. 3 phase, 4 wire plus ground.
   3. Service entrance approved by PECO.

C. Features:
   1. Metal clad outdoor switchgear, non-walk-in type.
   2. Electrically operated draw-out main circuit breaker with solid state adjustable trips for overcurrent and ground fault protection.
   3. Surge arrestors on each phase.
   4. Line and Load side current transformers.
   5. Local potential transformer and Distribution Transformer (DT).
   6. Heaters for condensation prevention, fed by DT.
   7. SCADA interface for remote supervision and operation.
   8. Tamper proof hardware and built-in enclosure entry sensors tied into SCADA interface.
   9. Two (2) sets (redundant) enclosure grounding pads for external connection to a local ground grid.
   10. Nameplates and warning labels, including arc flash hazard labels.

D. Mounting Accessories:
   1. Furnish switchgear complete with stainless steel anchor bolts and template for drilling the anchor holes into a concrete pad furnished by the Contractor.
   2. Include permanent lifting eyes as part of enclosure. Fork lift slots in the base, with bolt-on covers to make the installation rodent proof are optional.

2.03 Substation or Switching Station Disconnect Switch

A. Manufacturers:
   1. Eaton.
   2. Square D.
   3. Or Approved Equal.

B. Ratings:
   1. 600 V class.
2. 3 phase, 4 wire plus ground.

C. Features:
   1. Outdoor, Weatherproof.
   2. Include a SPD, Type 1, as manufactured by the following:
      a. APT, series XDS.
      b. Or Approved Equal.
   3. Bottom entry.

PART 3 - EXECUTION

3.01 Preparation
   A. Test the equipment ground grid prior to installing the switchgear.
   B. Coordinate the final concrete pad size and mounting bolt locations.
   C. Coordinate that final grading and crushed stone surrounding the equipment pad are complete prior to energizing the service.
   D. The electrical utility construction will require advance preparation to provide SEPTA’s Project Manager, for approval, a construction plan, a request for flagging, a request for a Class A electrician and planned outages to perform the work under the tracks.
   E. All work shall be coordinated and performed in the presence of a SEPTA electrician.

3.02 Installation
   A. Lift switchgear into place using integral lifting eyes.

3.03 Testing
   A. Perform factory and field tests in accordance with the requirements of Section 16950.

END OF SECTION
THIS PAGE NOT USED
SECTION 16240

BATTERY EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. This Section specifies the manufacturing, testing and furnishing requirements for the following station battery equipment:

1. Battery cells.
2. Battery racks and containment.
3. Battery accessories.
4. Battery chargers.
5. Battery charger accessories.
6. DC distribution panelboard.
7. Fused DC disconnect switches.
8. DC manual transfer switch.

B. Design the battery system, having the equipment as described above, as a fully integrated system and within the specified space limitations. The design of the integrated system shall provide features for the safety of personnel during installation, operation and maintenance.

C. Provide SCADA supervisory and alarm indications.

1.02 Related Sections

A. Section 16950 – Testing

1.03 Submittals

A. Battery:

1. Submit shop drawings, catalog cuts, illustrations, specification, schedules and material lists showing complete details.
2. Submit sizing calculation for sixty-four (64) hours of support for AC switchgear controls.
3. Submit ventilation requirements.
4. Submit maintenance and installation instruction manual(s).
5. Submit battery rack tier and step configuration.
6. Submit dimensions of the battery rack.
7. Submit dimensions of the spill containment barrier, including its volume.

B. Battery Charger:

1. Submit manufacturer’s product description, catalog data and information.
2. Submit manufacturer’s arrangement, wiring, and detail outline dimensions drawings, floor plans and one line diagrams.

3. Submit design calculations for battery and battery charger.

4. Submit certified test reports for the following tests on battery chargers having identical requirements as described in this Section:
   a. Dielectric tests.
   b. Voltage adjustment.
   c. Temperature rise.
   d. Current limit.
   e. Short circuit.
   f. Static voltage deviation.
   g. Efficiency measurement.
   h. Power factor measurement.
   i. Ripple voltage measurement.
   j. Audible noise.
   k. Stability and response.
   l. Transient voltage withstand.
   m. No load.

5. Submit battery charger control wiring diagram and schematics.

6. Submit typical values for the following battery charger test results:
   a. Dielectric test.
   b. Full load tests with a 200 ampere-hour, sixty (60) cell, lead acid battery, running in parallel with, and without a battery, with momentary overload. The full load test shall show output ripple voltage lies within 0.06% of normal output voltage.
   c. Voltage test.
   d. Current limit test.
   e. Ripple voltage measurement.
   f. Charging capability within twelve (12) hours, of a battery already discharged to 105 V DC from its nominal 130 V DC value.
   g. Float voltage tests.
   h. Temperature compensation.
   i. Automatic “Equalizing Charge” capability.

7. Submit field test plan.

C. Submit nameplate information.

D. Submit training course instructor’s outline and a copy of the presentation materials.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
   1. ANSI Z535, Safety Alerting Standards.
4. Institute of Electrical and Electronic Engineers (IEEE).
5. NEMA AB 1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
6. NEMA FU 1, Low Voltage Cartridge Fuses.
7. NEMA PB 1, Panelboards.
9. UL 67, Panelboards.

B. Utilize manufacturers that are regularly engaged in the manufacture of batteries and battery chargers and only provide products that have proven reliability in similar applications. The manufacturers of the supplied equipment shall not have less than 15 years' experience in the production of the specified products.

C. Select a manufacturer having a ISO approved in-house quality control program.

D. Workmanship shall conform to recommended practices for the manufacture of a product suitable for application in substation environment.

1.05 Delivery, Storage and Handling

A. Permit no more than ninety (90) days to elapse between the final manufacturing date of battery cells and installation with a functional battery charger.

1.06 Operations and Maintenance Data

A. Installation, operation and maintenance/repair manuals.

B. As-built drawings.

C. Parts list manual.

D. Nameplate information.

E. Manufacturer's arrangement, wiring, and detail outline dimensions drawings, floor plans and one line diagrams.

F. Design calculations for battery and battery charger.

G. Certified test reports.

1.07 Warranty

A. The manufacturers of each component within the complete battery system shall warrant their respective components to operate per this Specification for a period of five (5) years from the date of delivery, except that the warranty on the cells shall be extended and prorated for a period of ten (10) years.
PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Manufacturers:

1. Battery Charger 60 Hz:
   a. Provide battery charger manufactured by one (1) of the following:
      1) EnerSys, Inc.
      2) C & D Technologies, Inc.
      3) Saft NiFe.
      4) Alcad.
      5) Hindle Power.
      6) Or Approved Equal.

2. Battery Charger 25 Hz:
   a. Provide battery charger manufactured by one (1) of the following:
      1) Hindle Power.
      2) EnerSys, Inc.
      3) Or Approved Equal.

3. Battery:
   a. Provide battery cells manufactured by one (1) of the following:
      1) EnerSys, Inc.
      2) C & D Technologies, Inc.
      3) ALCAD.
      4) Chloride.
      5) GNB.
      6) Or Approved Equal.

2.02 Equipment Characteristics

A. Batteries:

1. General Requirements:
   a. The battery system shall be used in an unattended, non-climate-controlled traction power substation. The ambient temperature will vary from -20 °C [14 °F] to 45 °C [113 °F].
   b. The battery shall be a 120 V, 190 Ampere-hour pure lead VRLA (Valve-Regulated, Lead-Acid) AGM (Absorbent Glass Mat) stationary battery of flat plate construction, comprised of ten (10) monoblocs (a.k.a. multi-cell unit or monoblock) at 12 V each. Each monobloc shall be comprised of six (6) cells, and shall have terminals accessible from the front, not the top, of the package. All acid shall be immobilized in the AGM. No free acid shall be present in the cell.
   c. The cells shall be lead-acid chemistry with a design life of fifteen (15) years in float service operation under the environment and application described in this Specification. End-of-life is defined as retaining 80% of rated capacity and a voltage of 1.75 volts per cell; 10.5 V per monobloc.
   d. The battery shall be comprised of 10 monoblocs, connected in series.
e. The monobloc and cell construction shall be as follows:

7) Monobloc containers and lids shall be constructed using flame retardant ABS with a UL94 rating of V0 and an LOI (Limiting Oxygen Index) of at least 28%, and shall have leak-proof joints.

8) Monobloc containers shall incorporate integrated handles designed for lifting.

9) The monobloc containers and the lid-to-container joint shall be capable of withstanding an internal pressure of at least four times the normal working pressure. Monoblocs shall be equipped with a low-pressure self-resealing one-way safety pressure relief valve, which will prevent ambient air entering the cell/monoblocs.

10) The cell plate shall be a rolled and punched grid type. Recycled lead shall not be used in the manufacturing process. No antimony or calcium shall be used in the plates. The grid thickness of the positive plate shall not exceed 1.25 mm [0.049 in].

11) Monobloc internal terminals shall consist of lead-tin coated inserts machine cast into the lead.

12) The design of the cell/monobloc shall be sufficiently robust to withstand external short circuits in full compliance to IEC 60896 Part 21.

13) The battery shall have a recombining efficiency greater than 98% during normal float charge operation.

14) Monobloc external terminals shall consist of stainless steel front access, with top access copper alloy insert.

15) The external links between the monoblocs shall be made from insulated flexible connectors.

f. Monoblocs shall not exceed the following physical characteristics:

16) Length: 561 mm [22.9 in]
17) Width: 125 mm [4.92 in]
18) Height: 316 mm [12.44 in]
19) Mass: 60 kg [132.3 lbs]

16) Length: 561 mm [22.9 in]
17) Width: 125 mm [4.92 in]
18) Height: 316 mm [12.44 in]
19) Mass: 60 kg [132.3 lbs]

G. The battery shall consist of ten (10) monoblocs to provide a nominal 120 V output voltage.

h. The nominal capacity at the eight (8) hour discharge rate at 25 °C [77 °F] to 1.75 volts per cell (10.5 V per monobloc) shall be no less than 190 A.

i. Each cell in the battery system shall have the following discharge rates down to 1.75 V per cell at 25 °C [77 °F]:

20) Eight (8) hours - 23 Amps minimum
21) One (1) hour - 137 Amps minimum
22) Fifteen (15) minutes - 332 Amps minimum

j. 

k. 

l. Design the batteries for float service.
   1) Provide batteries having sixty (60) cells to provide a nominal output float voltage of 130 volts DC.
   2) :
      a) Normal continuous demand of substation or switching station loads, including circuit breaker and motor operated switch control, relays, indicating lamps, local annunciator panel and SCADA control.
      b) Simultaneous closing followed by tripping of all circuit breakers in the substation or switching station, once per twenty-four (24) hour period while no charger input is available.
   3) Specific gravity shall be 1.300 at 77°F with float volts of 2.25 to 2.27 per cell.
   4) Require that the battery manufacturer clearly and permanently identify polarity of cell terminals posts.
   5) Provide monoblocs with inter monobloc, inter tier, inter step, end-to-end inter rack, back-to-back inter rack connectors, terminal lugs and terminal plates as required. Provide connectors, plates and lugs having tin plated solid copper. Specify that the bolt hardware be stainless steel.

2. Battery Rack:
   a. Provide batteries with two (2) tier structural steel support racks. Treat racks with two (2) coats of acid-resistant, ANSI 61 Gray, finish paint coat.

3. Battery Electrolyte Spill Containment System:
   a. Provide electrolyte spill containment system for the battery system, having a liquid capacity of more than one hundred (100) gallons of electrolyte.
      1) Each rack of batteries or group of racks shall be provided with a liquid tight, minimum 4 inch deep spill control, anti-corrosive polystyrene barrier which extends at least 1 inch beyond the battery rack in all directions. This barrier shall prevent free flow of spilled electrolyte.
      2) Within the liquid tight barrier and underneath the entire group of battery racks, sufficient number of approved neutralizing and absorbing pillows or pads with matching capacity shall be provided to meet IFC paragraph 608.5.

4. Nameplate:
   a. Provide the battery bank with a stainless steel nameplate. Attach nameplate to the battery rack by stainless steel rivets and marked with the following information:
      1) Manufacturer’s name.
      2) Month and year of manufacture.
      3) Battery and cell type.
      4) One (1) minute, one (1) hour, and eight (8) hour ampere rating.
      5) 

B. Battery Accessories:
1. Furnish accessories for normal operation and maintenance of the batteries for each battery and shall include the following:
   a. One installation, Operation and Maintenance Manual
   b. Cell lifting sling complete with strap and spreader bar.
   c. Battery logbook.
   d. Three 0.24 ounce (7 gram) containers of electrical contact grease NO-OX-ID "A-Special".
   e. Set of special tools for maintenance, as required.
   f. Set of inter cell connectors.
   g. One (1) set of connecting bolts.
   h. One (1) set of inter rack and load terminal lugs.
   i. Furnish and install on each monobloc, individual adhesive backed numbers. The numbers shall be 1 inch character height, numbers from “1” through “10”.
   j.

C. Battery Charger:

1. Provide battery chargers that are solid state, completely automatic, fully regulated, convection cooled, having a silicon controlled rectifier and having a constant temperature compensated output voltage.

2. Charger shall be a filtered unit capable of operating as a DC power supply and has the ability to supply the load without batteries (battery eliminator) in addition to its function as a battery charger. Connect the battery and its associated charger in parallel. Battery shall be capable of supplying the balance of the heavy short time current demands. When the AC supply to the charger is interrupted, the battery shall supply all of the required power for the specified load duty cycle.

3. Battery charger shall be engineered for thirty (30) year life expectancy with a minimum MTBF of 60,000 hours.

4. Battery charger shall be rated as follows:
   a. Capacity to be in accordance with its associated battery size.
   b. Shall be able to recharge the battery from 1.75 volts per cell to 85 percent of the battery capacity in eight (8) hours maximum. Shall also be able to fully recharge the battery in twelve (12) hours, including an automatic equalizing charge period, after the battery discharge to a level of 105 volts at its stated discharge rate.
   c. Refer to the Contract Drawings for input voltage and frequency.
   d. Output voltage (nominal) to be 130 volts DC.
   e. Output current to be in accordance with its associated battery size and continuous DC load, but shall not be less than 25 amperes.
   f. The charger regulation shall consistently maintain float voltage within 0.5 percent of output DC float voltage over its complete load range (zero to full load) with plus/minus 10 percent variation of input AC voltage, and line frequency of plus/minus 5 percent. Float voltage shall be adjustable between 118.2 volts and 139.5 volts.
   g. The equalizing voltage shall be adjustable between 128.1 volts and 144.5 volts.
   h. Current limit to be adjustable from 90 to 115 percent; factory set at 110 percent of nominal output current rating.
   i. Output filter to be 30 mV rms ripple or 0.06 percent of normal output voltage, whichever is higher, without the battery connected.
j. The charging voltage for the battery shall be temperature compensated. Temperature compensation shall be automatically effected to control the charging voltage as the temperature increases from its optimum limit.

k. Automatic Charger Protection and Control:
   1) The charger output current shall be automatically limited to the eight (8) hour discharge rate for the battery to prevent the cell temperature from exceeding 110°F during the equalize cycle. The charger shall automatically give an equalizing charge, following a charger outage and use of the battery for more than five (5) seconds, for a time preset on the equalizer timer. The charger shall then revert to the normal cycle for full float charging. The equalizing timer shall be adjustable from zero (0) to seventy-two (72) hours.
   2) The charger shall have built-in protection from overload including short circuit of the output terminals. This protection shall be by means of a current limiting device or circuit which will limit the output current to the rating of the charger without disconnecting the charger from the battery or AC supply. The charger shall be self-protected against battery discharge into the charger on less of input AC voltage.

l. Manual Charging Control:
   1) Provide a three (3) position, manual selector switch on the panel door.
   2) Mark the switch “Automatic”, “Float” and “Manual-Equalize”. In the “Float” position, the charger output shall be limited to the float condition and shall permit adjustment of the float rate. In the “Manual-Equalize” position, the charger shall apply equalizing voltage to the battery and permit adjustment of the equalizing rate. The adjustment devices shall be clearly marked.

m. All DC relay contacts for remote indication shall be wired to a separate terminal block in the cabinet for supervisory indications. The terminal blocks shall be rated for 130 V DC, 1 ampere.

5. Battery Charger Enclosure:
   a. Provide NEMA Type 1 enclosure that is provided with a hinged front panel complete with handle, louvers (to permit the convection cooled charger to operate satisfactorily under ambient temperatures of up to 100°F). The door shall be equipped with cylinder type lock, operated by a master key. Provide three (3) keys for each locked enclosure.
   b. Select the enclosure to be either freestanding or wall mounted, ventilated, welded type and formed of sheet steel. The front of the enclosure shall be panel type with all meters and accessories mounted.
   c. De-burr and degrease the enclosure following fabrication. Apply a phosphate bath to the enclosure as a unit. Immediately after, apply a rust inhibiting coat of primer with a finish coat of light gray enamel color 61 paint as specified in ANSI Z535.

6. Battery Charger Accessories:
   a. In addition to the charging circuit elements, include on each charger:
      1) One (1) DC Voltmeter, 0 to 150 volts.
      2) One (1) DC ammeter, range as applicable (0-50 ampere scale on 25 ampere chargers).
      3) One (1) AC input pilot light marked as “AC Supply.”
      4) One (1) three (3) position selector switch marked “AUTOMATIC,” “FLOAT” and “MANUAL EQUALIZE” with indicating lights.
      5) Two (2) ground detection alarm relays, positive and negative, for local and remote annunciation, with relay coils connected to terminal block for remote sensing to indicate “battery grounded.”
6) One (1) AC input, 3 pole, molded case circuit breaker, NEMA AB 1.
7) One (1) DC output, 2 pole, molded case circuit breaker, NEMA AB 1.
8) One (1) equalizing time charger, zero (0) to seventy-two (72) hours, to terminate a manually set adjustable equalizing charge of 2.33 volts per cell. One (1) DC low voltage alarm relay for local and remote annunciation.
9) One (1) DC low voltage alarm relay for local and remote annunciation, with relay coil connected to a separate terminal block for remote sensing to indicate “low battery voltage”.
10) One (1) AC charger failure alarm relay, with “charger failed” indication light, for local and remote annunciation.
11) One (1) test switch and two (2) indicating lights for ground detection system devices.
12) One (1) surge and transient protection package.
13) One (1) nameplate containing the manufacturer’s type and serial number complete rating information and wiring diagram reference number.
14) For alarm relays, described above, provide two (2) normally open and two (2) normally closed dry contacts, rated 130 V DC, 1 ampere.
15) Provide permanent nameplates for operating device and indication device.
16) Provide eye bolts or other attachment devices for ease of lifting and transporting the battery charger unit.

D. Fuse Disconnect Switch:
   1. Manufacturers:
      a. Square D Company.
      b. Siemens Energy and Automation.
      c. Or Approved Equal.
   2. Provide a two (2) pole, external handle operated, fused disconnect switch to permit isolation of the battery. Coordinate the fuse rating and switch size with the DC output circuit breaker in the battery charger. Mount the disconnect switch and fuse in a NEMA Type 4X stainless steel enclosure with mechanical defeatable door interlock to prevent opening door when the switch is in “ON” position, adjacent to the battery rack. Require that the fuses meets NEMA FU 1 and that they provide short circuit protection for the battery and main cables to the DC distribution panelboards.
      a. Provide the fused disconnect switch with the required auxiliary contacts for providing local and remote alarms. Arrange the fuse disconnect switch to alarm when fused disconnect switch is opened.
      b. Fuse shall be rated 100 amperes, 1000 volts DC, as manufactured by one (1) of the following manufacturers:
         1) Ferraz Shawmut.
         2) Cooper Bussmann.
         3) Or Approved Equal.

E. DC Distribution Panelboard:
   1. General:
      a. Provide the DC panelboard that meets the requirements of NEMA PB 1 and certified to UL 67 and shall be suitable for two (2) wire, 150 volts DC ungrounded power distribution service. Equip the panelboard with branch circuit breaker type disconnects meeting NEMA AB 1.
b. Manufacturers:
   1) Square D Company.
   2) Siemens Energy and Automation.
   3) ABB.
   4) Or Approved Equal.

2. Interior:
   a. Provide a main lugs only style panelboard interior sized per the Contract Drawings to accept 2 pole 250 VDC rated circuit breakers.

3. Enclosure:
   a. Provide a panelboard that is suitable for surface mounting, that is the dead front type, and housed in a NEMA Type 1 extra heavy galvanized steel enclosure with hinged front cover, lockable handle and two (2) point latch.
   b. Furnish and attach a moisture resistant circuit directory to the inside face of the cover.
      1) For each circuit breaker, print complete information concerning the circuit controlled.
      2) Permanent numerical identification by each breaker space.

4. Circuit Breakers:
   a. Rated at 25 kA RMS symmetrical interrupting at 250 volts DC, 2 pole, UL 877, with appropriate ratings.
   b. The breaker trip element to be enclosed and compensated for temperature rises and calibrated to 40°C ambient temperature.
   c. Circuit breakers of the same ratings to be interchangeable, quick make, quick break, front of panel bolt-on type.
   d. Terminals to be rated solder-less type, suitable for copper conductors sized at maximum rated terminal capacity.
   e. Populate the panelboard interior with a minimum of six (6) double pole circuit breakers. Define the quantity plus at least two (2) spares as part of the substation or switching station switchgear control system design.

5. Finish:
   a. Thoroughly cleaned, phosphatized or equivalent coated with at least one (1) coat of corrosion resistant paint.
   b. Paint light gray enamel paint ANSI 61 color as specified in ANSI Z535.

PART 3 - EXECUTION

3.01 Preparation
   A. Transmit submittals and deliverables required by this Section.
   B. Furnish products as indicated.
   C. Battery cells shall be delivered fully charged.
   D. All components of the Battery System shall be packed and shipped in a manner that avoids damage. Damaged shipments will be rejected.
   E. Ensure substrates are in suitable condition to receive the work of this Section.
3.02 Installation
A. Install battery and specified equipment per the manufacturer’s recommendation, plumb and level and in true alignment with related adjoining work.
B. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts and angles, as required to set and rigidly connect the work. Securely fasten the battery racks to the floor as required for seismic considerations.
C. Assemble battery cells on the battery racks and give an equalizing charge, following the installation of the substation or switching station circuit breakers and related equipment.
D. The electrolyte spill containment system shall be properly installed in compliance with the fire safety code, prior to the installation of the battery rack and lead acid battery system.

3.03 Testing
A. Furnish technical assistance necessary for installation and startup of the equipment.
B. Provide factory and field testing of the battery and charger in accordance with Section 16950.

3.04 Training
A. Provide, arrange for and establish battery system maintenance training for six (6) substation maintainers. Provide all training materials, notes, CD-ROM and classroom presentation equipment.

END OF SECTION
THIS PAGE NOT USED
SECTION 16270
DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 Description
A. This Section covers the requirements for a single phase, 25 hertz, outdoor, liquid filled, self-cooled transformer installed as shown on the Contract Drawings.
B. Transformer dielectric liquid shall be mineral oil to meet ASTM D 3487.

1.02 Related Sections
A. All requirements that are described in Division 1.
B. Section 01300 – Submittals
C. Section 16050 – Basic Materials and Methods for Electrical Work
D. Section 16060 – Grounding and Bonding
E. Section 16075 – Electrical Identification
F. Section 16120 – Conductors and Cables
G. Section 16950 – Testing

1.03 Submittals
A. The Contractor shall provide the design drawings for the new auxiliary power supply system for each substation or switching station including a distribution transformer connected to the 12 kV trolley bus.
B. Submit shop drawings complete with construction details including outline dimensions including plan and elevation views, base plan, top high voltage bushings and low voltage terminal chamber with bottom conduit entry openings.
C. Submit weights of the tank, empty and full of insulating oil and total transformer weight.
D. Submit nameplate data, arrangement of bushings and other related characteristics.
E. Submit rigging instructions, center of gravity determination and support points.
F. Submit technical data for temperature monitor/controller.
G. Submit volume of oil in gallons.
H. Submit manufacturer’s catalog cuts, material specifications, installation instructions, weights, impedance, excitation current and other pertinent data for all components to be furnished.
I. Submit certification:
   1. The manufacturer’s certification that the transformer furnished meets the specified requirements.
2. Certification shall be based upon factory test results for this product or the results of
tests of products constructed to the requirements of this Section.

3. Certification of tamper resistant design with complete test data.

4. Certified high and low voltage impulse data.

5. The transformers supplied under this Section contain less than 1 ppm PCB.

J. Submit transformer oil time constant, time for top oil to obtain 63 percent of steady state
rise above ambient.

K. Submit performance data:
   1. No load and full load losses at the specified ambient temperature shall be quoted on the
      transformer shop drawings as certified factory design test data. Transformer acceptance
      will be based in part, upon the test results of actual losses versus the quoted losses.
      SEPTA reserves the right to reject the transformer if losses exceed 5 percent from
      quoted losses.
   2. Efficiency at full load, 75 percent, 50 percent load.
   3. Regulation at 95 percent and 90 percent power factor.
   4. Factory test results for all tests as defined in IEEE C57.12.00.

L. Submit nameplate drawing:
   1. Percent impedance volts of the low voltage winding with respect to the high voltage
      winding at rated self-cooled kVA.
   2. De-energized external tap changer technical data.

M. Submit accessory data.

N. Submit short circuit withstand capacities.

O. Submit factory test plan (The plan shall include all tests as defined in IEEE C57. 12.00).

P. Submit field test plan.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
   1. ANSI Z535, Safety Alerting Standards.
   2. ASTM D 3487, Standard Specification for Mineral Insulating Oil Used in Electric
      Apparatus.
   3. ASTM D 3612, Standard Test Method for Analysis of Gasses Dissolved in Electrical
      Insulating Oil by Gas Chromatography.
   7. IEEE C57.12.00, IEEE Standard for General Requirements for Liquid-Immersed
      Distribution, Power, and Regulating Transformers.
9. IEEE C57.12.34, IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High-Voltage, 34.5 kV Nominal System Voltage and Below; Low-Voltage, 15 kV Nominal System Voltage and Below.
11. NEMA TR 1, Transformers, Step Voltage Regulators and Reactors.
12. NFPA 70, National Electrical Code (NEC).

B. Submit shop drawings of the transformer to the SEPTA Project Manager for review and approval prior to manufacturing.

C. Provide transformer with ratings as shown on the Contract Drawings.

1.05 Delivery, Storage and Handling
A. Secure non-moving parts that may shift in transportation.
B. A list of all temporary equipment restraints which were installed at the factory, shall accompany the shipment to serve as a checklist for installation and energizing the equipment.
C. Provide protection from concealed damage by providing within shipping container mechanical impact recorder of rating recommended by the manufacturer for shipment by railroad and submit impact record chart with the manufacturer’s instructions for disposition of damaged materials.
D. Store in a clean dry location.
E. Handle transformers using only lifting eyes and brackets provided for handling purposes.
F. Protect units against damage from rain, sleet or snow if handled in inclement weather.

1.06 Operation and Maintenance Data
A. Furnish hard copies of the maintenance instruction manual as required by Section 01300 and one (1) electronic file copy on CD-ROM in Adobe Acrobat (PDF) format for the following:
   1. Operation and maintenance manual.
   2. Maintenance schedule for the first cycle of scheduled maintenance, not less than twelve (12) months.
   3. Spare parts list, renewable parts list and consumable list.
   4. As-built drawings including final fabrication drawings.
B. Electronic file copy of shop drawings, factory test report, field commissioning report and other related data, contained on CD-ROM in Adobe Acrobat (PDF) format.
1.07 Warranty

A. The standard warranty for design, material and workmanship shall apply as follows:

1. The warranty shall begin upon substation or switching station acceptance by SEPTA. In addition to the standard one (1) year warranty, provide an extended warranty for three (3) additional years.

B. The warranty shall include full repair or replacement at no cost to SEPTA.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Subject to compliance with the requirements of this Section, provide transformers as manufactured by one (1) of the following manufacturers:

1. Niagara Transformer Corporation.
2. ABB.
3. Vantran Industries, Waco TX.
4. Virginia Transformer.
5. Or Approved Equal.

B. Requirements

1. General:
   a. The insulating liquid shall be mineral oil as specified in ASTM D 3487.
   b. Transformers shall be capable of withstanding stresses resulting from operating conditions, including external and internal short circuits without distortion or other damage. In addition, the transformers shall be designed to withstand the large inrush currents.
   c. Transformers shall have provisions to facilitate moving and maintenance as follows:
      1) A structural steel base with jack step skids to provide movement in either direction and also provide a means for attaching shipping skids.
      2) Pulling eyes.
      3) Lifting lugs for lifting the complete transformer assembly by overhead crane.
      4) Lugs for lifting cover only to expose the core and coil in the field for repair purposes.
      5) Alarm, control and indication contacts shall terminate in a separate termination box or compartment with separate access through the enclosure. All wiring of contacts for alarm, control or indication shall be wired to terminal strips.
      6) Polarity, angular displacement and lead markings shall be in accordance with IEEE C57.12.00 standard identification.
      7) All accessories shall be located in accordance with ANSI/IEEE standards.
      8) Primary and secondary areas shall be furnished of sufficient size to accommodate connections of the incoming conduits, cables, stress cones and other such items.

2. Core:
   a. Design the transformer core using a high efficiency, high electrical resistance, and high magnetic permeability, electrical grade steel alloy to produce distribution transformers with low no-load and load losses.
b. Select a cold rolled, heat treated grain oriented steel to reduce hysteresis loss.

3. Tank:
   a. The tank shall be of sufficient strength to withstand a pressure of 7 psi without permanent distortion.
   b. Provide a tank that is welded using precision cut, cold rolled steel plate and equipped with extra heavy duty, welded-in-place lifting lugs and jacking pads.

4. Coil Supports:
   a. Design the coil supports to meet the requirements of IEEE C57.12.28. They shall be sufficiently rigid to withstand any mechanical or thermal stresses due to short circuit current or transformer weight during transportation.

5. Transformer Oil Temperature Gauge and Mechanical Pressure Relief Device:
   a. Provide transformer with liquid temperature gauge.
   b. Provide a mechanical pressure relief device with alarm contacts.

6. Ratings:
   a. Tentative ratings of the transformer shall be as follows. The Contractor shall determine the final ratings.
      1) kVA rating to be 25 kVA. The Contractor to determine the final size of distribution transformers.
      2) Primary voltage to be 12,500 V, 1 phase, two (2) wire.
      3) Frequency to be 25 Hz.
      4) Primary taps to be five (5), no load, 0 percent, +/- 2 x 2 1/2 percent.
      5) Basic impulse level to be 125 kV BIL (Primary).
      6) Secondary voltage to be 120 V/240 V to match the battery charger and other 25 Hz loads.
      7) Basic impulse level to be 30 kV BIL (Secondary).
      8) Efficiency, at rated load to be 98.8 percent minimum.
      9) AC impedance to be 3.5 percent to 5 percent meeting IEEE C57.12.34.
     10) Temperature rise to be 55°C maximum over average ambient of 30°C.

7. Transformer Internal Construction:
   a. The transformer shall be capable of withstanding both the electrical and mechanical stresses resulting from handling and operating conditions, including external and internal short circuits without distortion or other damage.
   b. High Voltage Taps:
      1) High voltage taps shall be provided and shall be suitable for de-energized operation only and shall have provision for padlock. Set the tap on the 100 percent tap at the factory and secure to prevent inadvertent change from this position.
   c. High Voltage Changer:
      1) Voltage changer shall be provided and shall be suitable for de-energized operation only. The voltage changer switch shall be ganged and shall be externally operable.
   d. Cooling System:
      1) The transformer cooling system shall be Oil Natural Air Natural (ONAN) self-cooled.
   e. Finish:
      1) Transformers shall be finished in ANSI 61 gray two (2) part epoxy of ANSI Z535.
f. Enclosure:
1) Transformers shall be designed to protect against accidental contact of energized parts, discouraging access to, or climbing upon, the unit, and protect against weather as required by a NEMA 3R (outdoor) enclosed and gasketed design.
2) Each unit shall consist of the transformer tank, high voltage bushings housed on cover and the low voltage cable terminations. The transformer tank and compartment shall be assembled as a rain tight compartment, outdoor and tamper resistant integral unit suitable for mounting on a flat surface.
3) There shall be no exposed screws, bolts or other fastening or hinging devices (other than pentahead bolts) that are externally removable. There shall be no opening through which foreign objects such as sticks or wires might be inserted to contact energized parts. Suitable means for padlocking the compartment doors shall be provided.
4) The high and low voltage bushings shall be located on top cover and the low voltage terminals shall be located on one (1) side of the transformer tank.
5) All external surfaces of ferrous material used in the construction of the assembly shall have undercoating over the regular finish, applied to the bottoms of the components and extending up the side to a point 1 to 2 inches above the bottom of their bases in a straight edge.

g. Protective Coating:
1) All coated surfaces both exterior and interior shall be painted using a system that meets the requirements of IEEE proposed finishing.

h. Low Voltage Bushings and Terminals:
1) Provide three (3) low voltage bushings.
2) Electrical characteristics of completely assembled low voltage terminations shall meet the requirements of IEEE C57.12.34.
3) All low voltage terminals shall be insulated from the tank with 1.2 kV class bushings.
4) The low voltage neutral shall be a fully insulated bushing.
5) Low voltage terminals shall be two (2) hole spades with NEMA hole spacing to provide the number of holes required.

i. High Voltage Bushings and Terminals:
1) Provide two (2) bushings on 12 kV side.
2) High voltage bushings are to be made of wet process porcelain and clamped externally to the wall of the transformer. Reusable nitrite rubber gaskets shall seal the bushings to the tank wall in the terminals to the porcelain.
3) The design of the transformer shall allow field replacement of high voltage bushing wells and low voltage bushings by means of common hand tools and oil handling equipment, without totally un-tanking the transformer.

j. Nameplate:
1) The transformer shall be equipped with a nameplate per IEEE C57.12.00 (Type B nameplate).
2) Nameplate shall be located on the inside of the low voltage compartment door.

k. Information specified in paragraph 5.12 of IEEE C57.12.00 shall be provided on the nameplate.

l. Nameplate shall indicate that the transformer oil contained less than 1 ppm PCB at time of manufacture.

m. A winding diagram with high and low voltage connections shall be shown on the nameplate.
C. Oil Preservation:
   1. Transformers shall be of sealed tank construction, so designed that the interior is sealed from atmosphere and the gas plus oil volume remains constant. The transformer shall remain effectively sealed for all temperatures to 105°C top oil.

D. Accessories:
   1. Provide sign indicating:
      a. "Transformer Does Not Contain PCB".
      b. "High Voltage".

PART 3 - EXECUTION

3.01 Preparation
   A. Transmit submittals and deliverables required by this Section.
   B. Verify that concrete pad is ready to receive work including conduit stub-ups properly located.
   C. Ensure substrates are in suitable condition to receive the work of this Section.

