Kenosha County – Brookside Care Center Generator Upgrade project - Specification Table of Contents

SECTION 260010
BASIC DIVISION 26 REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general administrative, material, and procedural requirements for Division 26 to expand the requirements specified in Division 01.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Permits and Inspections:

1. Permits: Obtain and pay for all permits, bonds, licenses, tap-in fees, etc., required by the City, State, or other authority having jurisdiction over the work, as a part of the work of the affected sections.
2. Inspections: Arrange and pay for all inspections required by the above when they become due as part of the work of the sections affected. Conceal no work until approved by these governing authorities. Coordinate inspection period with Authorities Having Jurisdiction and Engineer through Construction Manager. Present the Engineer with properly signed certificate of final inspection.

B. Coordination:

1. Coordinate arrangement, mounting, and support of Division 26 equipment:
    a. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
    b. To provide for ease of disconnecting the equipment with minimum interference to other installations.
    c. To allow right of way for piping and conduit installed at required slope.
    d. To assure connections of raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
2. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
3. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
    a. Ensure access doors are sized to permit complete access for concealed or inaccessible junction boxes, control and monitoring devices, elevator shaft and duct mounted fire alarm detectors and other items of equipment requiring access, maintenance, and/or operation.
        1) Ensure access to devices per codes and local authorities having jurisdiction.
4. Coordinate equipment furnished by Division 26: Install and wire in accordance with the manufacturer's recommendations and applicable standards and codes. Provide installation instructions, locating dimensions and wiring diagrams for the other trades. Supervise the installation and start-up and test the equipment unless otherwise specified.
5. Coordinate Equipment Furnished by Other Divisions: Equipment specified in other Divisions and requiring electrical supply will be erected, aligned, leveled and prepared for operation. Provide required controls and accessories along with installation instructions, diagrams, dimensions and supervision of installation and start-up. Provide the required electrical rough-ins and confirm the electrical controls and accessories furnished under the specifications for the other divisions. Install those controls and accessories not located in the mechanical piping and ductwork. Provide additional electrical controls, accessories, fittings and devices not specified under the equipment but required for a finished, operating job. Make final electrical connections. Participate in the start-up and test services.

1.3 SUBMITTAL PROCEDURES

A. General: Provide required submittals in accordance with Division 01 "Submittal Procedures".

B. Definitions:

1. Submittals: A written or graphic expression of the Contractor's interpretation of requirements in the Contract Documents to show how the Contractor intends to fulfill those requirements. Identify deviations from Contract Documents.
2. Action Submittals: Required submittal which Engineer reviews and approves or takes other appropriate action to communicate to the Contractor the status if the submittal and subsequent action required.
3. Other (Information, Closeout and Maintenance and Material) Submittals: Required submittals which Engineer reviews and may elect to respond. If rejected by Engineer for not complying with requirements, resubmittal or other action may be required on the part of the Contractor.

C. Failure to Submit:

1. Contractor's failure to provide submittals does not alleviate the responsibility to provide the requirements in the Contract Document as interpreted by the Engineer. Correct non-compliant items.

D. Applicable Information:

1. All information not applicable to the project shall be crossed out in the submittal. All applicable accessories, options, etc., shall be clearly indicated. Failure to comply shall be grounds for the submittal to be rejected.

1.4 ACTION SUBMITTALS

A. Submit action submittals in groups by systems. For example, all lighting fixtures, lamps, ballasts and accessories shall be submitted simultaneously in one package.

B. Submit the following action submittals as qualified in associated Division 26 Sections:
1. Batteries and battery chargers (submit with associated system).
2. Conduit fittings.
3. Disconnect switches.
4. Generators.
5. Lighting.
6. Lighting control equipment.
7. Panelboards.
8. Protective device coordination.
9. Protective devices.
10. Surge protection devices.
11. Switchgear.
12. Transfer switches (automatic and/or manual).
13. Underground ducts.
14. Wiring devices.

C. Action submittals submitted for other than those listed above or specifically required in the appropriate Specification Section will not be reviewed or returned.

D. Contractor Certificates:

1. Contractor certification forms may be submitted in accordance with Division 01 Section "Submittal Procedures" in lieu of system action submittal product data requirements except for the systems or products listed below:
   a. Luminaire and lighting systems.
   b. Lighting control systems.
   c. Protective devices.
   d. Switchgear.
   e. Transfer switches.
   f. Disconnect switches.

g. Panelboards.
h. Protective device coordination.
i. Surge protection devices.
j. Wiring devices.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Submit general coordination drawings in accordance with Division 01 Section "Project Management Coordination," to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

   a. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

      1) Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
      2) Exterior wall and foundation penetrations.
      3) Wall and floor sleeve penetrations.
      4) Floor box and poke-through assembly installations.
      5) Equipment connections and support details.
      6) Sizes and location of required concrete pads and bases.

   b. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
   c. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
   d. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, luminaires, communications systems components, sprinklers, and other ceiling-mounted devices.

2. Submit the following specific coordination drawings and others as defined in other Division 26 Sections:

   a. Access door locations and sizes.
   b. Building Cable Entry Rooms and Vaults.
   c. Electrical Equipment Rooms.
   d. Feeder Routings.
   e. Underfloor Duct Systems.

3. Contract Document Drawing copies may be used as base for coordination drawings then marked to depict actual equipment sizes and other requirements of coordination drawings. Those not marked will be rejected.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Prepare and submit operations and maintenance manuals in accordance with Kenosha County Requirements. In addition to the requirements specified in Division 01, include specific Division 26 Section requirements, and the following general information for equipment items:

   a. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

b. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
c. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
d. Servicing instructions and lubrication charts and schedules.

2. Include the following minimum information in the operations and maintenance manual:

a. Individual characteristics for trouble shooting sequences for each item of each:

1) Branch Circuit Panel.
2) Distribution Panel.
3) Fire Alarm System.
4) Switchgear Assembly.
5) Transfer switch.

b. Catalog cut sheets for every item for which a shop drawing is required.
c. Schedule of loads served from each:

1) Branch Circuit Panel.
2) Distribution Panel.
3) Emergency Generator Control System.
4) Switchgear Assembly.
5) Transfer Switch.
6) Refer to Division 26 Section “PANELBOARDS” for schedule organization and format.

d. On-hand spare parts list and complete parts list for each:

1) Distribution Panel.
2) Switchgear Assembly.

e. Bolt tightening torques and inspection intervals on each:

1) Bolted bus connection.
2) Cable connection.
3) Miscellaneous bolted electrical connections.

f. Manufacturers' recommended cleaning intervals and special procedures for each:

1) Cooling fins.
2) Dry-type transformer coil assembly.
3) Electrical equipment interior.
4) Electrical equipment ventilation opening.
5) Luminaire lenses, louvers, and reflectors.

g. Main and arcing contact adjustment and replacement for each:
1) Circuit breaker.
2) Fused switch.
3) Transfer switch.

h. Calibration and exercise procedures and intervals for each:
1) Control system.
2) Emergency battery ballast.
3) Insulated case breaker.
4) Molded case breaker.
5) Relay.
6) Transfer switch.

i. "As designed" and "as left" relay settings.
j. Testing interval and target values for ground fault protection circuit relays.
k. Testing and troubleshooting procedures unique to special systems. For example:

1) Infrared scanning.
2) Phase balancing.

