Addendum #3 To
Request for Proposal
For Electrical Reliability Upgrades – Bid Pack #1: Project 003-245182 – Physics Building
090-245186 – Engineering Building
Dated Tuesday, August 26, 2014

The Addendum must be acknowledged on your lump sum bid.

NOTE: You must have attended a pre-bid conference in order to be eligible to bid on a particular project. Receipt of minutes or addenda without being at a pre-bid conference does not qualify your company to bid.

Please find the following clarifications:

2. Please find drawings for Physics Building and Engineering Building, located at the University’s website at: www.procurement.wayne.edu and click on bid opportunities.

Question 1: 090 Engineering Bldg. - Sheets E105.1 shows normal MV feeder to ATS-5 to come from existing underground 4800 volt 3 phase cable to PLD Utility Switchgear Room. Sheet 104 shows normal feeder to be from PLD Utility Source. Sheet C-1 shows duct bank to ATS-5 with no electrical detail. Please provide more detail of source, sizing of normal line side feeder to ATS-5 and cable type?

Answer: See Commonwealth Addendum 3, Item 10.

Question 2 090 Engineering Bldg. - Both sheets E-102 and E-103.1 show panel schedules for Panel UPR-2. Is it a 2-section panel? Please advise.

Answer: See Commonwealth Addendum 2, Item 23, 24 and 25.

Question 3: 090 Engineering Bldg. - Sheet E-0 in Detail 1 shows a 100 amp panel to feed HVAC, lighting and H2 Ventilation. Please provide panel schedule?

Answer: See Commonwealth Addendum 3, Item 11.

Question 4: BP#1 does not show Siemens Diesel Fuel Meters. Please review and advise. Is Ground Penetrating Radar required for BP #1?

Answer: See Commonwealth Addendum 3, Item 7 for fuel meters and Commonwealth Addendum 2, Item 4 for Ground Penetrating Radar requirement.

Question 5: 030 Physics Bldg. – On Sheet E-103 & E102 the feeder from MDB#2 to UPS shows 3 – 250 MCM. Please review and advise if a neutral conductor and provide ground size are required?


Question 6 090 Engineering Bldg. – Sheet E-104 the feeder from G-2 to ATS-4 is shown as both feeder type 25 & 26. Which is correct?

Answer: 25

Question 7: 090 Engineering Bldg. – Will there be an auxiliary power feeder to G-2 for battery charger, jacket warmers, etc.? If so, please provide details.
Answer: See Commonwealth Addendum 3, Item 14.

Question 8: We need some clarification on the property insurance requirement. The contract states in 11.2 A. 5 “amount sufficient to cover total value of the contractor’s property in the care custody or control of WSU” and then item 11.3.1 indicates full insurable value thereof. Does this mean full contract amount? Basically the question is “what limit” is acceptable for job site, in transit, and temporary location?

Answer: Provide Insurance equal to the full Contract Amount

Question 9: 090 Engineering Bldg. - Please indicate location Generator Annunciator and any other equipment associated with emergency system monitoring.

Answer: See Question 24.

Question 10: 030 Physics Bldg. - Please indicate location Generator Annunciator and any other equipment associated with emergency system monitoring.

Answer: See Question 24.

Question 11: Both buildings – Are Diesel Generator set Neutral Grounding (Earthling) Equipment required on each of the 480 volt generators?

Answer: See Commonwealth Addendum 3, Item 29, 32, 33.

Question 12: Both buildings – will Day Tank be required for the Gen Sets? Both generators have belly tanks.

Answer: Both buildings diesel generators include an 1100 gallon “belly tank”. No additional day tank is required.

Question 13: Bid Pack #1 Specification Section 260553, 3.3.O.2 states, “Comply with Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels” but there is no Section 260574 with which to comply. Question #2 is related.

Answer: See Commonwealth Addendum 3, Item 3

Question 14: Bid Pack #1 Specification - there seems to be no specification for Short Circuit/Coordination/Arc Flash Study. Please provide specification asap in order for us to obtain pricing for these studies in time for bid submittal.

Answer: See Commonwealth Addendum 3, Items 2 and 3

Question 15: BP#1 Physics Addendum 2 – Sheet E102 shows new panel E-104. Sheet E-103 shows the loads of both panels UPS RP-1 & UPS-RP-2 and the panel schedule for Panel UPS-RP-1. Please provide panel schedule for new panel UPS-RP-2?

Answer: See Commonwealth Addendum 3, Item 21

Question 16: BP#1 Physics Addendum 2 – Sheet E-102 on lower right shows a 100 amp breaker and feeder for auxiliary power for generator. Sheet E-1 shows the two duct banks in sections 1/ES-1 and 2/ES-1. Should a 2” conduit be added for the auxiliary power feeder to generator?

Answer: See Commonwealth Addendum 3, Item 14

Question 17: BP#1 Physics Addendum 2 – Are any Spare conduits required in the duct banks?

Answer: See Commonwealth Addendum 3, Item 14.
Question 18: BP#1 Physics Addendum 2 – Sheet C-2 has a note on the upper right in the clouded notes that indicate that a section of the sloped stone wall & foundation are to be removed for the duct bank and be replaced.

- Please indicate the section of the wall to be demoed on the drawings or indicated where the duct bank will enter the Switchboard room?
- Please provide cut sheet of sloped wall and foundation.

Answer: a. The duct bank enters the PLD and WSU electrical room in open area space. Install duct bank per Addendum 2 Physics Drawing Set.
- No cut sheet is required.

Question #19: BP#1 Physics Addendum 2 – Sheet E-101 Section 2 shows the new cable tray and conductors to the PLD transformers.

- We did not have access to the PLD Room on the walk thru. Working in a room with energized transformers brings up many safety questions. Can pictures of this room be provided?
- Please provide specification for cable tray. (Spec 026036 is listed in Table of Contents but is not provided).
- The drawings shows the conduits entering the PLD room from under the foundation wall. Do the conduits enter the room in this manner or do they enter thru the foundation wall?

Answers: a. See Commonwealth Addendum 3, Item 15
- See Commonwealth Addendum 3, Item 1
- See Commonwealth Addendum 3, Item 24

Question #20: BP#1 Physics Addendum 2 – Sheet E-103 Panel Schedule for UPS-RP-1 & UPS-RP-2 shows circuit UPS-RP-1 to use #6 in 1" conduit and the load of the circuit is 80 amps. Panel Schedule UPS-RP-1 (on the right side) shows to use #2 for the circuit. Please advise.

Answer: The load identified in question 20 is 9600 watts. This circuit requires #4 Cu with #8 ground.

Question #21: BP#1 Physics Addendum 2 – Sheet E-103 Panel Schedule for UPS-RP-1 & UPS-RP-2 shows circuit UPS-RP-1 to use #4 in 1" conduit and the load of the circuit is 80 amps. Panel Schedule UPS-RP-1 (on the right side) shows to use #2 for the circuit. Please advise.

Answer: See Question 20.

Question 22: BP#1 Physics - The ceiling of the upper floors does not have access (see enclosed photo). Can surface mounted conduit be run? If not please advise as to acceptable method that may be used in this facility?

Answer: See Commonwealth Addendum 3, Item 30

Question 23: BP#1 Physics – The ramp from the loading dock walkway into the pit will be removed. Will a metal set of steps be required?