3.02 Installation, Application and Execution
   A. Transformer shall be installed on a concrete pad as shown on the Contract Drawings, and connected in accordance with the manufacturer's recommendations, and in conformance with IEEE C2 and the NEC.
   B. Ensure that the height of the lowest energized part meets NESC requirements.
   C. Securely fasten the transformer support frame to the concrete pad/support bracket in accordance with applicable Seismic Zone requirements.
   D. Prior to being energized, each transformer shall be field tested as described in Article 3.03 of this Section.
   E. Mount transformers with vibration dampeners between the transformer and structure where mounted.
   F. Ground the secondary neutral in accordance with the NEC.
   G. Install the transformers with adequate air circulation for removal of the heat produced by the transformers. Meet the manufacturer's requirements and listing requirements.
   H. Check for damage and tight connections prior to energizing transformers.
   I. Clean and inspect bushings, inspect bushing clamps and gaskets, inspect cover and hand hole gasket seals, inspect tap and voltage changer seals.
   J. Check for fluid leaks and liquid level.

3.03 Testing
   A. Refer to Section 16950 for factory and field testing requirements.
B. Perform short circuit and other design tests at an approved independent laboratory on the first transformer of the supply. SEPTA may waive design tests, at its discretion, if the reports of recent design tests performed on similar transformers are submitted and approved.

C. Perform field tests per applicable IEEE standards and as recommended by the manufacturer. At a minimum, perform the following tests.

1. Ratio test at all tap positions.
2. Verification of operation of tap changer.
3. Verification of accessories.
4. Dielectric (high voltage) test.

D. After energization, measure the primary and secondary voltage for record in the installation report.

END OF SECTION
SECTION 16275

INSTALLATION OF TRACTION POWER AUTOTRANSFORMERS

PART 1 - GENERAL

1.01 Description

A. Provide two (2) 5 MVA autotransformers at each of the substations covered in this Contract.

B. Autotransformers required for the substations covered in this Contract have been ordered by SEPTA. The autotransformers will be delivered, partly disassembled, in multiple packages, FOB at each substation site to the Contractor.

C. The Contractor is responsible for all works from unloading of the autotransformers to final commissioning and placing into revenue service. It includes, but is not limited to:

1. Unloading.
3. Assembly of the transformer either by supplier's technicians or under supplier's supervision
4. Construction of oil containment system and fire barriers (where required).
5. Performing all connections including grounding, control cables and power connections.
6. Testing, commissioning and energization.
7. Post commissioning tests.

D. The Contractor is responsible for safe storage and handling of the autotransformers until acceptance by SEPTA in revenue service.

E. The Contractor shall work in close coordination with the autotransformer supplier, ABB, for the installation and testing work. Arrange for the ABB installation and commissioning engineer’s presence for installation and commissioning of each autotransformer. Estimate the duration in consultation with ABB. It is expected that one (1) week will be required for each autotransformer.

1. ABB’s local contact person is:
   Jeff Sikkema
   Sikkema Electrical Sales
   208 W. Browning Road
   Collingswood, NJ 08108
   (856) 428-1425
   jeff@sikkemaelectric.com

1.02 Related Sections

A. All Sections of Division 1.

B. Section 01452 – Contract Quality Control – Traction Power Equipment

C. Section 01752 – Spare Parts and Maintenance Material – Traction Power Equipment
D. Section 01822 – Demonstration and Training – Traction Power Equipment
E. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment
F. Section 02450 - Oil Containment System
G. Section 09910 – Paints and Coatings
H. Section 16052 – General Electrical Requirements – Traction Power Equipment
I. Section 16060 – Grounding and Bonding
J. Section 16075 – Electrical Identification
K. Section 16290 – Protective Devices and Instrument Transformers
L. Section 16335 – Surge Protection
M. Section 16331 – Installation of Circuit Breakers
N. Section 16791 – Combined Relay and Control Switchboard
O. Section 16952 – Electrical Testing – Traction Power Equipment (RRD)

1.03 Submittals
A. Submit the following documents and product samples for SEPTA's review and approval:

1. Submit the unloading and installation procedure for review and approval of SEPTA. The procedure shall be prepared in coordination with ABB and shall include:
   a. Unloading procedure, specific for each substation. Include special precautions for each substation.
   b. Transportation to the foundation pad. Address the site specific issues related to the movement and installation especially for Neshaminy due to peculiar location of the substation.
   c. Installation procedure including anchoring, grounding of the tank and fall protection.

2. Submit operations and maintenance manuals as specified in Section 01832.

3. Submit product data. Obtain the technical product data for the following equipment and components from ABB and submit in a book form.
   a. Cooling liquid.
   b. Current transformers.
   c. Surge arresters.
   d. Protective devices.
   e. Auxiliary relays.
   f. Instruments.
   g. Indicating devices.
   h. Cables and wires.
   i. Insulating materials.
   j. Insulators and bushings.
   k. Terminal blocks and connectors.
   l. Paint and coating systems.
   m. Other equipment.
4. Submit the following installation drawings for the autotransformers for review and approval. The Contractor shall obtain the drawings marked with an asterisk from ABB for inclusion in the submittal.
   a. Front cover sheet.
   b. List of drawings.
   c. Legend, abbreviations and notes.
   d. Transformer winding schematic diagram. *
   e. Design load and no-load losses. *
   f. Weight empty and with oil. *
   g. Fully dimensioned transformer elevation and plan drawings sitting on the foundation pad. The drawing shall include adjacent columns and show clearances of the high voltage terminals from the columns and ground, between high voltage terminals, and routing of control cables.
   h. Control cable connection diagrams showing all terminal blocks.
   i. Surge protection arrangement. *
   j. Transformer nameplate and label designs. *
   k. Terminal block designations for all control cables.
   l. Conductor and cable schedules.
   m. Hydraulic diagram including location of valves and joints. *
   n. Jacking and lifting provisions. *
   o. Fall protection provisions (The Contractor shall verify the adequacy of the provided fall protection system by the supplier and improve as required).

5. Submit samples of the following products:
   a. Cables and wires for control cables.
   b. Terminal blocks and connectors.
   c. Paint and coating systems used for touching up.

6. Submit the following test plans, procedures and test reports:
   a. Provide test plans and procedures for the commissioning and first time energization tests. The procedure shall have the approval of ABB.

7. Prepare and submit a commissioning report detailing all tests performed on the autotransformers up to the time of placement in revenue service. The report shall include, but not be limited to:
   a. Report of factory tests performed by the supplier at its works prior to shipment. The Contractor shall obtain the copy of the report from SEPTA or ABB.
   b. Technical data and name plate details. Obtain the information from SEPTA.
   c. Wire, control and instrumentation cable sizes.
   d. Wire, cable and terminal designation system.
   e. Anchoring information.
   f. Paint and coating touch-up procedures.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:


1.05 Warranty
A. The Contractor shall provide the warranty for installation for three (3) years.
B. The warranty shall begin upon substation acceptance by SEPTA and shall include, if attributed to faulty storage, handling or installation:
   1. Full repair or replacement of autotransformers.
   2. Full repair or replacement of autotransformer components and accessories.
   3. Factory and field testing and adjustments of the replaced autotransformers, components and accessories.
C. All work associated with warranty, such as manufacturing, shipping, installation and testing shall be performed at no cost to SEPTA.
D. Any autotransformer component and accessory replaced under the warranty provision shall be guaranteed for one (1) year from date of acceptance of the replacement.

1.06 Coordination

PART 2 - PRODUCTS

2.01 Traction Power Autotransformers
A. Autotransformers for the substations covered by the Contract have been ordered by SEPTA. Refer to the SEPTA purchase specification in Annex 1 for technical details.
B. Shop drawings provided by ABB are attached at Annex 2.

2.02 Current Transformers (CTs)
A. Multi-ratio current transformers are supplied with the autotransformers. Test report of the CTs on one (1) of the autotransformers is attached in Annex 3.
B. The Contractor shall set the CT ratios suitable for the relay protection per relay protection study.
2.03 Surge Arresters
   A. Provide surge arresters on the 12 kV and 24 kV terminals with appropriate grounding. Refer to supplier’s drawings.

2.04 Protective Devices
   A. Refer to the SEPTA purchase specification and ABB’s drawings for details of the protective devices.
   B. Wire the protective devices to the appropriate relay and control board.

2.05 Grounding
   A. Connect the rail return (neutral terminal, H2) of the autotransformers to the perimeter ground bus and directly to the ground grid.
   B. Connect the autotransformer tank to the substation ground grid at two (2) locations. Coordinate with autotransformer supplier.

PART 3 - EXECUTION

3.01 General
   A. All phases of unloading, storage, installation and commissioning shall be performed by qualified and experienced personnel using proper tools and equipment under competent supervision. Ensure presence of ABB’s engineer as specified earlier.
   B. The Contractor shall not use products and materials containing asbestos or other potentially harmful substances.

3.02 Unloading
   A. The Contractor is responsible for unloading the autotransformers from the delivery vehicles, moving to the concrete pad and installing on the pad. Coordinate the time and point of delivery with SEPTA and ABB.
   B. Verify that the shock/tilt or impact recorder is intact. Advise SEPTA and ABB if there is evidence of any damage.
   C. Move the autotransformers to the concrete pad with due site specific caution.

3.03 Installation
   A. Install the autotransformers on the concrete foundations in accordance with ABB’s instructions.
   B. Anchor the transformer to prevent movement under adverse weather conditions and under short circuits.
   C. Verify integrity of the fall protection. Supplement as required.
   D. Perform assembly of the components which are supplied loose, such as bushings, conservator tank, and the radiators etc. by supplier’s technicians or under supplier’s supervision.
E. Perform all grounding connections.
F. Connect the rail return (neutral terminal) of the autotransformers to the substation perimeter ground bus, to the rail return bus, and directly to the substation ground grid.
G. Remove protective shorts from the current transformers.
H. Perform all electrical connections of control and power circuits.

3.04 Grounding
A. All grounding connections shall be capable of carrying the rated short circuit current. In each case the grounding connections shall be via the shortest possible route.
B. Connect the autotransformer grounding pads directly to the substation ground grid or ground bus.
C. Ground the rail return (neutral terminal) of each autotransformer directly to the substation ground grid and to the perimeter rail return bus.
D. Do not use splices in the return circuit.

3.05 Factory Tests
A. Obtain reports of factory tests from ABB and provide to SEPTA with the commissioning tests report.

3.06 Field Commissioning Tests
A. Submit field commissioning tests procedure, prepared in coordination with ABB, for review and approval at least thirty (30) days before the proposed date of tests. The tests shall include all tests recommended by ABB and required by the applicable standards.
B. Arrange attendance of the ABB commissioning engineer for tests and commissioning of all autotransformers. Allow one (1) week, or more, of the commissioning engineer’s time, for each autotransformer.
C. The following tests shall be performed as a minimum:
   1. Test of all status and control functions.
   2. Test of all protective devices.
   3. Winding resistance and ratio test at the rated tap.
   4. Insulation resistance test.
   5. Hipot test.
   6. Doble Test.
D. Submit the commissioning test report within fifteen (15) days of the completion of the tests for review and approval. Include the factory test report obtained from ABB.

3.07 Commissioning
A. Upon completion of pre-commissioning tests, energize the autotransformers in the presence of the commissioning engineer.
B. Measure no-load current and record for future reference. Also provide other measurements which have to be made periodically to ensure good health of the autotransformers as recommended by ABB.

C. Perform other post commissioning tests recommended by ABB.

ANNEX 1
ANNEX 3
END OF SECTION
SECTION 16290

PROTECTIVE DEVICES AND INSTRUMENT TRANSFORMERS

PART 1 - GENERAL

1.01 Description

A. This Section specifies general requirements for application of protective relays, instrumentation and associated devices.

B. Detailed requirements are specified in the relevant individual equipment sections. The equipment sections and the Contract Drawings describe the minimum protective scheme required and are intended to serve as an aid to the functional requirements. Components such as auxiliary relays, isolating diodes, fuses and other similar devices required for a complete installation are not individually specified, but shall be provided by the Contractor.

C. Perform all final design details including selection of device models, styles, ranges, connections, and settings to ensure satisfactory coordination of all protective devices and a fast fault clearance.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contract Quality Control - Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling - Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials - Traction Power Equipment

E. Section 01822 – Demonstration and Training - Traction Power Equipment

F. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment

G. Section 05090 – Metal Fasteners, Joining and Welding

H. Section 09910 – Paints and Coatings

I. Section 16052 – General Electric Requirements - Traction Power Equipment

J. Section 16060 – Grounding and Bonding

K. Section 16075 – Electrical Identification

L. Section 16335 – Surge Protection

M. Section 16952 – Electrical Testing - Traction Power Equipment (RRD)

1.03 Submittals

A. Submit the following documents and samples for SEPTA’s review and approval:

1. Provide technical product data sheets for all system equipment. Including the following equipment:
   a. Current transformers.
   b. Potential transformers.
c. Protective devices.

d. Auxiliary relays.

e. Measuring instruments.

f. Indicating devices.

g. Cables and wires.

h. Equipment enclosure.

i. Terminal blocks and connectors.

2. Submit product samples:

a. The Contractor shall submit samples of the following products for approval:

1) Cables and wires.

2) Terminal blocks and connectors.

3. Submit relay setting software for each relay.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following standards:

1. ASCII, American Standard Code for Information Interchange.

2. IEEE 242, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.


12. NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

13. NEMA ICS 4, Application Guideline for Terminal Blocks.


15. NEMA PB 1, Panelboards.

17. UL 486A-486A, Wire Connectors.
18. UL 508, Industrial Control Equipment.
19. UL 1437, Electrical Analog Instruments, Panel Board Type.

PART 2 - PRODUCTS

2.01 Protective Devices

A. Design and provide a comprehensive protective relay scheme to protect the substation or switching station equipment and the overhead distribution system, as well as to provide back-up protection to the vehicle protective devices.
   1. Base the protective scheme design on the load, overload and short circuit currents.
   2. Select the characteristics and ranges of all protective devices to ensure satisfactory coordination of all devices and a fast fault clearance.
   3. All devices (relays, panels, etc.) that are considered long lead items must be submitted by the Contractor within the 1st 90 days of the Contractor's Notice to Proceed.

B. Provide sufficient hard wire connections for all protective functions to allow for all substation or switching station equipment, including the 12 kV and 24 kV switchgear, autotransformer circuit breakers and autotransformers, to continue to be functional, via local control, in the event of failure of any bay module, local area network, gateway computer, or any part of the SCADA or communications equipment.

C. Select solid state, microprocessor based, multifunction, self-reset protective relays. All main functions of the relays shall be individually configurable on a computer and shall be enabled or disabled by the user by means of straightforward configuration procedure.

D. Provide high quality, utility type, protective relays of modular design enclosed in rustproof, dustproof, metal or high impact plastic cases suitable for flush mounting on equipment cabinets.

E. Provide relays with provisions for relay setting, adjustments and testing from the front of the relay. Provide each protective relay with readily visible and accessible LCD control panel integrated with the relay. The control panel shall enable entry of all data required for operation of the relay, including the following:
   1. Readout and modifications of settings.
   2. Readout of measured data.
   3. Readout of operating data logs and of monitored signal logs.
   4. Readout of event logs, at least last ten (10) events.
   5. Support relay testing and commissioning tasks.

F. Provide each relay with comprehensive and continuous self-monitoring capability ensuring that hardware and software errors are detected and do not cause malfunction of the protective device. Depending upon the fault diagnosis, the self-monitoring system shall issue alarm or block the relay operation. Provide all relays with provision to annunciate operation and failure on the relay as follows:
1. Locally, the relay operation, alarm and failure shall be indicated by light emitting diodes (LEDs).

2. Remotely, provide each relay with a sufficient number of contacts and outputs to enable operation, alarm and failure of the relay to be indicated on the SCADA system.

G. All protective relays shall be arranged to be conveniently accessible, easily visible and logically grouped. Devices of related functions shall be located in proximity to each other. The protective relays shall be installed on the cubicle door and shall be semi-flush mounted.

H. Provide test switches to disable all tripping circuits of the relay in the event that it is necessary to remove the relay for service or replacement or for testing the relay functions. Provide test switches so that current transformer circuits shall be short circuited and potential transformer circuits shall be open circuited prior to the relay removal from its case or its rack or for testing the relay functions.

I. Provide the protective relays with the following other features:

1. Internal clock for event logging capable of being synchronized to the communications protocol.

2. Silver or silver/copper alloy non-bonding contacts.

J. Manufacturers:

1. Areva.


3. Or Approved Equal.

2.02 Protective Relay Philosophy

A. Autotransformer Faults:

1. Autotransformer protection shall include overcurrent relays, differential relays as well as pressure relief, temperature and low oil devices. The relays shall trip the respective autotransformer circuit breaker via hand reset and electrical/hand reset lockout relays.

B. Trolley-to-Ground Faults:

1. Trolley-to-ground faults shall be detected by instantaneous overcurrent relay (Device 50). Circuit overload conditions shall be detected by a three (3) zone distance relay (Device 21). First zone will cover approximately first half of the circuit. The second zone will cover the second half of the circuit. The third zone will cover the section from the connecting breaker at the end of the circuit up to the next substation’s bus. Following a trolley-to-ground fault, only the trolley circuit breakers feeding the faulted section of the trolley system shall open.

C. Feeder-to-Ground Faults:

1. Feeder-to-ground faults shall have protection shall be similar to the trolley-to-ground protection described in Article 2.02.B.1 in this Section. Following a feeder-to-ground fault, only the feeder circuit breakers feeding the faulted section of feeder shall open.

D. Busbar Faults:
1. Busbar faults shall be detected by instantaneous bus differential relays. Additionally, bus differential relays shall have an overcurrent element.

2. Upon operation, a bus lockout relay shall trip all circuit breakers connected to the bus.

E. Trolley/Feeder Protection Back-Up:
   1. No additional circuit breaker back-up relays are considered necessary. Faults not cleared by the trolley/feeder protection shall be cleared by the circuit breakers at other substations which are feeding into the fault. At no time will any breaker on a bus open to clear a fault on a different breaker or bus.

F. Breaker Failure Relaying:
   1. Failure of trolley or feeder breakers to interrupt fault current shall be detected by breaker failure relays. Following operation of trolley or feeder protective relay, the breaker failure relay shall pick up and a timer shall be started.
   2. If at the end of a pre-selected time delay, the current remains above the current setting, all breakers on the bus shall be tripped via lockout relay.

G. Automatic Reclosure:
   1. The circuit breakers shall not have automatic reclosure capability. All closing operations of circuit breakers shall be initiated locally by an operator or remotely by the power dispatcher via the SCADA system.

H. Protective Devices Wiring:
   1. Use copper cables for the wiring related with the protection circuits including wiring from current transformers and potential transformers and the wiring for the trip circuits between various cubicles.

2.03 Auxiliary, Tripping and Control Relays
   A. Provide compact, highly reliable, mechanically stable, voltage operated, self-reset, hand-reset and electrically/hand-reset auxiliary, tripping and control relays, as required for the particular application.
   B. Provide each relay with a flag to indicate relay operation.

2.04 Current Transformers
   A. Current Transformers (CTs) associated with the circuit breakers are pre-ordered by SEPTA along with the circuit breakers. Current transformers associated with the bus tie disconnect switches shall be procured by the Contractor. Since the current transformers are used in the bus differential circuit, these shall be similar to the current transformers supplied by circuit breaker manufacturer.
   B. Provide current transformers to accurately transform the system currents for metering and relaying. Select the current transformers to satisfy ANSI and IEEE requirements for metering and relaying accuracy classification under the burdens imposed by the metering and protective devices. The current transformers shall be suitable for outdoor installation.
   C. Select ring core type current transformers with toroidally wound and fully distributed secondary windings.
D. Select current transformers insulated with structural grade thermoplastic to withstand dielectric test levels of the equipment and to carry the currents occurring during rated load, overload, and short circuit currents without excessive heating or injury.

E. Provide each current transformer with a mounting frame which bolts securely to the mounting beam. Run secondary wiring from the current transformer terminal studs to terminal blocks. Provide the current transformer terminal blocks with covers having integral shorting bars.

F. Ensure that the current transformer ratio and accuracy are commensurate with the current transformers supplied with the circuit breakers.

2.05 Potential Transformers

A. Provide Potential Transformers (PTs) to accurately transform the system voltages for metering and relaying. Select the potential transformers to satisfy ANSI and IEEE requirements for metering and relaying accuracy classification under the loads imposed by the metering and protective devices.

B. Potential transformers shall be suitable for outdoor installation.

C. Select dry type potential transformers with physically strong protective cases and with superior insulating properties. The Contractor may propose oil filled units for acceptance by the SEPTA Project Manager.

D. Select potential transformers with adequate insulation to withstand the dielectric test levels of the equipment and to carry their load continuously without excessive heating or injury.

E. Select the PTs with high resistance primary windings and with high knee point (not less than 1.2 p.u.) suitable for electric traction application.

F. Rating:

1. Trolley Circuit:
   a. Frequency to be 25 Hz.
   b. Primary voltage rating to be 12 kV.
   c. Secondary voltage rating to be 120 V.
   d. Basic Insulation Level (BIL) to be 150 kV.
   e. Power frequency withstand to be 95 kV.

2. Feeder Circuit:
   a. Frequency to be 25 Hz.
   b. Primary voltage rating to be 24 kV.
   c. Secondary voltage rating to be 120 V.
   d. Basic Insulation Level (BIL) to be 250 kV.
   e. Power frequency withstand to be 105 kV.

3. Burden and accuracy to be consistent with relay requirements.

G. Protect the primary circuits of all potential transformers by means of non-renewable cartridge type fuses. Provide fuses with blown fuse indication. Protect secondary circuits of all potential transformers by molded case circuit breakers mounted in the cubicle control compartment.
2.06 Transducers and Converters
   A. Select transducers and converters as required for the applications specified.
   B. Choose transducers and converters with inputs compatible with outputs from CTs, PTs, and other measuring devices and outputs compatible with switchgear cubicle bay module inputs.
   C. Provide compact transducers and converters to convert input variables into proportional output signals with accuracy of 0.1 percent or better.
   D. The transducers and converters may be stand-alone devices or may be an integral part of relays or measuring devices.
   E. Install the transducers and converters in a suitable enclosure.

2.07 Instrumentation
   A. Provide high quality, metal case, semi-flush, 4 1/2 inch square, switchboard type meters with accuracy of 1 percent of full scale value.
   B. Select all instruments to match the input signals, including fault currents.

2.08 Indication
   A. Provide illuminated and non-illuminated indication for all key functions of the equipment as specified herein.
   B. All illuminated indication shall be by LEDs located on cubicle doors. The indicators may consist of individual LEDs or clusters of LEDs, depending on the required brightness. In order to identify LED failures, each LED or group of LEDs shall have a push-to-test switch located conveniently near the LED or group of LEDs. When depressed, the test switch shall disconnect the normal circuit feed and cause the LEDs to illuminate. The LED color shall be selected by SEPTA during shop drawing review.

2.09 Test Blocks/Test Switches
   A. Provide test blocks in semi-flush cases of uniform sizes suitable for panel mounting.
   B. Wire the test blocks to provide a direct access to the system protection and measurement. Include the following monitoring and testing functions:
      1. Recording of all instrument measured functions.
      2. Monitoring of CT currents and PT voltages.
      3. CT short circuiting.
      4. CT secondary injection testing.
      5. Operation of circuit breakers.
      6. DC auxiliary power monitoring.
   C. Provide a dull black dust cover permitting covering of the test blocks when not in use.
2.10 Annunciation

A. All control, status and alarm functions which are transmitted to the Operations Control Center (OCC) shall be annunciated locally at the touch screen Human Machine Interface (HMI) installed on the door of the proposed Remote Terminal Unit (RTU). The HMI screen shall be subject to SEPTA pre-approval and shall replicate the display at the OCC. The circuit breaker control functions, circuit breaker status and voltage of trolley and feeder buses shall also be annunciated on the relay and control switchboard. Include test, silence, acknowledge and reset switches, as well as other associated equipment. The Contractor may propose an alternative location of the HMI for review and approval SEPTA.

B. Design the audible alarm to operate only when the annunciator control switch is in "Local" position.

PART 3 - EXECUTION

3.01 Testing

A. Perform tests specified in section 16952 and include all applicable tests from:
   1. Test indicating instruments in accordance with UL 1437.
   2. Test relays and transducers in accordance with IEEE C37.90 and IEEE C37.90.1.
   3. Test instrument transformers in accordance with IEEE C57.13
   4. Test annunciator in accordance with IEEE C37.90.

B. It will be required by the contractor (and SEPTA) that the relay manufacturers' programmer(s) be on each of the sites ready for startup activities and all other programming exercises, and the Contractor will be required to provide payment for these programmers' services as part of his Step Two Price Proposal. Additionally, these programmers are to be compensated by the contractor to remain on site (or exclusively accessible) for a period of 1 week after commissioning/startup to make any SEPTA-authorized setting adjustments during this time).

END OF SECTION
SECTION 16310

TRANSMISSION AND DISTRIBUTION

PART 1 - GENERAL

1.01 Description

A. Perform modifications, as required, to the gantry and overhead structure and to the 24 kV feeder bus to install disconnect switches, including horngap switches, associated with the installation of 24 kV feeder bus circuit breakers and install connections from the circuit breakers to the feeder bus sections.

B. Perform modifications, as required, to the existing gantry and overhead structure to install disconnect switches, including horngap switches, associated with the installation of the 12 kV trolley bus circuit breakers and install connections from the circuit breakers to the trolley bus sections.

C. Perform modifications, as required, to the overhead structure to install disconnect switches associated with the autotransformers and autotransformer circuit breakers.

D. Install 12 kV, 24 kV and 46 kV disconnect switches (isolating and horn gap disconnect switches) for the trolley, feeder and autotransformer circuits.

E. Install bus tie and ground switch assemblies on the gantry or overhead structure associated with the 12 kV and 24 kV busses and transfer busses.

F. Install connections from the new 24 kV feeder circuit breakers to the disconnect switches on the overhead structure. Replace the disconnect switches and substation or switching station and connections.

G. Install connections from the new 12 kV trolley circuit breakers to the disconnect switches on the overhead structure. Replace the disconnect switches and substation or switching station connections.

H. Provide required supports for installation and connection of new surge arresters.

I. Provide required supports for installation and connection of 12 kV, 24 kV, ground and transfer busses.

J. Provide required supports for installation of 24 kV-120 V potential transformers and 12 kV-120 V potential transformers, including associated fused disconnects (or equivalent), and installing necessary connections.

K. Provide required supports for installation and connection of distribution transformers, including associated fused disconnects (or equivalent).

L. Use of aluminum conductors and cables is not permitted. Use copper conductors and cables.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 16060 – Grounding and Bonding
C. Section 16075 – Electrical Identification
D. Section 16120 – Conductors and Cables
E. Section 16121 – Medium Voltage Cable
F. Section 16335 – Surge Protection
G. Section 16950 – Testing

1.03 Submittals

A. Submit certified copies and test reports in accordance with the referenced standard, these specifications and the erection drawings.

B. Submit Electric Traction (ET) and Overhead Catenary System (OCS) wires:
   1. Provide to the SEPTA Project Manager for review and approval, the wire manufacturer’s shop drawings, prior to cable and wire manufacture. Included as a minimum shall be:
      a. Physical characteristics and parameters.
      b. Size.
      c. Type.
      d. Material.
      e. Number of and diameter of individual wires.
      f. Overall diameter.
      g. Cross sectional area.
      h. Weight per foot.
      i. Rated breaking load.
      j. Initial and final modulus of elasticity.
      k. Coefficient of thermal expansion.
      l. Yield stress.
      m. Hardness value.
   2. Electrical Characteristics:
      a. Rated current carrying for each size (AWG/kcmil).
      b. Resistance per unit length.
      c. Insulation rating where applicable.

3. C. Submit Assemblies, Fittings and Hardware:
   1. As and when applicable, provide certificates of compliance for functional tests performed on each assembly component. Tests shall be designed to demonstrate that the equipment will perform correctly for its intended application.
   2. Shop drawings shall be submitted prior to fabrication.

D. Submit Disconnect Switch and Grounding Switch Assemblies:
   1. Provide complete and detailed shop drawings of the disconnect switch, with all ratings described, operating mechanisms, installation instructions, dimensions, weights, rods, interlockings, as a complete assembly.
E. Submit Bus Assemblies:
   1. Provide catalog cuts for all components that make up the completed bus assemblies.

1.04 Quality Assurance

A. Electric Traction (ET) and Overhead Catenary System (OCS) wires to meet the applicable provisions of the most recent issues of the following references:

B. All OCS wires shall have a minimum in service life expectancy of thirty (30) years under normal operating conditions.

C. All cables shall have a guaranteed service life expectancy of forty (40) years.

D. All cables and wires shall have been manufactured within one (1) year of date of initial delivery to construction site.
E. Catenary assemblies, fittings and hardware (as applicable for substation or switching stations assemblies) to meet the applicable provisions of the most recent issues of the following references:

1. AISC, Manual of Steel Construction.
2. AISI 1035 to 1045, SBA Forged Steel Types 302 and 304 Stainless Steel.
7. ANSI/NEMA C29.8, Wet Process Porcelain Insulators - Apparatus, Cap and Pin Type.
8. ASME B1.1, Unified Inch Screw Threads, UN and UNR Thread Form.
9. ASME B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
36. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

F. For general industrial use ASTM A 711/A 711M carbon and alloy steel blooms, billets, and slabs for forgings.

PART 2 - PRODUCTS

2.01 Material and Equipment

A. Outdoor Air Interrupter Switches (Horngaps):

1. Provide manually operated, vertical break, single pole, 12 kV and 24 kV disconnect switches with arcing horns to replace the existing horngap switches of trolley and feeder circuits. The switches shall be provided with the similar operating handles as the existing due to space limitations.

2. The switches are intended to provide isolation between the overhead contact system and the substations.

3. Switches shall be manually operated per the Contract Drawings, with limited current interrupting capability. Continuous rating shall be 1,200 A with no load break interrupting capacity. For 24 kV duty; provide 46 kV class/250 kV BIL units. For 12 kV
duty, provide 27 kV class/150 kV BIL units. Installation shall include all components, operators, operating poles, pole guides and connections. The Contractor shall coordinate the momentary fault rating with the short circuit study.

4. Provide four (4) normally open and four (4) normally closed auxiliary contacts on all disconnect switches for status indication and other applications. The contacts shall be provided in a weatherproof enclosure.
   a. Normally open contacts shall close only after the main contacts have closed.
   b. Normally closed contacts shall close only after the main contacts have fully opened.

5. The switches shall be manufactured by one (1) of the following manufacturers:
   b. Southern States.
   c. Cleaveland Price, Model V2-C.
   d. Or Approved Equal.

B. Fused Disconnect Switch for Potential and Distribution Transformers:

1. Provide fused disconnect switches for protection and isolation of the distribution and potential transformers.

2. Fused disconnect switches shall be of vertical mount and vertical break type, operable manually by an insulated hook stick.

3. The fuses shall be expulsion type which will drop when activated. The fuses shall be rated for 3 A, or less, continuous current.

4. Supply appropriately rated hook sticks with the switches, minimum two for each substation.

5. The fuses shall be 7500 A, minimum, interrupting capability. The fused disconnect switch assembly shall be rated for 150 V BIL for trolley circuits and 250 kV BIL for the feeder circuits.

6. Likely Suppliers
   a. Southern States, Type BP
   b. Or, approved equal

C. Isolating Disconnect Switches for Trolley, feeder, and Autotransformer Circuit Breakers:

1. Provide manually operated isolating disconnect switches for the trolley, feeder and autotransformer circuit breakers.

2. Operating pipes of the switches shall be made of galvanized heavy duty steel.

3. Provide four (4) normally open and four (4) normally closed auxiliary contacts with each disconnect switch as specified in Article 2.01/A/4 in this Section.

4. Trolley Circuit Breaker Switches:
   a. Intended to isolate trolley circuit breakers via 2 poles operated (one on the line side and one on the load side) by a single operating handle.
   b. Rated current to be 2000 A.
   c. Nominal system voltage (L-G) to be 12 kV.
   d. Basic Insulation Level (BIL) to be 150 kV.
5. Feeder Circuit Breaker Switches:
   a. Intended to isolate feeder circuit breakers via 2 poles (one on the line side and one on the load side) operated by a single operating handle.
   b. Rated current to be 1200 A.
   c. Nominal system voltage (L-G) to be 24 kV.
   d. Basic Insulation Level (BIL) to be 250 kV.

6. Autotransformer Circuit Breaker Switches:
   a. Intended to isolate 2 phase autotransformer circuit breakers via 4 poles (two (2) on line side and two (2) on load side) operated via a single operating handle.
   b. Rated current to be 1200 A.
   c. Nominal system voltage (L-G) to be 24 kV.
   d. Basic Insulation Level (BIL) to be 250 kV.

7. Bus Tie and Grounding Switches:
   a. Intended to isolate and/or ground sections of bus.
   b. Nominal System Voltage (L-G):
      1) 12 kV for trolley bus.
      2) 24 kV for feeder bus.
      3) Momentary short circuit current to be 63 kA for trolley circuit breakers and 40 kA for feeder circuit breakers.

8. Manufacturers:
   a. Cleaveland Price.
   b. S&C.
   c. Southern States.
   d. Or Approved Equal.

D. Buses:

1. Design and provide busbars for trolley, feeder and ground circuits.
   a. Busbars shall be made of high conductivity rigid copper tubes, pipes, rounds or flats. Use of round shapes is preferred to match the existing busbars. Use of aluminum is prohibited.
   b. Rating:
      1) Trolley circuit buses shall be designed and provided for 2000 A continuous current.
      2) Feeder circuit buses shall be designed and provided for 1200 A continuous current.
      3) Ground circuit buses shall be designed and provided for 2000 A continuous current.

2. Temperature Rise:
   a. Buses shall be designed for 65°C, or less, temperature rise.

3. Thermal Stress:
   a. The buses shall be capable of withstanding forces and thermal stresses due to short circuit currents for five (5) seconds.

4. Braces:
   a. Buses shall be supported and braced to withstand the forces caused by the available short circuit current for five (5) seconds.

E. Feeders and Taps:
1. Design and provide cross feeders between trackside gantry and the substation or switching station gantry, and between the two (2) substation or switching station gantries.

2. Rating for the cross feeders shall be 2000 A continuous. The cross feeders shall be capable of withstanding substation or switching station short circuit currents.

3. Cross feeders shall be made of hard drawn bare stranded copper conductors of 4/0, minimum, but not less the existing conductor.