3) High-pot tests.
4) Transformer tests.

l. Approved special construction details that differ from the details shown on Drawings.
m. Permits and inspections certificates.
n. Testing and Commissioning results.
o. Final submittal copy.
p. Special warranty information.
q. Service contract data.

B. Record Documents:

1. Prepare record documents in accordance with the requirements in Division 01 Section "Project Closeout Procedures." In addition to the requirements specified in Division 01, indicate installed conditions for:

a. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
b. Major equipment locations (exposed and concealed), dimensioned from prominent building lines.
c. Contract Modifications and actual equipment and materials installed.
d. Training and demonstration videos.
e. Keying schedules.
f. Software CDs.
g. Final field quality control test reports.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Material:

1. Provide four (4) keys for every different piece of electrical equipment which is equipped with a lock.
2. Provide all other loose equipment and extra material specified or supplied for use with all systems.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Obtain similar products through one source from a single manufacturer.

C. Testing Agency Qualifications: An agency with the experience and capability to conduct the testing indicated and that is acceptable to authorities having jurisdiction.

1. For electrical power equipment and systems, the agency shall be a member company of the International Electrical Testing Association (NETA) or is a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
2. For other than electrical power equipment or where NETA is not a recognized testing agent, the testing agency shall be as defined in the appropriate Division 26 section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Work and materials shall conform to and be executed, inspected and tested in accordance with the latest edition of the National Electric Code and with the governing rules and regulations of federal, state and local governmental agencies. References to "NEC" within the Division 26 Sections shall be considered synonymous to this electrical code.

B. Other codes and standards which will apply to this installation include the current editions of:

1. ANSI C2 - National Electrical Safety Code.
2. NFPA 70E – Standard for Electrical Safety Requirements for Employee Workspaces.
3. NFPA 99 - Health Care Facilities.
4. NFPA 101 - Life Safety Code.
5. NPFA 110 – Standard for Emergency and Standby Power Systems
6. Underwriters Laboratories.

C. Where governing codes indicate the Drawings and Specifications do not comply with the minimum requirements of applicable codes, be responsible for either notifying the Engineer in writing during the bidding period of the revisions required to meet code requirements, or providing an installation which will comply with the code requirements.

D. U.L. Listing

1. All electrical equipment, products and materials shall bear the Underwriter's Laboratories (UL), or other approved agency, listing label. Acceptable alternates include:

   a. Intertek Testing Service NA, Inc. (ITSNA) (formerly ETL).
   b. Wherein an item of equipment is specified to be U.L. Listed, the entire assembly shall be listed by Underwriters Laboratories, Inc. Any modifications to suit the intent of the Specifications shall be performed in accordance with the National Electrical Code and listed by U.L.

2. Definitions:

   a. Listed: Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintain periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner.
   b. Labeled: Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by who’s labeling the manufacturer indicated compliance with appropriate standards or performance in a specified manner.

2.2 MATERIALS

A. Products and the terms materials, equipment, devices, components, assemblies, and systems are considered synonymous.

B. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Seconds, rejects, or damaged materials will be rejected.

C. The materials to be provided under these Specifications shall be essentially the standard commercial grade product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer.

D. The listing of a manufacturer for certain products does not indicate acceptance of a standard or catalogued item of equipment. All products shall conform to the Specifications.

E. All equipment and materials specified shall be products currently in production.

1. If the specified item is not available or is discontinued, a similar product with the same features and functionality shall be provided from the same manufacturer in the newer/upgraded series of product.
2. Equipment and/or devices discovered to be discontinued after submission approval will not be accepted and will require resubmittal for an approved replacement.

F. Product Selection for Restricted Space: Drawings indicated maximum dimensions for products including clearances between products and adjacent surfaces and other items. Comply with indicated maximum product dimensions.

1. Assembly Selection: The Drawings indicated sizes, profiles and dimensional requirements of assembly equipment. Equipment having equal performance characteristics and complying with indicated maximum dimensions and profiles may be considered, provided deviations do not change the design concept intended performance, or code/future extension provision clearances. The burden of proof of equality is on the proposer a minimum of 10 days prior to bid.

G. Include the component parts thereof equipment such as disconnect switches, motor controllers, motors, drives, and guards necessary to the satisfactory and safe operation of the equipment.

2.3 SOFTWARE PROTECTION

A. All software supplied with new equipment shall be warranted against leap year program failure.

B. All software supplied with the new equipment shall be warranted against Daylight Savings Time program disruption or failure. Refer to Division 01 Section "Warranties and Supplementary Conditions for Requirements."

C. All software shall be the most current release of the latest available software of the equipment provided.

1. BETA software versions will not be accepted.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:

1. Comply with NECA 1 – "Standard For Good Workmanship in Electrical Contracting."
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Right of Way: Give to piping systems installed at a required slope.

B. Manufacturer's Directions and Supervision:

1. Follow all instructions where supervision by a manufacturer is specified. Provide recommended manufacturer and specified field tests, and other recommendations of the manufacturer. The manufacturer shall supervise the installation, connection, start-up, testing, adjustment, instruction of the Owner and final tests of such equipment or system. Where two or more manufacturer's equipment are interrelated, take responsibility to coordinate their work and provide supervision.
2. Have the manufacturer instruct the Owner in the proper operation and maintenance techniques of all equipment, systems, etc., at the time of completion of all work.

C. Rough-In:

1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
2. Refer to equipment specifications in Divisions 02 through 28 for rough-in requirements.

3.2 INSTALLATION

A. General:

1. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment.
2. Workmanship shall conform to NECA 1 – "Standard for Good Workmanship in Electrical Contracting" published by the National Electrical Contractors Association.

B. Locations:

1. When Drawing details are not available, the Engineer shall control the placement of wall and ceiling mounted electrical devices, luminaires and outlets. The intent is to aesthetically locate luminaires/outlets by providing rough-in hardware, boxes and/or mounting plates, as required, when stud or furring may not be readily available for direct mounting. Consult with Engineer's representative for actual placement.
2. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
3. Verify all dimensions by field measurements.
4. Install systems, materials, and equipment to provide the maximum headroom possible, where mounting heights are not detailed or dimensioned.
5. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
6. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
7. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
8. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

C. Field Coordination:

1. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
2. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
3. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
4. Protect all equipment and materials from the elements, dirt and other damage from the time it is removed from the point of storage until final acceptance.
5. Include setting equipment to accurate line and grade, leveling equipment, aligning equipment components, providing and installing couplings, bolts, guards, and anchor bolts.
6. Align and level and meet the quality of workmanship subject to manufacturer's installation instructions.
7. Provide all trench and conduit excavation and backfilling required for his work inside and outside the building, including repairing of finished surfaces, all required shoring, bracing, pumping, and all protection for safety of persons and property. In addition, check the indicated elevations of the utilities entering and leaving the building. If such elevations require excavations lower than the footing levels, the Engineer shall be notified of such

conditions and a redesign shall be made before excavations are commenced. Make the excavations at the minimum required depths in order not to undercut the footings.

8. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from the premises when no longer required.
9. No electrical equipment, raceways or other work of any kind shall be covered up or hidden from view before it has been examined and approved. Any unsatisfactory work or materials shall be removed and corrected immediately.
10. Coordinate installation of access panel or doors where units are concealed behind finished surfaces.