Answer: See Commonwealth Addendum 3, Item 16.

Question 24: BP#1 Physics Addendum 2 – What are locations of Siemens Fuel Meter, Generator Annunciator, ATS Annunciator, closest BMS & Communication Room (for phone line to system communication devices)?

Answer: See Commonwealth Addendum 3, Item 17.

Question 25: BP#1 Physics Addendum 2 – Sheet S-3 3/S.1 shows replacing existing steel beams over pit with new W10x19 beams. Please provide layout of existing beams to be replaced.

Answer: See Commonwealth Addendum 3, Item 31
Question 26: BP#1 Engineering Bldg. – Please indicated on the plans the location, conduit routing and size of cables of Medium Voltage Feeder from the Utility to ATS-5?

Answer: See Question 1

Question 27: BP#1 Engineering Bldg. Addendum #2 – Sheet E-0 detail 1/E.0
   a. Note 2 states louver on door. Please provide specification on door, hinges and hardware.
   b. Please provide elevation sketch of 8" block wall indicating height and any other necessary details
   c. Please provide specification for exhaust fan
   d. The fan shows to exhaust out the foundation wall. Please provide elevation sketch showing the relationship of the duct with the exterior elevation. (Will we be coming out underground and need a well?)
   e. What size duct will be used for the exhaust fan to the exterior?
   f. Please provide specification for 'Self Contained Eye Wash Station'
   g. Please provide panel schedule for Panel UPS-PP

Answer: 
   a. See Commonwealth Addendum 3, Item 4 and 5.
   b. See Commonwealth Addendum 3, Item 18.
   c. See Engineering Addendum 2, Key Note 1 on Sheet E-0
   d. See Commonwealth Addendum 3, Item 19
   e. No duct work required, See Commonwealth Addendum 3, Item 19.
   g. See Commonwealth Addendum 3, Item 11.

Question 28: BP#1 Engineering Bldg. Addendum #2 – Sheet E-0 Note 16 references a smoke detector tied into existing fire alarm system. Please provide contact for owner’s fire alarm vendor.

Answer: The main fire Alarm Panel in office is National Time & Signal. Auxiliary panels are Simplex Grinnell.

Question 29: BP#1 Engineering Bldg. Addendum #2 - The generator will need a feeder to an auxiliary panel in the generator enclosure. Please provide information on the breaker and circuitry for feeder and routing in duct bank.

Answer: See Commonwealth Addendum 3, Item 14.

Question 30: BP#1 Engineering Bldg. Addendum #2 Please indicate conduit for controls to generators and annunciators.

Answer: See Question 7

Question 31: BP#1 Engineering Bldg. Addendum #2 Are any spare conduits required in duct banks?

Answer: See Question 17

Question 32: BP#1 Engineering Bldg. Sheets ES-1 & E-104 What size MV cables run from 2000 KVA 480v to 4800v XFMR to ATS-5?

Answer: See Question 1

Question 33: BP#1 Engineering Bldg. Sheets ES-1 & E-104 What size MV cables run from ATS-5 to the existing 600 amp MV switch?

Answer: See Question 1

Question 34: Please provide a detailed specification, approved manufacturers, and product information as noted on detail 4 on sheet S-1 "sound blanket & anchors for grommets" for the existing pit walls.

Answer: See Commonwealth Addendum 3, Item 22.
Question 35: BP#1 Could not find a specification issued for low voltage data/communication wiring for Siemens interface. Is there a WSU Standard for this?

Answer: See Commonwealth Addendum 3, Item 8

Question 36: re: 003 Physics Bldg. – The floor plans drawings are Not To Scale (NTS). Can scale drawings be provided?

Answer: See Commonwealth Addendum 3, Item 23.

END OF ADDENDUM

IMPORTANT- This is an addendum which MUST be acknowledged on your bid form.

We will require two copies each of your lump sum proposals, vendor qualification questionnaire and your bid bond documents.

All questions concerning this project must be emailed to: Robert Kuhn, Procurement & Strategic Sourcing. Email: ac6243@wayne.edu, and copy Valerie Kreher, Sr. Buyer, at ab4889@wayne.edu.

Do not contact either FP&M or the Design Firm directly as this may result in disqualification of your proposal.

Thank you for interest shown in working with Wayne State University.

Robert Kuhn
Sr. Buyer

CC: Robert Jacobs (Project Manager), Anne Vandenbussche, Valerie Kreher, Sr. Buyer.
Wayne State University
Physics and Engineering Building
Electrical Reliability Upgrades
Bid Package No 1

Commonwealth Addendum No 3 to WSU Projects 003-245182 Physics Building and 003-245186 Engineering Building

September 24th, 2014

The clarifications and additions to follow become part of the bid documents

Attachments:

Specification Section 260536 Cable Tray
Specification Sections 260573 Overcurrent Protective Device Coordination Study
Specification Sections 260574 Overcurrent Protective Device Arc Flash Study
Specification Sections 081100 Prefinished Steel Doors and Frames
Specification Sections 087100 Door Hardware
Specification Sections 260523 Control Voltage Electric Power Cables
Sketch 1 for panel schedule Engineering Building UPS-PP; Refer to item 11
Sketch 2 for Steel Stairs. 2 sets of Stairs for accessing the Gen Set location is required; Refer to Item 16
Sketch 3 UPS-RP2 to be added to Physics Sheet E-103; Refer to item 21.
Original Building drawings of the Physics building are provided for clarity/dimensions; Refer to Item 23.
Sketch 4 - To replace major equipment table at Physics on Sheet E-103; Refer to Item 27
Sketch 5 – To replace schedules on Engineering sheets E-102; Refer to item 28
Sketch 6 – To add clarify to the Physics Pit beam spacing; Refer to Item 31.
Sketch 7 – To clarify location of building grounding system for Physics; Refer to Item 32.
Sketch 8 - To clarify location of building grounding system for Engineering; Refer to Item 33.
Physics PLD Photos – To add clarity to the connection points within the PLD room at the Physics; Refer to Item 15.

Clarifications and additions are as follows:

Item 1. Added specification section 260536 Cable Tray.

Item 2. Added specification sections 260573 Overcurrent Protective Device Coordination Study.

Item 3. Added specification sections 260574 Overcurrent Protective Device Arc Flash Study.

Item 4. Added specification sections 081100 Prefinished Steel Doors and Frames.

Item 5. Added specifications sections 087100 Door Hardware.

Item 6. Section 263353, page 1 – clarified that the UPS systems are supplied by the contractor from the Owners preferred vendor.
Item 7. Specification 263213, Section 2.3.4 starting on page 4 – Clarify Diesel Gen set manufacturer to provide 4/20 mA level sensor and associated intrinsically safe circuitry for 50%, 80% and 90% fuel monitoring. Siemens to connect to protected side dry contacts only.

Item 8. Added specification sections 260523 Control Voltage Electric Power Cables.

Item 9. NOT USED

Descriptions for Answers to Contractor Questions Issued For Addendum 3; See WSU Write Up

Item 10. The existing 4800 volt PLD feed is to be spliced at the PLD 2007 man hole and routed to the new ATS-5 through the existing main disconnect cabinet. The approximate length of the run is 50ft. The cable is 350kcmil, 1 per phase and 350kcmil neutral.