F. Insulators

1. Design and provide insulators for the busbars, cross feeders, vertical taps and disconnect switches.

2. The insulators shall be of string type for cross feeders. Use of solid core ceramic insulators is also allowed.

3. Insulators for buses and disconnect switches shall be solid core ceramic station class post insulators.


5. Insulators to meet the ratings in Tables 16310-1 and 16310-2.

<table>
<thead>
<tr>
<th>Table 16310-1 Suspension Insulator Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Number of Discs per String</td>
</tr>
<tr>
<td>Voltage Class (kV), String</td>
</tr>
<tr>
<td>BIL (kV), String</td>
</tr>
<tr>
<td>Creepage Distance (Inches), per Disc</td>
</tr>
<tr>
<td>Low Frequency Wet Withstand (kV), String</td>
</tr>
<tr>
<td>Mechanical Strength (Pounds)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 16310-2 Post Insulator Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Voltage Class (kV)</td>
</tr>
<tr>
<td>BIL (kV)</td>
</tr>
<tr>
<td>Low Frequency Wet Withstand (kV)</td>
</tr>
<tr>
<td>Creepage Distance (Inches)</td>
</tr>
<tr>
<td>Mechanical Strength, Cantilever (Pounds)</td>
</tr>
<tr>
<td>Tensile Strength (Pounds)</td>
</tr>
</tbody>
</table>

G. Rail Return Bus Assembly/Aerial Ground Bus/Return Cables:

1. Furnish and install the complete flat copper bar rail return bus assembly and support system on the existing steel columns as required.
2. Provide spacers for the Type HHF connectors as required for connector sizes above 500 kcmil.

3. Furnish and install the new return cables from the rail return bus to the running rails. Provide four (4) 500 kcmil copper cables in PVC conduits. Size the conduits to meet the cable and NEC requirements.

4. Replace the existing ground bus (perimeter ground bus) at its existing location with a new ground bus. The new ground bus shall be 1.5 inch copper tube, or higher, to match the existing ground bus. The new ground bus shall be supported on 5 kV post insulators.

H. Electric Traction/OCS Wires [Not Applicable for Construction Contract No. 1]:

1. Existing Wires – For information only:
   a. Bronze trolley wire to be No. 4/0 AWG and meet ASTM B 9 for grooved trolley wire No. 4/0 AWG alloy 55.
   b. Auxiliary wire to be No. 4/0 AWG grooved hard drawn copper to meet ASTM B 47.
   c. Messenger wire to be 0.613 inch diameter, No. 4/0 AWG type E, nineteen (19) strand composite copperweld copper conductor as manufactured by the Copperweld Steel Company.

2. Continuity jumper shall be No. 4/0 AWG, thirty-seven (37) strand, hard drawn copper, meeting ASTM B 1.

3. Traction power feeder wire shall be thirty-seven (37) strand hard drawn copper 400 kcmil, meeting ASTM B 1.

4. Feeder tap shall be two (2) No. 4/0 AWG, seven (7) strand copper meeting ASTM B 1.

5. Aerial ground (static) wire to be 336.4 kcmil, 30/7 ACSR meeting ASTM B 232.

6. Steady strand wire to be 7/16 inch diameter, seven (7) No. 7 strand high strength copperweld (breaking load 13,910 pounds) or 9/16 inch diameter nineteen (19) No. 9 strand, high strength copperweld (breaking load 25,500 pounds) as manufactured by the following:
   1) Copperweld Steel Company.
   2) Or Approved Equal.

7. Pull off wire to be 7/16 inch diameter, seven (7) No. 7 strand, high strength copperweld (breaking load 13,910 pounds) as manufactured by the following:
   1) Copperweld Steel Company.
   2) Or Approved Equal.

8. Rail return cable shall be thirty-seven (37) strands hard drawn copper 400 kcmil meeting ASTM B 1, except new substation or switching station rail return cable shall meet Section 16121.

I. Catenary Assemblies, Fittings and Hardware – as application to the Electric Traction work within the substation or switching station [Not Applicable for Construction Contract No. 1].

1. The work specified in this paragraph Includes furnishing of sub-assemblies, fittings and hardware for cantilevers, registration arms, pull offs/push offs, and other components required as part of the ET and OCS hardware within the substation or switching station, as shown on the Contract Drawings and specified herein.
2. Materials shall be selected for each of the required assemblies, based on the performance requirements, working loads and basic dimensions as shown on the Contract Drawings and specified herein.
   a. Non-ferrous metals to be used for grounding components shall be the manufacturer’s standard items. Copper alloys for fittings and components to meet ASTM B 584.
   b. All copper components to meet ASTM B 248, ASTM B 249 or ASTM specified on the approved shop drawings.
   c. All bronze castings to meet ASTM B 148 and ASTM B 179 or ASTM specified on the approved shop drawings.
   d. Cantilever arm pipe to meet ASTM A 53/A 53M type S Grade B, hot dip galvanized.
   e. Aluminum pipe (or tube) for steady arms and other mechanical applications shall be of the dimensions and schedules shown on the Contract Drawings. Aluminum pipe shall be extruded, alloy 6061-T6 for mechanical applications, and alloy 6063-T6 for electrical purposes such as tubular bus.
   f. Hardware items furnished already galvanized shall be delivered with the necessary certificates of conformance with ASTM A 153/A 153M and the required zinc coating specified.

3. Fasteners:
   a. The work specified in this paragraph includes furnishing various types of fasteners (bolts, nuts and washers) for general use and structural connections as part of the ET and OCS hardware within the substation or switching station, as shown on the Contract Drawings and specified herein.
   b. Ferrous Metal Fasteners:
      1) The material for ferrous metal fasteners not specifically called out to meet the applicable portions of the referenced standards, or where not covered in referenced standards shall be commercial products of proven performance in similar service as this system.
      2) Structural joint and fitting connections to be ferrous fasteners used with structural connections and fittings to meet ASTM F 3125/F 3125M.
      3) U-bolts and studs to meet ASTM A 449.
      4) Washers to meet ASTM F 436/F 436M and nuts to meet ASTM A 563, Grade B.
      5) Ferrous fasteners shall be galvanized to meet ASTM A 153/A 153M, Grade C.
   c. Stainless Steel Fasteners:
      1) Stainless steel bolts, studs, nuts and washers shall be used for connections between ferrous and nonferrous metals, and in other applications as shown on the Contract Drawings.
      2) Stainless steel bolts and studs to meet ASTM F 593. Stainless steel nuts to meet ASTM F 594.
   d. Nonferrous Metal Fasteners:
      1) Nonferrous metal fasteners shall be manufactured from material meeting the applicable portions of the referenced standards.
      2) Nonferrous bolts and studs to meet ASTM F 468. Nonferrous nuts to meet ASTM F 467. Nonferrous washers and lock-washers shall be the manufacturer’s standard product.
   e. Bolted Connections:
      1) Bolted connections using standard fasteners to meet ASTM A 307 shall meet the applicable requirements of AISC specification for structural joints using ASTM A 307 bolts.
2) Bolted connections using high tensile strength bolts to meet ASTM F3125/F 3125M shall meet the applicable requirements of AISC specification for structural joints using ASTM F 3125/F 3125M bolts.

f. Bolts, nuts, washers, anchors and other items of iron or steel hardware shall be hot dipped galvanized as follows:
   1) Perform galvanizing to meet ASTM A 153/A 153M, as applicable. The weight of the zinc coating shall be not less than 1.25 ounces per square foot.
   2) Thread of bolts shall be standard size before galvanizing and the nuts shall be oversized to allow for galvanizing of the bolt's thread. Nuts and bolts to meet ASTM F 3125/F 3125M and A 563 requirements. Thread of galvanized nuts shall not be galvanized and shall be protected with suitable grease.

PART 3 - EXECUTION

3.01 Preparation
   A. Transmit submittals and deliverables required by this Section.
   B. Ensure substrates are in suitable condition to receive the work of this Section.

3.02 Installation
   A. Materials and equipment shall be stored, applied, installed and connected as recommended by the manufacturer.
   B. Air interrupter switch operating handles/motorized operators shall be located approximately 3 feet 6 inches above finished grade, shall be insulated and grounded. Insulation of the switches shall include both insulated interphase rod sections and insulated vertical shafts.
   C. Wire brush the copper bus bar prior to installing tee connectors to remove incidental oxidation
   D. Tighten the cable hex stud with a torque wrench following the manufacturer's recommendations (600 in/lbs). For bolts used to clamp down on the bus bar, tighten to 40 ft/lbs. Confirm these values with the manufacturer.

3.03 Testing
   A. Refer to Sections 16950 and 16952 for factory and field testing requirements.
   B. Submit factory test reports.

END OF SECTION
SECTION 16331

INSTALLATION OF CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 Description

A. This Section covers the storage, installation, testing and commissioning requirements of the following outdoor circuit breakers for the substations covered by this Contract.

1. 12 kV single pole trolley circuit breakers.
2. 24 kV single pole feeder circuit breakers.
3. 36 kV (or 46 kV) two pole autotransformer circuit breakers.

B. Circuit breakers for all three (3) substations within this Contract have been ordered by SEPTA from ABB, Switzerland. Coordinate with SEPTA for the place and schedule of delivery. The Contractor is responsible for all activities from the receipt of the circuit breakers until commissioning and acceptance by SEPTA.

C. The Contractor is responsible for safe storage and handling of the circuit breakers until commissioning and acceptance by SEPTA. The Electrical Contractor shall receive, store, install, test and commission the circuit breakers per Contract requirements, supplier’s instructions and procedures approved by SEPTA.

D. The Contractor shall work in close coordination with the supplier, ABB, for the installation and testing. Arrange ABB’s installation and testing engineer’s presence for important phases of installation and commissioning. Estimate the duration in consultation with ABB. It is expected that at least one (1) week of ABB engineer’s presence will be required for each stage of construction at each substation.

E. ABB’s local sales representative is:

Jeff Sikkema
Sikkema Electrical Sales
208 W. Browning Road, Collingswood, NJ 08108
(856) 428-1425  jeff@sikkemaelectric.com

F. Upon completion of the work, the Contractor shall submit the full documentation and record for the circuit breakers for each substation. The documentation shall include, but not limited to:

1. Supplier’s drawings provided by ABB.
2. Installation drawings prepared by the Contractor.
3. Set of construction photos of circuit breaker installation taken during the construction period.
4. As-built drawings.
5. All test reports including:
   a. Factory test reports (The Contractor shall obtain from SEPTA or ABB),
b. Commissioning test reports, and
  c. Post commission test reports

G. The Contractor shall provide fall protection on the outdoor structures where circuit breakers are installed.

H. See SEPTA provided related information designated as Reference Documents.

1.02 Related Sections

A. All Sections of Division 1
B. Section 01452 – Contractor’s Quality Control - Traction Power Equipment
C. Section 01752 – Spare Parts and Maintenance Materials - Traction Power Equipment
D. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment
E. Section 05520 – Hand Rails and Railings
F. Section 09900 – Paints and Coatings
G. Section 16052 – General Electrical Requirements - Traction Power Equipment
H. Section 16060 – Grounding and Bonding
I. Section 16075 – Electrical Identification
J. Section 16275 – Installation of Traction Power Autotransformers
K. Section 16290 – Protective Devices and Instrument Transformers
L. Section 16335 – Surge Protection
M. Section 16791 – Combined Relay and Control Switchboard
N. Section 16952 – Electrical Testing - Traction Power Equipment (RRD)

1.03 Submittals

A. Submit the following documents and product samples for SEPTA’s review, approval and record:
   1. Prepare, in consultation with the supplier, and submit a detailed storage, handling, and installation procedure to SEPTA for review and approval, prior to the delivery of the circuit breakers.
   2. Manuals as specified in Section 01832.
   3. Provide technical product data for the following equipment and components of the circuit breakers. Note that some of the information and documents have to be obtained from the circuit breakers supplier.
      a. Circuit breaker and associated equipment including interrupter, interrupter support and operating mechanism.
      b. Grounding connections for the breaker and control circuit.
      c. Current transformers.
      d. Protective devices.
      e. Auxiliary relays.
f. Control and selector switches.
g. Instrumentation devices.
h. Transducers and converters.
i. Indicating devices.
j. Operation counter.
k. Auxiliary contacts.
l. Test blocks.
m. Wires, control cables and instrumentation cables including types of lugs.
n. Terminal blocks and connectors.
o. Equipment enclosures.
p. Anti-condensation heaters.
q. Paint.
r. Operating handles.
s. Push buttons.
t. Switches.
u. Motors.
v. Linkages.
w. Hinges.
x. Support and test equipment.

4. The Electrical Contractor shall prepare detail installation drawings for the circuit breakers. The drawings shall include:
   a. Front cover sheet.
   b. Legend, abbreviations and notes.
   c. Installation drawings showing supporting structures (including existing columns and beams to be provided under this Contract), attachment details, electrical clearances, grounding and fall protection.
   d. Lifting and handling drawing.
   e. AC and DC elementary diagrams showing all power and control circuits.
   f. Interlocking logic diagram.
   g. Conductor and cable schedules and termination designation indicating compatibility with the terminal blocks of the circuit breakers.
   h. Connection diagrams of circuit breaker showing physical locations of devices, device terminal arrangement and wiring connections.
   i. Cable connection details.
   j. Grounding connections.
   k. Fully dimensioned three-dimensional views of circuit breaker installation showing clearance from the adjacent columns and circuit breakers, vertical clearance from finished grade, and maintenance access to various items of equipment.
   l. Mounting and anchoring details.
   m. Nameplate and label drawings.

5. Submit samples of the following products:
   a. Cables and wires.
   b. Insulating materials.
c. Terminal blocks and connectors.
d. Paint and coating systems.

6. Test Plans, Procedures and Test Reports:
   a. Submit test plans and procedures for the field tests to SEPTA for review and approval at least four (4) weeks before the proposed tests. The test plans and procedures shall demonstrate that the equipment will be tested to verify that it performs all functions in accordance with the Contract Documents, industry standards and with the approved shop drawings.
   b. Prepare the test plan in coordination with the circuit breaker supplier. The plan, at a minimum, shall include all tests required by applicable IEEE standards.
   c. Submit the test report within fifteen (15) days of successful completion of the commissioning tests.

1.04 Quality Assurance
   A. Submit the quality assurance plan for review and approval to SEPTA. Comply with the quality assurance plan approved by SEPTA.

1.05 Warranty
   A. Provide warranty for installation for a period of three (3) years from the date of acceptance by SEPTA. The warranty shall begin from the date of acceptance of each substation by SEPTA and shall include:
      1. Full repair or replacement of circuit breakers and their components and accessories if not attributable to the manufacturing.
      2. Factory and field testing and adjustments of the replaced circuit breakers, components and accessories at no cost to SEPTA.
   B. All work associated with warranty, such as manufacturing, shipping, installation and testing shall be performed at no cost to SEPTA.
   C. Any circuit breaker, component, and accessory replaced under the warranty provision shall be guaranteed for the period remaining in the warranty but not less than a minimum period of one (1) year from date of acceptance of the replacement.

PART 2 - PRODUCTS

2.01 Circuit Breakers
   A. SEPTA has ordered the circuit breakers required for all the substations in the Contract from ABB. Refer to the SEPTA purchase specifications and supplier’s drawings for more information.
   B. Purchase specification of SEPTA is provided in Annexure 1 to this Section.
   C. Shop drawings submitted by ABB are provided in Annexure 2 to this Section.

2.02 Circuit Breaker Rating
   A. Circuit breaker ratings are provided in SEPTA purchase specifications.
B. Trolley and feeder circuit breakers are identical in construction and rating, however, the current transformers are of different ratios. Test certificates of the current transformers are provided in Annexure 3 to this Section.

C. On the two pole autotransformer circuit breakers, 24 kV feeder side is identified by red line; 12 kV trolley side is identified by orange line.

2.03 Circuit Breaker Support and Components

A. Bus Terminals:
   1. Provide terminals on the cables and taps to match the pads on the circuit breakers.

B. Support Structure:
   1. Provide support structures as indicated on the Contract Drawings. Trolley and feeder circuit breakers are proposed to be installed on a new beam to be provided and installed by the General Contractor between the existing columns. Autotransformer circuit breakers are proposed to be installed on short columns to be supplied by ABB with the circuit breakers. The foundation and installation drawings shall be reviewed and concurred by the circuit breaker supplier before submittal to SEPTA.
   2. Ensure compliance of NESC requirements for clearances.

C. Control Circuitry:
   1. All circuit breakers shall normally be controlled from Rail Operations Control Center (ROCC) via SCADA or from the relay and control board in the control room. The circuit breakers are also provided with closing and tripping push buttons on the control cabinet. Provide the following control circuitry:
      a. Electrically close the circuit breaker from SCADA only when the master local/remote selector is in Remote.
      b. Electrically close the circuit breaker from the relay and control board or from control cabinet only when the master local/remote selector is in Local.
      c. Trip the circuit breaker from SCADA, relay and control board, or from the control cabinet in any position of the local/remote switch.
      d. Provide anti-pumping control mechanism making the circuit breaker electrically trip free.
   2. Each circuit breaker control cabinet is wired to the relay and control board by copper cables.
   3. In case of the two pole autotransformer circuit breakers, the control cabinet of the 24 kV pole is connected to the relay and control board. The control cabinet of the 12 kV pole works as slave of the 24 kV pole cabinet.

2.04 Current Transformers

A. The circuit breakers are provided with the multi-ratio current transformers per SEPTA purchase specifications.

   1. 12 kV Trolley Circuit Breakers:
      a. Two (2) 2000/5 A multi-ratio, one (1) on the load side and one (1) on the line side.

   2. 24 kV Feeder Circuit Breakers:
      a. Two (2) 1200/5 A multi-ratio, one (1) on the load side and one (1) on the line side.
3. 36 kV, Two Pole Autotransformer Circuit Breakers:
   a. Two (2) per pole, one (1) on the line side and one (1) on the load side of the circuit breaker.
   b. Ratio to be 2000/5 multi-ratio for trolley pole.
   c. Ratio to be 1200/5 multi-ratio for feeder pole.

B. Details of the taps are provided in the test reports at Annexure 3. The Contractor shall determine the ratio to be used for each breaker based upon relay coordination study.

C. Current transformers for the bus tie disconnects, matching with the circuit breaker current transformers, shall be provided by the Contractor.

2.05 Indoor Relay and Control Cubicle
A. Protective relays and control switches of the circuit breakers are provided on the relay and control board in the control room.
B. Refer Section 16791 for details of the relay and control board.

2.06 Miscellaneous Apparatus
A. Operations Counter:
   1. A four (4) digit, non-resettable operations counter is provided with each circuit breaker to record the number of operations.
B. Anti-Condensation Heaters:
   1. The circuit breaker control enclosures are provided with thermostatically controlled space heaters to prevent condensation.
   2. Provide 120 VAC power supply for the heaters.
C. Spare Auxiliary Contacts:
   1. Each circuit breaker is provided with four (4) normally open and four (4) normally closed contacts. Utilize the contacts for status indication and other requirements. Wire at least two (2) normally open and two (2) normally closed contacts to the relay and control board with sufficient number of spare cables to allow for future field modification of control logic.
   2. Determine the number of contacts needed based on the specified operation, control and indication requirements. As a minimum, provide two (2) normally opened and two (2) normally closed spare contacts.

2.07 Nameplates
A. Provide stainless steel engraved name plate with the breaker designation (B1N, FN1B, FN2M, etc.) as required by SEPTA.
B. Obtain the name plate size and designations from SEPTA.
C. Attach the nameplate to the side of the circuit breaker operating mechanism cabinet.

PART 3 - EXECUTION
3.01 General
   A. Store the circuit breakers until installed in weather proof environment per supplier recommendations.
   B. Provide grounding connections.
   C. Install the circuit breakers and their associated current transformers on supporting columns or beams constructed under this Contract.
   D. Meet the NESC requirements of vertical and horizontal clearance of live parts from finished grade and adjacent structures.
   E. Install supervisory and control cables and connections. Coordinate the location and number of conduits with the supplier. Utilize existing trenches to the extent possible. Provide PVC conduits from the trench to the circuit breakers.
   F. Install high voltage connections only after testing the control and protective functions.

3.02 Factory Testing
   A. Factory tests have been performed before delivery to the Electrical Contractor.
   B. Obtain reports of the factory tests and incorporate in the substation test report documentation.

3.03 Field Commissioning Tests
   A. Submit a comprehensive circuit breaker commissioning test plan, prepared in coordination with ABB, to SEPTA for review and approval at least four (4) weeks before proposed commencement of the tests.
   B. Commissioning tests shall be performed in the presence of ABB commissioning engineer.
   C. At a minimum, the tests shall include:
      1. Verification of fall protection.
      2. All tests required by applicable IEEE standards.
      4. Closing and opening from the control board and via SCADA, performed at lowest working DC voltage.
      5. Integrity of insulation of control cables.
      6. High voltage test on the power circuit.
      7. Operation of anti-condensation heaters and maintenance lights.
   D. Verify grounding of the circuit breakers installation.
   E. Perform field commissioning tests to verify the operation and integrity of the circuit breakers before first time energization at the rated voltage.
   F. Perform post-energization tests to include, at a minimum:
      1. Operate each circuit breaker ten (10) times. Record switching surge.
      2. Verification of operation from remote and local.
END OF SECTION
SECTION 16335

SURGE PROTECTION

PART 1 - GENERAL

1.01 Description

A. Furnish suitable surge arresters and transient voltage surge suppression devices to protect traction power substation or switching station equipment against overvoltages. Replace the existing surge arresters on the feeder and trolley circuits as a minimum as shown on the Contract Drawings.

B. Existing surge arresters shall be replaced and where necessary relocated to accompany the associated relocated feeder and catenary circuit.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contract Quality Control - Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling - Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials - Traction Power Equipment

E. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment

F. Section 05610 – Miscellaneous Metals

G. Section 09910 – Paints and Coatings

H. Section 16050 – Basic Electrical Materials and Methods

I. Section 16052 – General Electrical Requirements -Traction Power Equipment

J. Section 16060 – Grounding and Bonding

K. Section 16075 – Electrical Identification

L. Section 16275 – Installation of Traction Power Autotransformers

M. Section 16290 – Protective Devices and Instrument Transformers

N. Section 16310 – Transmission and Distribution

O. Section 16952 – Electrical Testing - Traction Power Equipment (RRD)

1.03 Submittals

A. Submit the following documents for SEPTA's review and approval:

1. Technical product data for the following equipment:
   a. Surge arresters.
   b. Transient voltage surge suppressors.
   c. Connecting wires and cables.
2. Submit the manufacturer’s certified test data including evidence that the arresters and transient voltage surge suppressors that meet the specified standards.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

7. UL 96, Lightning Protection Components.
8. UL 96A, Installation Requirements for Lightning Protection Systems.

PART 2 - PRODUCTS

2.01 Equipment to be Protected

A. Protect all power and electronic equipment outside and within the substation or switching station as appropriate, including the following equipment:

1. 12 kV, 24 kV and 46 kV outdoor circuit breakers, autotransformers, high voltage cables and distribution transformers.

2. Electronic equipment, including, but not limited to:
   a. Power supplies.
   b. Electronic equipment including bay modules.
   c. Remote terminal unit.
   d. Data communication lines.
   e. Medium voltage shielded cables.

B. Select the protective equipment voltage rating, energy dissipation rating and other characteristics compatible with the equipment to be protected.

2.02 Overvoltage Protection

A. Protect all electrical and electronics equipment taking into account the following:

1. Possible Sources of Overvoltages:
   a. Lightning strikes in the project locale.
   b. Circuit breaker switching surges.
   c. Presence of high voltage overhead lines.
2. Location of Equipment:
   a. Take into account the maximum expected overvoltage for outdoor equipment.
   b. Take into account the equipment distance from the service entrance for indoor equipment.

3. Equipment Type:
   a. Voltage level of equipment input and output.
   b. AC or DC power input and output.
   c. Analog or digital signal input and output.
   d. Voice or data signal input and output.

4. Ground grid resistivity at the substation or switching station location.

5. In accordance with the existing substation or switching station design and the Contract Drawings, design and coordinate equipment insulation and protection at three (3) levels:
   a. Primary level shall prevent surges from lightning and other power sources from entering the substation or switching station. Surge arrester devices shall be placed at these interfaces to divert any damaging surges from reaching main equipment.
   b. Use secondary level of protection directly in front of the protected equipment. Design the units to allow for protection against surges that pass the primary level protection. Ensure that primary level of protection that exists is adequate.
   c. Use tertiary level of protection, also called equipment withstand capability, to protect against all remaining overvoltages.
   d. Coordinate all three (3) levels of protection to ensure that, following a lightning strike, switching surge, or increase in noise energy, the protective devices clamp the voltage at the terminal of each item of equipment to a safe level.

B. Provide the following:

   1. A sufficient number, as shown on the Contract Drawings or described in this Section, of appropriately rated protective devices suitable for the protected circuit voltage level and functional requirement. Protect circuits using the following equipment:
      a. Surge arresters
      b. Transient Voltage Surge Suppressor (TVSS) devices.

   2. An adequate bonding of equipment to reduce potential differences between equipment and limit circulating currents.

   3. A low resistance grounding system for the protected and protective equipment to safely shunt overvoltages to the ground grid.

2.03 Surge Arresters

A. Provide at locations shown on the Contract Drawings.

   1. 12 kV Trolleys and 24 kV Feeders, Autotransformer & Autotransformer Circuit Breakers:
      a. Provide one (1) surge arrester on the line side of each trolley and feeder horn gap switch.
      b. Provide surge arresters on 12 kV and 24 kV terminals of the autotransformers.

B. Ratings:

   1. Provide porcelain body surge arresters with characteristics as shown in Table 16335-1.
### Table 16335-1 Surge Arrester Ratings

<table>
<thead>
<tr>
<th>Surge Arrester Characteristic</th>
<th>12 kV Circuits, 150 kV BIL</th>
<th>24 kV Circuits, 250 kV BIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>Station Class</td>
<td>Station Class</td>
</tr>
<tr>
<td>Type</td>
<td>Gapless Metal-oxide</td>
<td>Gapless Metal-oxide</td>
</tr>
<tr>
<td>Rating</td>
<td>18 kV</td>
<td>36 kV</td>
</tr>
<tr>
<td>Maximum Continuous Operating Voltage (MCOV)</td>
<td>15.3 kV</td>
<td>29 kV</td>
</tr>
</tbody>
</table>

2. Manufacturers:
   a. GE Tranquell Station Class.
   b. Or Approved Equal.

3. The rated power frequency shall be 25Hz for use on the catenary and feeder circuits.

4. The surge arresters shall be designed, tested and manufactured in accordance with IEEE C62.11 and IEEE C62.22.

5. Structural steel shapes and plates shall be galvanized in accordance with ASTM A 123/A 123M. All other steel parts shall be hot dip galvanized in accordance with ASTM A 153/A 153M.

6. Installation:
   a. The surge arresters will be base mounted on pedestals supplied by the purchaser. Mounting will be in an upright position.

7. Nameplates:
   a. Each surge arrester shall be provided with an aluminum nameplate which shall be riveted to the exterior of the surge arrester, easily readable and contain the following information:
      1) Arrester classification.
      2) Manufacturer’s name.
      3) Manufacturer’s type and identification number.
      4) Duty cycle voltage rating of the arrester in kV.
      5) MCOV rating of the arrester in kV.
      6) Electrical connection of arrester and/or instruction manual number.
      7) Year of manufacture.
      8) Pressure relief rating in amperes.

2.04 Transient Voltage Surge Suppressors

A. Locate the transient voltage surge suppressors in close proximity of the protected devices.

B. Consult the protected device/equipment manufacturer about the type and rating of the most suitable transient voltage surge suppressor for protection of the device/equipment. Meet the device/equipment manufacturer recommendation.

PART 3 - EXECUTION
3.01 Installation

A. Use only UL listed materials and UL certified installers for the work associated with surge and lightning protection system.

1. Surge Arresters:
   a. Install surge arresters on top of the outrigger on the line side of each horn gap switch associated with the trolley and feeder circuit breakers.

2. Transient Voltage Surge Suppressors:
   a. Install the transient voltage surge suppressors in accordance with the suppressor and the protected device/equipment manufacturers’ recommendations.

3.02 Grounding

A. General:

1. Install each grounding connection via the shortest possible route without unnecessary bends and kinks in the grounding conductor.

2. Use only copper conductors.

3. Splices are not allowed in the grounding connections.

B. Surge Arresters:

1. Ground each surge arrester to the substation or switching station perimeter ground bus.

2. Use the ground grid pigtails to connect the surge arrester ground bus to the ground grid.

C. Transient Voltage Surge Suppressors:

1. Use bare stranded copper wires for connections between surge arresters and grounding busbar.

2. Use conductors and grounding techniques as recommended by the transient voltage surge suppressor manufacturers.

3.03 Testing

A. Test surge arresters in accordance with IEEE C62.11.

B. Submit design test reports to SEPTA for review and approval.

C. Submit routine test reports per IEEE C62.11, with the serial numbers of the models tested, to SEPTA for review and approval before installation.

D. Perform power frequency and partial discharge test per IEEE C62.11 after installation. Record the leakage current and measured PD in the installation report.

END OF SECTION
THIS PAGE NOT USED
SECTION 16411

ENCLOSED SWITCHES

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of materials for furnishing, installing, connecting, energizing, testing, cleaning and protecting enclosed disconnect switches and fuses.

1.02 Related Section
A. Section 16075 – Electrical Identification
B. Section 16950 – Testing

1.03 Submittals
A. Submit with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.
B. Submit product data for all products provided. Indicate clearly the usage of each product.
C. Submit manufacturer’s instructions for all enclosed disconnect switches.

1.04 Quality Assurance
A. Provide products that are listed or labeled by Underwriters Laboratory, approved by factory mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and the application intended, unless products meeting the requirements of these testing laboratories are not available, or unless standards do not exist for the products.
B. Install work under supervision of licensed electricians.
C. Meet the applicable provisions of the most recent issues of the following references:
   1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
   3. NFPA 70, National Electrical Code (NEC).
   4. UL 98, Enclosed and Dead-Front Switches.
   5. UL 198E, Class R Fuses.

PART 2 - PRODUCTS
2.01 Enclosed Disconnect Switches

A. Provide enclosed disconnect switches meeting NEMA KS 1, UL 98 and the following requirements. Horsepower, voltage, amperage, number of poles and type shall be as indicated on the Contract Drawings.

1. Enclosure to be NEMA 250 Type 1, unless indicated otherwise on the Contract Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust inhibiting phosphate and finished in gray baked enamel. Enclosure furnished with the manufacturer's permanent record of switch type, catalog number and horsepower rating.

2. Switch mechanism to be quick make, quick break operating handle and mechanism forming an integral part of the box, not the cover, with positive padlocking provisions in the OFF position. Switch current carrying parts electroplated for resistance to corrosion. Switch blades visible in the OFF position when door is open. Switch lugs UL listed for copper cables and front removable.

3. Heavy duty type fusible disconnect switch to be dead front construction with permanent arc suppressors and dual cover interlock (to prevent unauthorized opening of switch in ON position) and positive pressure fuse clips.

4. Heavy duty type non-fusible disconnect switch to be dead front construction with permanent arc suppressors and dual cover interlock (to prevent unauthorized opening of switch in ON position).

B. Manufacturers:

1. Square D Company.
2. General Electric.
4. Or Approved Equal.

2.02 Fuses

A. Current limiting type, of voltage and amperage as indicated on the Contract Drawings. Provide one (1) set of spare fuses for each ampere size indicated and each point of use.

1. Use Limitron, fast acting, single element type, UL Class RK1 for non-motor loads.
2. Use Fusetron, dual element, time delay type, UL Class RK5 for motor, welder and transformer loads.

B. Manufacturers:

1. Bussman.
2. Gould-Shawmut.
3. Or Approved Equal.

PART 3 - EXECUTION
3.01 Preparation
A. Ensure that painted surfaces which will be covered by items of this section have a prime and finish coat of paint.
B. Ensure that all indoor areas are enclosed from the weather.

3.02 Installation
A. Space enclosures out from surfaces mounted on 1/4 inch spacers or U-Channel supports.
B. Install all disconnect switches in accordance with the manufacturer’s instructions.
C. Set enclosure top 6 feet 6 inches above finished floor or grade unless otherwise indicated or specified.
D. Punch holes for conduit entries in the enclosures.
E. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.
F. Interface with other work:
   1. Connect conduits to enclosure with water tight hubs except as follows:
      a. The bottom of enclosures in damp locations may have a sealing locknut and interior locknut, and grounding bushing in place of a water tight hub.
      b. In dry locations, two (2) locknuts and bushings may be used in place of a water tight hub.
   2. Connect wiring to line and load terminals with lugs provided or approved by the manufacturer. Remove interior or protect interior components during wire pulling.
   3. Identify in accordance with Section 16075.
G. Protection:
   1. During painting, mask all nameplates, all plastic parts, push buttons, operating shafts and all items not to be painted.
   2. Protect all items during work of other trades including welding and cutting.
   3. Protect disconnect switches against overloads, short circuits and improper operation. Padlock off when work is being done on downstream circuits.

3.03 Field Quality Control
A. Site Testing:
   1. Prior to energizing ensure that all load side wiring is clear of shorts and has received and passed the insulation tests of Section 16950.
   2. Perform tests in accordance with Section 16950.

END OF SECTION
SECTION 16413

ENCLOSED TRANSFER SWITCHES

PART 1 - GENERAL

1.01 Description

A. The Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.
   2. Bypass/isolation switches.
   3. Remote annunciation and control systems.

1.02 Related Section

A. Section 01300 - Submittals
   B. Section 01305 - Requests for Information
   C. Section 01400 - Quality Requirements
   D. Section 01820 - Demonstration and Training
   E. Section 03300 - Cast-In-Place Concrete
   F. Section 16050 - Basic Electrical Materials and Methods
   G. Section 16060 - Grounding and Bonding
   H. Section 16075 - Electrical Identification
   I. Section 16123 - Building Wire and Cable
   J. Section 16130 - Raceway and Boxes
   K. Section 16950 - Testing

1.03 Submittals

A. Submit product data for each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties and accessories.

B. Submit shop drawings including dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
   1. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch on a single line diagram.

1.04 Quality Assurance

A. Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight (8) hours from time of notification.
B. An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing agency's field supervisor to be a person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Article 3 in this Section.

C. Obtain automatic transfer switches bypass/isolation switches and remote annunciator and control panels through one (1) source from a single manufacturer.

D. Meet the applicable provisions of the most recent issues of the following references:

2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
3. NEMA ICS 1, Industrial Control and Systems: General Requirements.
4. NEMA ICS 6, Industrial Control and Systems: Enclosures.
5. InterNational Electrical Testing Association (NETA).
6. NFPA 70, National Electrical Code (NEC).
9. 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
10. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
11. UL 508, Industrial Control Equipment.
13. UL 1008, Transfer Switch Equipment.

1.05 Delivery, Storage and Handling

A. Secure non-moving parts that may shift in transportation.

B. A list of all temporary equipment restraints which were installed at the factory, shall accompany the shipment to serve as a checklist for installation and energizing the equipment.

C. Provide protection from concealed damage by providing within shipping container mechanical impact recorder of rating recommended by the manufacturer for shipment by railroad and submit impact record chart with the manufacturer's instructions for disposition of damaged materials.