D. Excavation:

1. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
2. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

    a. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut to of sheeting at an elevation of 30 inches below finished grade elevation.

3. Install sediment and erosion control measures in accordance with local codes and ordinances.
4. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and form flooding project site and surrounding area.

    a. Do not allow water to accumulate in excavations. Remove water to present softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
    b. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

5. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

    a. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
    b. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

6. Trenching: Excavate trenches for electrical installations as follows:

    a. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
    b. Excavate trenches to depth indicated or required.
    c. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
    d. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface an electrical installations.

7. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg. F (1 deg. C).
8. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

    a. Under walls and pavements, use a combination of subbase materials and excavated or borrowed materials.

b. Under building slabs, use drainage fill materials.
c. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
d. For raceways less than 30 inches below surface of roadways, provide 4 inch thick concrete base slab support. After installation of raceways, provide a 4 inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
e. Other areas use excavated or borrowed materials.

9. Backfill excavations as promptly as work permits, but not until completion of the following:

a. Inspection, testing, approval, and locations of underground utilities have been recorded.
b. Removal of concrete formwork.
c. Removal of shoring and bracing and backfilling of voids.
d. Removal of trash and debris.

10. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
11. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen or contain frost or ice.
12. Place backfill and fill materials evenly adjacent to structures, piping and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
13. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

a. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture density relationship (cohesionless soils).

1) Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
2) Areas Under Walkways: Compact tope 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
3) Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils and 90 percent relative density for cohesionless soils.

b. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

14. Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e. pavement, lawn, or other finish), add backfill material, compact to specified conditions and replace surface treatment. Restore appearance, qualify and condition of surface of finish to match adjacent areas.

E. Painting:

1. Provide the prime painting of all equipment and materials furnished under Division 26 specifications, unless specifically stated otherwise. In general, all equipment except raceways and galvanized boxes that are not provided with a factory-applied final finish shall be delivered to the job site with a shop applied prime coat of paint. Refer to Division 09 Sections "Interior Painting" and "Exterior Painting."
2. All manufacturers' finished equipment surfaces damaged during construction shall be brought to an "as new" condition by touch up or repainting. Any rust shall be completely removed and the surface primed prior to repainting as specified in Division 09.

3.3 FIELD QUALITY CONTROL

A. Refer to Division 26 Section "Electrical Inspections and Testing."

3.4 ADJUSTING

A. Complete system programming to the satisfaction of the Owner. If, after preliminary use of the system or training, the increased understanding of the system's features and capabilities necessitate programming or set-up adjustments, perform at no additional cost.

B. Provide software programming changes to match Owner's final room number designations. The room numbers indicated on the Drawings are not necessarily the final room numbers and may be subject to change by the Owner.

C. Provide on-site assistance in reprogramming software-based system to suit actual occupied conditions during the warranty period. Provide up to three 8-hour visits to the site for this purpose.

END OF SECTION

SECTION 260505

ELECTRICAL INSPECTIONS AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes electrical equipment and systems inspections and testing requirements for Division 26 to expand the requirements specified in Division 01 and Division 26 Sections "Basic Division 26 Electrical Requirements. This Section includes:

1. Electrical Acceptance Testing.
2. General Electrical Field Quality Control:
    a. Operational Testing.
    b. Functional Performance Testing.
    c. Corrective Action.
    d. System Certifications.
    e. Demonstrations and Training.

1.2 TESTING DESCRIPTION

A. Test, inspect, and calibrate electrical equipment and material installed and connected under Division 26. The purposes of these inspections, tests, and calibrations are to assure that the installed electrical systems and equipment**,** both Contractor and Owner supplied**,** are:

1. Installed in accordance with design specifications and manufacturer's instructions.
2. Ready to be energized.
3. Operational and within industry and manufacturer's tolerances.

B. Provide all material, equipment, labor and technical supervision to perform specified tests, inspections, studies and calibration.

C. Implement all testing at the project site.

1.3 ELECTRICAL ACCEPTANCE TESTING RESPONSIBILITIES

A. Contractor Responsibilities:

1. Pretesting:
    a. Perform routine insulation resistance, continuity and rotation tests for distribution and utilization equipment prior to and in addition to tests performed by the specified testing agency specified in this Section.
    b. Supply one set of the following for use in conjunction with electrical acceptance testing: short circuit analysis, coordination study, protective device setting table,

complete set of electrical Drawings, Specifications and any pertinent Change Orders.

2. Scheduling:

   a. Schedule project to allow adequate time for electrical acceptance testing. Notify the testing agency through the Construction Manager when equipment becomes available for acceptance tests. Coordinate work to expedite inspection and test scheduling.

   b. Notify the Construction Manager, Owner, and Engineer not less than seven days prior to commencement of any testing.

3. Testing Agency Support:

   a. Supply a suitable and stable source of electrical power to each test site. Coordinate specific power requirements with the testing agency.

   b. Witness and report to the Construction Manager, Owner and Engineer, any system, material, equipment or workmanship which is found defective on the basis of acceptance tests or inspections by the testing agency.

   c. Maintain a written record of all tests and, upon completion of project, assemble and submit a certified final test report that includes the test procedures and test results for each system and equipment item.

4. Corrective Action:

   a. Within 15 days of direction from the Construction Manager, Owner or Engineer, rework, repair or replace any system, material, equipment or workmanship which is found defective on the basis of acceptance tests or inspections at the Contractor's expense.

B. Testing Responsibilities:

1. Independent Testing Agency: Engage an independent qualified testing and inspecting agency to perform field tests and inspections and prepare test reports for the equipment identified as "I" in the testing responsibility matrix below.

2. Contractor Testing Agency: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports for the equipment identified as "C" in the testing responsibility matrix below.

C. Testing Responsibility Matrix:

System	Testing Agency
Disconnect Switches	C
Electric Metering Equipment	I
Grounding Systems	C

System	Testing Agency
Low Voltage Feeder Cable	C
Panelboards	C
Protective Devices	I
Surge Protection Devices	I
Switchboards	I
Transfer Switches	I

1.4 GENERAL ELECTRICAL FIELD QUALITY CONTROL RESPONSIBILITIES

A. Contractor Responsibilities:

1. Operational Tests.
2. Functional Performance Testing.
3. Corrective action other than calibration deficiencies.
4. System Certifications.
5. Demonstrations and Training.

1.5 SUBMITTALS

A. General: Submit the following in accordance with Kenosha County Requirements, Specification Sections, and Division 26 Section "Basic Division 26 Requirements."

1.6 INFORMATIONAL SUBMITTALS

A. Testing Agency Qualifications:

1. Provide with exception to Owner Testing Agency.

B. Field Quality Control Test Reports:

1. Field test reports.
2. Field inspection reports.
3. Demonstration reports.
4. Manufacturer's field reports.
5. Systems Certifications.

1.7 CLOSEOUT SUBMITTALS

A. Submit a final report of testing and inspection at the completion of the project. Include the following information:

1. Summary of the project.
2. Description of the equipment tested.
3. Visual inspection report.
4. Description of the tests.
5. Test results.
6. Conclusions and recommendations.
7. Appendix including appropriate test forms.
8. Identification of the test equipment used and calibration date.
9. Systems certification with signature of technicians.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Demonstration and training materials and recorded electronic media.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: An agency with the experience and capability to conduct the testing indicated and that is acceptable to authorities having jurisdiction.