Item 11. Sketch 1 for panel schedule Engineering Building UPS-PP.

Item 12. NOT USED

Item 13. Physics Sheet, E-103 and E-102, the feeder from MCB2 to UPS shall also have 350kcmil neutral and #2 Cu Ground.

Item 14. The duct banks at the Engineering Building and Physics Building shall have an additional 2” conduit/cable for 100 amp aux power, a 2” conduit dedicated to controls monitoring and 2 each 3” conduits to act as spares. The main switchgear in both buildings have available spaces for Genset Aux power. See associated One-Line Diagram for available breaker locations. Feeders to be 2/0 Cu with Cu ground.

Item 15. Physics PLD Photos – Attached.

Item 16. Sketch 2 for Steel Stairs. 2 sets of Stairs for accessing the Gen Set location is required.

Item 17. The connection to the B.M.S. is assumed to be in the main electrical room for the Physics Building and the main electrical room of the EDC section of the Engineering Building. Annunciators to be installed in the mechanical room associated to each building to provide easily accessible, convenient monitoring of the new electrical equipment.

Each Diesel GenSet located at the outdoor location will be intraconnected to Siemens designed and manufactured monitoring panels that will be installed at a basement (or ground floor) optimum location selected by Siemens. Those signal data connections will be adjacent to some existing Low Voltage and/or ATS LV switchgear (or perhaps Medium Voltage) configured rooms. Siemens Industry Inc. (Plymouth Township) has produced a typical WSU ‘building specific’ Generator/Fuel Oil Control signal cabling diagram that depicts LV GenSet monitoring, fuel status, and ATS status digital signal intraconnections shown on the existing Siemens Building Management System schematic data recently issued Addendum 2.
Siemens remains responsible for identifying logic circuit cross-connections and terminal destinations between major electrical equipment and their added monitoring panels. Electrical Raceway installation provisions and Cabling placement destination pulls from/to field located apparatus ought to be provided by the General Contractor. The Telephone digital circuitry communication cabling and communication speed termination details will be arranged with Siemens assistance after the telephone company now employed by WSU has been appraised of the design detail requirements. Telephone company existing closet destination terminations will be accomplished by that service supplier.

**Item 18.** The wall height of the Battery/UPS room located in the basement of the Engineering Building extends to ceiling approximately 10'-0", VIF.

**Item 19.** A well is required to terminate the exhaust fan at the engineering building. A prefab corrugated galvanized steel 37"W x 24'D x 36" tall well with 4" of 1" stone placed in the bottom for drainage. 1" galvanized steel grating shall be provided.

**Item 20.** An Eye Wash Station is required in the battery area of the UPS room located in the basement of the Engineering Building. Eye wash station to be of the Portable, self contained type for easy cleanup and spill mitigation. Eye wash station to provide a minimum of 0.4 gallons per minute and have storage capacity of 15 minutes.

  **Acceptable Manufacturer Honeywell Fendall 2000**
  **Model Number 32-00200-0000**

**Item 21.** Sketch 3 UPS-RP2 to be added to Physics Sheet E-103.

**Item 22.** Sound attenuating blankets are required at the Physics Building in the Pit. The following is additional information:

  **Acceptable Manufacturers**

  1. Acoustical Surfaces, Inc.
     123 Columbia Court North ● Suite 201 ● Chaska, MN 55318
     (952) 448-5300 ● Fax (952) 448-2613 ● (800) 448-0121
     Email: sales@acousticalsurfaces.com
  2. Owens Corning
     One Owens Corning Parkway
     Toledo, Ohio 43659
     www.owenscorning.com
  3. Industrial Noise Control
     800-954-1998
     www.inc-noise.com

  **Additional Specification**
WSU Electrical Reliability Project  
Bid Pack 1, Addendum 3

- Exterior grade, UV resistant heavy-duty faced quilted fiberglass absorber bonded to a one-pound per sq. ft. reinforced loaded vinyl barrier.
- Suitable for use as modular curtain panels in outdoor applications, -20° to +180° F.
- Heavy-duty 10 oz per sq yd vinyl-coated-polyester quilted to the sound absorber.
- Curtain panels constructed with grommets across the top and bottom and exterior grade Velcro seals along the vertical edges.
- STC 33 Rating, NRC .75, 1.45 lb psf, nominal 2” thickness, 54” widths.

**Item 23.** Original Building drawings of the Physics building are provided for clarity/dimensions

**Item 27.** Sketch 4 - To replace major equipment table at Physics on Sheet E-103.

**Item 28.** Sketch 5 – To replace schedules on Engineering sheets E-102.

**Item 29.** The grounding system for the physics must be connected to the existing building grounding system. See attached Sketch 7 and 8.

**Additional Clarifications Issued for Addendum 3**

**Item 24.** Physics Building. The feeders from the transformers in the PLD room to the outdoor ATSSs are currently shown exiting the PLD room through the floor (under the foundation wall). It is acceptable to exit the foundation wall at an elevation above the transformers. The feeders will be connected to the low side of the transformers, routed to a cable tray above the transformers and then penetrate the wall of the PLD room in route to the ATS.

**Item 25.** Engineering Sheet E105.2. ATS-4 and ATS-5 shall be service entrance rated, circuit breaker type as shown at Physics.

**Item 26.** Engineering Sheet E-105.1 and E-105.2. Remove the existing power cable, 2 sets of 350kcmil from fire pump 600 amp outdoor disconnect to fire pump and jockey pump at penthouse elevation. Replace with 2 sets of 350kcmil fire resistant "Draka Lifeline" or similar cable to comply with NEC Art. 695.6 part 2. Approximate circuit length of 500 feet.

**Item 30.** Surface mount conduits are not acceptable in any finished areas including the upper floors. Conduits shall be installed above existing ceilings and supported to the wall and/ or structure. Any access points must be brought back to preconstruction condition at completion. Contractor shall provide access doors in the existing ceiling where access to boxes or other items are required by code. Contractor shall patch to match existing ceiling construction as necessary for piping installations. 2’ x 2’ minimum access doors with screwdriver type locking hardware is acceptable.

**Item 31.** Sketch 6 – To add clarify to the Physics Pit beam spacing. The configuration of the new beams match existing, with beams centered at third points in the 20'-0”+- north-south direction. Additional revision and detail added for beam size and support configuration.

**Item 32.** Sketch 7 – Physics building Grounding connection clarification.
Item 33. Sketch 8 – Engineering Building Grounding connection clarification.