D. Store in a clean dry location.

E. Handle transformers using only lifting eyes and brackets provided for handling purposes.
F. Protect units against damage from rain, sleet or snow if handled in inclement weather.

1.06 Operation and Maintenance Data
A. Furnish hard copies of the maintenance instruction manual as required by Section 01300 and one (1) electronic file copy on CD-ROM in Adobe Acrobat (PDF) format for the following:
   1. Operation and maintenance manual.
   2. Maintenance schedule for the first cycle of scheduled maintenance, not less than twelve (12) months.
   3. Spare parts list, renewable parts list and consumable list.
   4. As-built drawings including final fabrication drawings.
B. Electronic file copy of shop drawings, factory test report, field commissioning report and other related data, contained on CD-ROM in Adobe Acrobat (PDF) format.

1.07 Warranty
A. The standard warranty for design, material and workmanship shall apply as follows:
   1. The warranty shall begin upon substation or switching station acceptance by SEPTA. In addition to the standard one (1) year warranty, provide an extended warranty for three (3) additional years.
B. The warranty shall include full repair or replacement at no cost to SEPTA.

1.08 Field Conditions
A. Do not interrupt existing electrical service to facilities occupied by SEPTA or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
   1. Notify SEPTA no fewer than five (5) days in advance of proposed interruption of electrical service.
   2. SEPTA's written permission.

1.09 Coordination
A. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03300.

PART 2 - PRODUCTS

2.01 Manufacturers Units
A. Contactor Transfer Switches:
   1. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following manufacturers:
      a. Caterpillar; Engine Division.
      b. Emerson; ASCO Power Technologies, LP.
      c. Kohler Power Systems; Generator Division.

e. Russelelectric, Inc.

f. Or Approved Equal.

2.02 General Transfer Switch Product Requirements

A. Indicated current ratings and apply as defined in UL 1008 for continuous loading and total system transfer, unless otherwise indicated.

B. Tested fault current closing and withstand ratings to be adequate for duty imposed by protective devices at installation locations in the Contract under the fault conditions indicated, based on testing according to UL 1008.

C. Solid state controls to provide repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20°C to plus 70°C.

D. Components shall meet or exceed voltage surge withstand capability requirements when tested according to IEEE C62.41.1. Components shall meet or exceed voltage impulse withstand test of NEMA ICS 1.

E. Electrical operation to be accomplish by a non-fused, momentarily energized solenoid or electric motor operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch to be designed for continuous duty repetitive transfer of full rated current between active power sources.

1. Switches using molded case switches or circuit breakers or insulated case circuit breaker components are not acceptable.

2. Switch action to be double throw; mechanically held in both directions.

3. Contacts to be silver composition or silver alloy for load current switching. Conventional automatic transfer switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Where four pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral terminal to be solid and fully rated, unless otherwise indicated.

I. Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

J. Train and bundle factory wiring and label, consistent with shop drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated terminals to use pressure type, suitable for types and sizes of field wiring indicated.

2. Power terminal arrangement and field wiring space to be suitable for top, side or bottom entrance of feeder conductors as indicated.

3. Control wiring to be equipped with lugs suitable for connection to terminal strips.
K. Enclosures to be general purpose NEMA 250, Type 3R, meeting NEMA ICS 6 and UL 508, unless otherwise indicated.

2.03 Automatic Transfer Switches

A. Meet requirements for Level 1 equipment according to NFPA 110.

B. Switching arrangement to be double throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Automatic switch operation to be under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual switch operation to be unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

F. Digital communication interface to be matched to capability of remote annunciator or annunciator and control panel.

G. Transfer switches based on molded case switch components to meet UL 489 and UL 869A.

H. In-phase monitor to be factory wired, internal relay controls transfer so it occurs only when the two (2) sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

I. Motor disconnect and timing relay controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between one (1) and sixty (60) seconds, and settings are as indicated. Relay contacts handling motor control circuit inrush and seal currents are rated for actual currents to be encountered.

J. Switch operator has a programmed neutral position arranged to provide a midpoint between the two (2) working switch positions, with an intentional, time controlled pause at midpoint during transfer. Pause is adjustable from one-half (0.5) to thirty (30) seconds minimum and factory set for one-half (0.5) second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

K. Automatic Transfer Switch Features:

1. Undervoltage sensing for each phase of normal source to sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2. Adjustable time delay for override of normal source voltage sensing to delay transfer and engine start signals. Adjustable from zero (0) to six (6) seconds, and factory set for one (1) second.
3. Voltage/frequency lockout relay to prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time delay for retransfer to normal source to be adjustable from zero (0) to thirty (30) minutes, and factory set for ten (10) minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

5. Test switch to simulate normal source failure.

6. Switch position pilot lights to indicate source to which load is connected.

7. Source available indicating lights to supervise sources via transfer switch normal and emergency source sensing circuits.
   a. Normal power supervision to be a green light with nameplate engraved "Normal Source Available."
   b. Emergency power supervision to be a red light with nameplate engraved "Emergency Source Available."

8. Unassigned auxiliary contacts to be two (2) normally open, single pole, double throw contacts for each switch position, rated 10 A at 240 VAC.

9. Transfer override switch overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

2.04 Bypass/Isolation Switches

A. Meet requirements for Level 1 equipment according to NFPA 110.

B. Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer switch operation, except for testing or maintenance.

2. Drawout arrangement for transfer switch to provide physical separation from live parts and accessibility for testing and maintenance operations.

3. Bypass/isolation switch current, voltage, closing, and short circuit withstand ratings to be equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.

4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer switch contacts when they are carrying rated load.

5. Constructed so load bypass and transfer switch isolation can be performed by one (1) person in no more than two (2) operations in fifteen (15) seconds or less.

6. The manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
7. Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of bypass/isolation switches with automatic transfer switches to be factory installed copper bus bars; plated at connection points and braced for the indicated available short circuit current.

2.05 Remote Annunciator and Control System

A. Include the following functions for indicated transfer switches:

1. Indication of sources available, as defined by actual pickup and dropout settings of transfer switch controls.
2. Indication of switch position.
3. Indication of switch in test mode.
4. Indication of failure of digital communication link.
5. Key switch or user code access to control functions of panel.
6. Control of switch test initiation.
7. Control of switch operation in either direction.
8. Control of time delay bypass for transfer to normal source.

B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand alone, self-contained operation. Automatic transfer switch sensing, controlling or operating function shall not depend on remote panel for proper operation.

C. Remote annunciation and control panel to be constructed of solid state components. Include the following features:

1. Controls and indicating lights grouped together for each transfer switch.
2. Label each indicating light control group. Indicate transfer switch it controls, location of switch and load it serves.
3. Digital communication capability to be matched to that of transfer switches supervised.
4. Mounting to be flush, modular, steel cabinet, unless otherwise indicated.

2.06 Source Quality Control

A. Factory test and inspect components, assembled switches and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time delay settings for compliance with specified requirements. Perform dielectric strength test meeting NEMA ICS 1.

PART 3 - EXECUTION

3.01 Installation

A. Design each fastener and support to carry load.
1. Concrete bases to be 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated.

B. Annunciator and control panel to be surface mounted, unless otherwise indicated.

C. Set field adjustable intervals and delays and relays, and engine exerciser clock.

3.02 Connections

A. Wiring to remote components to match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by the manufacturer. Increase raceway sizes at no additional cost to SEPTA if necessary to accommodate required wiring.

B. Ground equipment according to Section 16060.

3.03 Field Quality Control

A. Engage a qualified testing agency to perform tests and inspections.

B. Engage a factory authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory authorized service representative:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.


3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by the manufacturer. Meet the manufacturer's specified minimum resistance.
   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three (3) times.
   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer switch operations.
f. Perform contact resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool down and shutdown.

5. Coordinate with testing of ground fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.

D. Coordinate tests with tests of generator and run them concurrently.

E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. After substantial completion, but not more than sixty (60) days after final acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

   1. Perform an additional follow-up infrared scan of each switch eleven (11) months after date of substantial completion.

   2. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

   3. Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.04 Demonstration

A. Train SEPTA's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 01820.

END OF SECTION
SECTION 16421

ENCLOSED MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 Description
A. The work specified in this Section consists of materials for furnishing, installing connecting, energizing, testing, cleaning, and protecting enclosed low voltage individually mounted enclosed starters and contactors and related accessories.

1.02 Related Sections
A. Section 01300 - Submittals
B. Section 01305 - Requests for Information
C. Section 01400 - Quality Requirements
D. All sections of Division 15.
E. Section 16050 - Basic Electrical Materials and Methods
F. Section 16060 - Grounding and Bonding
G. Section 16070 - Hangers, Anchors and Supports
H. Section 16075 - Electrical Identification
I. Section 16123 - Building Wire and Cable
J. Section 16950 - Testing

1.03 Submittals
A. Make all submittals in accordance with Section 01300.
B. Submit with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of SEPTA.
C. Submit product data and catalog cuts for all products provided. Indicate clearly the usage of each product.
D. Submit shop drawings of all enclosed low voltage starters.
E. Submit manufacturer’s instructions for all enclosed starters and contactors.

1.04 Quality Assurance
A. Install work under supervision of skilled licensed electricians.
B. Meet the applicable provisions of the most recent issues of the following references:
   1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA ICS 1, Industrial Control and Systems: General Requirements.
3. NEMA ICS 2, Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600V.
4. NEMA ICS 4, Application Guideline for Terminal Blocks.
5. NEMA ICS 5, Industrial Control and Systems Control - Circuit and Pilot Devices.
6. NEMA ICS 6, Industrial Control and Systems: Enclosures.
7. NFPA 70, National Electrical Code (NEC).
8. UL 98, Enclosed and Dead-Front Switches.
10. UL 508, Industrial Control Equipment.

PART 2 - PRODUCTS

2.01 Motor Starters

A. Provide manual motors starters in NEMA 250 Type 1 enclosure, unless indicated otherwise on the Contract Drawings, and having the correct number of poles needed and sufficient horsepower, or fractional horsepower rating to operate the connected motors.

1. Fractional horsepower manual starters to consist of a manually operated quick make, quick break toggle switch equipped with melting alloy type thermal overload relay. Thermal unit sized to suit imposed load and of one (1) piece construction and interchangeable. Starter rendered inoperative when thermal unit is removed. Starter contacts of double break silver alloy type in a trip free switch mechanism.

2. Manufacturers:
   a. Square D Company.
   b. General Electric.
   c. Cutler-Hammer.
   d. Or Approved Equal.

B. Provide combination line starter units as indicated on the Contract Drawings and meeting the following requirements:

1. Magnetically held, electrically operated, three (3) pole assemblies with arc extinguishing characteristics and double break silver alloy renewable contacts meeting NEMA ICS 2. Full Voltage Reversing (FVR) type single speed, Full Voltage Non-Reversing (FVNR) type single speed, Reduced Voltage Non-Reversing (RVNR) type single speed, or three (3) winding autotransformer closed transition type having three (3) taps at 80 percent, 65 percent and 50 percent. Starters to accommodate three (3) overload relay thermal units properly sized and installed on each phase of the respective motor to be controlled. Thermal unit must be in position to operate starter.

2. Provisions to add a minimum of four (4) normally open, or normally closed, electrical interlocks.

3. Three (3) pole melting alloy element block type overload relays, trip free hand reset. Furnish thermal units.
4. Circuit breakers of the magnetic trip type meeting UL 489. Provide adjustment screw to simultaneously set the magnetic trip level of each individual pole with a single magnetic adjustment, with adjustment continuous throughout the trip range. Provide clear indication of whether the breakers are in the ON, OFF or TRIPPED position by the position of the external operating handle. Mechanically interlock handle with the unit door to prevent access unless the breaker is in the OFF position. Provide padlocking facilities to positively lock the breaker in the OFF position with from one (1) to three (3) padlocks with the door open or closed.

5. UL Listed short circuit rating not less than short circuit current indicated on the Contract Drawings, and not less than 22,000 amperes Root Mean Square (RMS) symmetrical.

6. Provide starters with operating and indicating devices as indicated on the Contract Drawings.

7. Provide each starter with an individual terminal board within the unit, completely accessible from the front, and so arranged that connection to starter can be made from the front when unit frame and starter are in place. Provide clearly marked studs for line, load and control connections. Clearly mark terminals and indicate on the manufacturer's supplied interconnection diagrams.

8. Voltage:
   a. Control voltage to be 120 volts, using individual control transformers. Control transformers having a capacity of 100VA more than the capacity required to operate external solenoids, relays, alarms and such other control voltage components.
   b. Service voltage as indicated on the Contract Drawings.

9. Enclosure to be NEMA 250 Type 1, unless indicated otherwise on the Contract Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust inhibiting phosphate and finished in gray baked enamel.

10. Manufacturers:
    a. Square D Company.
    b. General Electric.
    c. Cutler-Hammer.
    d. Or Approved Equal.

2.02 Contactors

A. Provide contactors which meet the following:

1. Multi-pole, electrically operated, mechanically or magnetically held type.

2. Continuous duty for each type of load.

3. Number of poles per contactor, amperages and load voltages.

4. Construction to be flush dead back design with arc shields and barriers to prevent pole-to-pole flashover. Parts accessible for inspection and maintenance. Contacts readily replaceable from front. Contactors suited for tungsten and ballast lighting and resistance heating loads. Interrupting capacity 150 percent of rating with no de-rating for high inrush loads.
5. Enclosure to be NEMA 1 surface type, unless indicated otherwise on the Contract Drawings, with provision for padlocking.

B. Manufacturers:
   1. Square D Company.
   2. General Electric.
   4. Or Approved Equal.

2.03 Control Relays
A. Unless otherwise noted on the Contract Drawings, provide industrial control relays having characteristics, components and enclosure as follows:
   1. Relay coil voltage of 120V AC.
   2. Number of normally open convertible contacts as indicated on the Contract Drawings, contacts rated 600V, 10 A.
   3. NEMA 250 Type 1 enclosure unless indicated otherwise on the Contract Drawings

B. Manufacturers:
   1. Square D Company
   2. General Electric
   3. Cutler-Hammer
   4. Or approved equal

2.04 Operating and Indicating Devices
A. Provide operating and indicating devices manufactured in accordance with current NEMA ICS 1 and NEMA ICS 5 standards for heavy duty control stations.
   1. Multi-position selector switches to be single-hole mounted, heavy duty, oil tight, watertight, industrial type multiple position selector switches. Double break silver switch contacts rated 600V AC, 7200 VA make, 720 VA break, 10A continuous at 35 percent inductive power factor.
   2. Pushbutton switches to be single-hole mounted, heavy duty, oil tight, watertight, industrial type pushbutton switches with momentary contacts. Double break silver switch contacts rated 600VAC, 7200 VA make, 720 VA break, 10A continuous at 35 percent inductive power factor.
   3. Pilot lights to be single-hole mounted, heavy duty, oil tight, water tight, industrial type transformer pilot lights with interchangeable Fresnel lenses.

B. Manufacturers:
   1. Square D Company.
   2. General Electric.
4. Or Approved Equal.

2.05 **Timing Relays and Repeat Cycle Timers**

A. Provide relays having characteristics and components as follows:

1. Solid state CMOS timing circuit with transient protection. Type of timing circuit as indicated on the Contract Drawings.
2. Knob adjustable time delay.
3. Double pole double throw contacts, 10 A at 120V AC.
4. High impact plastic case with eight (8) pin octal or eleven (11) pin round base. Include matching socket with screw terminals.
5. 120V AC operation.
6. UL Recognized component.

B. Manufacturers:

1. IDEC.
2. Diversified Electronics.
3. Agastat.
4. Potter & Brumfield.
5. Or Approved Equal.

PART 3 - EXECUTION

3.01 **Preparation**

A. Ensure that painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

C. Verify direction of motor rotation in equipment being served by motor starters before making final connections of such to motor starters.

3.02 **Installation**

A. Space enclosures out from surfaces mounted on 1/4 inch spacers or U-Channel supports. Provide supports as specified in Section 16070.

B. Install all starters in accordance with the manufacturer instructions.

C. Set enclosure top 6 feet 6 inches above finished floor or grade unless otherwise indicated or specified. If other equipment is installed in an area the top of the circuit breaker may be set lower than 6 feet 6 inches but in no case set the bottom of the enclosure lower than 6 inches above the finish floor or grade.

D. Punch holes for conduit entries in the enclosures.
E. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

F. Interface with other work:
   1. Connect conduits to enclosure with water tight hubs except in damp locations on the bottom of enclosures. A sealing locknut may be used in place of water tight hubs and in dry locations two (2) locknuts and bushings may be used.
   2. Connect wiring to line and load terminals with lugs provided or approved by the manufacturer to meet Section 16123 requirements. Remove interior or protect interior components during wire pulling.

G. Protection:
   1. During painting mask all nameplates, all plastic parts, pushbuttons, operating shafts and all items not to be painted.
   2. Protect all items during work of other trades including welding and cutting.
   3. Protect circuit breaker against overloads, short circuits and improper operation. Padlock off when work is being done on downstream circuits.

3.03 Field Quality Control
   A. Consult Section 16950 for requirements for field inspection and testing of motor starters.

3.04 Cleaning
   A. Clean installed products of this section where deposits of oil, grease, dirt, dust, mud or debris are present after installation. Use detergent-water solution, solvents where necessary, or other liquid cleaners not harmful to material and equipment finishes, making sure not to get moisture on cable or current carrying components.

END OF SECTION
SECTION 16440

PANELBOARDS

PART 1 - GENERAL

1.01 Description
   A. The work specified in this Section consists of all materials for furnishing, installing connecting, energizing, testing, cleaning and protecting wall mounted panelboards.

1.02 Related Sections
   A. Section 01300 – Submittals
   B. Section 16070 – Hangers, Anchors and Supports
   C. Section 16075 – Electrical Identification
   D. Section 16123 – Building Wire and Cable
   E. Section 16240 – Battery Equipment
   F. Section 16950 – Testing

1.03 Submittals
   A. Make all submittals in accordance with Section 01300.
   B. Submit all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.
   C. Submit product data for all products provided. Indicate clearly the usage and designation of each product.
   D. Submit shop drawings for all panelboards.
   E. Submit manufacturer’s instructions for all panelboards.

1.04 Quality Assurance
   A. Provide panelboards which have been design tested in accordance with NEMA PB 1.
   B. Provide panelboards which have been production tested in accordance with NEMA PB 1.
   C. Install work under supervision of licensed electricians.
   D. Meet the applicable provisions of the most recent issues of the following references:
      1. ANSI Z535, Safety Alerting Standards.
5. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
6. NEMA PB 1, Panelboards.
7. NEMA PB 1.1, General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
8. NFPA 70, National Electrical Code (NEC).
9. UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
10. UL 67, Panelboards.
11. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.05 Performance Requirements

A. Panelboards are connected to system voltages as follows:
   1. 480Y/277 Volt, 3 phase, 4 wire, 60 Hz.
   2. 208/120 Volt, 3 phase, 4 wire, 60 Hz.
   3. 240/120 Volt, 1 phase, 3 wire, 25 Hz.
   4. 130 Volt, 1 phase, 2 wire, DC (Refer to Section 16240).

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Those products such as conduit, wireways, wire and connectors, cable, support devices, fasteners and similar devices as required for work of this Section are as specified in other Sections of these Specifications.

2.02 Panelboards

A. Provide dead front panelboards as follows:
   1. Accommodate bolt-on molded case circuit breakers as specified below.
   2. Conform to NEMA PB 1 and the NEC.
   3. Consist of interiors, matching enclosures and covers of a single manufacturer as specified below.
   4. Have circuit breakers of frame sizes, trip ratings, number of poles, and types as scheduled, indicated and noted.
   5. Provide branch circuits phased in sequence vertically and numbered uniformly left to right, top to bottom.

B. Provide panelboards that are fully rated for a short circuit capacity as scheduled, indicated and noted on the Contract Drawings.

C. Provide interiors, as follows:
1. Provide tin plated main, ground and neutral copper buses meeting ASTM B 187/B 187M having not less than 98 percent conductivity.

2. Mount interiors on galvanized steel back plate.

3. Make provisions for future breakers and for circuit breakers in all future spaces as indicated, scheduled or noted and so that additional circuit breakers can be mounted without additional connectors or extension of busses.

D. Provide solder-less type main, sub-feed, and through feed lugs rated for copper and aluminum conductors of size, number and type, as indicated, scheduled and noted on the Contract Drawings.

E. Enclosures:

1. Provide enclosures meeting NEMA 250 for the types as indicated, scheduled, noted and specified. Provide NEMA 1 enclosures unless otherwise indicated on the Contract Drawings.

2. Fabricate from galvanized steel without knockouts.

3. Provide side, bottom and top gutters of minimum 4 inch width, of minimum 5 1/2 inch depth, and sized as indicated, scheduled and noted and as required by the NEC for the actual entry point.

4. Provide circuit directory of sufficient size to allow forty (40) characters per circuit; indicate the source of service (i.e., upstream panelboard, switchboard, motor control center, etc.) to the panelboard. Mount the directory in a transparent protective covering.

F. Provide doors as follows:

1. Provide concealed hinges and trim clamps.

2. Provide combination catch and master keyed, flat key lock with two (2) keys for each lock and common keying throughout each building of the facility.

G. Finishes:

1. Factory finish enclosure cover completely using an electro-deposition process that deposits a complete finish coat of paint on all interior and exterior surfaces as well as bolted joints.

2. Include in the paint process cleaning, rinsing, phosphatizing, pre-paint and post paint rinses, bake cure and cool down steps.

3. Finish switchboards with rust inhibiting primers and electro-disposition acrylic baked enamel top coating of No. 61 medium light grey conforming to ANSI Z535.

4. Provide overall finish capable of passing a three hundred (300) hour salt spray per ASTM B 117 with less than 1/8 loss of paint from a scribed line.

H. Molded Case Circuit Breakers:

1. Provide inverse time and instantaneous tripping characteristics.

2. Provide trip ratings, frame sizes and number of poles as indicated, scheduled and noted on the Contract Drawings.
3. Provide full rated circuit breakers with short circuit ratings equal to the panelboard installed as scheduled on the Contract Drawings.

4. Provide molded case circuit breakers meeting UL 489.

5. Provide circuit breakers of the same manufacture and type as the panelboard installed.

I. Panelboard Types:
   1. Branch Power and Lighting (208Y/120V).
   2. Branch Power and Lighting (480Y/277V).
   4. Distribution.

J. Manufacturers:
   1. Square D.
   2. General Electric.
   4. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation
   A. Ensure that painted surfaces which will be covered by items of this section have a prime and finish coat of paint.
   B. Ensure that all indoor areas are enclosed from the weather.

3.02 Installation
   A. Space enclosures out from surfaces mounted on 1/4 inch spacers or U-channel supports. Provide supports as specified in Section 16070.
   B. Install all panelboards and circuit breakers in accordance with the manufacturer’s instructions and NEMA PB 1.1.
   C. Set enclosure top 6 feet 6 inches above finished floor or grade unless otherwise indicated or specified.
   D. Punch holes for conduit entries in the enclosures.
   E. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.
   F. Interface with other work:
      1. Connect conduits to enclosure with water tight hubs, except in damp locations on the bottom of enclosures a sealing locknut may be used in place of water tight hubs, and in dry locations two (2) locknuts and bushings may be used.
2. Connect wiring to line and load terminals with lugs provided or approved by the manufacturer in conformance with Section 16123. Remove interior or protect interior components during wire pulling.

3. Identify in accordance with Section 16075.

G. At the end of the Contract update the circuit directories to reflect as-built conditions. Circuit directions shall be typed.

H. Protection:
   1. During painting, mask all nameplates, all plastic parts and all items not to be painted.
   2. Protect all items during work of other trades including welding and cutting.
   3. Protect panelboards against overloads, short circuits and improper operation; padlock off when work is being done on downstream circuits.

3.03 Field Quality Control

A. Site Testing:
   1. Prior to Energizing:
      a. Have insulation testing and setting of overcurrent protective device adjustments made in conformance of Section 16950.
      b. Ensure that all load side wiring is clear of shorts and has received and passed the insulation tests of Section 16950.
      c. Open all downstream disconnects and open circuit breaker.
   2. Perform tests in accordance with Section 16950.

3.04 Cleaning

A. After wiring, vacuum out interior and wipe clean of all foreign material.

B. After painting in areas, remove all over paint, drips and splashes.

END OF SECTION
SECTION 16460

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 Description
   A. The work specified in this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting transformers.

1.02 Related Sections
   A. Section 01300 – Submittals
   B. Section 01600 – Materials and Equipment
   C. Section 01830 – Operations and Maintenance Data
   D. Section 16060 – Grounding and Bonding
   E. Section 16123 – Building Wire and Cable
   F. Section 16130 – Raceways and Boxes
   G. Section 16950 – Testing

1.03 Submittals
   A. Make all submittals in accordance with Section 01300.
   B. Submit all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.
   C. Submit product data:
      1. List of transformers and accessories to be furnished and installed.
      2. Catalog cuts of all transformers and accessories.
   D. Submit shop drawings for the following:
      1. Complete outline drawing in English Units, showing overall length, width and height and including ratings of equipment, impedance and installation restrictions.
   E. Submit factory test reports as specified in this Section.
   F. Submit Installation certificates for transformers.
   G. Submit record drawings, shop drawings, product data and operation and maintenance manuals for project closeout.

1.04 Quality Assurance
   A. All work shall conform to regulatory requirements of all state, local, and national governing codes and requirements.
B. Install work under supervision of skilled licensed electricians.

C. Meet the applicable provisions of the most recent issues of the following references:
   1. ANSI Z535, Safety Alerting Standards.
   2. ASTM D 635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   6. NEMA ST 20, Dry Type Transformers for General Applications.
   7. NFPA 70, National Electrical Code (NEC).

1.05 Delivery, Storage and Handling
   A. Protect items from damage during delivery, storage and handling in accordance with Section 01600.

1.06 Factory Testing
   A. Prior to shipment, perform the following tests on each transformer in accordance with NEMA ST 20 and IEEE C57.12.91:
      1. Turns ratio.
      2. Winding resistance.
      3. Impedance.
      4. Load loss.
      5. Exciting current.
      6. Induced potential.
      7. Sound level.
   B. Submit certified test certificate.

1.07 Performance Requirements
   A. Design Criteria:
      1. Provide transformers with ratings as indicated on the Contract Drawings.
      2. Provide transformers designed for the following conditions:
         a. 40°C maximum ambient temperature.
         b. Minus 20°C minimum ambient temperature.
c. 100 feet above sea level.
d. Indoor unless otherwise indicated or specified.

B. Provide transformers for connecting to systems with a let through fault capability up to the limits of IEEE C57.12.59.

1.08 Qualifications
A. Firm specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

1.09 Operation and Maintenance Data
1. Submit operation and maintenance manual in binder form with indexes and tabs for each Section. Meet Section 01830.

PART 2 - PRODUCTS

2.01 Manufacturers
A. Manufacturers:
1. Square D.
2. General Electric.
4. Or Approved Equal.
   a. Request for substitutions shall be made in conformity with Section 01600 and in addition the following must be included with each request:
      1) Guaranteed performance data for each size including sound level, losses at full load, impedances, and size and number of taps.
      2) Overall dimensions for each size.
      3) Capacitance between windings for each shielded isolation transformer.

2.02 Secondary Transformers
A. Provide general purpose, indoor, double wound, ventilated, dry type transformers conforming to NEMA ST 20.
B. Provide copper windings.
C. Design transformer for continuous operation at rated KVA, twenty-four (24) hours a day, three hundred and sixty-five (365) days a year, with normal life expectancy, without exceeding 80°C temperature rise above 40°C ambient. 80°C rise transformers shall be capable of carrying a continuous 30 percent overload without exceeding a 150°C rise in a 40°C ambient.
D. The maximum temperature of the top of the enclosure shall not exceed 35°C rise above a 40°C ambient.
E. Provide 220°C insulation systems. Provide final insulation treatment of total immersion in an insulating varnish that provides superior bond strength, high dielectric strength and outstanding power factors at temperatures. Cure at normal operating temperatures for
sufficient time to complete curing of the varnish and drive off all volatile elements in the varnish solvent. Provide sufficient air ducts to prevent any undesirable hot spots in the winding.

F. Wind secondary low voltage winding next to the core, for step down service; wind secondary high voltage winding next to the core for step up service.

G. Construct transformer core of a high quality, non-aging, low loss silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Design and size core to keep flux density well below the saturation point. Clamp core laminations securely with heavy gauge steel angles.

H. Mount core on rubber, vibration absorbing mounts and securely bolt the core to the base. Provide design to meet NEMA ST 20 standards according to KVA rating.

I. Provide mechanical bracing to brace the cores and coils to withstand short circuit currents established by IEEE C57.12.59.

J. Provide wall mounted transformers with wall brackets adequate for the supporting weight.

K. Provide transformer materials that are flame retardant and that shall not support combustion as defined in ASTM D 635.

L. Provide terminals marked in accordance with IEEE C57.12.70.

M. Provide taps in accordance with Table 16460-1.

### Table 16460-1 Transformer Taps

<table>
<thead>
<tr>
<th>Phase</th>
<th>Rating</th>
<th>Full Capacity Above Normal (FCAN)</th>
<th>Full Capacity Above Below (FCBN)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Size</td>
</tr>
<tr>
<td>Single</td>
<td>15 through 100 kVA</td>
<td>Two (2)</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

N. Enclosures:

1. Provide transformers with NEMA 1 code gauge sheet metal enclosures with removable front and back panels.

2. Provide screens or grills for all ventilation openings. Design screens and grills to prevent accidental access to electrified parts.

3. Degrease, clean, phosphatize, prime coat and finish coat with an ANSI Z535 number 61 gray baked enamel.

### PART 3 - EXECUTION

#### 3.01 Preparation

A. Ensure that ground cable of proper size is installed in floor or wall as required in conformity with Section 16060.

B. Check conduit stub-ups for correct type, size and location.

C. Correct any and all defects.
3.02 Installation

A. Install, set level and plumb. Shim as required at each support point with shims on all sides of anchor bolts. After leveling, replace multiple shims with a single machined plate and no more than two (2) small shims at each location. Unless otherwise noted, set transformer level to within 1/16 inch from end to end and side to side.

B. Provide 4 inch steel platforms for all floor mounted transformers. Extend platform to wall if the wall is less than 8 inches from the transformer and extend platform 2 inches beyond the transformer.

C. Provide through bolts with 1/8 inch thick galvanized steel backing plates for all wall mounted transformers mounted on masonry walls when the wall opposite the transformer is an unfinished masonry wall. On masonry walls that are exterior walls or interior walls with finish, grout in mounting bolts as wall is constructed. For wall mounted transformers mounted on wood walls, provide 4 inch x 6 inch wood blocking in the wall during construction of wall.

D. Provide sufficient anchor bolts to restrain transformer movement against tipping.

E. Connect transformer to conduit system in accordance with Section 16130 and as follows:
   1. Use liquid tight flexible metal conduit formed into a J-hook shape with sufficient slack to prevent transmission of vibration or provide bottom entry of conduit without direct connection to enclosure. Use insulating grounding bushing and two (2) locknuts on all conduit entries.

F. Make electrical connections as follows and in accordance with the NEC and Section 16123. Make electrical connections with compression lugs approved by the manufacturer. Leave sufficient slack to allow for remaking connections twice and also allow for any expansion and contraction and limit the transmission of vibration.

G. Grounding:
   1. Ground neutral of all three phase transformers with wye connected secondaries.
   2. Ground neutral of all single phase transformers with three (3) wire secondaries and secondaries of all two (2) wire single phase transformers.
   3. Ground transformer to closest equipment ground bus bar.

H. Protection:
   1. Protect against short circuits and overloads. Replace any transformer subjected to a short circuit exceeding the allowable magnitude and time limits of IEEE C57.12.59.
   2. Protect against painting splash and spray.
   3. Protect against damage during work of other trades.

3.03 Field Quality Control

A. Perform the initial start-up under the direct supervision of a licensed electrician in the presence of the SEPTA.

B. Prior to Startup/Energization:
1. Perform insulation tests in accordance with Section 16950 prior to energization. Dry out all transformers with low readings and retest.

2. Insure that all wiring connected to the transformer is free of shorts.

3. Insure that the proper size of overcurrent protective device is installed and set to the proper settings.

C. Conduct field tests in the presence of SEPTA.

D. Perform tests in accordance with Section 16950.

E. Correct all defects found and retest after correction of defects.

F. Submit a certified report of the test. Certified report to include detailed losses.

**END OF SECTION**
SECTION 16500
LIGHTING

PART 1 - GENERAL

1.01 Description
   A. This Section specifies the requirements for general and emergency egress lighting equipment, components and related installations.

1.02 Related Sections
   A. Section 01300 – Submittals
   B. Section 01305 – Requests for Information
   C. Section 01400 – Quality Requirements
   D. Section 16010 – Basic Electrical Requirements
   E. Section 16050 – Basic Electrical Materials and Methods
   F. Section 16060 – Grounding and Bonding
   G. Section 16070 – Hangers, Anchors and Supports
   H. Section 16075 – Electrical Identification
   I. Section 16123 – Building Wire and Cable
   J. Section 16950 – Testing

1.03 Submittals
   A. Make all submittals in accordance with Section 01300.
   B. Submit shop drawings showing specially fabricated supporting and fastening devices and details of all assemblies and sub-assemblies.
   C. Submit shop drawings showing light fixture wiring diagrams.
   D. Submit bill of material consisting of an itemized list of each part identified by a part number and/or the manufacturer's numbers (i.e. LED drive, etc.). This bill of material must be referenced to the shop drawings.
   E. Submit manufacturer’s literature to describe lighting fixtures, exit signs, emergency battery backup LED drive and indicated appurtenances including all required photometrics.
   F. Submit calculations for interior and exterior illuminance using photometrics of the Contractor’s proposed luminaires.
   G. Submit a light fixture schedule.
   H. Submit one (1) sample of each type of light fixture, as requested or directed by SEPTA, prior to manufacturing/ordering.
   I. Submit verification that each light fixture is in compliance with applicable codes, regulations, reference standards and specifications for the location at which it is to be used. Indicate
requirements that each light fixture is required to meet; expected energy efficiency, lamp life, etc.; which will be met or exceeded by the installed light fixtures.

J. Certified test data to show compliance with the specified requirements including providing actual THD, in-rush current level, performance at minimum and maximum ambient temperatures, efficiency, power factor level, maximum recommended operating temperature, CRI index level, lumen level, wattage and operating life. Test data shall also show that the operating temperatures stay within the manufacturer's recommendations.

1.04 Quality Assurance

A. Products to be Underwriters' Laboratories (UL) listed, and each light fixture, emergency battery backup LED drive and exit sign bears the UL label. Light fixtures to be installed in areas subject to the weather to be UL listed as "enclosed and gasketed suitable for wet locations". The execution of work of this Section must satisfy the applicable requirements of the NEC, regulations of jurisdictional authorities and the National Occupational Safety and Health Act.