1. For electrical power equipment and systems, the agency shall be a member company of the International Electrical Testing Association (NETA) or is a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
2. For other than electrical power equipment or where NETA is not a recognized testing agent, the testing agency shall be as defined in the appropriate Division 26 Section.
3. The testing agency shall have successfully completed not less than five acceptance testing, inspection, and calibration projects of similar scope to this project.
4. The testing agency lead, on site, technical person shall be currently certified Level III by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
5. The testing agency shall only utilize engineers and technicians who are regularly employed by the firm for testing service.

B. Regulatory Requirements: Make inspections and testing in accordance with the local authorities having jurisdiction on in compliance with the following applicable codes and standards of the following agencies:

1. InterNational Electrical Testing Association:
    a. NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

2. National Fire Protection Association – NFPA:

   a. ANSI/NFPA 70 – National Electrical Code.

   b. ANSI/NFPA 70B – Recommended Practice for Electrical Equipment Maintenance.

   c. NFPA 70E – Electrical Safety Requirements for Employee Workplaces.

C. Use the following references:

1. Project design specifications.

2. Project design drawings.

3. Project short-circuit and coordination study.

4. Manufacturer's instruction manuals applicable to each particular apparatus.

5. Project list of equipment to be inspected and tested.

D. Safety and Precautions: Comply with required safety practices which include, but are not limited to, the following:

1. Occupational Safety and Health Act.

2. Accident Prevention Manual for Industrial Operations, National Safety Council.

3. Applicable state and local safety operating procedures.

4. National Fire Protection Association – NFPA 70E – Standard for Electrical Safety Requirements for Employee Workplaces.

5. American National Standards for Personnel Protection.

1.10 COORDINATION

A. Coordinate all electrical inspections and testing activities and reports through the Contractor to and from the Construction Manager.

B. Coordinate all testing assistance and preparations including manufacturer's representatives at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT GENERAL REQUIREMENTS

A. Use only test equipment that is in good mechanical and electrical condition.

B. Use true RMS measuring meters.

C. Field test metering used to check power system meter calibration shall have an accuracy higher than that of the instrument being checked.

D. Use test equipment with accuracy of metering that is appropriate for the test being performed.

E. Use test equipment with waveshape and frequency output that are appropriate for the test and tested equipment.

2.2 TEST EQUIPMENT QUALITY CONTROL

A. Use only equipment for testing and calibration procedures that has the following characteristics:

1. Maintained in good visual and mechanical condition.

2. Maintained in safe operating condition.

B. Use test equipment having operating accuracy equal to, or better than, the following limits:

1. Portable Multimeters: True RMS measuring.

2. Multimeters shall have the following accuracy limits, or better:

a. AC Voltage Ranges: .75% +/- 3 last single digits @ 60 Hz.

b. AC Current Ranges: .90% +/- last single digits @ 60 Hz, including adapters, transducers.

c. DC Voltage Ranges: .25% +/- 1 last single digit.

d. DC Current Ranges: .75% +/- 1 single digit.

e. Resistance Ranges: .50% +/- 1 last single digit.

f. Frequency Range: .10% +/- 1 single digit @ 60 Hz.

3. Clamp-on Ammeters: AC current +/- 3% of range +/- 1 last single digit @ 60 Hz.

4. Dissipation/Power Factor Field Equipment:

a. +/- 0.1% power factor for power factor values up to 2.0%.

b. 5% of the reading for power factor values above 2.0%.

5. Low Range DC Resistance Equipment: 1.0% of reading, +/- 2 last single digits.

6. Transformer Turns Ratio Test Equipment: 0.5% or better @ 60 Hz.

7. Ground Electrode Test Equipment: +/- 2% of range.

8. Insulation Test Sets: 0-1000V DC +/- 20% of reading at mid-scale.

9. Electrical Load Survey Equipment:

a. +/- 5% total error, including sensors.

b. 1% resolution.

c. Current Transformers: +/- 2% of range @ 50 Hz.

d. Voltage Transformers: +/- 0.5% of range @ 60 Hz.

10. Liquid Dielectric Strength Test Equipment: +/- 2% of scale.

11. Infrared Scanning Equipment: Sensitivity of 2C.

12. Phase Shifting Equipment: +/- 1.0 over entire range.

13. High Current Test Equipment: +/- 2% or range.

14. DC High Potential Test Equipment: +/- 2% of full scale.

15. AC High Potential Test Equipment (60 Hz): +/- 2% of full scale.

2.3 TEST EQUIPMENT CALIBRATION

A. Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

B. Calibrate equipment in accordance with the following schedule:

1. Field Equipment: 6 months maximum.

2. Leased Specialty Equipment: 12 months (where accuracy is guaranteed by lessor).

C. Place dated calibration labels at visible locations on all test equipment.

D. Keep up to date records which show date and results of test equipment calibrated or tested; have such records available for review.

E. Maintain up to date test equipment calibration instructions and procedures for each test equipment.

F. Use calibration standards of higher accuracy than the accuracy of the test equipment being calibrated.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. General: Furnish the materials, equipment and personnel required for field testing of electrical Work as specified herein and in other specification sections. Perform tests in accordance with the Specification requirements.

B. Contractor shall be responsible to perform the following pre-acceptance testing procedures and tests:

1. Clean dirt, dust, and moisture from equipment.

2. Replace fuses blown during construction and testing.

3. Check for loose bus and cable connections.

4. Check for proper clearances of live parts, between phases and to ground and ascertain that required barriers are in place.

5. Check for missing insulation in equipment and on conductors.

6. Check for modifications, alterations, and the use of unapproved parts in the assembly of the equipment against the approved submittals.

7. Ascertain that fuse and circuit breaker short circuit interrupting ratings are adequate.

8. Ascertain that the equipment rooms and areas are free of dampness and moisture accumulations.

9. Check conductors run in multiple to ensure that they are properly phased.

10. Conduct a megger test of all equipment and wiring. Do not use battery operated test lights and bells for this test.

11. Contractor shall startup equipment following manufacturer recommendations and best safety practices.

12. Loads on all parts of electrical distribution systems shall be balanced, insofar as is practical. Particular attention shall be directed to the revision of labeling and marking of feeders, sub-feeders and branch circuits as required for load balancing. All necessary revisions shall be incorporated into the "Final Record" drawing set.

13. Overload devices shall be installed and adjusted to suit the loads which they control.

C. Field Tests and Inspections:

1. Schedule field tests and inspections with at least seven (7) days advance notice to Construction Manager, Owner and Engineer.

2. Use testing equipment appropriate for the tests in conjunction with industry product testing and performance guidelines and calibrated to assure test quality.

3. Comply with latest edition of ANSI/NETA ATS – Standard for Acceptance Testing and addition requirements defined in the appropriate Division 26 Sections for field testing of electrical power equipment, systems and components.

4. Comply with field testing requirements defined in the appropriate Division 26 Sections for other than electrical power equipment.

5. Follow up testing shall be included under testing responsibility matrix.

6. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, responsible agency and representative, and date.