End of Addendum
PHYSICS & ENGINEERING BUILDING’S
ELECTRICAL RELIABILITY UPGRADES

Project Specifications

Prepared for:
Wayne State University

Addendum #3
9/24/2014

Prepared by
Commonwealth
associates, Inc.
<table>
<thead>
<tr>
<th>Specifications</th>
<th>Table of Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physics Building</strong></td>
<td><strong>Engineering Building</strong></td>
</tr>
<tr>
<td>Building No. 663</td>
<td>Building No. 90</td>
</tr>
<tr>
<td>666 W. Hancock</td>
<td>5050 Anthony Wayne</td>
</tr>
<tr>
<td>Detroit, MI 48201</td>
<td>Detroit, MI 48202</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Section No.</strong></th>
<th><strong>Division / Section Title</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>017823</td>
<td>Division 1 – General Requirements</td>
</tr>
<tr>
<td></td>
<td>Operation and Maintenance Data</td>
</tr>
<tr>
<td>022280</td>
<td>Division 2 – Sitework</td>
</tr>
<tr>
<td>023000</td>
<td>Flowable Fill</td>
</tr>
<tr>
<td>024119</td>
<td>Earthwork</td>
</tr>
<tr>
<td>025230</td>
<td>Demolition</td>
</tr>
<tr>
<td></td>
<td>Concrete Walks &amp; Pavements</td>
</tr>
<tr>
<td>031000</td>
<td>Division 3 – Concrete</td>
</tr>
<tr>
<td>032000</td>
<td>Concrete Formwork</td>
</tr>
<tr>
<td>033000</td>
<td>Concrete Reinforcing</td>
</tr>
<tr>
<td>034100</td>
<td>Cast-In-Place Concrete</td>
</tr>
<tr>
<td></td>
<td>Precast Structural Concrete</td>
</tr>
<tr>
<td>042000</td>
<td>Division 4 – Masonry</td>
</tr>
<tr>
<td></td>
<td>Unit Masonry</td>
</tr>
</tbody>
</table>
Division 5 – Metals

050940  Post Installed Anchors
055000  Metal Fabrications

Division 8 – Openings

081100  Metal Doors and Frames
087100  Door Hardware and Accessories

Specification Sections – Table of Contents

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Division / Section Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>260510</td>
<td>Division 26 – Electrical</td>
</tr>
<tr>
<td></td>
<td>Electrical Design and Equipment</td>
</tr>
<tr>
<td>260519</td>
<td>Low-Voltage Electrical Power Conductors and Cables</td>
</tr>
<tr>
<td>260526</td>
<td>Diesel Generator Neutral Grounding</td>
</tr>
<tr>
<td>260526</td>
<td>Grounding and Bonding for Electrical Systems</td>
</tr>
<tr>
<td>260529</td>
<td>Hangers and Supports for Electrical Systems</td>
</tr>
<tr>
<td>260533</td>
<td>Raceways and Boxes for Electrical Systems</td>
</tr>
<tr>
<td>260536</td>
<td>Cable Trays for Electrical Systems</td>
</tr>
</tbody>
</table>
Wayne State University
Physics & Engineering Building’s
Electrical Reliability Upgrades
September 23, 2014 – Addendum 3

260523  Control Voltage Electrical Power Cables

260544  Sleeves and Sleeve Seals for Electrical Raceways and Cabling

260553  Identification for Electrical Systems

260573  Overcurrent Protective Device Coordination study

260574  Overcurrent Protective Device Arc Flash Study

262200  Low-Voltage Transformers

262200  Power Transformer (Physics)

262200  Power Transformer (Engineering)

262416  Panelboards

262726  Wiring Devices

262816  Enclosed Switches and Circuit Breakers

263213  1000 KW Diesel Engine Generator

263213  2000 KW Diesel Engine Generator

263353  Static Uninterruptible Power Supply

263600  Automatic Transfer Switches

Appendix

Geotechnical Report
(For Reference Only)
SECTION 081100 - METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Prefinished steel frames for interior doors.

B. Related Sections: Section(s) related to this section include:

1.2 REFERENCES

A. ASTM International:

2. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
5. ASTM D3363 Standard Test Method for Film Hardness by Pencil Test.

B. American National Standards Institute (ANSI):

1. ANSI 115.1 Specifications for Steel Door and Frame Preparation for Hardware.

C. National Fire Protection Association (NFPA):

1. NFPA 80 Fire Doors and Windows.

D. Underwriters Laboratories, Inc. (UL):

1. UL 10B Fire Tests of Door Assemblies.
2. UL 10C Positive Pressure Fire Tests of Door Assemblies.

1.3 PERFORMANCE REQUIREMENTS

A. 1 1/2 hour fire rating in accordance with UL 10B.

B. Passes positive pressure test in accordance with UL 10C.

1.4 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 01 Submittal Procedures Section.
B. Product Data: Submit product data, including manufacturer's SPEC-DATA product sheet, for specified products. Include details of design and construction and printed instructions covering installation.

C. Shop Drawings: Submit shop drawings showing layout, profiles and product components, including anchorage, accessories, finish colors and textures. Indicate installation requirements of finish hardware and reinforcements.

1. Warranty: Submit the warranty documents specified.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer experienced in performing work of this section who has specialized in the installation of work similar to that required for this project.

B. Regulatory Requirements: Fire-rated steel frames shall be of types tested and approved by Intertek Testing Services, Warnock Hersey and shall bear labels of same.

1. Three-sided frames shall receive a permanent embossed 90 minute label. Sidelite and borrowed lite frames shall receive a Mylar Warnock Hersey label when specified.

1.6 DELIVERY, STORAGE & HANDLING

A. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

1. Factory package components in protective cartons to prevent damage during shipping.

B. Storage and Protection: Store materials protected from exposure to harmful weather and at temperature conditions recommended by manufacturer.

1. Store material on wooden skids under cover in a protected area and keep vented to avoid condensation until ready for installation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual measurements/openings by field measurements before fabrication. Show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress schedule to avoid construction delays.

1.8 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
METAL DOORS AND FRAMES

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.

1. Warranty Period: 1 year.

PART 2 - PRODUCTS

2.1 PREFINISHED STEEL DOOR FRAMES

1. Refer to drawings, door schedule and details for required types and sizes of frames.

2.2 MATERIALS

A. Header and Jamb Members: Form interior door frames of ASTM A366 commercial quality cold rolled steel. Form exterior door frames of galvanized steel (A40) per ASTM A653. Provide frames in the following gages:

2. 1 3/8 Inch (35 mm) or 1 3/4 Inch (44 mm) Door Frames: [18] [20] gage.

B. Casings:

1. Steel: 22 gage cold rolled steel to ASTM A366.
2. Aluminum: 0.050 inch (1.3 mm) aluminum extrusion 6063-T5 alloy.

C. Hinge Reinforcements: 14 gage hot dipped galvanized (G60) steel to ASTM A653 (10 gage equivalent number of threads, SDI-107).

D. Strikes and Deadbolt Covers and Dust Box: 18 gage commercial quality cold rolled steel to ASTM A366.

E. Door Closer Reinforcement: Steel or aluminum in accordance with manufacturer's standard.

1. Standard Arm Mounting: Aluminum extrusion 6063-T5 alloy in accordance with manufacturer's standard.
   a. Door Guard: Aluminum extrusion 6063-T5 alloy in accordance with manufacturer's standard.

2. Parallel Arm Mounting: 16 gage galvanized (A40) steel per ASTM A653.

F. Casing Corner Alignment Clips: Prepainted 22 gage ASTM A366 commercial quality cold rolled steel.
METAL DOORS AND FRAMES

G. Felt Silencers, Weatherstripping and Smoke Gasketing (Standard Profile): In accordance with manufacturer's standard.
   1. Interior Frames: Install felt silencers on the header and strike jamb. Single door opening, 3 per strike jamb. Pair door opening, 2 per header.

H. Weatherstripping and Smoke Gasketing (Kerf Profile):
   1. Interior and Exterior Frames: Kerf weatherstrip to seal opening. Schlegel QDS500 is acceptable.