B. Experience:

1. The Contractor shall demonstrate experience in completing similar work and have been engaged in electrical contracting for a minimum of five (5) years prior to the bid opening of this Contract. Railroad experience shall be specifically identified.

2. Furnish products, preferably by the same manufacturer, that have been in satisfactory use for a period of five (5) years prior to the bid opening of this Contract.

3. The manufacturer(s) shall have local representatives in or around the Philadelphia area available on short notice to respond to design, pricing, operation or maintenance questions related to their products.

C. Meet the applicable provisions of the most recent issues of the following references:

1. Aluminum Association (AA).


18. ASTM D 635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
22. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
25. FS FF-B-588D, Bolt, Toggle; and Expansion Sleeve, Screw.
26. FS FF-S-325, Shield, Expansion; Nail Expansion, and Nail, Drive Screw (Devices, Anchoring, Masonry).
27. FS FF-P-395, Pin Drive, Power Actuated.
32. NFPA 70, National Electrical Code (NEC).
33. Occupational Safety and Health Administration (OSHA).
34. SSPC-SP 6, Commercial Blast Cleaning.
35. SSPC-SP 10, Near White Blast Cleaning.
36. UL 508, Industrial Control Equipment.
37. SEPTA Standard Specifications:

1.05 Performance Requirements

A. Design Criteria:

1. Fixture manufacturers and corresponding model numbers and fixture description as included in the lighting fixture schedule indicated on the Contract Drawings, constitute the Contract design.
   a. Lighting fixtures as scheduled are correct for the Contract design with respect to visible style; number of lamps and lenses desired but may not cover special required design details. Provide lighting fixtures having such special details as noted in Article 2 of this Section. SEPTA assumes no responsibility for clearance, dimensions, tolerances or exact hanging frame dimensions.

1.06 Maintenance Service and Extra Material

A. Provide a single wall mounted steel storage cabinet with capacity for the items listed below and a set of maintenance manuals.

B. Provide two (2) complete spare light fixtures of each type and ten (10) sets of replaceable components applicable to each light fixture including lamps, lenses and reflectors.

C. Provide in a toolbox kit one (1) each of maintenance tools as may be necessary for fixture maintenance.

D. Provide in sealed bags cloths suitable for cleaning the luminaire during periodic maintenance.

E. Mount on the door of the cabinet a complete schedule with detailed product description and reorder information.

PART 2 - PRODUCTS

2.01 Materials

A. General Requirements or Light Fixtures:

1. Components of the same type, size, rating, functional characteristics and make are to be interchangeable.

2. Materials for Housings:
   a. Grade of steel as recommended by the manufacturer, unless otherwise shown on the Contract Drawings.
b. Grade of stainless steel as recommended by the manufacturer, unless otherwise shown on the Contract Drawings.

c. Aluminum alloy as recommended by the manufacturer, unless otherwise shown on the Contract Drawings.

d. Approximate shape and size will be determined by the Contractor’s selection of LED light fixtures. Fixture bodies shall be sealed to a preferred rating of IP66, but a minimum rating of IP65 to prevent ingress of moisture and dust.

e. The housings shall be vandal resistant.

3. Lamps:
   a. In accordance with applicable ANSI standards.
   b. LED Light:
      1) Wattage as determined by the light design performed by the Contractor to meet the foot-candle level criteria found on the Contract Drawings.
      2) Base as recommended by the manufacturer.
      3) Operating voltage as determined by the design of the Contractor at 60 Hertz.
      4) Rated life to be fifty thousand (50,000) hours.
      5) Color to be white.
      6) Color Rendering Index (CRI) to be 75+.
      7) Color temperature to be 5000+ Kelvin.
      8) Approximate lumens output as determined by the light design performed by the Contractor to meet foot-candle level criteria on the Contract Drawings.
      9) Total Harmonic Distortion (THD) less than 15 percent.
     10) Light distribution pattern as determined by the light design performed by the Contractor to meet foot-candle level criteria found on the Contract Drawings.

4. Lampholders:
   a. LED Lamps:
      1) In accordance with UL 496 and per the manufacturers standards.
      2) Provide vibration proof mounting to prevent damage to the lamp.

5. LED Driver:
   a. Provide internal driver factory installed operating at voltage as indicated on the light fixture schedule.

6. Internal Type Emergency Power Unit:
   a. Self-contained, modular, battery inverter unit, factory mounted with luminaire body.
   b. Emergency connection to operate lamp(s) continuously at an output of 1100 lumens upon loss of normal power. Connect unswitched circuit to battery inverter unit and switched circuit to luminaire driver.
   c. Relay automatically turns lamp on when unswitched power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      1) Ambient temperature to be less than 0°F or exceeding 104°F, with an average value exceeding 95°F over twenty-four (24) hour period.
2) Humidity to be more than 95 percent (condensing).
3) Altitude to be < 1000 feet.

e. Test Push Button and Indicator Light:
   1) Visible and accessible without opening luminaire or entering ceiling space.
   2) Push button to be push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   3) Indicator light to be LED indicating normal power is on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Battery to be sealed, maintenance free, lead acid type.
g. Charge to be fully automatic, solid state, constant current type with sealed power transfer relay.

7. Reflectors:
   a. Reflector material to be aluminum or stainless steel polished to a mirror finish to provide improved light efficiency.

8. Diffusers:
   a. Shape and size as shown on the light fixture schedule on the Contract Drawings. One (1) piece molded or extruded polycarbonate plastic or tempered glass lens having the following properties:
      1) Suitable for substation or switching station environment.
      2) Wall mounted type light fixtures shall have plastic or refractory.
      3) Self-extinguishing, in accordance with ASTM D 635.
      4) No apparent yellowing after five hundred (500) hours exposure to lamp source.
      5) No alteration to optical properties of the light fixture when finished diffuser treated with anti-static wax.
   b. Formed so that the finished piece retains its design contours and dimensions at normal operating temperature.
   c. Resistant to shrinking, wrapping, crazing, cracking or discoloring, either in service or when stored in the manufacturer’s standard shipping containers under normal conditions.

9. Lenses:
   a. Plastic lenses to be heat resistant, prismatic polycarbonate, minimum thickness of 0.06 inches to prevent glare. UV stabilized.
   b. Glass lenses to be 1/4 inch tempered glass, laminated glass, or 1/8 inch double strength clear glass.
   c. Refractory lenses to be heat resistant annealed prismatic borosilicate glass, with the following additional requirements:
      1) Minimum efficiency to be 85 percent.

10. Light fixture wiring to meet the requirement of Section 16050.

11. Gaskets:
   a. Keyed gaskets to be one (1) piece extruded solid neoprene having Type A durometer hardness of 30 plus or minus 5 when tested in accordance with ASTM D 2240.
   b. Self-Retaining Gaskets:
      1) One (1) piece, closed cell sponge neoprene, soft or medium density.
      2) Resistant to aging, heat, ultra-violent light, water, oil, weathering and setting as determined by ASTM D 1056, NEMA 12.
3) Cemented to component with resilient neoprene sealing compound compatible with finish; adhesive not applied to diffuser.

c. Silicone gaskets equal to neoprene; at the Contractor’s option.

d. Provide gaskets for fixtures located in tunnels having UL labeling for wet locations and able to withstand water hose spray cleaning with 100 psi water pressure.

12. Hardware:

a. Latches, catches, release mechanism, hinges, screws, bolts, studs, nuts, rivets, washers and springs to be heavy duty stainless steel or bronze. Where possible, hinges and catches shall be the concealed type.

b. Latches and catches to be captive type.

c. Operating hardware to be self-retaining type.

13. Construction:

a. Light fixture body, reflectors, wiring channels, end caps and castings formed to prevent buckling or distortion.

b. Minimum of two (2) wire clips provided in wiring channels to support wiring.

c. Seams and joints continuously welded and ground smooth.

d. When aluminum is in contact with a dissimilar metal, separate contact surfaces with a gasket, non-absorptive type or coating to prevent corrosion.

e. Light fixtures shall be provided with anti-vandal features that do not modify the required photometric performance.

f. All fixtures shall be suitable for use in a substation or switching station environment where strong winds are experienced.

g. All light fixtures shall be designed to prevent the ingress of dust.

h. Light fixtures shall be able to withstand washing with industrial detergents applied from a high pressure hose. Water shall not enter the light fixture.

i. Light fixtures shall be designed such that all components can withstand the expected lamp operating temperatures without reduction in the capability of the light fixture.

14. Finish:

a. Suitable for railroad tunnel environment. The finish shall be resistant to corrosion from water and chemicals.

b. Baked enamel to be non-specular finish consisting of six (6) stage hot cleaning wash, phosphate coat, prime coat and finish coat of sprayed white or other acrylic enamel as shown, baked at 3500°F for a minimum of thirty (30) minutes, with the following additional requirements:

   1) Dry film thickness (DFT) per ASTM D 7091 to be 1.25 mils minimum.

   2) Undercutting of enamel film from scored line after exposing to 10 percent slat spray for one thousand five hundred (1,500) hours, per ASTM B 117 to be 0.067 inch maximum.

   3) Baked white enamel after one hundred (100) hours exposure to fadeometer to be 86 percent minimum reflectance factors, no appreciable visual color change.

c. Specular anodized coating to be fourteen (14) stage process for permanently sealed specular or semi-specular finish, as shown, in accordance with patented electrolytic process, Alzak or equal.

d. Anodic coating to meet AA-M22-C22-A41, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot water seal overall, tested in accordance with the following requirements:
1) Coating weight to meet ASTM B 137.
2) Coating thickness to meet ASTM B 244.
3) Sealing test to meet ASTM B 136.
4) Undercutting of anodic film from scored line after exposing to 10 percent salt spray for one thousand five hundred (1,500) hours, in accordance with ASTM B 117 to be 0.067 inch maximum.
e) Zinc coating to meet ASTM A 123/A 123M.
   1) Prepare surfaces in accordance with SSPC-SP 6 for shop painting. Apply coating of 8.0 mil total OFT as follows:
      a) First coat to be inorganic zinc silicate primer applied with a dry film thickness of 2.5 to 3 mils.
      b) Second coat to be high building epoxy primer applied with a dry film thickness of 4 mils.
      c) Third coat to be aliphatic polyester polyurethane with a dry film thickness of 1.5 to 2.5 mils.
   2) Color anodized finish to meet AA-M22-C22-A42, minimum coating thickens 0.8 mil, coating weight 35 milligrams per square inch, hot water seal overall, tested in accordance with the following requirements:
      a) Coating weight to meet ASTM B 137.
      b) Coating thickness to meet ASTM B 244.
      c) Sealing test to meet ASTM B 136.
   3) Prepare surfaces for electrostatic powder coating by sandblast cleaning method SSPC-SP 10 near white blast cleaning, apply coating promptly after cleaning. Ground material to be coated. Apply coating as electrostatically charged dry powder using electrostatic spray gun to product OFT of 6 mils plus or minus 2 mils. Cure by heat treatment.

15. Mark each light fixture and its components in accordance with applicable reference standard.

16. Fasteners to be size and type shown or as approved by SEPTA.
   a. Expansion anchors to meet FS FF-S-325, Group II, Type 3, Class I, stainless steel, Type 303.
   b. Per the manufacturer’s recommendations.

17. Fuses:
   a. All light fixtures shall be factory equipped with individual fuses.

2.02 Light Fixtures
A. All light fixtures provided for this Contract to be LED. Refer to the light fixture schedule on the Contract Drawings for the basis of design light fixtures for this Contract.

2.03 Lighting and Emergency Battery Unit Support Devices
A. In addition to the supporting devices and fasteners as previously specified in Section 16070, provide with the lighting equipment and luminaries specified or indicated suspension accessories, canopies, casing, sockets, holders, reflectors, plaster frames, recessing boxes, etc., as required for support.

B. Supply pendant stems, special mounting supports and hardware, miscellaneous materials and incidentals required to install the products in place.
C. Spacers for maintaining clearance between products and concrete, mortar and other masonry surfaces are to be neoprene.

2.04 Grounding
A. Provide the housing of each light fixture with a separate, factory installed grounding device and ground conductor. The grounding device is to be used for connecting a separate grounding conductor and meet the requirements specified in Section 16060.

2.05 Light Fixture Brackets
A. Light fixture brackets are to be of the type and style as indicated or scheduled on the Contract Drawings.

1. Designed and fabricated to be compatible with configuration of light fixture and color matched to light fixture.

2. Provide outlet boxes, neoprene gaskets and stainless steel hardware to render the installation waterproof.

2.06 Lighting Contactors
A. The remote control switch shall be electrically operated by a dual acting, single solenoid mechanism that is inherently interlocked and mechanically held in both the open and closed positions. The main contacts shall be power driven in both directions. Positive locking of contact positions shall not be dependent on gravity, hooks, latches or semi-permanent magnets.

B. The remote control switch shall be capable of operating in any position. Provisions shall be incorporated for manual operation during inspection and maintenance.

C. The remote control switch shall be Underwriters' Laboratories listed under UL 508. Main contacts shall be double break, continuous duty rated 20 amperes at 600 volts AC, 60 Hz (30 amperes at 600 volts AC, 60 Hz, for general purpose loads), and be marked for ballast lighting (electric discharge lamps), tungsten and general purpose loads. Lighting contactors requiring de-rating when used in an enclosure or with tungsten lamp loads shall not be acceptable.

D. The remote control switches shall be provided with clamp type, self-rising terminal plates for solder-less connection of line, load and control conductors. Terminals shall accept a copper wire range of No. 18 AWG to No.10 AWG.

E. The number of poles, up to a maximum of twelve (12), on a single remote control lighting contactor, shall be provided as indicated on the Contract Drawings.

F. The remote control switches shall be UL listed for the following short circuit withstand current ratings when coordinated with a UL listed molded case circuit breaker rated 30 amperes:

1. 22,000 amps rms symmetrical, 250 volts, 60 Hz.
2. 14,000 amps rms symmetrical, 480 volts, 60 Hz.
3. 10,000 amps rms symmetrical, 600 volts, 60 Hz.
G. The operating coil and main contacts shall be replaceable from the front without major
disassembly and visual indication shall be provided for each contact.

H. Provisions shall be included to permit remote pilot lamp type visual indications without the
necessity for auxiliary contacts or additional wiring.

I. Each remote control switch shall be furnished with an Owner's manual providing installation
and operating instructions.

J. Each remote control switch shall be furnished in a NEMA 1 enclosure.

K. Manufacturers:
   1. ASCO, Model 918.
   2. Or Approved Equal.

2.07 Photoelectric Controls

A. Cadmium sulphide hermetically sealed cell for remote mounting. Photoelectric control fully
temperature compensated and designed to provide for a fifteen (15) second time delay to
prevent false switching. Provide two (2) photoelectric controls; one (1) for the light over the
main entrance door and one (1) for the dawn shut off function.

B. Photoelectric controls required for individual luminaries are to be of the plug-in, twist-to-
lock type, and be of the voltage characteristics compatible with the unit.

C. Photoelectric control required for a group of lighting fixtures is to be of the conduit
mounted type and be of the voltage characteristics as indicated on the Contract Drawings.

D. Manufacturers:
   1. Tork.
   2. Area Lighting Research, Inc.
   3. Paragon.
   4. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Verify that other construction work is complete to the extent that light fixtures may be
installed in the yard or incorporated into integrated systems, such as the prefabricated
building.

B. Verify locations and clearances of other installed or proposed work and coordinate lighting
fixture installations accordingly.

3.02 Installation

A. Coordinate the installation of lighting fixtures with all building systems and components so
as to avoid any conflicts of installation.

B. Assemble where required, wire and install lighting fixtures, supports, brackets, and
accessories at locations and mounting heights indicated on the Contract Drawings.
1. Perform wiring as specified in Section 16123.
2. Ground light fixtures according to requirements of the NEC and Section 16060.

C. Install surface mounted and exposed fixtures as indicated on the Contract Drawings.
   1. Hang suspended fixtures plumb, with continuous rows of fixtures in alignment.
   2. Unless indicated otherwise on the Contract Drawings, mount suspended fixtures in each room or area at the same height regardless of varying clear height conditions.
   3. Install surface mounted fixtures drawn up tight against the substrate to eliminate gaps, except where the NEC or local code restrictions require a separation between fixtures and substrate.
   4. Install exit fixtures directly over doorways, for those doors as indicated on the Contract Drawings. Center fixtures over doorway and install fixtures to clear door and associated hardware.

D. Install all photoelectric controls facing north for proper operation.

E. Apply touch-up paint if necessary.

3.03 Field Quality Control

A. Refer to Section 16950 for functional and photometric testing requirements.
B. Verify installation is per the Contract Drawings and the manufacturer's recommendations.
C. Test lighting circuits for continuity and operation.
D. Test light fixtures and equipment enclosures for continuity of grounding system.
E. Aim and adjust light fixtures to provide required distribution pattern.

3.04 Cleaning

A. New Light Fixtures:
   1. Follow the cleaning procedures as recommended by the light fixture manufacturer with respect to new light fixture cleaning for construction work practice.
   2. Use only those products for cleaning as outlined in the light fixture manufacturer's literature.

3.05 Warranty

A. The Contractor shall provide a warranty for new light fixtures and all associated components for a minimum of five (5) years from the final acceptance by SEPTA. The Contractor shall be responsible, at no cost to SEPTA, to replace any and all components that become defective during the warranty period, due to material defects, workmanship or design, or do not meet the identified specification requirements.
B. The LED lamp and ballast shall be guaranteed for a minimum for forty thousand (40,000) hours of operating life.
3.06 Rejection

A. SEPTA expressly reserves the right to reject any light fixture which does not meet all of the requirements of this Specification and other SEPTA standards. SEPTA further has the right to reject any light fixtures received in cartons which are obviously damaged or have not been adequately protected from injury, in the opinion of SEPTA. Upon notice to the Contractor or supplier, any such rejected material shall be removed promptly from SEPTA's property and shall be replaced, at no additional cost to SEPTA, with material which meets this Specification.

END OF SECTION
SECTION 16700

COMMUNICATIONS

PART 1 - GENERAL

1.01 Description
A. Section includes the work specified in this Section consisting of materials for furnishing, installing, connecting, energizing, testing, cleaning, and protecting a structured wiring system for voice and Security.
B. System Overview:
1. Voice and Security runs for substation or switching station.
2. Building entrance terminals with primary and secondary protection for copper.
3. “Wire set” to each outlet to be one (1) Category 6 white jacketed voice cable. The voice outlet shall have color icon indicating the cable connected to the jack which shall be white cable – white icon. Voice cables shall be terminated on 110 Blocks. Security cables shall be terminated on separate rack mounted patch panel.

1.02 Related Sections
A. Section 16060 - Grounding and Bonding

1.03 Submittals
A. Submit with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of SEPTA.
B. Submit with all product data evidence of third party performance testing by a Nationally Recognized Independent Testing Laboratory.
C. Submit product data and catalog cuts for all products provided. Indicate clearly the usage of each product.
D. Submit shop drawings:
1. Provide Registered Communications Distribution Designer (RCDD) approved drawings complete with wiring diagrams and details required to prove that the distribution system shall properly support connectivity from the equipment cabinet to telecommunications work area outlets. Show the entrance facility and layout of cabling and pathway runs, cross connect points, grounding system, terminating block arrangements and type. Drawings shall depict final telecommunications cabling configuration, including location, color coding, gauge, pair assignment, polarization, and terminating blocks layout at cross connect points and patch panels after telecommunications cable installation.
2. Provide shop drawing showing layout of applicable equipment inside distribution frames including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks and equipment spaces and racks.

E. Prior to installation, submit data of the installer's experience and qualifications. Installers shall be a Building Industry Consulting Service International (BICSI) registered cabling installation technician. Include names and locations of two (2) Projects successfully completed using copper communications cabling systems. Include written certification from the users that the systems have performed satisfactorily. Include specific experience in installing and testing structured telecommunications distribution systems using Category 6 cabling systems.

F. Submit a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the Unshielded Twisted Pair (UTP) components and accessories. Include procedures for certification, validation and testing.

G. Submit operation and maintenance manuals which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures and operating instructions.

1.04 Quality Assurance

A. Provide products that are listed and labeled by Underwriters Laboratories Inc., approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.

B. Provide products that have been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Test results shall be provided upon request of SEPTA.

C. Firm specializing in manufacturing products of this Section with sufficient previous experience to successfully manufacture the products indicated.

D. Conform all work to NFPA 70, National Electrical Code.

E. Firm specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

F. Install work under supervision of skilled licensed electricians.

G. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI/NEMA WC 63.1, Performance Standard for Twisted Pair Premise Voice and Data Communications Cable.


5. ANSI/TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard - General Requirements.
10. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.
12. Factory Mutual (FM).
13. ICEA S-84-608, Telecommunications Cable, Filled Polyolefin Insulated, Copper Conductor.
14. ICEA S-90-661, Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and Communication Wiring Systems Technical Requirements.
15. IEEE 802.3ab, IEEE Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T.
17. UL 444, Communications Cables.
18. UL 467, Grounding and Bonding Equipment.
19. UL 497, Protectors for Paired-Conductor Communication Circuits.
21. UL 1863, Standard for Communications-Circuit Accessories.
22. 7 CFR 1755.390, RUS Specification for Filled Telephone Cables.

1.05 General Requirements

A. Provide a completely cabled and terminated communication system (voice/data) in a star topology.

C. Provide grounding and bonding per, at minimum, ANSI/TIA/EIA-607, NFPA 70 and UL 467.

### PART 2 - PRODUCTS

#### 2.01 Connection

A. UTP Copper Cable:

1. Voice and Data:
   a. Connectors shall meet FCC Part 68.5 and ANSI/TIA/EIA-568-B. UTP outlet/connectors shall be UL 1863 listed, non-keyed, four (4) pair, constructed of high impact rated thermoplastic housing and shall meet Category 6 requirements. Connectors shall be RJ45 terminated using a one hundred and ten (110) style PC board connector. UTP connectors shall meet durability for five hundred (500) mating cycles. Connector shall be color coded for telephone as directed by SEPTA.

2. Manufacturers:
   a. TE Connectivity part number 1375192-1.
   b. Or Approved Equal.

#### 2.02 Outlet

A. Outlets consisting of box, wallplate and connectors.

B. Wallplates shall be stainless steel.

C. Manufacturers:

1. The Siemon Company.
2. Leviton Voice and Data Division.
3. Hubbell Premise Wiring.
4. TE Connectivity.
5. Or Approved Equal.

D. Faceplates shall be four (4) port Almond color with color icons labeling the designated jacks as follows:

1. Voice to be white cable white icon.
2. Data to be gray cable black icon.
3. Data to be blue cable blue icon.
4. Pink cable red icon.

E. Surface mounted boxes shall be single gang almond.
2.03 Patch Panels

A. UTP Copper Cable (Data):
   1. Panel shall be constructed of 0.09 inch minimum aluminum and shall be compatible with an EIA 19 inches equipment rack.
   2. Panel shall be equipped with the indicated quantity of non-keyed, RJ45 ports, wired to T568A. Patch panels shall terminate the building cabling on one hundred and ten (110) style insulation displacement connectors and shall utilize a printed circuit board interface color coded for both T568A and T568B wiring. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.
   3. The rear of each panel shall have incoming cable strain relief and routing guides and shall accommodate top, bottom or side cable entry.

2.04 Equipment Cabinets

A. Standard 19 inch, height 42 RU, depth 30 inches minimum, lockable equipment cabinet.
B. Provide cabinet with vertical and horizontal cable management channels and copper bus bar.
C. Provide rack mounted power strip equipped with six (6) simplex receptacles and level 3 surge protection.
D. Manufacturers:
   1. Hubbell Premise Wiring.
   2. Bison.
   3. The Siemon Company.
   4. Corning Cable Systems.
   5. Or Approved Equal.

2.05 Uninterruptible Power Supply (UPS)

A. AC UPS:
   1. AC UPS shall be 2200 VA, mount 2U.
   2. UPS shall provide 70 min. battery backup for all equipment within cabinet.

2.06 Copper Cable

A. Category 6 Horizontal Cable:
   1. Meet NFPA 70, ANSI/NEMA WC 63.1, ICEA S-90-661 and performance characteristics in ANSI/TIA/EIA-568-B.
2. **UTP cable to be 100 ohm.** Provide four (4) each individually twisted pair, 24 AWG conductors, NFPA 70 plenum (CMP) rated. Individual pairs shall be constructed to contain a minimum two (2) twists per foot per each pair. Overall diameter of four (4) pair cable shall not exceed 0.25 inches. Ultimate breaking strength shall be minimum 90 pounds. Four (4) pair cable shall withstand a bend radius of 1 inch minimum at a temperature of minus 20°C maximum without jacket or insulation cracking. Conductors shall be color coded and polarized in accordance with ANSI/TIA/EIA-568-B. Jacket sequentially marked at 2 foot intervals. Shall meet Category 6 requirements and be 1000BASE-T compliant. Outdoor cameras, limited purpose to be type CMX cable.

3. **Manufacturers:**
   a. Belden.
   b. General Cable.
   c. Mohawk/CDT.
   d. Or Approved Equal.

### 2.07 Twenty-Five (25) Pair Cable Assemblies

A. Factory assembled Category 3 CMP twenty-five (25) pair cable assemblies factory tested for opens, shorts and continuity.

B. Manufactured with FCC part 68 subpart F compliant gold plated contacts, and ANSI/TIA/EIA-568-B.2 Category 3 compliant cable.

C. Cable length and connector ends (single ended male or female, double ended male or female, or one (1) male/one (1) female configuration) shall be as required for the application.

D. **Manufacturers:**
   1. The Siemon Company.
   2. Or Approved Equal.

### 2.08 Building Entrance Terminals

A. UL 497 Listed for primary and secondary protection.

B. Input to be a one hundred and ten (110) block.

C. Output to be RJ21.

D. Pair count as indicated on the Contract Drawings.

E. Large splice chamber.

F. Compact, lightweight 18 gauge welded steel housing.

G. Connection cover to be a small swing radius more room in tight quarters.

H. Fully loaded with protector modules to be gas tube type with voltage and current protection.

   1. Porta Systems 115SCG-240V.
2. Or Approved Equal.

I. Manufacturers:
   2. Or Approved Equal.

2.09 Rack Mount Lightning Surge Protection
   A. Shall be rated for Category 6 10/100/1000 BASE-T performance.
   B. Shall support a minimum of 12 ports.
   C. Shall fit a standard 19” cabinet and 1RU.
   D. Shall be 802.3af POE compatible.

2.10 Telephone Wall Phone – Standard
   A. Tone Dial
   B. Single line
   C. Corded: 5-foot cord
   D. Sturdy bell ringer
   E. No external power requirements
   F. Color: Black
   G. 5 Year Manufacturer Warranty

PART 3 - EXECUTION

3.01 Preparation
   A. Ensure that painted surfaces that will be covered by items of this Section have a prime and finish coat of paint.
   B. Ensure that all indoor areas are enclosed from the weather.

3.02 Installation
   A. Outside wire and cable shall be installed in ducts. Inside wire and cable shall be installed in conduit or cable tray. Use of cable tray limited to equipment rooms.
   B. During the installation of cables in conduits and ducts, the cable manufacturer’s recommended pulling tension shall not be exceeded. A suitable lubricating medium, harmless to the cable jacket, shall be used when pulling cables into conduits, pipes or duct banks. No oil or grease substances not specifically manufactured for cable installation will be permitted for such use on this Contract.
   C. Lengths of cables which are not installed in conduits and are run inside equipment rooms shall be secured to cable trays or cable ladders using nylon cable ties and attached to walls and backboards using nylon cable clamps or hangers or using a plastic wiring
system such as manufactured by Panduit, Or Approved Equal. Cables shall be attached or otherwise supported at intervals not to exceed 18 inches.

D. Provide sufficient strain relief (slack) in all cables, cable conductors, and wiring to avoid stress on all cables, wires and wiring connections.

E. Cables shall not be bent to a radius less than ten (10) times the diameter of the cable, or less than the manufacturer’s recommended minimum bending radius, during installation or as finally installed.

F. All cable runs shall be continuous without splices between cable terminating locations, except as specified or directed by the SEPTA Project Manager.

G. All conduit and cable entrance openings into equipment rooms and huts shall be sealed with a pliable sealing compound after the cable is in place. Sealing compounds for rooms, huts, walls, or other partitions shall be fire retardant per ASTM E 814. Sealing compound shall be used to seal the area around the cable where the cable emerges from the end of a conduit, pipe or duct bank. All spare conduits shall be sealed or plugged in an approved manner.

1. Fire retardant pliable sealing compound shall be an intumescent fire stop putty, reusable and re-penetrable, meeting ASTM E 814 and UL 1479, Nelson FSP Fire Stop Putty, or Approved Equal.

H. At all transition points where a cable runs from inside a conduit into a cable trough; or onto a cable tray or plywood backboard, the end of the conduit shall be fitted with a plastic bushing to prevent abrasive damage to the cable.

I. Cable installed in trays or troughs shall be laid therein and not pulled in place. Cables installed in trays and troughs shall have a minimum amount of crossover and shall not be pulled tightly around bends.

J. Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions, such as sharp corners on equipment. Cables damaged due to neglect by the Contractor, during installation, shall be replaced by the Contractor, at no additional cost to SEPTA.

K. All cables shall be continuous and without splices between the specified termination locations. The cable termination points shall be located within communication interface cabinets, equipment enclosures, splice cases, and equipment termination boxes as shown on the Contract Drawings and as described in the Specifications.

L. The shield of each section of communication cable shall be electrically continuous for the entire cable length.

M. All cables shall be terminated in standard order, according to the EIA/TIA and ICEA color codes. Individual cables shall be identified at each cable termination with self-adhesive labels. All spare pairs in each cable shall be terminated and identified.

N. Provide pull rope in all empty conduit runs with not less than 12 inches of slack both ends.

O. Conduits shall be restricted to no more than two (2) 90 degree bends or equivalent without a pull box.

P. Maintain minimum bending radius of changes in direction as follows:
1. Ten (10) times diameter of 4 inch and larger conduits.

2. Six (6) times the diameter of smaller conduits.

Q. Avoid bends in conduits from pull boxes.

R. Except as noted hereinafter for telecommunications cabling and pathways with copper media, keep conduit and cable tray minimum 6 inches away from parallel runs of electrical power equipment, flues, steam and hot water pipes.

S. Telecommunications cabling and pathways with copper media shall be installed in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment.

1. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling.

2. Pathways shall be installed in accordance with the following minimum clearance distances of 4 feet from motors, generators, frequency converters, transformers, x-ray equipment or uninterruptible power system, 12 inches from power conduits and cable systems, 5 inches from fluorescent or high frequency lighting system fixtures.

T. Install voice and data telecommunications cabling and pathway system as detailed in ANSI/TIA/EIA-568-B and ANSI/TIA/EIA-569-A. Screw terminals shall not be used except where specifically indicated on plans. Use an approved Insulation Displacement Connection (IDC) tool kit for copper cable terminations. Do not untwist Category 6 UTP cables more than 1/2 inch from the point of termination to maintain cable geometry. Provide service loop on each end of the cable, 10 feet in the telecommunications closet, 12 inches in the work area outlet. Do not exceed the manufacturers’ cable pull tensions for copper cables. Utilize a running line tensiometer with continuous data display and recording capabilities to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four (4) pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by the cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four (4) times the cable diameter.

U. All communications cables shall be terminated. Segregate voice and data terminations. Provide service loops for all voice (telephone) backbone cables. Provide excess cable at both ends of horizontal cable to facilitate future re-termination.

1. All telephone/voice cabling shall be punched down on one hundred and ten (110) type punch down blocks located in enclosure. Height of highest punch down block shall not exceed 78 inches above floor. All cabling shall be punched down.

2. Terminate all copper data cabling on Category 6 type data patch panels with jacks. Patch panels and equipment shall be rack mounted. Racks shall have a minimum of 39 inches clearance at front and back. Racks shall be permanently bolt anchored to the floor per the manufacturer’s recommendations.

V. Provide outlet box and jack(s) at each voice/data outlet. Depth of outlet boxes shall be sufficient to allow the manufacturer's recommended conductor bend radii.
1. Terminate UTP cable in accordance with ANSI/TIA/EIA-568-B and wiring configuration as specified.

W. Bond racks, conduits, raceways cable trays, etc. in accordance with ANSI/TIA/EIA standards, NFPA 70 and Section 16060. Grounding conductors shall be compatible with raceways. Protect all grounding and bonding conductors from physical damage.

X. Provide identification and labeling of communications cables, outlets and equipment per ANSI/TIA/EIA-606.

1. All cables shall be labeled at least at each end of each cable section, using SEPTA approved cable tags or labels. Inside plant cables shall be labeled using SEPTA approved self-adhesive waterproof labels; outside plant cables shall be labeled using SEPTA approved waterproof cable tags.

2. A cable labeling table shall be developed based on this Contract. The table shall be submitted for approval prior to cable installation.

3. Cable Tags:
   a. Attach to cable using two (2) nylon cable ties through holes in the tag.
   b. Use pre-printed plastic tags marked with a durable, abrasion resistant, waterproof ink.

3.03 Cleaning

A. After wiring, vacuum out interior and wipe clean of all foreign material.

B. After painting in areas, remove all over paint, drips and splashes.

C. Unpack all material and dispose of all trash and related material offsite. Keep work area clean.

3.04 Field Quality Control

A. Perform telecommunications cabling inspection, verification and acceptance tests in accordance with ANSI/TIA/EIA-568-B.

B. Visually inspect cabling jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for tip and ring pin assignments, and inspect cabling connections to confirm compliance with ANSI/TIA/EIA-568-B. Visually confirm Category 6 marking of outlets, wallplates, connectors and patch panels.

C. Perform testing after cables are terminated, but not cross connected.

D. Verification Tests:

1. UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks.

2. For UTP horizontal voice Category 6 cabling, test each pair for short circuit, continuity, short to ground, crosses and reversed polarity.

E. Acceptance Testing for Balance Twisted Pair Cabling:
1. Perform UTP permanent link tests in accordance with ANSI/TIA/EIA-568-B. Tests shall include wire map, length, insertion loss, Near-End Crosstalk (NEXT) loss, Equal-Level Far-End Crosstalk (ELFEXT), propagation delay and delay skew, return loss, Power Sum Near-End Crosstalk (PSNEXT) loss, and Power Sum Equal-Level Far-End Crosstalk (PSELFEXT). Each and every link shall be tested and shall pass the requirements of ANSI/TIA/EIA-568-B for Category 6 and IEEE 802.3ab for 1000BASE-T. Any failing link shall be diagnosed and corrected. The corrective action shall be followed by a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation.