D. Field Test Reports:

1. Submit field test reports and inspection logs in compliance with Division 01 Section "Quality Requirements" for each of the systems defined in the testing responsibility matrix and other special tests defined in the appropriate Division 26 Sections.

E. Operational Tests: After the work is complete and properly adjusted, the Contractor shall conduct operational tests as directed by Construction Manager, Owner or Engineer. Perform tests in the presence of Construction Manager, Owner and Engineer. Operational tests as herein

specified are defined as those tests and inspections which are required to ensure that the equipment involved is operating and functioning as specified or intended and within industry practices, standards and manufacturers tolerances and meet the performance as stated in the specification.

1. Demonstration: Demonstrate that all equipment and systems operate in accordance with the requirements of the Contract Documents. Where specified that the equipment manufacturer shall provide such demonstrations and costs for these services shall be at the Contractor's expense.

2. Voltage Test: Perform at the last outlet on each circuit. If drop in potential is excessive, correct the condition by locating the ground or high resistance splice or connection.

3. Cable Insulation: After cables are pulled in place and before connecting, test to determine that conductor insulation resistance is not less by megger test than that recommended by ICEA. Cables failing insulation test shall be removed, replaced and re-tested.

4. Transformers and Equipment: Test each entire system after final connections are made and verify each component shall pass drop in potential resistance tests.

5. Motors: Test motors under load with ammeter readings taken in each phase, and the RPM of motors recorded at the time. Test motors for correct direction of rotation.

6. Ground Testing: Subject the completed equipment grounding system to a meggered test at the substation ground bus to ensure that the ground resistance, without chemical treatment or other artificial means, does not exceed 5 ohms.

7. Control circuits shall be checked for proper functioning and fail-safe operation. The "Auto" position of all "Hand-Off-Auto" controlled equipment shall be checked for proper operation and interlocking with other equipment.

8. Lighting switching shall be tested for correct operation, with particular attention to 3 and 4 way switching and dimming system installations.

9. Receptacles shall be checked for correct and consistent phase and neutral positions. Ground receptacles shall also be tested for location and effectiveness of the grounded contact. Ground fault interrupter receptacles shall be tested for proper operation by simulating an actual line to ground fault at the receptacle.

F. Functional Performance Testing:

1. Perform functional performance testing together with representatives of other trades associated with the installation per the requirements of Division 20 Section "Functional Performance Testing – Common Work Results – Division 21 through 28.

2. Perform function tests on each system included in this Section to ensure total system operation.

3. Perform the system functional test upon satisfactory completion of equipment acceptance tests. It is the intent of system functional tests to prove the proper interaction of all sensing, processing and action devices to effect the designed end product or result.

4. Test interlocks, safety devices, fail-safe functions, and design functions.

G. Corrective Action:

1. Correct calibration deficiencies identified in field tests. Other deficiencies shall be corrected by Division 26.

2. Retest and reinspect per the requirements of Division 01 Section "Quality Requirements".

H. System Certifications:

1. Notify the Engineer in writing upon completion of the work, that the entire electrical installation has been examined, inspected, tested, and calibrated or adjusted as specified and that it is ready for final inspection.

a. Provide written certifications, prior to the final inspection, for each system or piece of equipment indicating that the equipment has been tested and meets the performance criteria of the Contract Documents.

b. Provide system certifications per the requirements of Division 20 Section "Systems Certifications – Common Work Results – Division 21 through 28."

Obtain Certificates of Compliance on completion of the work with written approval or acceptance from all authorities having jurisdiction over the work and deliver these to the Engineer. The work shall not be deemed to have reached a state of final completion until these certificates have been delivered.

I. Demonstration and Training:

1. Provide Owner’s personnel demonstration and training for Division 26 equipment and systems to expand the requirements specified in Division 01 Section, "Demonstration and Training" as follows:

a. Owner’s personnel demonstration and training shall be considered an inspection and testing function and shall be reported as such including correction of all deficiencies. Include general and emergency modes of operation.

b. All demonstrations and training shall be recorded on digital electronic media for future reference.

c. Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including start up, shutdown, fire alarm, power failure, etc.

d. During any demonstration, should the system fail to perform in accordance with the requirements of the Operations and Maintenance (O&M) manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

e. The appropriate trade or manufacturer’s representative shall provide the instructions on each major piece of equipment. This representative may be the start up technician for the piece of equipment, the installing contractor or

manufacturer's representative. Practical building operating expertise as well as in depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.

f. The training sessions shall follow the outline in the table of contents of the O&M manual and illustrate whenever possible the use of the O&M manuals for reference.

g. Training shall include:

1) Usage of the printed installation, operation and maintenance instruction material included in the O&M manuals.

2) Review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.

3) Discussion of relevant health and safety issues and concerns.

4) Discussion of warranties and guarantees.

5) Common troubleshooting problems and solutions.

6) Explanation of information included in the O&M manuals and the location of all plans and manuals in the facility.

7) Discussion of any peculiarities of equipment installation or operation.

h. Hands on training shall include start up, operation in all modes possible, including manual, shutdown, and any emergency procedures and maintenance of all pieces of equipment.

3.2 PROJECT REPORTS

A. Consistent project reports shall be similar to the following:

ELECTRICAL INSPECTION AND TESTING REPORT

Project: _____ Contact No._____

Equipment

Ref. No._____ Serial No.: _____

Inspection Inspecting

Date: _____ Organization:_____

Performed By: _____ Report No.: _____

Contractor, Architect/Engineer Representative Present:

_____

Ref. Specification: _____

A. Inspections Performed: _____

_____

(Attach manufacturer's recommended demonstration.)

B. Summary of Inspection:_____

_____

C. Attached Manufacturer's Demonstration

Report No. of Attached Sheets _____

D. Signatures:

Contractor,

Architect/Engineer

Representative: _____

Testing Contractor: _____

ELECTRICAL OPERATIONAL TEST REPORT

Project: _____ Contact No._____

Equipment

Ref. No._____ Serial No.: _____

Test Testing

Date: _____ Organization:_____

Performed By: _____ Report No.: _____

Contractor, Architect/Engineer Representative Present:

_____

Test Equipment:_____

Ref. Specification: _____

_____

A. Test Performed:_____

_____

_____

_____

(Attach manufacturer's recommended demonstration.)

B. Summary of Results: _____

_____

C. Attached Test and Results

Report No. of Attached Sheets _____

D. Signatures:

Contractor,

Architect/Engineer

Representative: _____

Testing Contractor: _____

ELECTRICAL ACCEPTANCE TEST REPORT

Project: _____ Contact No._____

Equipment

Ref. No._____ Serial No.: _____

Test Test

Date: _____ Organization: _____

Performed By: _____ Report No.: _____

Contractor, Architect/Engineer Representative Present:

_____

_____

Test Equipment:_____

_____

Ref. Specification: _____

A. Methodology Test: _____

_____

(Attach manufacturer's recommended demonstration.)

B. Summary of Results: _____

_____

C. Attached Test and Results

Report No. of Attached Sheets _____

D. Signatures:

Contractor,

Architect/Engineer

Representative: _____

Testing Contractor: _____

ELECTRICAL DEMONSTRATION AND TRAINING REPORT

Project: _____ Contact No._____

Equipment

Ref. No._____ Serial No.: _____

Demonstration Demonstrating

Date: _____ Organization: _____

Performed By: _____ Report No.: _____

Contractor, Architect/Engineer, Owner Representative Present:

_____

Ref. Specification: _____

A. Demonstration Performed: _____

_____

(Attach manufacturer's recommended demonstration.)