I. Fasteners: In accordance with manufacturer's standards, to comply with labeling agency for fire-rated frames.

J. Paint: Frame manufacturer's standard baked-on synthetic enamel, applied over a cleaned and phosphate coated surface.
   1. Application shall be by electrostatic method.
   2. Finish paint dry film thickness on doors panels shall be approximately 1 mil (0.03 mm) for finished paint.
   3. Factory finish paint shall pass 200 hour salt spray test in accordance with ASTM B117 and 700 hour humidity test in accordance with ASTM D1735 with no blistering.
   4. Paint hardness shall meet calibrated pencil lead test to ASTM D3363.
   5. Prime painted frames shall be field painted within 30 days of installation with a good quality oil based enamel as recommended, or a high quality water base latex. A flash rust inhibitor shall be used with water base latex method.

2.3 MANUFACTURED UNITS

A. General: Frames shall be prefinished type designed for installation at rough wall openings over prefinished walls.
   1. Provide steel frames to receive metal casings to conceal fasteners.
   2. Prepare steel frames to receive decorative wood moldings to conceal fasteners.
   3. Provide accessories and fasteners necessary for field assembly and installation in accordance with frame manufacturer's standards.
   4. Prepare for and provide reinforcements in accordance with manufacturer's standards as required to receive finished hardware.

B. Door Frames:
   1. Construct jamb member to interlock and align with header members to form a strong joint.
   2. Provide die cut mitered metal casings held tight together and in alignment with concealed corner backing pieces. Casings shall conceal all frame fasteners. Provide concealed clips to receive snap-on casings.

C. Hardware Preparations:
METAL DOORS AND FRAMES

1. In accordance with an approved Hardware Schedule, ANSI A115 and manufacturer's recommendations:
   a. Mortise frames for hinges and strikes.
   b. Drill and tap or reinforce frames for mortised or surface mounted hardware.

2.4 FINISHES

A. Frames and Door Finish:

   1. Standard Color selection by owner

2.5 SOURCE QUALITY CONTROL

A. Obtain steel door frame products from a single manufacturer.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.

3.2 EXAMINATION

A. Site Verification of Conditions: Verify that conditions of substrates previously installed under other sections are acceptable for product installation in accordance with manufacturer's instructions.

3.3 INSTALLATION

A. Prefinished Steel Door Frames:

   1. Install frames plumb and square, in accordance with shop drawings and manufacturer's instructions. Verify opening and dimensions with shop drawings. Use door as a template to ensure proper alignment and clearances.
   2. Attach hinges and hang door in frame. Adjust frame to door for equal and uniform clearance between top and sides of door and frame.
   3. Secure frame to wall with the appropriate type fasteners. Install casing on frame.
   4. Install silencers on interior door frames. Install weatherstripping on exterior door frames. Install smoke gaskets as required.
   5. Adjust strike plate to hold door tight to stops when closed.
   6. Install fire-rated door frames in accordance with NFPA 80.
3.4 CLEANING

A. Cleaning: Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance. Remove construction debris from project site and legally dispose of debris.

3.5 PROTECTION

A. Protection: Protect installed product and finish surfaces from damage during construction.

1. Repair or replace damaged or defective frames.
2. Touch up damaged areas of factory-applied finishes with aerosol spray cans of same paint as used in factory.

END OF SECTION
DOOR HARDWARE AND ACCESSORIES

SECTION 087100 - METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Hinges and Pivots.
   B. Stops.
   C. Pulls and Plates.
   D. Flush Bolts and Coordinators.

1.2 REFERENCES
   B. ANSI A156.1
   C. ANSI A156.26
   D. BHMA - Builder Hardware Manufacturers Association
      1. UL 10C
      2. UL 634

1.3 SUBMITTALS
   A. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.
   B. Shop Drawings: Manufacturer's approved shop drawings are required detailing the
      application of each product specified.

1.4 QUALITY ASSURANCE
   A. Manufacturer Qualifications: All equipment specified in this section will be provided by a
      single manufacturer with a minimum of ten (10) years experience manufacturing door
      hardware.
   B. Installer Qualifications: All products listed in this section are to be installed by a single
      installer with a minimum of five (5) years demonstrated experience in installing products of
      the same type and scope as specified.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Store products in manufacturer's unopened packaging until ready for installation.

1.6 WARRANTY
DOOR HARDWARE AND ACCESSORIES

A. At project closeout, provide to the Owner or Owner’s Representative an executed copy if the manufacturer’s Limited Warranty against Manufacturing Defects.

PART 2 PRODUCTS

2.1 Flush Bolts and Coordinators
   A. Manual Flush Bolts:
      a. Conformance: Meets ANSI A156.16.
      b. Throw: 3/4 inch (19mm).
      c. Backset: 15/32 inch (12mm).

2.2 Lock - Provide stainless steel mortise lock with ANSI 497 strike

2.3 Full mortise stainless steel ball bearing hinges

2.4 Parallel arm door closer with sweep and latch speed adjustment.

2.5 Door Panic Device – provide rim device on active door.

2.6 5 inch Saddle type threshold

PART 3 EXECUTION

3.1 PREPARATION
   A. Clean surfaces thoroughly prior to installation.

   B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.2 INSTALLATION
   A. Install in accordance with manufacturer’s instructions.

3.3 PROTECTION
   A. Protect installed products until completion of project.

   B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

PART 1 -

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.2 SUMMARY
   A. Section Includes:
      1. Ladder cable trays.
      3. Trough cable trays.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include data indicating dimensions and finishes for each type of cable tray indicated.
   B. Shop Drawings: For each type of cable tray.
      1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   C. Delegated-Design Submittal: For seismic restraints.
      1. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
      2. Vertical and horizontal offsets and transitions.
      3. Clearances for access above and to side of cable trays.
      4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAYS

A. Description:
   1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
   2. Rung Spacing: 12 inches (300 mm) o.c.
   3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
   4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
   5. No portion of the rungs shall protrude below the bottom plane of side rails.
   6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
   7. Minimum Usable Load Depth: 5 inches (125 mm).
   8. Straight Section Lengths: 12 feet (3.6 m) except where shorter lengths are required to facilitate tray assembly.
   9. Width: 18 inches (450 mm) unless otherwise indicated on Drawings.
   10. Fitting Minimum Radius: 24 inches (600 mm).
   11. Class Designation: Comply with NEMA VE 1, Class 12C
   12. Splicing Assemblies: Bolted type using serrated flange locknuts.
   13. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
   14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
2.3 SINGLE-RAIL CABLE TRAYS

A. Description:

1. Configuration: Center rail with extruded-aluminum rungs arranged symmetrically about the center rail.
2. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
3. Rung Spacing: 9 inches (225 mm) o.c.
4. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
5. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
6. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
7. Support Point: Splice fittings shall be hanger support point.
8. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
9. Loading Depth: 6 inches (150 mm).
10. Maximum Loads: 50 lb/ft. (74 kg/m).
11. Unbalanced Loads: Maintain cable tray rungs within six degrees of horizontal under all loading conditions.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
15. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.