3.05 Protection

A. During painting, mask all nameplates, all plastic parts, and all items not to be painted.

B. Protect all items during work of other trades including welding and cutting.

END OF SECTION
SECTION 16760

FIBER OPTIC NETWORK

PART 1 - GENERAL

1.01 Description
   A. This Section specifies the requirements for furnishing all equipment and material necessary to complete the installation of fiber optic cables. Use industry standard construction practices so that Project management, Project coordination and construction techniques that meet all federal, state, and local codes and regulations.
   B. Furnish and Install the most recent version of equipment available at the time of installation.
   C. Furnish and install all necessary equipment and materials identified in this Section and the Contract Drawings for the successful performance of the identified work.
   D. Cabling shall be installed in such a manner so that SEPTA’s normal day-to-day operations are not affected and that interruptions to SEPTA’s normal workday activities are kept to a minimum.
   E. Work along the right of way of this Section may require track outages and must be performed during the hours of 12:00 AM and 4:00 AM.
   F. Terminate cables in replacement substation or switching station. Prepare cable ends for termination to active circuits by SEPTA.

1.02 Related Section
   A. Section 01300 – Submittals
   B. Section 16075 – Electrical Identification
   C. Section 16950 – Testing

1.03 Submittals
   A. Submit proof of manufacturer’s certification, within ten (10) business days of the Contract award, which you or your sub-contractor is manufacturer certified to install the specified cabling systems that includes and will provide a manufacturer’s extended warranty of five (5) years (minimum).
   B. Submit for approval to SEPTA’s Project Manager, sets of catalog cut sheets for all materials to be used in this installation, in accordance with Section 01300. Each cut sheet shall be identified with the manufacturer’s name, part number, acquisition lead time and date of submittal. SEPTA will not be responsible for any materials ordered prior to SEPTA’s approval for the cut sheet item in question.
   C. Failure to provide a complete cut sheet submittal for a specific item will result in rejection. Upon rejection, resubmit the specified documentation for re-approval.
   D. Submit cut sheet submittals in a timely manner to permit proper consideration and approval. Coordinate the timing of each submission to assure adequate lead time for
procuring items required by this Contract and inform SEPTA’s Project Manager of any time
constraints concerning submittal approvals that are critical to the completion of the
Contract. Delays attributable to rejected cut sheet submittals shall not serve as a basis for
extending time for contract completion.

E. After an item has been approved, changes in make, manufacturer or part number shall not
be permitted, unless:

1. Satisfactory written evidence is presented, and approved by SEPTA, that the
manufacturer cannot make the scheduled delivery date of an approved item; or

2. Other conditions become apparent indicating approval of the item to be substituted will
be in the best interest of SEPTA.

F. Submit a cable and outlet identification plan to SEPTA’s Project Manager for approval before
final cable and faceplate labels are installed.

G. Submit pulling calculations (tensions and side wall pressure).

H. Field monitored pulling tension forces during actual installation of the cable.

I. Submit copies of the completed test results, in accordance with Section 01300, within
fifteen (15) working days of test completion, in both electronic and printed format. The
submission shall include copies of the print outs of all cables tested.

J. Submit copies of the marked-up “as-built” drawing(s) to SEPTA’s Project Manager within
fifteen (15) working days of completion of the work or each stage of the work. As a
minimum, annotate on a clean set of prints, the following information:

1. The approximate routing of all cabling installed.

2. All other pertinent information concerning the performance of the work regarding “as-
built” conditions that will provide a more accurate set of drawings

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:


2. NFPA 70, National Electric Code (NEC).

3. TIA/EIA 568-B.1, Commercial Building Telecommunications Cabling Standard, Part 1:
General Requirements.

4. TIA/EIA 568-B.2, Commercial Building Telecommunications Cabling Standard, Part 2:
Balanced Twisted Pair Cabling Components.

5. TIA/EIA 568-B.3, Optical Fiber Cabling Components Standard.

6. TIA/EIA 569-A, Commercial Building Standards for Telecommunications Pathways &
Spaces.

7. TIA/EIA 607, Commercial Building Grounding and Bonding Requirements for
Telecommunications.
1.05 Performance Requirements
A. All work shall be performed in a professional manner using practices of good craftsmanship.
B. All cables shall have the specified connectors affixed using the tools specified by the manufacturer.
C. All cables shall be terminated using the tools specified by the manufacturer.
D. All cables and outlets shall be labeled in accordance with Paragraph 3.08 in this Section.
E. Remove trash, debris, spent reels and all other refuse related to this installation, daily.

1.06 Qualifications
A. Provide the services of personnel having at least five (5) years experience in the installation and termination of single mode optical fiber.

1.07 Operation and Maintenance Data
A. Certified factory test reports.
B. Pulling calculations.
C. Certified detailed field test reports that verify the total db losses.

1.08 Warranty
A. Provide the standard warranty. The warranty shall begin upon substation or switching station commissioning by SEPTA.

1.09 System Acceptance
A. Final acceptance will be made by SEPTA upon satisfactory completion of the work, including all cable testing and an integrated SCADA/Communications systems test, that will insure that all equipment and cabling have been properly installed. Additionally, SEPTA’s acceptance is based upon the submission and approval of all test records, cable run summaries and as-built drawings.
B. The work will not be considered complete until:
   1. It has been inspected and accepted by SEPTA.
   2. All discrepancies have been resolved.
   3. All test records, cable run summaries and as-built documentation have been received.

PART 2 - PRODUCTS

2.01 General
A. Items not listed in this document or shown on the Contract Drawings, but necessary for the complete and proper performance of the work as specified, shall be considered part of the work. Verify exact types and quantities of all materials with SEPTA before purchase.
2.02 Composite Copper/Fiber Optic Cable

A. Provide one (1) composite cable consisting of twenty-five (25) pair CAT-3, No. 22 AWG solid copper cable and twelve (12) 8.3/125 single-mode fiber under one (1) jacket for voice and data applications.

B. Manufacturers:
   1. Superior-Essex Part No. 70-062-12.
   2. Or Approved Equal.

C. Within one (1) empty 4 inch duct of existing and new communications duct banks to be used for this Contract, provide two (2) 1 1/4 inch diameter inner ducts and one (1) 1 inch diameter inner duct. Utilize one (1) of the 1 1/4 inch diameter inner ducts for this Contract’s composite cable system. Inner duct shall be rated for placement in an outside plant environment, and shall be in accordance with Table 16760-1, or approved equal.

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>Pyramid</td>
<td>4404-04T</td>
</tr>
<tr>
<td>1 1/4 inch</td>
<td>Pyramid</td>
<td>4404-05T</td>
</tr>
</tbody>
</table>

2.03 Cable Terminations

A. Terminations for Fiber Optic Elements:
   1. Single Mode fiber optic elements of the composite copper/fiber optic cable shall be terminated on SC connectors installed within fiber optic patch panels.
   2. Fiber optic terminations shall be in accordance with Table 16760-2, or approved equal.

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturer</th>
<th>Anixter Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC connector to be single-mode</td>
<td>Corning</td>
<td>515987</td>
</tr>
<tr>
<td>Buffer tube fan-out kit, 12 fiber</td>
<td>Corning</td>
<td>152286</td>
</tr>
<tr>
<td>Wall-mounted patch panel to be two (2) insert</td>
<td>Corning</td>
<td>180542</td>
</tr>
<tr>
<td>Connector panel, w/(3) SM duplex SC adapters</td>
<td>Corning</td>
<td>180435</td>
</tr>
</tbody>
</table>

B. Terminations for Voice Cabling:
   1. Copper pairs (No. 22 AWG) of the composite copper/fiber optic cable shall be terminated on wall mounted protector blocks designed to facilitate cross connection and interconnection using patch cords or cross connect wire.
   2. Protector blocks shall be twenty-five (25) pair, one hundred and ten (110) type connector input and output. Protector blocks to be Underwriter's Laboratories (UL) listed. Protector blocks to be equipped with a cover and external ground connector that will accept between No. 6 AWG and No. 14 AWG ground wire.
3. The twenty-five (25) pair protector block manufacturer:
   a. Anixter Part No. 195420.
   b. Or Approved Equal.

4. Protector modules shall be five (5) pin, solid state with heat coils. Protector module manufacturer:
   a. Anixter Part No. 106805.
   b. Or Approved Equal.

2.04 Audio Repeaters with Power Supply
   A. Part numbers shall be in accordance with Table 16760-3, or approved equal.

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturer</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFS audio repeater (single mode, for use on 120 volt AC 60 Hz power supply)</td>
<td>International Fiber Systems</td>
<td>A2125</td>
</tr>
</tbody>
</table>

2.05 Fire Stop
   A. Provide UL-listed fire stopping for all conduits, sleeves, floor openings and wall penetrations used for this cable installation.
   
   B. Submit for approval the method(s) and material(s) to be used to fire stop all wall, floor, and ceiling penetrations, and all conduits and sleeves used as a part of the cabling installation.

PART 3 - EXECUTION

3.01 General
   A. Do not exceed the recommended pulling tension of the cable manufacturer. Assume responsibility to pay all costs associated with the replacement of any cable that exhibits evidence of cuts, crimps, severe abrasions and damage due to exceeding the manufacturer’s specified pulling tension.
   
   B. Install, dress and terminate cabling in a professional manner, using practices of good craftsmanship. Where communications cabling must cross power cables/conduits, they shall cross at right angles (90 degrees) to the power runs. A minimum of 12 inches separation from power cables/conduits shall be maintained where communications and power cabling follow the same route.
   
   C. Place all new sleeves and penetrations required for successful cable installation.
   
   D. Upon completion of the cable installation, install fire stopping/sealing material in all sleeves and penetrations used during this installation.
   
   E. Ground equipment racks and cabling in accordance with all manufacturer’s specifications and recommendations, the NEC and accepted industry standards for grounding communications cable and ancillary devices.
3.02 Backbone Cable Installation
   A. Furnish and install the specified composite copper/fiber optic cable as shown on the Contract Drawings.
   B. Furnish and install the specified inner ducts.

3.03 Cable Termination
   A. Terminate unshielded twisted pair voice backbone on the specified protector blocks.
   B. Each element of the specified fiber optic cabling installed shall be connectorized using the specified SC connectors, and shall be mounted into the specified fiber optic patch panels and SC insert panels.
   C. Furnish and install all termination equipment according to the manufacturer’s instructions using the required tooling and materials.

3.04 Floor and Wall Penetrations
   A. Install all required floor, wall and building penetrations.
   B. Submit to SEPTA’s Project Manager for approval, all required floor, wall and building penetrations before proceeding with this portion of the work.

3.05 Fire-Stop
   A. Furnish and install fire-stop material in all floor, wall and building penetrations after all cabling has been installed.
   B. Save all fire stopping containers, tubes, jars, boxes, etc., all vendor/distributor packing slips, and all MSDS sheets as a part of the end of Contract submittals. These shall be available for inspection by SEPTA’s Project Manager as part of the system acceptance for this installation.

3.06 Splices
   A. SEPTA’s intend that cabling shall be installed in one (1) continuous run between termination locations. However, should the SEPTA approved pulling calculations by the Electrical Contractor indicate the need to construct a splice or splices, assume all costs for and provide the required splices and enclosures.

3.07 Damage
   A. Any cuts, abrasions, burns, stretched segments and/or other damage that will be detrimental to the performance of that cable shall be cause for replacement of that entire segment of cable.
   B. Incidental damage to cables and connectors shall be corrected at the Electrical Contractor’s expense before testing and final acceptance of cables.

3.08 Cable Labeling and Identification
   A. Submit a cable and outlet identification plan to SEPTA for approval before final cable labels are installed.
B. Each cable, patch panel port and termination block position shall be labeled individually with a unique cable number using machine printed labels.

C. Each outlet shall be labeled individually with a unique identification number, using machine printed labels.

D. Cable labels that are cut off during the installation process shall be replaced with new labels after final dress and termination in such a position that permits the label to be easily read.

3.09 Testing

A. Factory and field testing shall be performed in accordance with the requirements of Section 16950.

END OF SECTION
SECTION 16772

CCTV SYSTEM

PART 1 - GENERAL

1.01 Description
   A. Section includes:
      1. Closed Circuit Television (CCTV) system; complete, including all wiring, cables, raceways, terminal cabinets, pull boxes, outlet and mounting boxes, cameras, POE management hardware, software licenses, mounting hardware, testing, and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described.
      2. Place SEPTA approved label on each camera to uniquely identify the camera.
      3. Refer to Contract Drawings for specific quantity, location and type of equipment.

1.02 Related Section
   A. Section 16050 - Basic Electrical Materials and Methods

1.03 Submittals
   A. Submit to SEPTA the following information in accordance with the requirements of general conditions of Contract:
      1. Manufacturer’s product data, user, and installation manuals for all equipment and software programs including computer equipment and other equipment required for complete video management system.
      2. Shop drawings including system device locations on architectural floor plans; full schematic of system, including wiring information for all devices.

   B. Submit complete submittals, which shall include schematic wiring drawings and specification sheets for all equipment. Partial submittals will not be accepted.

1.04 Quality Assurance
   A. General:
      1. All equipment and software provided shall be standard components that are regularly manufactured and utilized in the manufacturer’s system.
      2. All systems and components shall have been thoroughly tested and proven in actual use.
      3. All systems and components shall be provided with the availability of technical support from the manufacturer during normal business hours at no charge.
      4. Confirm the compatibility of all new equipment being provided on this Contract with SEPTA standards.
5. All systems and components shall be listed by UL and FCC specifically for the required application. Provide evidence of compliance upon request.

B. Manufacturer with a minimum of ten (10) years of experience in the manufacture and design of video surveillance devices. Registered to ISO 9001 quality standard.

C. An experienced installer with a minimum of five (5) years of experience in the installation of CCTV systems of similar type, size, and scope; who is an authorized representative of the manufacturer for installation.

D. Genetec head end and storage installation shall be completed by SEPTA’s CCTV maintenance contract provider as part of this Contract. The Contractor shall submit for SEPTA approval all work and associated cost.

E. Meet the applicable provisions of the most recent issues of the following references:
   2. ICES-003, Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement.
   3. IEC 61000-4, Electromagnetic Compatibility (EMC).
   4. ISO 9001, Quality Management Systems - Requirements.
   6. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   7. NFPA 70, National Electrical Code (NEC).
   8. UL 294, Standard for Access Control System Units.
   9. UL 864, Control Units and Accessories for Fire Alarm Systems.
   10. UL 1076, Proprietary Burglar Alarm Units and Systems.
   11. UL 60950, Information Technology Equipment
   12. All applicable Federal, State, and Local laws, regulations, and codes.

1.05 Operation and Maintenance Data

A. Submit to SEPTA the following operation and maintenance information in accordance with the requirements of general conditions of Contract:
   1. Instruction books and/or leaflets.
   2. Focus aid.
   3. Recommended renewal parts list.
   4. Maintenance requirements.
   5. Final as-built drawings.
   6. Complete wiring diagrams.
   7. CCTV camera field of view definitions spreadsheet.
   8. CD-ROM with manual, software and tools.
1.06 Acceptance of Systems
A. Total acceptance of the system will only be made after the required tests, complete record document package and the instruction period have been provided.

1.07 Guarantee
A. The Contractor shall guarantee labor, materials, and equipment provided under this Contract against system defects for a period of one (1) year after the date of final acceptance of this work by the SEPTA.
B. Provide manufacturer’s three (3) year warranty for CCTV products, covering replacement and repair of defective equipment.

1.08 Maintenance Service and Extra Materials
A. Make ordering of new equipment for expansions, replacements, and spare parts available to dealers and end users.
B. Provide live factory direct technical support minimum 8:00am to 8:00pm (EST/EDST) via telephone and email.
C. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to SEPTA.
   1. One (1) fully operational camera per station.
   2. One (1) fully operational display console, recording device, and media converter.

1.09 Environmental Requirements
A. Temperature:
   1. Equipment Cabinet Equipment:
      a. Hardware installed in equipment cabinet shall be designed, fabricated, and environmentally tested to operate in the temperature range between minus 13°F and plus 122°F with a relative humidity range of 5 to 95 percent, non-condensing.
   2. Interior Equipment:
      a. Interior equipment to be installed within SEPTA substations or switching stations shall be designed and certified by the manufacturer to operate in a range of between minus 13°F and plus 122°F with a relative humidity of 20 to 80 percent, non-condensing. The Contractor shall make clear in the technical proposal any additional heating or air conditioning that may be required.
   3. Equipment Storage and Start-up:
      a. All exterior and equipment room products shall be designed to avoid damage due to thermal shock during normal operation or start-up during low temperature conditions.
      b. All equipment shall be designed for dry storage in temperatures that range from minus 13°F to plus 145°F.
B. Weather and Elements:
   1. All interior, exterior and communication room equipment and any other potentially exposed units, shall be designed and tested to operate continuously and reliably in...
varying conditions of humidity, rain, salt, dust, cleaning detergents, water spray, roadway chemicals, exhaust emissions and other contaminants found in the transportation areas. This means that appropriate rain/corrosion/ tightness testing shall be conducted for all transit equipment. All exterior components shall be designed and finished to resist adverse effects from solar radiation.

C. Electromagnetic and Electrostatic Susceptibility:
   1. System equipment shall not be adversely affected by radiated or conducted electromagnetic or electrostatic interference from other onboard or fixed site equipment. Certain tests for Electromagnetic Interference (EMI) and Electrostatic Discharge (ESD) susceptibility are required. These conditions shall include, but not be limited to fixed site, portable, and mobile radio interference, incidental (spurious) radiation, ignition noise, lighting fixture (static) interference, electrical power system transients and electrostatic discharge (air or contact).
   2. The Contractor shall investigate all environmental factors that may affect equipment operations both before and after installation of the equipment, including shock and vibration. Environmental deficiencies uncovered during installation testing, on-line demonstration, or final tests may be cause for additional design adjustments and additional environmental testing by the Contractor. SEPTA shall retain the exclusive right to judge the environmental acceptability of the components before final acceptance.

D. Electrical Power:
   1. All components shall be certified via testing to operate with normal outputs when the input voltage varies as much as plus or minus 10 percent.

E. Shock and Vibration:
   1. All interior, exterior and communication room equipment, when in their fully assembled configuration, shall not be damaged, nor shall the operational performance be degraded, after subjection to vibration of 1G at 10 Hz to 500 Hz or shocks of 20G for eleven (11) plus or minus one (1) millisecond.
   2. Vibration isolation for equipment housings shall be provided (if applicable) to protect electronic components within the cabinets from long term low frequency events resulting from continual train operations through the stations. The Contractor shall coordinate with the electronic equipment and cabinet manufacturers to determine proper vibration isolation hardware to meet the manufacturer’s electronic equipment environmental test specifications.

1.10 Test and Waivers
   A. The Contractor may request a waiver of environmental testing for any component previously tested and certified. In such an event, fully certified technical test data shall be submitted to SEPTA with the waiver request. SEPTA shall retain the exclusive right to require representative environmental testing or to waive such testing after reviewing the Contractor’s waiver request.
   B. The Contractor may request where applicable representative, and or sample testing to be provided. In such an event, fully certified technical test data shall be submitted to SEPTA
with the representative or sample request. SEPTA shall retain the exclusive right to require testing or to waive such testing after reviewing the Contractor’s request.

C. All environmental testing in accordance with these Specifications shall require written test procedures prepared by the Contractor and approved by SEPTA. All environmental test procedures shall be submitted for SEPTA review and approval before the testing.

D. All environmental tests shall be completed and the results submitted to SEPTA for approval prior to installation of equipment at any SEPTA site or sites outlined in this Section.

E. All environmental tests shall be conducted by an independent test facility that has been previously approved by SEPTA. The Contractor may use appropriate subcontracting to achieve environmental testing at the approved facility.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Manufacturers:

1. Cameras:
   a. Panasonic.
   b. Or Approved Equal.

2. Media Converter:
   a. Antaira FCU-1802P-SC-S15.
   b. Or Approved Equal.

3. IP Video Recorder PC:
   a. BCDVideo BCD-RGD-4700.
   b. Or Approved Equal.

4. LCD Console:
   a. Pelco AP5719.
   b. Or Approved Equal.

5. Copper Camera Cabling:
   a. Belden.
   b. Or Approved Equal.

6. Refer to Contract Drawings material list.

B. Manufacturers submitted by the bidder as equal shall meet the requirements for substitutions in specification Section 16050, and the following:

1. The equipment to be supplied will be considered only if it meets all sections of the performance Specification. Any deviations of system performance outlined in this Section will only be considered when the following requirements have been met.
   a. The supplier shall furnish evidence that the proposed or alternate system performance is equal or superior to the system operation stated in this Section.
   b. The supplier shall submit a point by point statement of compliance for all sections in this Section. The statement of compliance shall consist of a list of all paragraphs within these sections. Where the proposed system complies fully with the paragraph as written, placing
the word "comply" opposite the paragraph number shall indicate such. Where the proposed system does not comply with the paragraph as written, and the supplier feels the proposed system will accomplish the intent of the paragraph, a full description of the function as well as a full narrative description of how its proposal will meet its intent shall be provided. Any submission that does not include a point by point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed system does not comply.

c. The acceptability of any alternate proposed system shall be the sole decision of SEPTA.

2.02 System Description

A. The intent of these Specifications is to provide a new CCTV system with the following features and capabilities:

1. Provide color cameras monitoring selected interior and exterior areas of the substation or switching station as directed.
2. Provide hardware, software and all other required components to view and record locally as well as remotely at the SEPTA Wayne Junction location.
3. Provide all required components, accessories, hardware, cabling, terminations, etc. for a complete and operable system, in accordance with the intent of the Contract Drawings and these Specifications, whether enumerated herein or not.

2.03 Fixed Camera

A. Provide fixed cameras per the following:

1. The manufacturer of the specified color dome camera shall provide optional hardware to allow the camera to be mounted per the camera schedule located on the Contract Drawings. Coordinate ceiling types and mounting hardware required.
2. Lens selection based on “coverage” criteria in camera schedule.

2.04 IP Video Recorder PC

A. Provide Genetic Pro base software, one (1) camera license per camera, one (1) Federation license for the site, and one (1) license for each PC. The Contractor shall configure and install the units for a base configuration of four (4) cameras per PC at the substation or switching station requiring a leased connection between the substation or switching station and SEPTA’s head end equipment located at 200 West Wyoming Ave. Installation configuration shall be completed as per the approved design drawing.

2.05 LCD Console

A. Provide 17-inch rack LCD keyboard combination console for local CCTV viewing.

2.06 Copper Cable

A. The Contractor shall utilize Cat 6 cable for camera feeds. When cameras are located indoor, Orange plenum rated PVC jackets shall be utilized.
B. When cameras are located outdoor, Black outdoor rated jackets apply. Outdoor cables may not run within building exceeding 50 FT.

C. Cable for POE IP cameras may not exceed 295 FT.

D. Each camera shall receive two (2) CAT 6 cables, (1) active, (1) spare. Coil spare inside junction box by camera. Do not plug horizontal cable directly into camera. Provide UL listed disconnect in a water tight junction box. Utilize patch cord installed in LFMC to connect to camera. LFMC shall not exceed 3 FT.

E. All outdoor cable must first land on lightning/surge protection.

2.07 Cable, Wires and Miscellaneous Accessories

A. Provide all necessary parts and accessories, including but not limited to adapters, connectors, plugs, transformers, switches, relays, lamps, splitters, and power supplies required to guarantee a complete and fully functional CCTV system.

2.08 CCTV Digital Video Encoding/Recording System

A. Subject to compliance with requirements, provide IP video recorder PC by BCD video as follows:

BCD-RGD-4700

B. The PC shall be able to record video streams from SEPTA at fifteen (15) images per second at 4CIF resolution at thirty (30) day storage plus an additional 20 percent spare capacity. It shall play back up to fifteen (15) simultaneous streams and support up to ten (10) simultaneous queries.

C. The PC shall use redundant power supplies to eliminate the power supply as a single point of failure.

D. The PC shall be capable of continuous scheduled alarm/event and motion recording. Pre-alarm and post alarm recording shall also be available and shall be fully programmable on a per channel basis.

E. All video shall be digitally signed before being written to the hard disk drives. Video authentication shall be verified on the system before being played back with the video player.

F. The following diagnostics shall be reported to the viewing system:

1. Hard disk drive status.

2. Power supply status.

3. Fan status.

4. Air temperature.

5. Video input stream status.

6. Administration shall be able to view the status of individual components in real time to prevent failures before they occur.
G. Regardless of the number of cameras being furnished by the Contract onto the PC, all Contract supplied PC shall be sized to accommodate the minimum cameras worth of stored video for a period of thirty (30) days based upon the following.

1. Resolution to be 4CIF (704x480).
2. Quality to be normal.
3. Frame rate per camera to be fifteen (15) frames per second.
4. Storage capacity to be twenty-four (24) hours per day for thirty (30) days.
5. Record audio to be off.

H. The Contractor shall provide technical training and system administrator training. Technical training shall consist of two (2) three (3) day sessions; each session shall be eight (8) hours long for a total of twenty-four (24) hours and accommodate ten (10) students. The Contractor shall supply all training material and documentation in the form system drawings, system configuration and setting, user documentation, manufacturer OEM manuals and all custom configurations done by the contractor during installation. All training shall be onsite at a SEPTA designated facility. All system software and hardware configuration options shall be documented and provided to SEPTA in the form of CAD files, excel spread sheets, screen capture and word documents. The Contractor shall provide single line diagrams, system interconnection and wiring details in the form of CAD files. Documentation shall include all OEM documentation.

I. The CCTV installation shall require configuration of storage, firewalls and network equipment.

J. The Contractor shall rack mount all equipment in server grade cabinets. All cabling shall be secured using industry standards for cable management. Patch cords shall be a minimum of CAT 6 and have factory molded connectors. No crimp connections will be accepted.

PART 3 - EXECUTION

3.01 General

A. Examine areas to receive devices and notify SEPTA of adverse conditions affecting installation and/or subsequent operation prior to proceeding. Do not begin installation until unacceptable conditions are corrected.

B. Protect devices from damage during construction. Ensure operating temperature and humidity are within range accepted and recommended by the manufacturer.

3.02 Installation

A. The Contractor shall visit each fixed camera installation location identified on the Contract Drawings with SEPTA prior to ordering camera equipment for those locations and prior to performing any installation work, and shall perform the following with SEPTA witnessing and approving each planned installation.

1. Bring the one (1) spare camera.
2. Bring a suitable ladder or ladders, safety items, portable video monitor, portable power supply, and all other necessary cables, accessories, supplies and manpower.
3. Temporarily but steadily, position a camera equipped with the design proposed lens into the proposed installation location. The SEPTA representative shall view the image at ground level on the portable monitor.

4. The Contractor shall adjust the lens as necessary as directed by SEPTA such that SEPTA can determine if the view in that camera location will be acceptable.

5. The proposed camera location may need to be moved in any direction in order to obtain the desired view. The Contractor shall relocate the camera and adjust the lens to test the view in the new location.

6. If the design proposed lens does not provide the desired result, another spare camera with a different lens will be tested.

7. The Contractor will continue the test process with SEPTA until the optimal lens and location is determined for each camera installation location. Once a camera distance, height and lens are determined, it will likely be the same for many camera locations. When parameters such as the camera height, distance and width of field of view vary, additional testing will be required. Testing shall be conducted for as many locations as required by SEPTA.

8. A digital photo will be taken for each tested location and the lens and camera location information shall be documented.

9. The exact position for each camera location will be identified by careful measurements and will be documented along with a printed copy of the digital photo and all parameters, and signed by both the Contractor’s and SEPTA’s representative. The Contractor and SEPTA shall each receive a copy of the approved installation plan documentation.

10. The Contractor shall configure the lens setting after the above testing has been conducted and approved by SEPTA.

B. Installation shall be performed by qualified service personnel.

C. All cabling shall be installed in rigid galvanized steel conduit.

3.03 Tests

A. Test snugness of mounting screws of all installed equipment. Test proper operation of all video system devices. Determine and report all problems to the manufacturer’s customer service department.

B. Demonstrate that video management system and devices function properly for local recording/display. Demonstrate camera’s functionality and video recording capabilities.

C. SEPTA acceptance test will only be made after the above inspection, testing and adjusting of the complete CCTV System is performed, and the test report results are turned over to the SEPTA for evaluation. SEPTA’s test will be the same as the above Contractor’s tests. The Contractor shall perform these tests in the presence of the SEPTA or the SEPTA’s representative.
3.04 Field Adjustments

A. The Contractor shall repair or replace at his expense any defective devices, equipment or wiring and shall again perform any and all testing required to demonstrate that the system is in full compliance with the Contract Drawings and Specifications.

B. Make proper adjustments to video system devices for correct operation. Make any adjustment of camera settings to meet specific customer needs.

3.05 Training

A. Upon the completion of all work and of all tests, the Contractor shall furnish the necessary skilled labor for providing operating and maintenance instructions of all systems and equipment for a minimum period of eight (8) hours per contract of documented formalized instruction for the SEPTA, detailing the proper operation and maintenance of the installed system.

B. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

3.06 Environmental Test Procedures

A. The environmental requirements described herein shall be in effect for all components unless specifically excluded by other specification sheets of this procurement document.

B. All test procedures related to environmental testing for temperature, rain, humidity, salt fog, dust, vibration and shock which are prepared by the Contractor for SEPTA approval shall be formulated in accordance with the requirements of MIL-STD-810(E). Testing for ESD shall be formulated in accordance with IEC 61000-4. No exceptions shall be made to this requirement without prior written approval by SEPTA.

END OF SECTION
SECTION 16791

COMBINED RELAY AND CONTROL SWITCHBOARD

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for the design, manufacturing, installation in the substation or switching station control room, and testing and commissioning of an assembled switchboard and associated relay and control apparatus as specified herein and indicated on the Contract Drawings at each of the substations or switching stations included in this Contract.

B. The term “Combined Relay and Control Switchboard” as used herein shall mean an assembly of control, metering, protective and regulatory apparatus mounted and wired on panels and their supporting structure. The switchboard shall be completely assembled, wired and tested at the place of manufacture by the manufacturer. The switchboard shall be shipped only after approval of the test results by SEPTA.

C. The substations or switching station are unmanned and shall be locally and remotely controlled and monitored by SEPTA via Supervisory Control and Data Acquisition (SCADA) as specified and as shown on the Contract Drawings.

D. The substations or switching stations shall be provided with a gateway (network server) control system. The gateway network server shall be located within the switchboard. Access shall be via a panel mounted Human Machine Interface (HMI) (with withdrawable keyboard) which shall be used for substation or switching station network and relay troubleshooting. The gateway server, HMI, keyboard, mouse and interconnecting Ethernet or fiber optic cabling is considered part of the relay and control panel.

1.02 Related Sections

A. Section 01300 – Submittals
B. Section 16050 – Basic Electrical Materials and Methods
C. Section 16052 – General Electric Requirements - Traction Power Equipment
D. Section 16060 – Grounding and Bonding
E. Section 16290 – Protective Devices and Instrument Transformers
F. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI
G. Section 16952 – Electrical Testing - Traction Power Equipment (RRD)

1.03 Submittals

A. Submit the following for approval in accordance with the general requirements.
   1. Type of switchboard as defined herein.
   2. Overall dimensions and approximate weight.
   3. Number and size of panels.
4. List of switches, instruments, relays and other devices included on each panel.
5. Description of switchboard construction.
6. For devices in item no. 4 (above), manufacturer’s catalog data, shop drawings and product information, including model numbers or item identification, ratings and characteristics for a complete product description.
7. Front view, rear view and floor plan drawings, locating all switchboard devices.
8. Manufacturer’s installation instructions and recommendations.
9. Manufacturer’s operation and maintenance manual.
10. Complete schematic and panel wiring diagrams.
11. Internal wiring diagrams, outline dimensions and drilling plans for all separately furnished devices.
12. Description and product information for the gateway/network control system and associated HMI and keyboard.
13. Manufacturing and factory test schedule.
14. Field test procedures.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. American Iron and Steel Institute (AISI).
   3. IEC 61850, Power Utility Automation.
   6. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   7. NEMA ICS 6, Industrial Control and Systems: Enclosures.
   8. UL 1437, Electrical Analog Instruments - Panel Board Types.

1.05 Manufacturers
A. Subject to compliance with requirements of the Contract Documents, vendors offering product and services which may be considered for control and instrument panels for this project include, but are not limited to the following:
   2. Controlled Power Ltd. (CPC), Lafayette Hill, Pennsylvania.
   4. Powercon Corporation, Severn, Maryland.
5. TPS Co./Powell Industries (Traction Power Systems), California.
6. PEECO (Philadelphia Electrical Equipment Manufacture Co.), Aston, Pennsylvania
7. Or Approved Equal.

PART 2 - PRODUCTS

2.01 General

A. Relay and control panels shall be provided for the local and remote control and data acquisition of all substation or switching station equipment, including circuit breakers, autotransformers, and disconnect switches, and will interface with the SCADA system via a Remote Terminal Unit (RTU) as specified in Section 16910. Note that the status of disconnect switches is not required to be displayed on the board. Status indication of all disconnect switches shall be provided to RTU for transmission to master station. Protective relays shall be as specified in Section 16290.

B. All alarms, status points and control functions shall be annunciated on a touch screen Human Machine Interface (HMI) installed on the door of the Remote Terminal Unit (RTU) or on the relay and control board. The HMI shall have all indications, status, alarms and control functions as the master station. The screen display of the HMI shall be approved by SEPTA.

2.02 Control Panels

A. Relay and Control Panels:

1. Relay and control panels shall be located as shown on the Contract Drawings and shall be metal enclosed, indoor type structures, factory assembled and tested, containing units and devices as shown on the Contract Drawings and specified herein. The panels shall be 90 inches high.

2. The control panel will be installed in the existing control room with the existing equipment in service. The location shall be as shown on the Contract Drawings. Space in the existing control room and along the wall is limited. Therefore, attempt shall be made to limit the panel width to 13 feet, if possible, not to exceed 15 feet in any case. Relay and control panels shall be enclosed on the top, the bottom and all sides, designed for free standing installation with brush grommet and/or gland plates on the top, and sides for cable access. Access for maintenance will be from the front only. Develop during detail design phase.

3. Provide gasketed access plate on bottom, side and top with the required number of openings sealed with hole-plugs. Doors shall be fully gasketed standard projection doors with lift off hinges and provisions for locking per NEMA 12. Suitable door stops shall be provided to prevent damage to hinges.

4. Relay and control panels shall be constructed from highest quality hot rolled, pickled and oiled sheet steel equal to AISI C1010. Front and rear panels shall be constructed from No. 11 gauge steel minimum. Side sheets and top members shall be constructed from No. 13 gauge steel minimum. Suitable stiffeners shall be used to prevent warping. The control panel shall be NEMA 12.
5. Adequate ventilating openings complete with filters located behind each opening to retard the entrance of dust, foreign matter, insects and rodents shall be provided. Panels shall be self-ventilated without requiring fans.

6. Relay and control panel wiring shall be factory wired with type SIS cross linked polyethylene, 600 volt, tinned copper flexible wires. Control wiring and voltage transformer circuit wiring shall be stranded No. 12 AWG minimum. Current transformer circuit wiring shall be stranded No. 10 AWG minimum. Indication wiring shall be stranded No. 14 AWG minimum.