B. Summary of Demonstration: _____

_____

C. Attached Manufacturer's Demonstration

Report No. of Attached Sheets _____

D. Signatures:

Contractor,

Architect/Engineer, Owner

Representative: _____

Testing Contractor: _____

DIVISION 26 INSPECTIONS AND TESTING SUMMARY REPORT

Project: ______________________ Report No.: ______________

Contact No.: ______________________ Date: ______________

System	Completed Submittals					Functional Performance Testing (FPT)		Division 20 Functional Performance Testing (FPT)		Division 20 System Certification		Deferred Testing		Acceptance Testing		Operations & Maintenance Documents		Training		Seasonal Testing		
	Action	Informational	Closeout	Maintenance Material	Pre-Functional Checklists & Start Up Performed	Deficiencies	Accepted	Required	Accepted	Required	Certified	Date	Reason	Deficiencies	Accepted	Required	Accepted	Required	Accepted	Required	Date	Accepted

End of Section

SECTION 260519

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (100-600 VOLTS)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes conductors, cables, and connectors rated 100 to 600 volts.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.3 ACTION SUBMITTALS

A. Product Data:

1. Multiconductor cables.
2. Box fittings approved for use with healthcare facilities MC cables.

B. Shop Drawings:

1. Calculations for conductor and associated conduit deratings for:

a. Panelboard branch circuit conductors when over eight current carrying conductors are combined in common conduit. Field installations found without such calculations will be rejected.

b. Conductor alterations from Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Record Documents:

1. Indicate all feeder sizes on the record drawings riser diagrams.

2. Indicated homerun junction box locations for all branch circuits.

1.6 QUALITY ASSURANCE

A. Field Testing: Refer to Division 26 Section "Electrical Inspections and Testing" for field inspections and testing requirements related to this Section including:

1. Electrical Acceptance Testing Responsibilities.

2. General Electrical Field Quality Control.

3. Testing Agency Qualifications.

B. Comply with ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems for field testing.

C. Maximum Cable Pull Compliance: Comply with manufacturer's maximum cable tension pulling characteristics so as not to damage wire and cable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Conductors and Cables:

a. AFC Cable Systems, Inc., a Division of Tyco.

b. Alcan Products Corporation; Alcan Cable Division.

c. American Insulated Wire Corp.; a Leviton Company.

d. Encore Wire Corporation.

e. General Cable Corp.

f. The Okonite Company

g. Senator Wire & Cable Co.

h. Southwire Company.

2. Connectors and Splices for Conductors and Cable Conductors:

a. AFC Cable Systems, Inc., a Division of Tyco.

b. AMP.

c. Burndy Corporation.

d. Hubbell Power Systems, Inc.

e. ILSCO

f. O-Z/Gedney Co.; EGS Electrical Group LLC.

g. 3M Company; Electrical Products Division.

h. NSi Industries

i. Raychem Corporation.

j. Square D Company.

k. Thomas and Betts Corporation.

l. Tyco Electronics Corp.

2.2 REGULATORY REQUIREMENTS

A. Comply with provisions of the following codes and standards:

1. NFPA 20 Centrifugal Fire Pumps.

2. NFPA 70 National Electrical Code.

a. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

3. UL Compliance: Provide components which are listed and labeled by UL under the following standards.

a. UL Std. 44 – Thermoset-Insulated Wires and Cables.

b. UL Std. 83 - Thermoplastic-Insulated Wires and Cables.

c. UL Std. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

d. UL Std. 1569 - Metal-Clad Cable.

4. NEMA/ICEA Compliance: Provide components which comply with the following standards:

   a. WC-70 – Standard for Non-Shielded Power Cables Rated 2000 volts or less.

5. IEEE Compliance: Provide components which comply with the following standard:

   a. Std. 82 - Test procedures for Impulse Voltage Tests on Insulated Conductors.

2.3 WIRES AND CABLES

A. General: Provide wire and cable suitable for the temperature, conditions and location where indicated.

   1. Derate conductors per the NEC for installations that are exposed to direct sunlight, are on and/or above rooftops where ambient temperatures are other than 30 deg. C (86 deg. F).

B. Conductor Material: Copper and Aluminum.

C. Conductors: Provide solid conductors for power and lighting circuits sizes No. 16 AWG and smaller. Provide stranded conductors for sizes No. 14 AWG and larger.

D. Insulation: Provide insulation type in accordance with Part 3 below.

E. Color Coding: Color shall be the full thickness of the insulation, not applied electrical tape.

208/120Volts		480/277 Volts		Isolated Power	
Phase	**Color**	**Phase**	**Color**	**Phase**	**Color**
A	Black	A	Brown	No.1	Orange
B	Red	B	Orange	No.2	Brown
C	Blue	C	Yellow		
Neutral	White	Neutral	Gray	3-Ph	Yellow
Ground	Green	Ground	Green	(All with Color Strip)	
IsoGround	Green w/Yellow Strips	IsoGround	Green w/Yellow Strips		

F. Jackets: Factory-applied nylon or PVC external jacketed wires and cables for pulls in raceways over 100-feet in length, for pulls in raceways with more than three equivalent 90 deg. bends, for pulls in conduits underground or under slabs on grade, and where indicated.

G. Multiconductor Cables: Provide the following type(s) of cables in NEC approved locations and applications where indicated. Provide cable UL listed for particular application:

1. Metal-Clad Cable: Type MC:

   a. Complete with ground conductor.

   b. Approved for use in Health Care Facilities patient areas – Type HCF MC – AP, where used in patient care areas.

2. Portable Cord: Type SO.

H. Conductors for isolated power systems shall have a distinctive color stripe other than white, green, or gray along the entire length of the conductor as required in NEC.

I. Dedicated neutral conductors shall have a distinctive color stripe to match the color of the phase conductor with which it is associated.

2.4 CONNECTORS FOR CONDUCTORS

A. Provide UL listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

1. Split-bolt connectors shall not be used for any application.

2.5 CONDUCTOR PULLING GRIPS

A. At Contractor's option, factory installed pulling grips may be provided to allow potential reduced pulling tension and a low profile head.

2.6 CONDUCTOR PULLING JACKET

A. At Contractor's option, lubricated type conductor pulling jackets may be provided for THHN and XHHW conductors to allow potential reduced pulling tension. Lubricated type conductors shall not be permitted for wiring associated with Isolated Power Systems.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install electrical cables, conductors and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

1. Install all conductors within raceways or approved cables.

2. Install conductors and cables run under the building slab in raceways.

3. Install minimum No. 12 AWG for circuits 100 volts and above.

4. Increase conductor size as required due to NEC derating requirements and availability. Minimum conductor sizes, based upon NEC Ampacity Table 310.15 (B) (16), (310.16 for NEC prior to 2014) and maximum 40 percent conduit raceway fill, are shown on Drawings. Generally use 60 deg. C ratings below 100 amperes and 75 deg. C rating above 100 amperes. If conductor size increased, be responsible for associated conduit size, based upon NEC Ampacity Tables and maximum 40 percent conduit raceway fill, and increased ground conductor size per NEC. If raceway type altered, also be responsible for associated conduit raceway size per NEC to meet 40 percent maximum fill.