2.4 TROUGH CABLE TRAYS

A. Description:

1. Configuration: Two longitudinal members (side rails) with a solid sheet over rungs exposed on the interior of the trough, or corrugated sheet with both edges welded to the side rails.
2. Rung Spacing: Rungs or corrugations shall be spaced a maximum of 6 inches (150 mm) o.c. and have a minimum flat bearing surface of 2 inches (50 mm).
3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
5. Minimum Usable Load Depth: 4 inches (100 mm).
6. Straight Section Lengths: 12 feet (3.6 m) except where shorter lengths are required to facilitate tray assembly.
7. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
8. Fitting Minimum Radius: 24 inches (600 mm).
9. Class Designation: Comply with NEMA VE 1, Class 12C.
10. Splicing Assemblies: Bolted type using serrated flange locknuts.
11. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
CABLE TRAY FOR ELECTRICAL SYSTEMS

12. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

2.5 MATERIALS AND FINISHES

A. Steel:

2. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
3. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.

B. Aluminum:

1. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.
3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.6 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.7 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-)high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

B. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
C. Remove burrs and sharp edges from cable trays.

D. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.

E. Fasten cable tray supports to building structure.

F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg).

G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

I. Support bus assembly to prevent twisting from eccentric loading.

J. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

K. Locate and install supports according to NEMA FG 1. Do not install more than one cable tray splice between supports.

L. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

M. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.

N. Make changes in direction and elevation using manufacturer's recommended fittings.

O. Make cable tray connections using manufacturer's recommended fittings.

P. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

Q. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

R. Install cable trays with enough workspace to permit access for installing cables.

S. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

T. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
U. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

V. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified.

B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.
CABLE TRAY FOR ELECTRICAL SYSTEMS

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.
260536

CABLE TRAY FOR ELECTRICAL SYSTEMS

END OF SECTION 260536
260573

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1. Study results shall be used to determine coordination of series-rated devices.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Coordination Study Software Developer.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. The following parts from the Protective Device Coordination Study Report:

   1) One-line diagram.
   2) Protective device coordination study.
   3) Time-current coordination curves.

b. Power system data.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and 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.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Comply with IEEE 242 and IEEE 399.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
   a. Arcing faults.
   b. Simultaneous faults.
   c. Explicit negative sequence.
   d. Mutual coupling in zero sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size and lengths.
   3. Transformer kilovolt ampere (kVA) and voltage ratings.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center, and panelboard designations.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

   a. Phase and Ground Relays:

      1) Device tag.
      2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
      3) Recommendations on improved relaying systems, if applicable.

   b. Circuit Breakers:

      1) Adjustable pickups and time delays (long time, short time, ground).
      2) Adjustable time-current characteristic.
      3) Adjustable instantaneous pickup.
      4) Recommendations on improved trip systems, if applicable.

   c. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

   a. Power utility's overcurrent protective device.
   b. Medium-voltage equipment overcurrent relays.
   c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
f. Cables and conductors damage curves.
g. Ground-fault protective devices.
h. Motor-starting characteristics and motor damage points.
i. Generator short-circuit decrement curve and generator damage point.
j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.

6. Provide adequate time margins between device characteristics such that selective operation is achieved.

7. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. The study shall be based on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:
   1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
   2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

   1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

   1. Electric utility's supply termination point.
   2. Switchgear.
   3. Unit substation primary and secondary terminals.
   4. Low-voltage switchgear.
   5. Motor-control centers.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY


M. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short-circuit ratings.
   2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
   3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY
   A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:
      1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
      2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
      3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.4 MOTOR-STARTING STUDY
   A. Perform a motor-starting study to analyze the transient effect of the system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.
   B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and, and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

3.5 POWER SYSTEM DATA
   A. Obtain all data necessary for the conduct of the overcurrent protective device study.
      1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
      2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
      3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
17. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Generator thermal-damage curve.
   e. Ratings, types, and settings of utility company's overcurrent protective devices.
   f. Special overcurrent protective device settings or types stipulated by utility company.
   g. Time-current-characteristic curves of devices indicated to be coordinated.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.
k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.6 FIELD ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7 DEMONSTRATION

A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573
SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals may be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

   a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Owner for preliminary submittal
OVERCURRENT PROTECTIVE DEVICE ARC FLASH STUDY

of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Software Developer.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

B. Operation and Maintenance Procedures: Provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and 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.
PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size and lengths.
   3. Transformer kilovolt ampere (kVA) and voltage ratings.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

G. Arc-Flash Study Output:
   1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated symmetrical fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. No AC Decrement (NACD) ratio.
      e. Equivalent impedance.
      f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
      g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
OVERCURRENT PROTECTIVE DEVICE ARC FLASH STUDY

H. Incident Energy and Flash Protection Boundary Calculations:
   1. Arcing fault magnitude.
   2. Protective device clearing time.
   3. Duration of arc.
   5. Working distance.
   6. Incident energy.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
   1. Location designation.
   2. Nominal voltage.
   3. Flash protection boundary.
   5. Incident energy.
   7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.
B. Preparatory Studies:

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Calculate maximum and minimum contributions of fault-current size.

   1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
   2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

   1. Fault contribution from induction motors should not be considered beyond three to five cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

   1. When the circuit breaker is in a separate enclosure.
   2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

   A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
OVERCURRENT PROTECTIVE DEVICE ARC FLASH STUDY

1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Owner.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.4 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:

1. Motor-control center.
OVERCURRENT PROTECTIVE DEVICE ARC FLASH STUDY

2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Control panel.

3.5 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 260574
SECTION 263353 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
   a. Surge suppression.
   b. Input harmonics reduction.
   c. Rectifier-charger.
   d. Inverter.
   e. Static bypass transfer switch.
   f. Battery with support stands and battery disconnect device.
   g. External maintenance bypass/isolation switch.
   h. Output isolation transformer.
   i. Remote UPS monitoring provisions.
   j. Battery wet cell charging system with monitoring.
   k. Remote monitoring connectivity.
   l. Cooling air fan arrays with ductwork.
   m. The contractor shall provide a suitable UPS enclosure with thermal and sound attenuation features.
   n. The UPS enclosure will be provided with contractor supplied HVAC system to maintain a uniform 73°F +/- 3°F for UPS operations and battery storage.
   o. The DC storage battery enclosure hydrogen evolution SCFH data provides a basis for a contractor supplied NEMA 7 explosionproof ventilation fan.

2. Two complete UPS systems (Contractor Purchased) Toshiba G8000 Series System Available from Ancona Controls.com; Houston, Texas 77041 are considered in this 263353 Specification

a. Part Number: T8MS3K30KK6XSN
   1) Engineering Building UPS 300 kVA/270 kW rated unit
   2) Quantity One G8000MM Standard System:
      a) 480V 3ϕ 60HZ Input
      b) 480V 3ϕ 60HZ Maintenance Output Voltage
      c) 480V 3ϕ 60HZ UPS Output Voltage
      d) 3ϕ 4 wire
      e) Battery: Charging Circuit DC Voltage
         Charging Circuit: ~ 40 Amps
STATIC UNINTERRUPTIBLE POWER SUPPLY

H₂ Gas Evolution SCFH
f) Heat Rejection: 61,000 BTU/Hr

g) Noise: ~ 78 dBA

h) Efficiency: ~ 93.8%

b. Part Number: T8MS3K10KK6XSN

1) Physics Building UPS 100 kVA/80 kW rated unit

2) Quantity One G8000MM Standard System:

a) 208V 3Φ 60HZ Input

b) 208V 3Φ 60HZ Maintenance Output Voltage

c) 208V 3Φ 60HZ UPS Output Voltage

d) 3 Φ 4 wire

e) Battery: Charging Circuit DC Voltage

Charging Circuit: ~ 13 Amps

H₂ Gas Evolution SCFH
f) Heat Rejection: 18,500 BTU/Hr

 g) Noise: ~ 68 dBA

h) Efficiency: ~ 93.7%

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. HVAC: Heating, Ventilation and Air Conditioning

C. LCD: Liquid-crystal display.

D. LED: Light-emitting diode.

E. PC: Personal computer.

F. THD: Total harmonic distortion.

G. UPS: Uninterruptible power supply.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to City of Detroit BOCA dataset.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include data on features, components, electrical duration ratings, and performance.