7. Wiring shall be firmly fixed in place with clamps of a type which will not damage insulation. Wiring shall be neat, with all wires grouped as much as possible and kept organized utilizing a pre-fabricated cable management system. Ring type solder-less terminal connectors of the heavy duty insulated type shall be used on all control wiring. Wiring associated with meters and transducers shall be arranged to permit the testing and calibration of the associated devices through built-in or panel mounted test blocks without disturbing the protective devices.

8. Terminal blocks shall have screw type terminals capable of receiving two (2) solid copper wires. 20 percent spare unassigned terminals are required. All terminal blocks shall be furnished with marking strips for wire identification. All devices shall be identified on the rear of the panel with device number.

9. All incoming wires to the control panels shall terminate on terminal blocks whereon a separate terminal suitable for No. 10 AWG wire shall be provided for each incoming wire and shall be plainly marked with an approved wire designation. Terminal blocks shall be located conveniently for connections to incoming control cables and shall be provided with a suitable locking device for all connections. Test blocks, with potential and/or current terminals as required, to be manufactured by the following:
   a. GE Type PK-2.
   b. OR Approved Equal.

10. Fuse blocks shall be kept toward the tops of these cabinets.

11. Equipment associated with a particular bus shall be on the respective side of the relay and control panel.

12. A 1 inch x 1/8 inch high conductivity (99 percent copper or better) copper ground bus shall be installed near the base of the combined relay and control switchboard extending the entire length of the switchboard. A mechanical connector for No. 2 AWG wire shall be provided at each end of each ground bus for connection to the substation or switching station ground system.

13. All relay device nomenclature, wiring nomenclature, wire tags and name plates shall conform to SEPTA standards. Obtain SEPTA approval before providing.

14. Panel interiors shall be high visibility white. Panel exteriors shall be ANSI 61 gray.

B. Nameplates:
   1. Nameplates shall be provided and mounted for all relays, switches, push buttons, instruments and other devices on the front of the panels. Switchboards shall include suitable painted mimic buses with arrangement and color as indicated on the Contract Drawings.
2. Nameplates shall be fabricated from 1/8 inch thick laminated plastic (heat resistant plastic lamicoid nameplates) with white letters on a black background. The lettering shall be accurately aligned and engraved into the black core. Nameplates shall be attached with screws or rivets.

3. Size of nameplates shall be 1 inch by 2 1/2 inches minimum. Letters shall be minimum 1/4 inch high normal block lettering, unless otherwise indicated.

C. Painting:

1. Prior to assembly and before shop painting, all surfaces of the panels shall be thoroughly cleaned of rust, oil, grease, dirt, and mill scale and painted both exterior and interior with one (1) coat of rust inhibiting primer.

2. The exterior of the panels shall be given two (2) or more finish coats of light gray enamel (equal to ANSI 61). The minimum total primer and finish dry film thickness shall be 5 mils. Interior of cubicles shall be white.

D. Maintenance Lighting

1. Provide maintenance lights, via LED lamps, in the cabinets for maintenance. Lighting shall be adequate for identifying the intricate wiring and markers. Switches for the maintenance lights shall be provided near the cubicle doors.

2.03 Control of Substations or Switching Stations

A. Master Local/Remote Selector Switch:

1. Provide a master local/remote selector switch for all circuit breakers. The selector switch shall be located near the door and shall have a large flashing yellow indicating light when it is in local mode. Status of the master local/remote selector switch shall be annunciated to SCADA also.

B. Control Switches and Indicating Lamps:

1. Control Switches to be as manufactured by the following:
   b. Or Approved Equal.

2. Voltage Transfer handles shall be three (3) position, multi-deck with knurled handle and manufactured by the following:
   a. Electroswitch #24202B.
   b. Or Approved Equal.

3. Breaker Control handles to be manufactured by the following:
   a. General Electric #16S81DB4166SPR39.
   b. Or Approved Equal.

4. Lock out relay handles shall be high speed multi-contact electric trip.

5. Two (2) LED indicating lamps shall be provided with each control switch; a red lamp indicating the “closed” position and a green lamp indicating the “open” position of the controlled apparatus. Each control switch shall have a locked out position in which the red and green lamp circuits and all other circuits connected to the control switch are
interrupted. The Indicating lamps to be rated voltage 125 V DC and manufactured by the following:

a. General Electric ET-16.
b. Or Approved Equal.

C. Provide a local annunciator to annunciate all status and alarms. The annunciator can also be provided on the RTU. Coordinate during detail design.

D. The Contractor shall verify the existing protection system power supplies and switching and maintain the same in the new relay and control switchboard.

E. All substation or switching station relays that are required for accomplishing the required functions shall be furnished, mounted and wired on the combined relay and control switchboard by the manufacturer.

F. Suitable test switches shall be included with each switchboard. Test switches shall be mounted on the front of the panels unless otherwise approved and shall be provided with suitable covers that leave no live parts exposed. Test switches shall provide for the following operations:

1. The disconnection of each instrument, meter and relay current element from its current transformer secondary circuit so as to be available for connection to a test circuit, without interrupting the circuit from which it is removed.

2. The insertion of a portable ammeter or other current element in each current transformer secondary circuit without interrupting the circuit and without short circuiting or disrupting any circuit element that normally is connected in the circuit. In the case of differential relays this requirement shall mean the insertion of different ammeters in series with the operating coil and in series with each restraining coil.

3. The short circuiting of each current transformer secondary, and, in the case of each current transformer used in a differential circuit, the isolation of this current transformer secondary from the secondary wiring of the other current transformers of the same differential circuit.

4. The disconnection of each instrument, meter and relay potential element so as to be available for connection to the test circuit.

5. The disconnection of all DC connections from each relay or unit of relays.

G. The following items shall be included on the combined relay and control switchboard:

1. One (1) control switch, with red and green indicating lamps, for each circuit breaker and each electrically operated switch to be controlled

2. One (1) voltmeter, 200 V DC, for control battery voltage.

3. One (1) voltmeter, 150 V AC, scale 0 – 15 kV, for trolley bus voltage.

4. One (1) voltmeter, 150 V AC, scale 0 – 30 kV, for feeder bus voltage.

5. One (1) voltmeter switch, for selecting the potential bus.


H. Satellite Clock: provide the display of the satellite clock on the control board. Clock is specified in Section 16910.
2.04 Relay Protection

A. Protective relays are identified on relay and meter diagrams per IEEE C37.2. All relays are subject to approval by SEPTA. The selection of correct range of operation of the relay shall be the responsibility of the Contractor.

B. Some relay suppliers require relay settings to be performed by their specially trained staff. Allow for the attendance of relay supplier's Engineers in the bid.

C. The relays shall be single phase unless otherwise noted. All relays shall be capable of communicating with the RTU and the gateway network. A HMI and keyboard shall be provided as part of the gateway network to facilitate trouble shooting of the network server. All relays shall be IEC 61850 compliant.

D. Types and typical equipment are as follows:

1. 25 Hz relays for autotransformers.
2. 25 Hz relays for 24 kV feeders.
3. 25 Hz relays for 12 kV trolleys.
4. Associated lockout and auxiliary relays

2.05 Equipment

A. Instruments:

1. Instruments shall meet the requirements of UL 1437 for electrical indicating switchboard instruments, accuracy class 1. All meters on the control board shall be analog type. Meter characteristics shall be as follows:
   a. Maximum continuous input voltage to be 150 volts.
   b. Maximum continuous input current to be 10 amperes (programmable to any current transformer ratio).
   c. Maximum burden for current circuit to be 0.5 VA.
   d. Maximum burden for voltage circuit to be 0.5 VA.
   e. Surge withstand capability to meet IEEE C37.90.1.
   f. Operating temperature to be 32°F to 158°F.
   g. Construction to be a metal housing with standard switchboard dimensions and cutout per ANSI 39.1.

2. Manufacturers:
   a. Bitronics
   b. Or Approved Equal.

B. Transducers:

1. Transducers shall be rated 5 amperes and 120 volt input, suitable for switchboard mounting or alternately integral components of the associated panel mounted meter. Associated current transformer and potential transformer ratios shall be as shown on the Contract Drawings. Output shall be 0-1 mA or as required by SCADA master station. Confirm with SEPTA. Output range related to primary input shall be in accordance with the RTU point list. Transducer characteristics shall be as follows:
   a. Accuracy to be plus or minus 0.15 percent reading, plus 0.1 percent rated output.
b. Maximum continuous input voltage to be 150 volts phase to neutral.
c. Maximum continuous input current to be 10 amperes.
d. Maximum burden for current circuit to be 0.25 VA.
e. Maximum burden for voltage circuit to be 2.2 VA.
f. Surge withstand capability to meet IEEE C37.90.1.
g. Minimum input/output isolation to be 1500 V AC, 60 Hz.
h. Construction to be a metal housing with standard switchboard dimensions and cutout per ANSI 39.1.
i. All wiring of instrument transformer circuits to transducers shall be through approved instrument transformer test switches.

2. Manufacturers:
   b. Or Approved Equal.

2.06 Factory and Field Testing

A. Factory testing shall be performed on each piece of equipment. Factory test plans and procedures shall be submitted in advance to the SEPTA Project Manager. Tests shall be performed only after approval of the test plans and test procedures.

B. Testing of the completely wired switchboard shall be performed.

C. Where necessary, input, output and proof of correct wiring of field terminals shall be performed by applying the appropriate operating voltages to each circuit in lieu of the remote equipment being made available.

D. The complete switchboard shall be given visual inspection, wiring checks and operational, continuity, and electrical tests for each circuit in accordance with the latest standards of IEEE, NEMA and ANSI, in order to assure completeness, adequacy and proper functioning of equipment.

E. The SEPTA Project Manager shall be notified at least two (2) weeks in advance of factory testing for witnessing by a SEPTA representative.

F. Field Tests:
   1. Upon installation equipment at the site and prior to acceptance of the combined relay and control switchboard, tests of all systems shall be required to demonstrate functional and operational requirements.
   2. The tests shall be performed in two (2) or more phases per construction staging plan. The tests shall be conducted at a mutually approved time. Provide all instruments, facilities and labor required to properly conduct the tests.
   3. Adjust and set all relay trip devices, shunt trip devices, alarm devices and calibrate the transducers in accordance with required values.
   4. All control circuits shall be given continuity tests and operational tests from the supply source for which they were designed. This shall include normal breaker operation three (3) times from each control point, relay trips and activation of associated alarm devices. Operation of breakers and motor operated disconnect switches shall be simulated.
5. All protective relays shall be tripped (electrically) to determine whether the proper breaker has functioned as intended and any device or devices (including alarms) have also operated correctly. Functioning of breakers shall be simulated by a suitable test board.

6. Voltmeters shall be checked against potential transformer ratios. Pointers shall be set on zero scale, with no voltage, then after energizing, voltmeter reading shall be checked with test voltmeter.

7. All test results shall be in accordance with these Specifications and the manufacturer's recommendations and subject to approval by SEPTA.

8. All equipment shall be given operational tests. These tests shall include mechanical operation as well as operation by control circuits, relays and tripping devices. Operating voltage at closing and tripping coils shall be checked to determine that voltage is of the proper value.

9. Operational tests shall be performed before making high voltage connections of the equipment. Certain tests will be repeated after making high voltage connections.

10. Access to the gateway network and its status via the HMI shall be tested.

11. Record and submit test reports in accordance with Section 01300.

12. Field test plans and procedures shall be submitted in advance to the SEPTA Project Manager.

2.07 Shipment

A. All relay and control panels shall be installed and secured within the substation or switching station control room and shall be shipped in accordance with the manufacturer's recommendations.

B. The new control boards will be installed in existing buildings with the existing control board in service. Survey the existing control room to determine the feasibility of transporting the new control board in a single assembly. In case of difficulty, plan the delivery in two (2) shipping splits.

C. Each shipment shall be monitored for damage during transport by the application of “Shockwatch” labels or equivalent.

PART 3 - EXECUTION

3.01 Installation

A. The equipment shall be installed in accordance with the Contract Drawings and these Specifications in the existing control room.

B. Existing equipment in the control room will be in revenue service. Exercise caution not to disturb or damage the existing equipment. Request delivery in shipping splits if required.

END OF SECTION
THIS PAGE NOT USED
SECTION 16826

CABLE TRENCH SYSTEM

PART 1 - GENERAL

1.01 Description
A. This Section specifies furnishing and installation of a precast concrete or polymer concrete cable trench system within the substation or switching station covered by this Contract.
B. This cable trench system will be used for the routing of low voltage power and control cables.
C. Precast high density polymer concrete or concrete cable trench system forming a surface duct for insulated power and control cables.

1.02 Related Sections
A. Section 16050 – Basic Electrical Materials and Methods

1.03 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   1. American Association of State Highway and Transportation Officials (AASHTO).

PART 2 - PRODUCTS

2.01 Manufacturers
A. Precast high density polymer concrete or concrete trench system to be manufactured by the following:
   1. Oldcastle Precast Inc.
   2. Synertech.
   3. Plastibeton.
   4. Or Approved Equal.

2.02 Material Requirements
A. Cable trench system as dimensioned on the Contract Drawings:
   1. Cable trench system bases shall be supplied in approximate 10 foot lengths.
   2. Model and size of cable trench system shall be as indicated on the Contract Drawings or as required by the Contractor’s design.
   3. Trench system shall include all necessary special fittings for routing of cable trench.
   4. All covers shall be reinforced with glass fiber for impact resistance. Cover material shall be dielectric. Cover weight shall not exceed allowable handling weight of two (2) people.
   5. The cable trench shall be of the self-supporting type.
   6. The cable trench and covers shall support H-20 loading per the following standards:
      a. AASHTO, Standard Specifications for Highway Bridges.
B. Trench Internal Dividers:
   1. The Contractor shall supply trenches with dividers as required to maintain physical separation between cable circuits.

2.03 Tests
A. The Contractor shall furnish standard production tests as provided by the manufacturer.

PART 3 - EXECUTION

3.01 Shipping and Handling
A. The cable trench and accessories shall be shipped using the manufacturer’s standard packaging and handling requirements to protect the material from damage.

3.02 Installation
A. The scope of installation shall include unloading, setting down of the cable trench system in accordance with the manufacturer’s instruction and the Contract Drawings.
B. Workmen shall take extreme care not to inflict damage on the equipment.
C. The Contractor shall furnish, as part of the Contract work, all necessary lifting and moving equipment required for the proper loading, unloading and installation.
D. The manufacturer’s installation specifications shall be followed in installing the cable trench system.
END OF SECTION
SECTION 16910

ELECTRICAL SYSTEMS CONTROL SCADA, REMOTE TERMINAL UNIT – INCLUDING HMI

PART 1 - GENERAL

1.01 Description

A. The substations included in this Contract (Bethayres, Neshaminy and Yardley) are normally monitored and controlled remotely from the Rail Operations Control Center (ROCC). The existing master station of the supervisory system is located at the control center at 1234 Market Street, 19th Floor, which utilizes TOMS-Plus units manufactured by QEI, Inc. Existing Remote Terminal Units (RTUs) at all three (3) substations are supplied by QEI. The RTUs are connected to the master station via combination of fiber optic and copper cables.

B. The Contractor shall design a complete end-to-end supervisory remote control system for control and supervision of each of the substations. The system shall include sensors, transducers, coordination of contacts for status and alarms of all equipment and security system, RTU, and cabling from the communication cabinet and relay & control board. The system shall be compatible with the new equipment supplied by SEPTA or designed and procured by the contractor and the existing master station of SEPTA.

C. The design will include development of final SCADA point assignment list to include all control, status, analog, alarm and self diagnostic points based on the equipment selected. Include points for the building security and fire alarm systems. Identify the status points which require dry contacts.

D. Contractor is also responsible for the design, execution and testing of the modifications required at the master control stations located at 1234 Market Street, Philadelphia and at the secondary control station at Wayne Junction Substation. Contractor shall utilize services of a firm experienced and licensed to work with the existing equipment and software installed at the master control stations. Contractor shall obtain SEPTA approval of the firm before commencement of the work. The Contractor or its subcontractor shall submit necessary information in the form of database, drawings, screen shots and charts for updating the master station for SEPTA review and approval. Coordinate the work with the Project Manager and SEPTA Operating Department.

E. The system shall be tested for end-to-end operation from the control centers at Market Street and Wayne Junction for each function and point.

F.

G. The RTU shall be a free standing cabinet connected with the relay and control board. Other I/Os that are not addressed by the traction power switchgear bay modules and gateway processor shall be landed directly in the RTU cabinet. An alternative secondary cabinet may be proposed if necessary for SEPTA approval. Such other I/Os comprise status indication of disconnect switches, battery alarms, smoke and intrusion alarms and satellite clock.

H. Make the necessary connections to the new RTU and to the new equipment in step with the construction staging to maintain the status and remote indication and controls for all devices and functions.
I. Furnish and install control and indication cable(s) from each piece of substation equipment that requires I/O to the control panels in the control room and RTU.

J. Integrate the RTU to function with the gateway network server. The status of the gateway network server shall be accessible via a panel mounted Human Machine Interface (HMI) within the control and relay panel which shall be used for substation relay troubleshooting.

K. Route all control, alarm, status and telemetry functions from the 12 kV/24 kV circuit breakers, autotransformer circuit breakers via gateway (network server) control system (See Section 16791). Coordinate the routing method with the switchgear and circuit breaker manufacturers. Protective relay functions to trip the circuit breakers shall remain independent of the RTU and SCADA.

L. The new RTU shall be installed and commissioned while the existing RTU continues to remain in service. New circuit breakers and other new equipment will be connected to the new RTU. Existing circuit breakers and other existing equipment will continue to be controlled via existing RTU. The existing RTU shall then be removed. All new equipment shall be routed via the new RTU.

M. The required controls and indications for supervisory control are listed in the SCADA points list, which is provided in the Contract Drawings.

N. Provide and test end-to-end control, supervisory and data acquisition functions from all new field equipment to new control panels, and from the control panels to the existing RTU in the control room.

1.02 Related Sections

A. All the requirements as described in Division 1.
B. Section 16010 – Basic Electrical Requirements
C. Section 16050 – Basic Electrical Materials and Methods
D. Section 16052 – General Electrical Requirements – Traction Power Equipment
E. Section 16060 – Grounding and Bonding
F. Section 16075 – Electrical Identification
G. Section 16120 – Conductors and Cables
H. Section 16240 – Battery Equipment
I. Section 16791 – Combined Relay and Control Switchboard
J. Section 16952 – Electrical Testing -Traction Power Equipment (RRD)

1.03 Submittals

A. Submit shop drawings including product description, catalog data, wiring details, interconnection diagrams, microprocessor details, instructions manual, operating and maintenance manuals, details of interface with existing systems, software documentation, test programs for detailed testing, and database preparation and completion.

B. Submit step-by-step installation instructions.

C. Submit recommended list of test equipment and spare parts.
D. Submit database, drawings and other information for updating the master station
E. Submit operation and maintenance manual.
F. Submit test plans and procedures for the field, and end-to-end tests.

1.04 Quality Assurance
A. Meet the applicable provisions of the most recent issues of the following references:
   7. NFPA 70, National Electrical Code (NEC).
B. The installation shall be performed by workmen with established skills in the type of work covered by this Section.

1.05 Inspection
A. Inspection of the material/equipment will be made via factory acceptance tests at the point of delivery and via field tests.

1.06 Warranty
A. Provide standard warranty against defective materials and workmanship for two (2) years from the date of substation acceptance by SEPTA.

1.07 Maintenance Service and Extra Material
A. Spare Parts:
   1. To insure inclusion with contract orders, submit for approval, a recommended list of spare parts.
   2. Furnish, prior to the system being placed in service, two (2) each of the active printed circuit boards that are utilized on this Contract, as required by SEPTA (latest board revisions should be provided).
   3. The intent of this clause is that a complete set of spare material is furnished to ensure the continued operation of the system, considering the long delays which may be inherent in future replacement and predicted usage rates.
   4. Specifically highlight any equipment which has unduly long delivery time exceeding twelve (12) weeks and/or where there is likelihood that spares may become unavailable within the next ten (10) years.
PART 2 - PRODUCTS

2.01 Basic Architecture

A. All functions of SCADA and RTU pertaining to the circuit breakers, autotransformers and 25 Hz service transformer shall be routed to the equipment via relay and control board.

B. Other functions as stated below shall be routed directly from the equipment to the RTU.
   1. Battery and battery charger alarms and indications.
   2. Intrusion and smoke alarms.
   3. Satellite clock (time shall be displayed on the relay and control board).
   4. Status indication of manually operated disconnect switches.

C. All status and alarms shall be annunciated on an annunciator. It can be provided on the RTU door or at a location on the relay and control board. Coordinate with SEPTA during detailed design.

D. “Close” commands from RTU shall be executable only if the master local/remote selector is in “Remote” mode. “Trip” commands shall be executable in both modes of master local/remote selector.

E. Likewise, “Close” commands from the control switches located on the relay and control board or at the circuit breakers cabinets shall be executable only if the master local/remote switch is in “Local” mode. “Trip” commands shall be executable in both modes of local/remote selector.

F. Protective relays commands to trip the circuit breakers shall be independent of the RTU and SCADA.

G. Failure of communication with the master station, RTU, gateway processor or bay modules shall not prevent the following functions:
   1. Local operation of the substation via control switches located on the relay and control board and
   2. Operation of protective relays to trip the circuit breakers.

2.02 Materials and Equipment

A. Provide all the necessary relays, indication contacts, interface cables and transducers, in the various power equipment enclosures, and in the substation, for connection to the supervisory system, as described herein.

   1. Supervisory "indication" power shall be 130 V DC positive from the supervisory RTU cabinet through normally open or normally closed contacts in the equipment, then back to the supervisory device point.

   2. Control power to operate circuit breakers shall be 130 V DC from the device being operated to the supervisory interposing relay then back to the device point.

   3. Supervisory interposing relays for control of circuit breakers shall be rated 130 V DC, 20A continuous with closing pulse duration of five hundred (500) milliseconds. If the equipment current requirements are greater than 20 A or if the pulse required is longer
than five hundred (500) milliseconds, provide interposing relays in the equipment to accomplish the desired close or trip operation.

4. Analog inputs for AC and DC voltage and current shall be 4-20 mA from transducers. The Contractor shall verify the compatibility of the transducers with master station during detail design.
   a. Transducers Manufacturers:
      1) AC Voltage and Current Transducers:
         b) Or Approved Equal.
      2) DC Voltage Transducers:
         c) Ametek Power Instruments.
         d) Or Approved Equal.

5. Name plates shall be 1 inch x 3 inch laminated black plastic and shall be engraved with 1/2 inch white lettering “Remote Terminal Unit”. Name plate shall be mounted on surface of the RTU.

B. Provide 20 percent spare wires in each cable with a minimum of two (2) spares per cable.

C. Control cables shall be as specified in Section 16120. Control cables from the control board to the outdoor equipment shall be coordinated with ABB.

D. Wire terminals shall be insulated, compression type, ring tongue lugs such as manufactured by the following:
   1. T & B.
   2. Sta-Kon.
   3. Or Approved Equal.

2.03 SCADA Points Table

A. The sample control, supervisory and data acquisition points, with minimum requirements, are shown on the Contract Drawings. Contractor shall develop the points table in the SEPTA approved format to include all the points for the equipment. This effort shall be completed early on in the project so as to order the RTU in a timely manner.

2.04 Supervisory Remote Terminal Unit

A. Supervisory remote terminal unit shall be of a micro-processor based design. The RTU shall contain all necessary subsystem equipment to provide a complete operating system. Subsystems shall include, but not be limited to, the following:
   1. Power supply unit to convert 130 V DC to the voltage required by RTU.
   2. Communications subsystem.
   4. Status input subsystem.
   5. Control output subsystem.
   6. Interposing relay subsystem.
7. Digital to analog subsystem for four (4) wire analog data transmission.

8. Multiport data modems to be manufactured by the following:
   a. Universal Data Systems.
   b. Or Approved Equal.

9. Ihrig B clock with a one (1) millisecond time stamp, or synchronized time system to ensure identical time with the master station and other substations. Coordinate with SEPTA during detail design.

10. This style RTU requires external voltage and current transducers.

B. All input and output terminals shall be capable of meeting and withstanding the requirements of the IEEE C37.90.

C. The RTU shall be totally enclosed in a NEMA 4, twist handle, three (3) point latch, gasketed, natural vented, free standing enclosure, UL listed and pad lockable (3/8 inch shank minimum). The enclosure shall be front accessible only, allowing placement of enclosure against a wall. Color shall be ANSI 61 gray.

D. Communications between the remote terminal unit and the master station equipment shall be over SEPTA’s existing fiber optics communication system. The RTU shall also be capable of communicating over Ethernet LAN using IP transport protocol. Termination options for Ethernet connections shall include 10/100 BaseT as well as single mode and multi mode fiber optics.

E. A micro-processor with programmable read only memories shall be provided in each panel for future changes in the substation.
   1. Operating software shall be proven to be resistant to malware. Provide data of past five (5) years to demonstrate that the selected software is not prone to malware attacks.
   2. All programs shall be stored in programmable read only memory that is not electrically erasable.
   3. Program reloading shall not be required due to power surges, dips or outages.
   4. Random access memory may be used to store temporary raw data prior to transmission.

F. Optical isolators shall be provided on all status or alarm inputs. A digital filter shall be employed on all inputs to eliminate contact bounce. All optical isolator components shall be installed in optoisolator sockets.

G. All status, alarm, potential, etc., indications from the substation equipment to the remote terminal unit shall be digital type from electrically isolated normally open or normally closed contacts. All status contacts will be energized with 130 V DC.

H. Interposing relays for control of substation equipment shall have two (2) form-C, heavy duty contacts. Contacts shall be rated for a 20A (resistive) load at 130 V DC and have adjustable close time up to five hundred (500) milliseconds. All control and status circuit boards shall include LED indications on every point. The circuit boards shall be installed via board sockets. Interposing relays to be manufactured by the following:
   1. Potter & Brumfield (P&B) catalog number PRD11DJ0-24V.
   2. Or Approved Equal.
I. Make all connections from external equipment that are connected to the remote terminal unit, shall be made to terminal blocks provided in the SIC.

J. All connections from the remote terminal unit to external equipment shall be made to terminal blocks provided in the remote terminal unit.

K. All connections from I/O relays on circuit boards shall be made to terminal blocks. Direct connections to circuit board relay I/O are not permitted.

L. The RTU shall contain a dc/dc converter which obtains power from the substation 130 V DC battery. The dc/dc converter to be manufactured by the following:
   1. Lambda Power Supply.
   2. Or Approved Equal.

M. Provide a sealed 12 V DC maintenance free battery back-up to sustain remote operation for minimum of one (1) hour.

N. Design the Remote Terminal Unit (RTU) with as small of a foot print as possible due to space limitations. Limit the foot print to 60 inches wide, 24 inches deep as far as possible. Larger foot print up to 72 inches wide by 24 inches deep will be considered.

O. The supervisory unit shall have a proven service record and shall be based upon the 6CPP6 Central Processor Panel architecture and shall operate from and be thoroughly and fully compatible with an existing substation master supervisory system, TDMS-Plus, manufactured by QEI, Inc., Springfield, New Jersey. The unit shall be programmed to respond to the QEI QUICS IV system communication protocol. No modification to the QEI, TDMS-Plus Alpha master station servers will be accepted. Licensing agreement fee for QEI, QUICS IV protocol must be included in the bid. In addition, the proposed RTU shall support multiple protocols and be capable of DNP3 communications with Intelligent Electronic Devices (IEDs) over RS232 serial port, RS485 or Ethernet link. The number of serial communications ports shall be expandable up to no less than eight (8) usable ports. One (1) serial port shall also be provided for RTU configuration and testing purposes. RTU configuration shall be accomplished via software. The configuration software shall provide a simple, logical, user-friendly graphical interface. The unit shall be sized for the required status points, control points and analog points as per the Contract Drawings. Provide all equipment required for full interface of the RTU with the master station at no additional cost to SEPTA. The supervisory unit to be manufactured by the following:
   1. QUICS Model 4150.
   2. ePAQ-9100 Gateway.
   3. Or Approved Equal.

P. Communications between the network server and the RTU shall be accomplished using single mode fiber optic cable which shall be connected to Port No. 2 of the RTU. The Contractor shall propose suitable cable.

Q. Provide 20 percent spare control and indication points, completely wired to terminal blocks in the remote terminal unit.

R. Install loosely shipped current and voltage transducers in the associated equipment and connect the transducer outputs to the remote terminal unit.
2.05 Master Station

A. Contractor shall design the modifications required at the master control stations at 1234 Market Street, Philadelphia and at Wayne Junction substation for each stage of construction at each substation. Note that the existing RTU will continue to be in service during first stage of construction. Ensure that the supervisory and control functions of other substations are not affected.

B. Contractor shall submit necessary charts, drawings, screen shots and details of software changes to SEPTA for review and approval in a timely manner. Approval may require more than one submittal and revision.

C. Develop a test procedure to test the proposed changes at the master station without hindering the control of the other substations in service.

PART 3 - EXECUTION

3.01 Preparation

A. Thoroughly review the Contract Drawings and Specifications in preparation for installation of the materials and equipment. Materials shall be procured, stored and planned for use which minimizes waste, and substitutions, and maximizes installation efficiency and quality of end product.

B. Examine all Contract and Reference Drawings to verify and properly coordinate the work; check all relevant drawings including civil; mechanical drawings and shop drawings.

C. Prepare all databases required for the SCADA system.

3.02 Shipment

A. Ship the RTU and other components only after successful completion of the factory tests and approval of the factory test report by SEPTA.

B. Ship the RTU and other delicate components by special air-ride equipped trucks if required by the supplier.

3.03 Installation

A. Following all repairs to the control room and install the new RTU at the location indicated on the Contract Drawings. Maintain all other existing control equipment in the room in revenue service. Exercise caution to ensure that the existing equipment is not damaged. Note that the existing RTU will continue to be in service simultaneously with the new RTU for a period of time. Coordinate required modifications at the control center.

B. Install control cable in cable trench, tray or conduit.

C. Install fiber optic cable in cable trench or conduit.

D. SCADA Interface Cabinet and RTU:
   1. Connect all wires from the substation equipment terminal blocks to the supervisory RTU terminal blocks.
2. Provide tape pothead where cable jacket is removed on both ends of each cable. Bundle and tie neatly all wiring inside equipment.


4. Identify each cable by device name and number and destination.

5. Identify each wire including spares with wire markers.

E. If RTU is a separate freestanding unit, i.e. not integral to the relay and control switchboard, securely fasten the SCADA interface cabinet and the RTU cubicle to the floor in accordance with seismic zone 2b requirements. Since the new RTU is required to be installed before removal of other equipment, make the footprint as small as possible.

F. Install 130 V DC power circuits to the RTU cabinet.

G. Install a 120 V AC receptacle in the RTU cabinet, and supply power to the receptacle from the AC distribution panel.

H. Connect the new RTU to the communication cable in coordination with SEPTA staff. Make sure that necessary modifications are made at the master station.

3.04 Modifications at the Master Control Station

A. After SEPTA review and approval, make required changes in the control and display at the master control station in synch with the construction schedule for each stage of construction at each substation.

3.05 Testing and Acceptance

A. Perform and successfully pass factory tests and field commissioning tests prior to the equipment being accepted by SEPTA.

B. Factory Tests:

1. Refer to Section 16952. Submit factory test procedure to SEPTA for review and approval at least 21 days in advance.

2. Furnish SEPTA with certified copies of the results of all tests and measurements made to determine the quality and serviceability of the equipment manufactured in accordance with this Specification. Such results shall show compliance with all the requirements of this Specification. SEPTA approval at actual acceptance test shall be contingent upon prior receipt and approval of these certified tests. During the actual acceptance test, minimum of 10 percent of all points shall be tested. If problems arise, SEPTA may specify that more or all points within the questionable remote terminal unit be re-tested.

3. The factory acceptance test shall be witnessed by a minimum of two (2) representatives of SEPTA.

C. Field Tests:

1. Perform the Field testing according to the SEPTA approved SCADA system test plan.

2. Test all points locally either from HMI or via laptop, both for status and control.

3. Perform the specified field tests including end-to-end tests from the control centers at Market Street and at Wayne Junction on all functions and points to the satisfaction of
SEPTA. Tests shall be performed in two (2) or more stages per construction staging and schedule.

4. Submit the test results to SEPTA.

5. Upon successful completion of tests, place the RTU in revenue service.

END OF SECTION
THIS PAGE NOT USED
SECTION 16950

TESTING

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for factory and field testing on electrical equipment furnished and installed under this Contract.

B. The following equipment and/or material shall be tested in accordance with the requirements of this Section:

1. Supervisory Control and Data Acquisition (SCADA) system.
2. Medium voltage cables.
3. Composite copper/fiber optic cable.
4. Battery, battery charger and DC distribution system.
5. Auxiliary power transformers.
6. Air interrupter switches (Non-loadbreak).
7. Automatic transfer twitches as integrated with the indoor switchboards.
8. Panelboards.
10. Receptacles.
11. Motor starters.
12. Enclosed switches.
13. Lighting system.
14. Fire alarm.
15. Intrusion detection and alarm.
16. Thermo-graphic testing of the auxiliary power equipment.

1.02 Related Sections

A. Section 01300 – Submittals

1.03 Submittals

A. Submit a detailed testing program for the equipment in accordance with the test procedures described in Section 01300 and the referenced industry standards organizations.

B. Submit a factory test plan and a field test plan to SEPTA sixty (60) days prior to performing the tests. Describe the overall test process, including the responsibilities of individuals and documentation of the test results. Demonstrate that a complete, safe and operable power system has been provided and that as a minimum the following data has been submitted:
1. A flow diagram indicating the logical sequence of tests starting with material receiving tests and inspections and concluding with system demonstration tests.

2. Test schedules.

3. Record keeping assignments, procedures and forms.

4. Procedures for monitoring, correcting and re-testing variances.

5. Procedures for controlling and documenting all changes made to the hardware after the start of testing.

6. Block diagrams for the hardware test configuration including external data transmission interfaces, and detailed descriptions of any and all test and/or simulation equipment.

7. Estimated duration of each test.

8. Software version numbers, CRC check sums, date and time for every module.

9. Calibration and the traceability to known standards of hardware, software, simulation tools and test equipment to be used for testing.

C. Submit test procedures and reports, for tests specified, to meet the requirements herein.

1. Detailed test procedures will not be required if such procedures are adequately described in ANSI, IEEE or NEMA Standards, or standards reviewed by SEPTA, and copies of the standards are submitted with the related test. Include the following in all detailed test procedures (minimum requirement):
   a. Test purpose.
   b. Applicable standards or code including specific paragraph or section reference.
   c. Equipment to be tested.
   d. Test set up.
   e. Chronological step-by-step test sequence.
   f. Pass/fail acceptance criteria.
   g. Test data form for recording and documenting test information.
   h. Pass/fail test conclusions.
   i. Signature of personnel.
   j. Date of testing.
   k. Test duration and schedule.