5. Keep conductor splices to a minimum.

6. Do not bend conductors and cables, either permanently or temporarily during installation to radii less than that recommended by the manufacturer.

7. Provide slack wire for all future connections with ends of wires taped and blank box covers installed.

8. Provide conductors of the same size from the protective device to the last load.

9. Make conductor length identical for parallel feeders.

10. Ground and continuously polarize systems properly throughout following the color coding specified.

11. Support conductors in vertical raceways. One cable support shall be provided at the top or as close to the top as practical, plus a support for each additional interval of spacing per NEC.

12. Install exposed cable parallel and perpendicular to surfaces, or exposed structural members, and following surface contours, where possible.

13. Support cables according to Division 26 Sections "Hangers and Supports."

14. In general homerun conduits shall be 1-inch minimum and contain a maximum of eight (8) #10AWG current carrying conductors unless permitted otherwise by Engineer or Owner.

B. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. When conductors larger than No. 12 AWG are installed on 15 – 20-A circuits, splice No. 12 AWG pigtails for device connections.

5. Existing Conductors:

   a. Cut back and pigtail, or replace all damaged conductors.

   b. Straighten conductors that remain and remove corrosion and foreign matter.

   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

C. Dedicated Branch Circuit Neutrals:

1. Provide dedicated neutrals for all branch circuits.

D. Coordinate conductor and cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires and cables with other work.

1. Pull conductors simultaneously where more than one is being installed in same raceway.

2. Use of pull compound or lubricant is to be avoided unless absolutely necessary and other reduced cable tension pulling methods exhausted; compound used must not deteriorate conductor or insulation, and be one of the following:

a. Ideal-Aqua-Gel.

b. Polywater.

c. Yellow 77.

3. Use of pull compound or lubricant shall not be permitted for wiring associated with Isolated Power Systems.

4. Use pulling means including lubricated conductor jackets, fish tape, cable, rope and basket weave wire and cable grips which will not damage cables or raceway.

E. Use conductors with 90 degree C insulation and appropriate NEC derating factors when wiring is within seven feet of passing over or attached to the following:

1. Boilers and other heat producing equipment.

2. Hot water heaters.

3. Rooftop and exposed exterior locations.

3.2 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for phase conductors of feeders smaller than 125A; copper or aluminum for phase conductors of feeders 125A and larger.

B. Branch Circuits: Copper.

3.3 CONDUCTOR APPLICATIONS

A. Install UL Type THHN or THWN wiring in conduit, for branch circuits #10 and smaller.

1. Include wet location label when installed in underground or above grade exterior raceways.

B. Install UL Type XHHW or THHN wiring in conduit, for feeders and branch circuits #8 and larger.

1. Include wet location label when installed in underground or above grade exterior raceways.

C. Install UL Type XHHW or THWN wiring in conduit, for feeders and branch circuits installed outside of the building envelope, in raceway in contact with soil, or whenever raceway may be subject to moisture and/or condensation.

D. Install UL Type XHHW wiring in conduit for isolated power branch circuits.

E. Install SO hard service cord with stainless steel, wire mesh, strain relief at terminations to suit application.

3.4 EQUIPMENT CONNECTIONS

A. Follow circuit numbers shown on Drawings in connecting circuits to panelboards. In the event that field observation shows that the indicated circuit numbers are not connected to the corresponding panel overcurrent device, make all corrections necessary. Each branch circuit homerun containing two or more circuits with a common neutral shall be connected to the circuit breaker or switch in a three- or four-wire branch circuit panelboard so that no two of the circuits will be fed from the same phase.

B. Provide all wiring to and between motors, controllers, line voltage (120-600 volt) control devices, disconnect switches, and other related electrical equipment, except where such items are factory wired.

C. Terminate power wiring for elevator systems at the respective controller and be in compliance with the manufacturer's approved shop drawings.

D. Provide power and all wiring connections to the control devices for electrically operated overhead doors, door operators and control devices which will be provided under another division.

E. Connectors for Splices, Taps, and Terminations:

1. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connector and terminals to comply with tightening torques specified in UL Std. 486A and B.

2. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings that unspliced conductors.

a. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

3. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

4. Make splices and taps in wiring No. 10 AWG and smaller mechanically and electrically secure with mechanical pressure type splicing devices.

5. Make splices and taps of conductors No. 8 AWG or larger using compression connectors requiring the use of compression tools for securing the conductors in the connectors. Make all splices in motor terminal boxes using insulated mechanical connectors specifically identified for use with motors to facilitate replacement of motor. Connectors shall be of high conductivity, corrosion-resistant material and have actual contact area that shall provide at least the current carrying capacity of the wire or cable. For conductors No. 1/0 and larger, connector lugs shall be of the two-hole type. Connector lugs shall be bolted to bussing using Belleville washers in combination with flat washers and nuts. Compression connectors shall be as manufactured by Thomas & Betts, Burndy, or approved equal.

6. Each conductor lug or bus connection shall be individually made with separate lug and/or bolt as required for the termination.

7. Provide insulated connectors for splices and taps with a self-fusing rubber insulating tape that is non-corrosive to the connector and the conductor. Insulation tape shall have a minimum of 350 volts per mil dielectric strength. Friction or vinyl tape shall be applied directly over rubber insulating tape equal to 3M Scotch 88 type.

3.5 METAL-CLAD CABLE (TYPE MC CABLE)

A. May be used only when approved by the local authority having jurisdiction and only for concealed branch circuit wiring in spaces above ceilings and in hollow studded interior partitions starting twenty-five feet maximum from first wiring device off a rigid metallic homerun raceway. MC Cable shall not be used for homeruns.

B. In general, may be used only for lighting and convenience outlet wiring, and only for those branches and areas which are not identified herein as exceptions.

C. The exception branches and areas where MC Cable is not acceptable for lighting and convenience outlet wiring are as follows:

1. Critical branch circuits.

2. Diagnostic/therapeutic equipment (x-ray, etc.).

3. Emergency branch circuit.

4. Exposed locations.

5. Exterior circuits.

6. Hazardous locations.

7. Isolated grounding device branch circuits.

8. Life safety branch circuits.

9. Mechanical, electrical, battery and boiler rooms.

10. Sitework.

11. Through fire and smoke barriers.

12. Wet and damp locations.

D. MC cable shall be secured at intervals not exceeding 6 feet and within 12 inches of every outlet box or fitting. Luminaire whips may be 6 feet maximum without support.

E. At all terminations, a fitting shall be provided to protect the conductors from abrasion. Approved insulating bushings shall be provided between the conductors and the armor. The connector or clamp by which the cable is fastened to boxes or cabinets shall be metal, UL approved for use with MC cable, and of such design that the insulating bushing will be visible for inspection. Internal box cable clamps are not acceptable.