B. Shop Drawings: For UPS. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show operations and termination access, workspace, and clearance requirements; details of control display panels; and battery arrangement.
   2. Wiring Diagrams: For power, signal, and control wiring. (one-line with all secondary and monitoring circuit equipment details).
   3. Provide heat resection rate data. (consider a 73° F +/- 3°F enclosure space).
   4. Provide wet cell storage battery hydrogen evolution into a closed space. State ventilation requirement data. (consider a 73°F +/- 3°F environment).

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency provide the test QA results data. 

B. Seismic Qualification Certificates: For UPS equipment, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: For each product, from manufacturer.

D. Factory Test Reports: Comply with specified requirements.

E. Field quality-control reports.

F. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

G. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For UPS units to include in emergency, operation, and systems maintenance manuals.
1.8 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. Fuses: Three each for each type and rating.
   2. Cabinet Ventilation Filters: Two complete set(s).

1.9 QUALITY ASSURANCE

A. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in "Performance Testing" Article.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. UL Compliance: Listed and labeled under UL 1778 by an NRTL.

E. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

1.10 WARRANTY

A. Not Chosen, Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

   1. Warranted Cycle Life for Valve-Regulated, Lead-Calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

<table>
<thead>
<tr>
<th>Discharge Rate</th>
<th>Discharge Duration</th>
<th>Discharge End Voltage</th>
<th>Cycle Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hours</td>
<td>8 hours</td>
<td>1.67</td>
<td>6 cycles</td>
</tr>
<tr>
<td>30 minutes</td>
<td>30 minutes</td>
<td>1.67</td>
<td>20 cycles</td>
</tr>
<tr>
<td>15 minutes</td>
<td>45 seconds</td>
<td>1.67</td>
<td>120 cycles</td>
</tr>
</tbody>
</table>
2. Not Chosen, Warranted Cycle Life for Premium Valve-Regulated, Lead-calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

<table>
<thead>
<tr>
<th>Discharge Rate</th>
<th>Discharge Duration</th>
<th>Discharge End Voltage</th>
<th>Cycle Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hours</td>
<td>8 hours</td>
<td>1.67</td>
<td>40 cycles</td>
</tr>
<tr>
<td>30 minutes</td>
<td>30 minutes</td>
<td>1.67</td>
<td>125 cycles</td>
</tr>
<tr>
<td>15 minutes</td>
<td>1.5 minutes</td>
<td>1.67</td>
<td>750 cycles</td>
</tr>
</tbody>
</table>

3. Chosen Battery Application, Warranted Cycle Life for Flooded Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

<table>
<thead>
<tr>
<th>Discharge Rate</th>
<th>Discharge Duration</th>
<th>Discharge End Voltage</th>
<th>Cycle Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hours</td>
<td>8 hours</td>
<td>1.75</td>
<td>40 cycles</td>
</tr>
<tr>
<td>1 hour</td>
<td>1 hour</td>
<td>1.75</td>
<td>80 cycles</td>
</tr>
<tr>
<td>15 minutes</td>
<td>45 seconds</td>
<td>1.67</td>
<td>2700 cycles</td>
</tr>
</tbody>
</table>

B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.

1. Special Warranty Period: TWO years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:

1. Normal AC input Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.
4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.

6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.

7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.

8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.

9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.

2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions in subparagraphs below without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.

2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.

3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.

1. Ambient Temperature for Electronic Components: 32 to 104 deg F (0 to 40 deg C).

2. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).

3. Relative Humidity: 0 to 95 percent, noncondensing.

4. Altitude: Sea level to 4000 feet (1220 m).
2.2 PERFORMANCE REQUIREMENTS

A. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is 50 percent unbalanced continuously.

B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is 15 minutes.

C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15 percent from nominal voltage.

D. Overall UPS Efficiency: Equal to or greater than >93% percent at 100 percent load.

E. Maximum Acoustical Noise: 78dBA, "A" weighting, emanating from any UPS component under any condition of normal operation, measured 48 inches from nearest surface of component enclosure.

F. Maximum Energizing Inrush Current: Six times the full-load current.

G. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.

H. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.

I. Limitation of harmonic distortion of input current to the UPS shall be as follows:

1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5 percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.
2. Description: THD is limited to a maximum of 32 percent, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.

J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.
K. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.

L. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.

M. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:

1. 50 Percent: Plus or minus 5 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

N. Input Power Factor: A minimum of 0.90 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.


2.3 UPS SYSTEMS

A. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

B. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

C. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

D. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressor filters tested according to IEEE C62.41.1 and IEEE C62.41.2, Category C.
2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.
E. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

F. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future 25 percent increase in UPS capacity.

G. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

H. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

I. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.5 INVERTER

A. Description: Pulse-width modulated, with sinusoidal output.

B. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.
2.6 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.7 BATTERY

A. Not chose, Description: Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.

1. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

B. Description: Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units; factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.

1. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

C. Chosen battery application, Description: Flooded, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers mounted on three-tier, acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.

D. Toshiba (Ancona)

E. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

2.8 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: **Plain-language messages on a digital LCD or LED.**

1. Quantitative indications shall include the following:
   
   a. Input voltage, each phase, line to line.
   
   b. Input current, each phase, line to line.
c. Bypass input voltage, each phase, line to line.
d. Bypass input frequency.
e. System output voltage, each phase, line to line.
f. System output current, each phase.
g. System output frequency.
h. DC bus voltage.
i. Battery current and direction (charge/discharge).
j. Elapsed time discharging battery.

2. Basic status condition indications shall include the following:
   a. Normal operation.
   b. Load-on bypass.
   c. Load-on battery.
   d. Inverter off.
   e. Alarm condition.

3. Alarm indications shall include the following:
   a. Bypass ac input overvoltage or undervoltage.
   b. Bypass ac input overfrequency or underfrequency.
   c. Bypass ac input and inverter out of synchronization.
   d. Bypass ac input wrong-phase rotation.
   e. Bypass ac input single-phase condition.
   f. Bypass ac input filter fuse blown.
   g. Internal frequency standard in use.
   h. Battery system alarm.
   i. Control power failure.
   j. Fan failure.
   k. UPS overload.
   l. Battery-charging control faulty.
   m. Input overvoltage or undervoltage.
   n. Input transformer overtemperature.
   o. Input circuit breaker tripped.
   p. Input wrong-phase rotation.
   q. Input single-phase condition.
   r. Approaching end of battery operation.
   s. Battery undervoltage shutdown.
   t. Maximum battery voltage.
   u. Inverter fuse blown.
   v. Inverter transformer overtemperature.
   w. Inverter overtemperature.
   x. Static bypass transfer switch overtemperature.
   y. Inverter power supply fault.
   z. Inverter transistors out of saturation.
   aa. Identification of faulty inverter section/leg.
   bb. Inverter output overvoltage or undervoltage.
   cc. UPS overload shutdown.
dd. Inverter current sensor fault.
e. Inverter output contactor open.
ff. Inverter current limit.