2. No testing shall commence until SEPTA’s Project Manager or designated representative reviews and approves the test procedures.

3. No testing shall commence until all control equipment, keypads, alarms, detectors and switches have been checked as an integrated system in accordance with the manufacturer’s recommendations.

D. Submit two (2) copies of the test report to SEPTA’s Project Manager for review and comments. After acceptance, six (6) final copies of the certified test report shall be submitted to SEPTA’s Project Manager.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
1. Association of Edison Illuminating Companies (AEIC).
2. ANSI C37.54, American National Standard for Indoor AC High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear - Conformance Test Procedures.
10. NEMA PE 5, Utility-Type Battery Chargers.

B. Perform the testing described herein, according to the referenced standards and this Specification.

C. Factory Testing Witness Program:

1. In case of a design or manufacturing failure during factory testing, design tests need to be performed on all similarly designed equipment that are included in this Contract. Perform such tests on replacement equipment until, and unless, a satisfactory resolution of the problem is accepted by SEPTA. In the event of such a failure, assume all costs of replacement and retesting, including the cost for SEPTA’s representatives to witness the testing.

2. In the event that equipment provided for this Contract fails during field commissioning, assume complete costs for shipping the equipment to the manufacturer, replacement equipment, complete factory testing, SEPTA witness of factory testing, return shipment to the Project site, installation and commissioning.

3. In the event that equipment provided for this Contract fails during warranty, after Project acceptance (All warranties begin with final acceptance), SEPTA will follow standard warranty procedures.

D. Field Testing:

1. Provide the services of a certified National Electrical Testing Agency independent testing company to perform the field testing work covered in this Section.
1.05 Deliverables

A. Six (6) hard copies and one (1) CD-ROM of the certified test reports for all field tests in Adobe Acrobat (PDF) format.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Factory Testing

A. General Requirements:

1. The purpose of the factory test is to demonstrate that each of the systems meet or exceed the functionality and performance requirements specified in the Specifications.

   a. Perform all factory tests according to the applicable standard whether such tests are specified herein or not.

   b. Provide the services of an independent testing laboratory to perform design tests of the equipment manufactured for specification compliance. Submit copies of certified results from prior design testing for all items of equipment that are being furnished without any modification from the item of equipment originally tested. Design tests are required if certified test results from prior article testing are not available.

   c. In addition to the specific design tests, the testing shall include items such as:

      1) Verification of all mechanical specifications.

      2) Verification of all operating, control and indicating functions.

      3) Electromagnetic compatibility, temperature, humidity, shock and vibration testing.

   d. The test data for each unit shall be certified by the testing laboratory. The equipment shall be fully operational during electromagnetic compatibility, temperature, humidity, shock and vibration testing.

   e. Submit the certified test data reports to SEPTA’s Project Manager for approval. Do not withhold any certified test data from SEPTA’s Project Manager even though the certified test data may indicate that a unit of equipment has failed the test. If any single unit equipment fails to meet the Specifications, or fails to provide the correct control or indication functions, then the unit of equipment will be inspected by SEPTA’s Project Manager, who shall determine whether the equipment shall be repaired, redesigned or shall be replaced and completely retested. In order to pass the test, the test report must indicate that each unit of equipment meets or exceeds the functionality and performance requirements of the tested equipment.

   2. Require that, at designated stages of the production process, the materials, components, assembly, subsystems and systems under test meet the Contract Drawings and Specifications. The proof of verification shall be submitted to SEPTA’s Project Manager.

   3. SEPTA’s Project Manager reserves the right to witness all factory testing. Within forty-five (45) days prior to the start of all factory testing, notify SEPTA’s Project Manager in writing. A detailed bar chart schedule of the tests and inspections and sample test reports shall be included. Equipment or material that fails factory testing or
malfunctions during the testing shall be replaced with new equipment and retested until the requirements are met. The equipment or material will not be accepted until the test reports are submitted to SEPTA's Project Manager for approval.

3.02 Thermo-Graphic Testing of Auxiliary Power Equipment

A. Perform thermo-graphic testing and record circuit parameters for the following auxiliary power equipment:

1. All electrical equipment cable terminations whose conductor size is No. 4 AWG or larger.
2. Panelboards.
3. Vacuum switches.
4. Transformers.
5. Transfer switches, motor starters and contactors.

3.03 Factory Tests of Equipment and Materials

A. SCADA Remote Terminal Unit (RTU):

1. Factory Tests:
   a. Perform SCADA RTU mainframe operational and functional tests that exercise all I/O and their associated control, supervisory and indications.

2. Field Tests:
   a. After the installation of the system has been completed, conduct a test of the system similar to the witnessed factory acceptance test to verify that the system has been properly installed and is properly operating.
   b. Assume responsibility for the SCADA system and the communications system performing as an integrated system. Assume responsibility for any and all equipment and cabling failures that prevent full SCADA operation.
   c. Submit copies of test reports to SEPTA within five (5) days after completion of testing in accordance with Section 01300.

3. Test Equipment:
   a. Provide all necessary test equipment and instruments to perform the required tests.

4. Site Tests:
   a. SEPTA and the manufacturer’s Field Engineer will test the supervisory system from the Power Dispatcher’s location of the SEPTA Control Center, 1234 Market Street, 19th floor, Philadelphia, Pennsylvania, for correct operation. Supervisory master unit and telephone line failures will be SEPTA’s responsibility. Assume responsibility to require all other failures and deficiencies be corrected under this Contract, by the SCADA RTU manufacturer's Field Engineer.

B. Cables and Conductors:

1. 24 kV (250 kV BIL) and 12 kV (150 kV BIL) Traction Power Cables:
   a. Factory tests to meet ICEA S-93-639/NEMA WC 74:
      1) Unaged and accelerated aging tests.
      2) Conductor DC resistance.
      3) Conductor diameter measurement.
4) Tensile, elongation & set.
5) Cold bend.
6) Electrical accelerated water absorption.
7) AC voltage withstand.
8) Partial Discharge Test:
   a) Each reel of shielded power cable shall meet the partial discharge test requirements of AEIC.
9) Insulation resistance.
10) Dielectric constant and dissipation factor.
11) Sunlight resistance test.
12) Cable tray flame test.
13) Spark test.
14) Insulation corona discharge.
15) Resistance for Class IV EPR.

b. Field Tests:
   1) Megger test.
   2) Hi-Pot test using DC voltage level as recommended by the manufacturer.

C. Composite Copper/Fiber Optic Cable:

1. Procure and provide all necessary test equipment, test cables, adapters, load boxes, light sources and any other hardware required to perform cable testing.
2. Before beginning testing, submit a list of all test equipment to be used to SEPTA for their approval.
3. Schedule all testing with SEPTA’s Project Manager in advance of testing. Additionally, SEPTA reserves the right to witness testing of all installed cabling.
4. Submit each test report to SEPTA for approval. Approval is based upon the expected results for the cable being tested and upon the corrective actions taken by the Contractor when specific tests fail.
5. Each optical fiber shall be tested from end-to-end at each patch panel to determine end-to-end attenuation, including connector and splice loss.
6. Each element of all new single mode fiber optic cabling shall be tested for continuity and attenuation in both directions at both 1310nm and 1500nm, with a fiber optic light source and power meter. Before beginning testing, the Contractor shall submit a design fiber optic loss budget for the segment to be tested, based upon the length of fiber optic cable installed. When tested at both windows in both directions, the measured attenuation of each fiber optic cable segment shall be less than or equal to the design attenuation of the segment being tested. Until this condition has been met, the installation shall not be considered complete and will not be accepted.
7. Each and every multi-pair copper conductor shall be tested for shorts, opens, continuity and grounds. These test results for the cable shall be furnished to SEPTA’s Project Manager.
8. Corrective Action:
a. If a cable test fails for any reason, the Contractor shall determine the cause of the failure. If a defective cable, outlet insert, wiring block and/or patch panel is found to be the cause of failure, replace the material in the question and assume responsibility for all costs associated with its replacement.

b. Perform the tests at both 1310nm and 1550nm wavelength. If any fiber testing reveals an abnormal test result, outside of the manufacturer’s normal parameters, then conduct a test of all fiber strands in the affected sheath with an Optical Time Domain Reflectometer (OTDR) to identify the source and location of the problem.

D. Battery:

1. Perform the following field test in the substation or switching station during the commissioning of the battery system:
   a. Constant current capacity discharge test in accordance with IEEE 450. The test shall verify the capacity discharge rate of the battery system for eight (8) hours. Provide computer plots and tabular data of the cell voltage taken before and after installation of the “Cell Voltage Equalizers”, to SEPTA’s Project Manager.
   b. Upon completion of the testing, the float voltage, equalizing voltage, specific gravity and temperature basis shall be set and maintained in accordance with the manufacturer’s recommendations.

E. Battery Chargers:

1. Factory Tests:
   a. The following factory tests shall be performed on one (1) battery charger per NEMA PE 5 as follows:
      1) Dielectric.
      2) Voltage adjustment.
      3) Temperature rise.
      4) Current limit.
      5) Short circuit.
      6) Static voltage deviation.
      7) Efficiency measurement.
      8) Power factor measurement.
      9) Ripple voltage measurement.
     10) Audible noise.
     11) Stability and response.
     12) Transient voltage withstand.
     13) No load.
   b. Additional factory tests shall be performed on all battery chargers per NEMA PE 5 as follows:
      1) Dielectric.
      2) Full load tests with a 270 ampere-hour, sixty (60) cell.
      3) Lead acid battery, running in parallel with, and without a battery, with momentary overload. The full load test shall show output ripple voltage lies within 0.06% of normal output voltage.
      4) Voltage.
      5) Current limit.
      6) Ripple voltage measurement.
7) Charging capability within twelve (12) hours of a battery already discharged to 105 V DC from its nominal 130 V DC value.

8) Float voltage tests.

9) Detection of positive and negative grounds circuit and system, overload protection and “low battery voltage” status indications.

10) Temperature compensation.

11) Automatic “Equalizing Charge” capability.

F. Vacuum Interrupter Switches:

1. Factory Tests:
   a. The switchgear shall be tested in accordance with the factory test outlined in IEEE C37.20.2 and ANSI C37.55 and shall include, but not be limited to, the following:
      1) Leak test.
      2) Resistance test (Switch contacts).
      3) Megger control and power wiring.
      4) Dielectric tests (Hi-pot test of vacuum interrupter).
      5) Calibration and testing of the protective relay, TCC.
      6) Characteristics (CO/IAC type) time overcurrent, instantaneous, ground fault, in-rush current restraint and setting relays through primary injection.
      7) Mechanical operation tests.
      8) Switch interlock scheme operation and restraint.
      9) Grounding of instrument transformer cases tests.
     10) Electrical operation and control wiring tests.

11) All circuit interrupters shall be tested in accordance with the factory tests outlined in IEEE C37.09 and ANSI C37.54 and shall include but not be limited to the following:
    a) Current transformer test.
    b) Nameplate check.
    c) Resistors, heaters and coils check tests.
    d) Control and secondary wiring check tests.
    e) Clearance and mechanical adjustment check tests.

2. The following factory tests need not be performed if the manufacturer has tested identical product within the past two (2) years. If such conditions apply, provide certified test reports for the following type tests:
   a. Basic impulse level.
   b. Mechanical operational tests.
   c. Timing test.
   d. Stored energy system test.
   e. Low frequency withstand voltage tests on major insulation components.
   f. Low frequency withstand voltage tests on control and secondary wiring.

3. Field Tests:
   a. Inspect the unit for any damage during shipment to the site and confirm that all safety signs are affixed to the cubicle exterior.
   b. Verify phase rotation of all cables.
   c. Megger test.
d. Perform mechanical operation of all switches and interrupter.

e. Test the cubicle heater / thermostat system.

f. Test the controller.

g. TTR tests.

h. Hi-pot tests.

i. Phase sequence tests.

G. Medium Voltage Air Interrupter Switches:

1. Factory Tests:
   a. All disconnect/ground switches and related equipment shall receive the following tests as described in IEEE 1247.
      1) 60 hertz wet and dry withstand tests.
      2) Impulse wet and dry withstand voltage test.
      3) Open gap withstand test.
      4) Radio influence tests.
         a) When tested at the test voltages that are applicable to the circuits on which the switches are to be used, all switches, including all terminal parts, shall be corona-free and the limits of radio influence voltage established by applicable NEMA standards shall not be exceeded.
      5) Temperature rise tests.
      6) Interrupting tests.
      7) Short time current tests.
      8) Capacitive current tests.
      9) Routine manufacturer’s tests.
     10) Voltage tests on control and auxiliary contacts.
     11) Mechanical operations tests.

2. The manufacturer must have available for SEPTA’s Representative, a disconnect/ground switch at the plant location. This switch shall be inspected and tested for dimensional accuracy and compatibility with mating components.

3. Certified copies of test reports shall be submitted as referenced herein to SEPTA’s Project Manager.

4. The SEPTA Project Manager and/or Representative, reserves the right to attend the test.

H. Automatic Transfer Switch (ATS):

1. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings meet the Specification requirements.

2. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the Specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
3. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

I. Panelboards:
   1. Field Tests:
      a. Cable lug mechanical torque (All lugs).
      b. Continuity test.
      c. Megger test.

J. Battery/Battery Charger System:
   1. Develop test procedures for function tests of the battery systems and submit to SEPTA’s Project Manager for approval prior to testing. Include the following test values in the testing plan:
      a. Specific gravity.
      b. Cell voltage.
      c. Equalize charge.

K. Fuse Cutout:
   1. Field Tests:
      a. Visual inspection of fuse type and rating.
      b. Function test (Close – Open).
      c. Megger test.

L. Receptacles:
   1. Field Tests:
      a. Continuity test.
      b. Polarity / ground configuration.
      c. Visual inspection of receptacle.

M. Motor Starters:
   1. Field Test:
      a. Visual inspection of starter and enclosure.
      b. Continuity test.
      c. Function tests and control circuit.
      d. Megger test.
      e. Confirm proper overload units are installed.

N. Enclosed Switches:
   1. Field Tests:
      a. Visual inspection of enclosure and switch mechanism.
      b. Functional tests (Close – Open) or (Close ‘A’-Open-Close ‘B’).
      c. Continuity.
      d. Megger test.
      e. Confirm proper fuse type and ratings of fusible switches.
O. Lighting System:
   1. Field Tests:
      a. Submit an illumination level report performed by a qualified independent testing agency after final installation/construction of the lighting system.
      b. The report shall include normal lighting and emergency lighting.
      c. Submit an illumination level report for the emergency lighting system as follows:
         1) Measure lighting levels on all egress paths, at each stair landing, at middle of stairs, at changes in direction, at doorways and every 25 feet along path
         2) In areas where daylight contributes to the total illumination, measure lighting levels at night.

P. Fire Alarm System:
   1. Field Tests:
      a. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
      b. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity and insulation.
      c. Open initiating device circuits and verify that the trouble signal actuates.
      d. Open and short notification appliance circuits and verify that the trouble signal actuates.
      e. Ground initiating device circuits and verify response of trouble signals.
      f. Check all alarm notification devices.
      g. Check installation, supervision and operation of smoke detectors.
      h. Verify that each initiating device alarm signal is properly received and processed by the fire alarm control panel (Walk Test).
      i. Conduct tests to verify trouble indications for common mode failures, such as alternating current power failure. Consult the manufacturer’s manual for other common mode failures and conduct the described testing procedures.
      j. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

Q. Intrusion Detection and Alarm System:
   1. Field Tests:
      a. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the intrusion alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
      b. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity and insulation.
      c. Open initiating device circuits and verify that the trouble signal actuates.
      d. Open and short notification appliance circuits and verify that the trouble signal actuates.
      e. Ground initiating device circuits and verify response of trouble signals.
      f. Check all alarm notification devices.
      g. Verify that each initiating device alarm signal is properly received and processed by the intrusion alarm control panel (Walk Test).
h. Conduct tests to verify trouble indications for common mode failures, such as alternating current power failure. Consult the manufacturer’s manual for other common mode failures and conduct the described testing procedures.

i. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

END OF SECTION
SECTION 16952

ELECTRICAL TESTING – TRACTION POWER EQUIPMENT (RRD)

PART 1 - GENERAL

1.01 Description

A. This Section includes requirements for testing of traction power equipment at Bethayres, Neshaminy Falls and Yardley traction power substations located on SEPTA’s regional system West Trenton line.

B. Factory Tests:
   1. This Section describes the factory tests in general. Detailed requirements for equipment factory tests are specified in the individual equipment Sections.
   2. The factory tests include:
      a. Design tests.
      b. Production tests.
   3. Design tests will be performed on the first equipment of the first substation only, if the equipment of other two (2) substations is identical.

C. Field tests:
   1. This section describes detailed requirements for the field tests. Note that each substation shall be tested in at least two (2) distinct phases. Additional tests may be necessary if equipment is to be energized or commissioned separately.
   2. The field tests include all commissioning and operation tests. The tests include:
      a. Tests performed prior to the equipment energization.
      b. Tests performed following the equipment energization.

D. Describe in the bid any deviations to the specified tests.

1.02 Related Sections

A. All requirements that are described in Division 1.
B. Section 16052 – General Electrical Requirements -Traction Power Equipment
C. Section 16060 – Grounding and Bonding
D. Section 16290 – Protective Devices and Instrument Transformers
E. Section 16335 – Surge Protection
F. Section 16791 – Combined Relay and Control Switchboard
G. Section 16910 – Electrical Systems Control SCADA Remote Terminal Unit – Including HMI

1.03 Submittals

A. Submit the following documents for each test for SEPTA’s review and approval:
   1. Test Plans:
a. Prepare and submit to SEPTA a comprehensive test plan for all factory and field tests to be performed. Include a detailed schedule of all tests including starting and completion dates.

b. Submit a factory test plan and a field test plan to SEPTA sixty (60) days prior to performing the tests. Allow thirty (30) days for SEPTA review and approval. Tests cannot start without SEPTA approval.

c. Include the following information for each test:
   1) A flow diagram indicating the logical sequence of tests starting with material receiving tests and inspections and concluding with system demonstration tests.
   2) Test schedules.
   3) Record keeping assignments, procedures and forms.
   4) Procedures for monitoring, correcting and re-testing variances.
   5) Procedures for controlling and documenting all changes made to the hardware after the start of testing.
   6) Block diagrams for the hardware test configuration including external data transmission interfaces, and detailed descriptions of any and all test and/or simulation equipment.
   7) Estimated duration of each test.
   8) Software version numbers, CRC check sums, date and time for every module.
   9) Calibration and the traceability to known standards of hardware, software, simulation tools and test equipment to be used for testing.
   10) Test location.
   11) Test objectives including pass/fail criteria.

2. Test Procedures:
   a. Prepare and submit to SEPTA the test procedure for each test to be performed. No testing shall occur and no results shall be considered valid until approval of the test procedures by SEPTA.
   b. Submit the test procedure for review and approval at least sixty (60) days before proposed date of commencement of test(s). Allow thirty (30) days for review and approval.
   c. Include in each test procedure the following information:
      1) Title of the test with reference to the appropriate Section of the Contract Documents.
      2) The name of the organization performing the test.
      3) Test location.
      4) Scheduled starting and completion date.
      5) Test objectives.
      6) Applicable procedures specified in ANSI, IEEE or NEMA standards.
      7) Test methodology and step-by-step procedure for performing the test.
      8) Instrumentation setup, circuit diagrams and test sequence.
      9) Required equipment and instrumentation.
      10) Forms to be used to record and evaluate data.
      11) Pass/fail criteria and justification for the criteria.
      12) SEPTA’s personnel requirements.
      13) Test evaluation procedures.
      14) Test report format.

3. Test Reports:
   a. Prepare a test report for each test performed.
b. Include the following information in each test report:
  1) Title of the test with reference to the appropriate Section of the Contract Documents.
  2) The name of the organization performing the test.
  3) Test location.
  4) Starting and completion date.
  5) Test objectives.
  6) Applicable procedures specified in ANSI, IEEE or NEMA standards.
  7) Test methodology and step-by-step procedure for performing the test, including instrumentation setup, circuit diagrams and test sequence.
  8) List of all equipment and instrumentation used including model number, serial number and calibration date.
  9) Pass/fail criteria and justification for the criteria.
 10) Test evaluation procedures.
 11) Conditions of test, including precipitation, temperature and humidity.
 12) Raw test data.
 13) Reduced test data in tables, charts, photographs and any additional data required to support the test results.
 14) Descriptions of all equipment and material failures and the reasons for the failure.
 15) Descriptions of all modifications to the equipment or wiring performed and the reasons for the modifications, and the names of individuals approving such modifications.
 16) Conclusions and signatures of responsible test supervisors.
 17) Prepare two (2) copies of the test reports to be submitted to SEPTA’s Project Manager for review and comment. After acceptance, six (6) final copies of the certified test report shall be submitted to SEPTA’s Project Manager.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

  1. ABB, Field Tests Recommended for Circuit Breakers and Autotransformers.


B. Perform the testing described herein, according to the referenced standards and this Section.

C. Factory Testing Witness Program:

1. In case of a design or manufacturing failure during factory testing, design tests shall be performed on all similarly designed equipment that are included in this Contract. Perform such tests on replacement equipment until, and unless, a satisfactory resolution of the problem is accepted by SEPTA. In the event of such a failure, assume all costs of replacement, retesting, including the cost for SEPTA’s representatives to witness the testing.

2. In the event that equipment provided for this Contract fails during field commissioning, the Contractor assumes complete costs for shipping the equipment to the manufacturer, replacement equipment, complete factory testing, SEPTA witness of factory testing, return shipment to the Project site, and replacement equipment installation and commissioning.

3. In the event that equipment provided for this Contract fails during warranty, after project acceptance (All warranties begin with final acceptance), SEPTA will follow standard warranty procedures.

4. Coordinate factory tests of equipment ordered by SEPTA with the SEPTA Project Manager. Depute personnel to witness the tests if required by SEPTA.

D. Field Testing:

1. Provide the services of a certified National Electrical Testing Agency independent testing company to perform the field testing work covered in this Section.

2. Coordinate with ABB and SEPTA to ensure presence and participation of ABB personnel for field testing of SEPTA ordered equipment. Prepare the test procedure of SEPTA ordered equipment in consultation with ABB personnel.

1.05 Deliverables

A. Submit six (6) hard copies and six (6) CD-ROM copies of the certified test reports for all factory and field tests in Adobe Acrobat (PDF) format.

PART 2 - PRODUCTS

2.01 Test Responsibility

A. The Contractor is responsible for all tests specified.

B. Perform tests under this Contract to verify compliance with all Contract Documents and design and performance requirements to the satisfaction of SEPTA.
2.02 Tests Included
A. Perform all tests specified in the Contract Documents and any other tests required in connection with quality assurance program. Perform all tests otherwise required to bring the substation to revenue service.
B. Include all tests performed and tests called for in the applicable ANSI, IEEE and NEMA Standards.
C. The tests specified under the Contract are not to be considered to be all inclusive and shall not relieve the Contractor from the responsibility of verifying compliance with all Contract Documents and design and performance requirements to the satisfaction of SEPTA.

2.03 Test Instruments, Personnel and Materials
A. Furnish all test instruments and equipment as well as personnel and materials necessary for performing all tests.
B. Ensure attendance of supplier’s Engineer for the testing and commissioning of the SEPTA supplied equipment to include all circuit breakers and autotransformers. It is considered that each substation would require the presence of the supplier’s testing and commissioning Engineer for the following durations:
   1. Circuit Breakers:
      a. One (1) week for each phase of construction.
   2. Autotransformers:
      a. One (1) week for each autotransformer.
C. Define any support required from SEPTA or others for tests. Include requirements of outage, electricians, and/or flagmen.

2.04 Test Failure
A. Replace and/or repair damaged items due to test failures at no cost to SEPTA.
B. Repeat any test showing unsatisfactory results. The original unsatisfactory results, description of corrections and the new satisfactory results shall be part of the test report provided to SEPTA.

2.05 Test Witnessing
A. Notify SEPTA four (4) weeks prior to performing any test.
B. Coordinate all field tests with SEPTA. Request flagmen, track and power outage at the time of test notification.
C. SEPTA may witness any and all testing.

2.06 Test Acceptance
A. Final acceptance of each test will be made by SEPTA upon satisfactory completion of the test and approval of the test reports.

PART 3 - EXECUTION
3.01 Factory Tests

A. Perform design and production tests in the factory prior to shipment of the equipment. Wire, adjust and test all equipment to ensure completeness, adequacy and proper functioning of equipment for the application intended.

1. Design Tests:
   a. Perform design tests on the first completely finished system component or equipment assembly of each type to establish their characteristics and conformity to the requirements of the Contract Documents or to applicable industry standard if there is not an explicit Contract Document requirement.
   b. SEPTA, at its sole and absolute discretion, may waive requirements for design tests on components and equipment assemblies in regular production that have been used in similar application on electrified railroads, for which design tests have already successfully been performed on the same or substantially the same equipment as that proposed for this Contract, and provided copies of the certified design test reports are furnished to SEPTA.
   c. If the design tests were performed at power frequencies other than 25Hz, calculations must be made to show that the expected performance will be successful at 25Hz. Calculations must be performed by a Professional Engineer licensed in the Commonwealth of Pennsylvania. A complete set of calculations with the results clearly shown must be submitted to SEPTA.
   d. Such a waiver does not in any way relieve the Contractor from full responsibility regarding the equipment quality, reliability, performance and safety.
   e. Design tests of the circuit breakers and autotransformers supplied by SEPTA have been performed.

2. Perform production tests on every system component and equipment assembly for the purpose of checking the correctness, quality and uniformity of manufacturing processes.

B. Refer to the specific sections of the Contract Documents for individual equipment test requirements.

C. Factory tests of the SEPTA supplied equipment (circuit breakers and autotransformers) will be completed before delivery to the Contractor. Compile test reports and include in the operations and maintenance manuals of each site.

3.02 Field Tests

A. Tests Prior to Equipment Energization:

1. Field tests at each substation shall be performed in two (2), or more, phases per construction phasing.

2. Verify that all equipment is installed according to Contract Documents.

3. Ground Grid Resistance Test:
   a. Measure the substation ground grid resistance. Compare the test results with design calculations.
   b. In the event that the measured value of resistance is higher than the design value, drive additional ground rods into the earth and connect the rods to the grounding grid to bring down the resistance to the design value.
   c. Verify grounding connections to all equipment and components. Measure the resistance of a few sample connections by low resistance ohmmeter.
4. Visual Inspection:
   a. Perform visual inspection to verify that all substation equipment has been correctly installed, connected and grounded, and that there are no equipment incompatibilities or omissions.
   b. Include visual inspection and checks of all equipment, including:
      1) Equipment mountings, with special attention to the clearances.
      2) Conductor installation.
      3) Bus connections.
      4) Bus insulation installation.
      5) Electrical clearances especially between the cable terminations and the circuit breakers and on the disconnect switches and surge arresters.
      6) Control and power cable connections and terminations.
      7) Wire and cable termination markings with respect to shop drawings.
      8) Cable attachments.
      9) Disconnect switch and surge arrester cable connections.
     10) Disconnect switch installation, operation and blade to contact alignment.
     11) Relay and auxiliary contact configuration check.

5. Functional and Operational Tests:
   a. Perform functional and operational tests to verify that all substation equipment functions correctly and in accordance with the Contract Documents and SEPTA approved control schematics.
   b. After successful testing, each function circuit shall be approved and so designated on the applicable control schematic. Test all interlocking functions to verify correct operation and safety of the design.
   c. Calibrate and adjust all instruments. Provide calibration certificates.

6. Dielectric Tests:
   a. Perform power frequency dielectric test for duration of one (1) minute at the manufacturer recommended and SEPTA approved voltages meeting the ANSI/IEEE standards for the equipment voltage class. Perform tests at 60 Hz test voltage if 25 Hz is not available. Verify applicability of 60 Hz test voltage with the manufacturer.
   b. Test the following equipment:
      1) Autotransformers.
      2) Power cables and control wiring interior and exterior to the substation.
      3) Circuit breaker wiring.
      4) Circuit breaker busbars.
      5) Circuit breakers.
      6) Disconnect switches.

7. Continuity and Resistance Tests:
   a. Check all power cables for electrical continuity. With the circuit breaker de-energized, the resistance of the cables shall be measured and the results shall be compared with calculated values and any deviations shall be analyzed and explained.

8. Relay Coordination and Calibration Tests:
   a. Set all protective devices in accordance with the results of the protective device coordination study.
b. Perform high current, low voltage secondary injection tests at 25 Hz on all circuit breaker protective devices.

c. For each protective device verify simultaneously satisfactory operation of the current transformer, the voltage transformer, the secondary winding polarity, the relay operation, the integrity of tripping circuit and the circuit breaker operation.

d. Perform all necessary tests to demonstrate and confirm satisfactory and correct coordination of all protective devices and circuit breakers.

9. Trolley, Feeder, and Autotransformer Circuit Breaker Testing:
   a. Prepare a field test procedure for SEPTA ordered circuit breakers in consultation with the supplier and submit for review and approval.
   b. The procedure shall include, at a minimum, all tests recommended or required by applicable IEEE or IEC standards. The tests shall include continuity and insulation test of control wiring, dielectric tests of the medium voltage circuit, local and remote operation, and operation of auxiliary contacts and operations counter.
   c. Verify grounding of each circuit breaker.
   d. Perform field tests per approved procedure.
   e. Submit consolidated test report to SEPTA for review and approval.

10. Autotransformer Testing:
    a. Perform the following tests and analyses on both autotransformers:
       1) Prepare a field test and commissioning procedure, in consultation with the supplier, and submit for review and approval to SEPTA. At a minimum, include all tests required by IEEE C57.12.00, IEEE C57.12.90, other applicable standards and the supplier.
       2) Verify grounding of the autotransformer.
       3) Verify connections and grounding of the surge arresters. Test surge arresters per approved test procedure.
       4) Test the traction return cables, connections, and continuity from the rail return bushing to the impedance bonds.
       5) Determine insulation resistance and power factor using Doble or other SEPTA approved test.
       6) Determine the dielectric strength and total acid number of the transformer oil in accordance with ASTM D 3487.
       7) Perform dissolved gas analysis of the transformer oil in accordance with ASTM D 3612.
       8) Perform test for corrosive sulfur in accordance with ASTM D 1275.

11. Disconnect Switches:
    a. Submit reports of design and routine tests performed per IEEE C37.34 and other applicable standards to SEPTA for review and approval. The reports shall include results of dry power frequency withstand test and contact resistance test on sample switches, minimum 20 percent of the quantity supplied.
    b. Perform field commissioning tests per IEEE C37.34 and other applicable standards and as recommended by the supplier.
    c. Operate each disconnect switch a minimum of ten (10) times without applying voltage to verify proper operation. Record the operation of all normally open and normally closed auxiliary contacts. Normally open contacts should close only after the main contacts have closed. Normally closed contacts should close only after the main contacts have opened fully.
    d. Operate each switch five (5) times with rated voltage to verify that there is no arcing.
12. Distribution Transformers
   a. Prepare and submit a testing and commissioning procedure to SEPTA for review and approval.
   b. Include all tests required by IEEE C57.12.00 and IEEE C57.12.90.
   c. Verify grounding of the tank and continuity of the return circuit.
   d. At a minimum, perform insulation resistance and oil dielectric tests.

13. Surge Arresters:
   a. Submit the reports of the design and routine tests as specified in Section 16335.
   b. Perform power frequency and partial discharge tests per IEEE C62.11. Submit the test results to SEPTA for review and approval.
   c. Record the measured leakage current in partial discharge (PD) tests in the installation report.

14. Annunciator:
   a. Verify correct operation of annunciator and Human Machine Interface (HMI) for all alarms, status and control points with local activation as well as from the Railroad Operations Control Center (ROCC).

15. Supervisory Control and Data Acquisition (SCADA) / Remote Terminal Unit (RTU) System Tests:
   a. Following installation of local area network, the network server, RTU, the SCADA interfaces to conduct the following tests:
      1) Confirm proper operation of all bay modules, local area network and the network server.
      2) Confirm all lines for proper data communication.
      3) Confirm operation of the HMI and keyboard connected to the gateway.
   b. Perform a complete operational test of the equipment. Test all SCADA control, monitoring and measuring functions on all equipment. Include tests on autotransformers, circuit breakers, disconnect switches, potential transformers, distribution transformer, battery and battery chargers, intrusion and smoke alarms, yard lighting control panel and all auxiliary systems. Test all SCADA functions for satisfactory local operation, remote operation from the control center and remote operation from the network server under both modes of Local/Remote selector. Perform point-to-point checks on all equipment as follows:
      1) Initiate a status change at each supervised, controlled and measured item of equipment and verify that the status change has been correctly transmitted to the control center.
      2) Apply a control signal at each control point in the control center and the network server and verify that the controlled item of equipment responded correctly.
      3) Apply an input signal to all measurement transducers and confirm the receipt of correct measurement at the control center.
      4) Ensure that all appropriate indications are displayed and logged and that all appropriate control actions are granted.
      5) Perform end-to-end tests for SCADA after successful completion of local control tests.

B. Tests Following Equipment Energization:

1. System Energization:
   a. Close all feeder, trolley and bus tie circuit breakers.
   b. Check voltage on all busbars.

2. Closing and Opening Switching Surge Test:
a. Close and open on 24 kV circuit breaker randomly twenty (20) times and measure the switching surge.
b. Close and open on 12 kV circuit breaker randomly twenty (20) times and measure the switching surge.

3. Relay Verification Tests
   a. Test the functioning of the protection circuit and relay settings by primary injection test at 25 Hz. The test set shall be capable of testing instantaneous, time overcurrent, impedance and differential relays.
   b. Test each relay by injecting the required current at 25 Hz in the power circuit to cause operation of the relay. Relay setting may be changed if so warranted by the limitations of the testing device.
   c. Use 25 Hz voltage from the test set for verification of the impedance relays.
   d. Submit the details of the test set and test procedure for review and approval at sixty (60) days before the proposed tests.

4. Post Short Circuit Inspection:
   a. Apply all required safety measures by equipment grounding and by other approved means.
   b. Circuit Breakers:
      1) De-energize and isolate the circuit breakers.
      2) Perform a visual check and inspect for any signs of damage.
      3) Revise the relay settings and reset relays, if required.
   c. Autotransformers:
      1) Determine insulation resistance and power factor using Doble test.
      2) Perform dissolved gas analysis of the transformer oil in accordance with ASTM D 3612.
   d. System Operation Tests – To be complete at discretion of the SEPTA Project Manager:
   e. Reenergize the system and observe system revenue operation.
   f. Monitor and record all measured values for two (2) hours.
   g. Thermo-graphic Measurement:
      1) Apply all required safety measures and recommendations provided in the arc flash study. Wear the appropriate Personal Protective Equipment (PPE).
      2) Test all traction power busbar connections and overhead system connections with thermo-graphic test instrument.

END OF SECTION