4. Controls shall include the following:
   a. Inverter on-off.
b. UPS start.
c. Battery test.
d. Alarm silence/reset.
e. Output-voltage adjustment.

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:
   1. UPS on battery.
   2. UPS on-line.
   3. UPS load-on bypass.
   4. UPS in alarm condition.
   5. UPS off (maintenance bypass closed).

E. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts. “e-stop”

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
   1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
   2. Switch shall electrically isolate other UPS components to permit safe servicing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full UPS load current.

D. Mounting Provisions: Internal to system cabinet.

E. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.
2.10 OUTPUT ISOLATION TRANSFORMER

A. Description: Unit with low forward transfer impedance up to 3 kHz, minimum. Include the following features:

1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately 9.
2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
3. Regulation: 5 percent, maximum, at rated nonlinear load current.
4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
5. Electrostatic Shielding of Windings: Independent for each winding.
7. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
8. Capacitive Coupling between Primary and Secondary: 33 picofarads, maximum, over a frequency range of 20 Hz to 1 MHz.

2.11 OUTPUT DISTRIBUTION SECTION

A. Panelboards: Comply with "Panelboards" except provide assembly integral to UPS cabinet.

2.12 MONITORING BY REMOTE STATUS AND ALARM PANEL

A. Description: Labeled LEDs on panel faceplate indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication. Describe HMI display interface pages and operations display data.

1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

2.13 MONITORING BY REMOTE COMPUTER

A. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:

1. Connectors and network interface units or modems for data transmission via RS-232 link.
2. Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computer are not included in this Section.
3. Software and Hardware: Compatible with that specified in Section 260913 "Electrical Power Monitoring and Control."
2.14 BASIC BATTERY MONITORING

A. Toshiba UPS system.

B. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

C. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 deg C occurs within the compartment.

D. Annunciation of Alarms: At UPS control panel.

2.15 ADDITIONAL BATTERY MONITORING

A. Monitoring features and components shall include the following:

1. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
2. Connections for data transmission via RS-232 link, network interface and modem and external signal wiring to electrical power monitoring and control equipment. External signal wiring and computer are not specified in this Section.
3. PC-based software designed to store and analyze battery data. Software compiles reports on individual-cell parameters and total battery performance trends, and provides data for scheduling and prioritizing battery maintenance.

B. Performance: Automatically measures and electronically records the following parameters on a routine schedule and during battery discharge events. During discharge events, records measurements timed to nearest second; includes measurements of the following parameters:

1. Total battery voltage and ambient temperature.
2. Individual-cell voltage, impedance, and temperature. During battery-discharging events such as utility outages, measures battery and cell voltages timed to nearest second.
3. Individual-cell electrolyte levels.

2.16 BATTERY-CYCLE WARRANTY MONITORING

A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.

B. Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on front panel display.

C. Additional monitoring functions and features shall include the following:
1. Measuring and Recording: Total voltage at battery terminals; initiates alarm for excursions outside the proper float-voltage level.
2. Monitors: Ambient temperature at battery; initiates alarm if temperature deviates from normally acceptable range.
3. Keypad on Device Front Panel: Provides access to monitored data using front panel display.
4. Alarm Contacts: Arranged to initiate local and remote alarm for battery discharge events abnormal temperature abnormal battery voltage or temperature.
5. Memory: Stores recorded data in nonvolatile electronic memory.
6. RS-232 Port: Permits downloading of data to a portable PC.
7. Modem: Makes measurements and recorded data accessible to a remote PC via telephone line. Computer is not specified in this Section.

2.17 SOURCE QUALITY CONTROL

A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation battery testing. Include the following:

1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
4. Overload test.
5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's choice. WSU site test demonstrations shall be conducted during the Monday through Friday normal work week between 0830-1700 hours. WSU will observe testing. The seller shall submit the QA program test plan for WSU acceptance.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

3.3 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.4 IDENTIFICATION

A. Identify all components and unique destination wiring according to "Identification for Electrical Systems."
   1. Identify each battery cell individually.

3.5 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Comply with manufacturer's written instructions.
2. Inspect interiors of enclosures, including the following:
   a. Integrity of mechanical and electrical connections.
   b. Component type and labeling verification.
   c. Ratings of installed components.
3. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
4. Test manual and automatic operational features and system protective and alarm functions.
5. Test communication of status and alarms to remote monitoring equipment.
6. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for the UPS unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
   a. Simulate malfunctions to verify protective device operation.
   b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
   c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
   d. Test output voltage under specified transient-load conditions.
   e. Test efficiency at 50, 75, and 100 percent of rated loads.
   f. Test remote status and alarm panel functions.
   g. Test battery-monitoring system functions.

E. Seismic-restraint tests and inspections shall include the following:

1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
2. Test mounting and anchorage devices according to requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

F. The UPS system will be considered defective if it does not pass tests and inspections.
G. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

H. Prepare test and inspection reports.

3.7 PERFORMANCE TESTING

A. Engage the services of a qualified power quality specialist to perform tests and activities indicated for each UPS system.

B. Monitoring and Testing Schedule: Perform monitoring and testing in a single 10-day period scheduled for each of the two UPS units: 300 KVA/270 KW Engineering Building, and 100KVA/80KW Physics Building.

1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.

C. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:

2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
3. Frequency transients.
4. Voltage swells and sags.
5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
6. High-frequency noise.
7. Radio-frequency interference.
8. THD of the above currents and voltages.
9. Harmonic content of currents and voltages above.

D. Monitoring and Testing Procedures[ for Each Test Period]:

1. Exploratory Period: For the first [two] <Insert number> days[ of the first scheduled monitoring and testing period], make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.
2. Remaider of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
   a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.
   b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.
   c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
   d. Using loads and devices available as part of the facility's installed systems and equipment and a temporarily connected portable generator set, create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
   e. Using temporarily connected resistive/inductive load banks and a temporarily connected portable generator set, create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
   f. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.

E. Coordination with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this article.
   1. Provide the temporary use of an appropriate PC and printer equipped with required connections and software for recording and printing if such units are not available on-site.
   2. Coordinate printouts with recordings for monitoring performed according to this article, and resolve and report any anomalies in and discrepancies between the two sets of records.

F. Monitoring and Testing Assistance by Contractor:
   1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
   2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.
   3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.

5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.

G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.

H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in each report:

1. Description of corrective actions performed during monitoring and survey work and their results.

2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.

3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.

4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.

5. Recommendations for operating, adjusting, or revising UPS controls.

6. Recommendation for alterations to the UPS installation.

7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.

8. Recommendations for power distribution system revisions.

9. Recommendations for adjusting or revising electrical loads, their connections, or controls.

I. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION 263353
SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Multimode optical-fiber cabling.
2. UTP cabling.
3. RS-485 cabling.
4. Low-voltage control cabling.
5. Control-circuit conductors.
6. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

E. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 260523