F. Metal-clad cable for use in Health Care Facilities shall be UL listed and labeled by Underwriters Laboratories as Metal-Clad – All Purpose (MC-AP). The cable shall contain an insulated green copper grounding conductor which is factory installed, along with color coded circuit conductors and a separate bonding wire. The assembly shall be protected by interlocked aluminum armor painted green and shall provide redundant, dual path grounding. Cable shall meet the requirements of National Electrical Code Article 517. This cable shall not be used for branch circuit wiring in the following applications:

1. Healthcare life safety branch.

2. Healthcare critical branch.

3. Emergency systems (NEC 700).

4. Legally required standby systems (NEC 701).

5. Optional standby systems (NEC 702).

3.6 MAXIMUM BRANCH CIRCUIT LENGTHS

A. Per NEC and as shown on Drawings.

3.7 CONDUCTOR AND CABLE IDENTIFICATION

A. Conductors shall have solid color coded insulation per Division 26 Section "Electrical Identification."

3.8 WIRING METHODS

A. The following wiring methods shall not be used:

1. Non-metallic sheathed cable.

3.9 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling".

3.10 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping".

3.11 FIELD QUALITY CONTROL

A. Inspection and Tests:

1. Perform inspections and test procedures as required by Division 26 Section "Electrical Inspections and Testing", ANSI/NETA ATS "Cables, Low-Voltage, 600-Volts Maximum", "System Functional Tests", and "Thermographic Survey" requirements, and the following additional requirements:

a. Limit tests to:

1) Service entrance conductors.

2) Feeder and 3 phase motor conductors.

b. Follow-up thermographic survey shall not be required.

c. Prepare test and inspection reports.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes solid grounding of building structures and electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications. Types of grounding systems include the following:

1. Electrical System and Transformer Grounding.
2. Building Grounding.
3. Equipment Room Ground Terminal Bar.
4. Electrical Equipment Grounding.
5. Surge Protective Device (SPD) Grounding.
6. Underground Distribution Grounding.

1.2 DEFINITIONS

A. Ground (Earth): An intentional or accidental connection to Earth.

B. Bonding (Bonded): The joining of metallic parts together to form an electrically conductive path.

C. Equipotential Ground: Grounded bonded metallic parts to minimize electrical circulating currents between them for human safety.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency and testing agency's field supervisor.

B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data", include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells grounding connections for separately derived systems based on NETA MTS and NFPA 70B.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

b. Include recommended testing intervals.

B. Record Documents: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Ground rods.

2. Grounding arrangements and connections for separately derived systems.

3. Grounding for sensitive electronic equipment.

1.6 QUALITY ASSURANCE

A. Field Testing: Refer to Division 26 Section "Electrical Inspections and Testing" for field inspections and testing requirements related to this Section including:

1. Electrical Acceptance Testing Responsibilities.

2. General Electrical Field Quality Control.

3. Testing Agency Qualifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following listed manufacturers:

1. Ground Rods:

a. Burndy.

b. Erico Products.

c. Knight Metalcraft.

d. Nehring.

e. Harger Lightning and Grounding.

2. Molded Fusion Welding Material:

a. Burndy.

b. Cadweld.

c. ThermOweld.

d. Harger Lightning and Grounding UltraWeld®.

3. Irreversible Compression Connectors:

a. Burndy Hyground Series.

b. Structured Ground™.

c. Thomas & Betts Corp.

d. E-Z-Ground® Series.

e. Harger Lightning and Grounding

4. Ground Clamps/Connectors:

a. Adalet – PLM Division; a Division of Scott Felzer.

b. Anderson Corp.

c. Anixter Bros., Inc.

d. Burndy.

e. Chance – A.B. Chance Co.

f. Crouse-Hinds, a Division of Cooper Industries.

g. Erico Products.

h. Ideal Industries, Inc.

i. Joslyn Corporation.

j. Harger Lightning and Grounding.

k. O-Z/Gedney Co.

l. Raco, Inc.

m. Thomas & Betts Corp.

5. Enclosure Equipment Grounding Kits:

    a. Same manufacturer as box/cabinet or for ground clamps/connectors.

2.2 REGULATORY REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with ANSI/TIA/EIA-607A – Commercial Building Grounding, Earthing and Bonding Requirements for Telecommunications.

D. Comply with ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems for field testing.

E. Comply with ANSI/TIA/EIA-607B – Commercial Building Grounding, Earthing and Bonding Requirements for Telecommunications.

2.3 GROUNDING AND BONDING PRODUCTS

A. Products: Of types indicated and of sizes and ratings to comply with NEC requirements. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.4 CONDUCTORS

A. General:

1. Comply with Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

B. Grounding Conductors:

1. Equipment Grounding Conductor: Green insulated. Conductors No. 4 and larger may use green taped conductor ends.

2. Grounding Electrode Conductor: Bare stranded, soft drawn or soft annealed, copper wire.

3. Underground Grounding Conductors: Install bare tinned-copper conductor, NEC sized AWG minimum.

    a. Bury at least 24 inches (600 mm) below grade.

b. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

4. Isolated Ground Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. **Bonding Conductors**:

1. Bonding Conductor: No. 4 or 6 AWG, stranded conductor.

2. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

3. Tinned Bonding Jumper: Tinned copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.5 EQUIPMENT ROOM GROUND TERMINAL BAR

A. Copper 1/4 inch thick by 4 inch wide by length shown on Drawings, unless otherwise indicated, with two (2) rows of predrilled holes on 1-1/2 inch centers for 1/2 inch bolt, to receive cables from two (2) directions. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.6 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

2. Split-bolt connectors shall not be used for any application.

C. Molded Fusion Welded Connectors: Exothermic welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Irreversible Compression Connectors: Mechanical compression tool and die kits of types recommended by kit manufacturer for materials to be joined and installation conditions.

2.7 GROUNDING ELECTRODES

A. Ground Rods: Copper clad steel with high strength steel core and electrolytic grade copper outer sheath, molten welded to core.

1. Size: 3/4 inch diameter by 10 feet.

B. Ground Test Station: Fabricate from 15-inch (400 mm) long, square cut sections of 8 inch (200 mm) diameter, Schedule 80, PVC pipe.

PART 3 - EXECUTION

3.1 GENERAL

A. Ground all equipment, furnished by this Division or by others.

1. Split-bolt connection methods shall not be used.

B. Provide building grounding as shown on Drawings.

C. All transformer enclosures and secondary neutrals shall be separately grounded to a separate ground electrode with a continuous grounding electrode conductor sized per NEC. Do not ground directly to building steel. Refer to Single Line Diagram and details on drawings.

D. Make molded fusion welds and irreversible compression connections in strict accordance with supplier's instructions. Clamp cables securely in place, independent of connection. Clean and inspect all connections.

E. At least one connection shall be made between the building ground, the electrical service ground for the building, and a metallic cold water pipe ground larger than 1 inch trade diameter.

F. Grounding cable shall not be buried directly in concrete, but a grounded metallic or non-metallic conduit sleeve shall be provided where cable passes through concrete.

G. Where ground conductors are shown on Drawings and for all feeders, the use of the metallic raceway in place of the ground conductor shall not be permitted. Provide grounding bushings (or other approved devices such as bonding-type locknuts or bushings) at each end of all low voltage and medium voltage feeder raceways. Where non-metallic conduit is used, coordinate the installation of a code sized ground conductor.

H. All grounding conductors run inside the building shall be run within NEC sized metallic raceways with raceway grounding bushings at each end and bonding jumper to the enclosure or ground bus. Extend raceway to associated equipment enclosures and to within 6 inches of

exposed ground terminal bar installations. Raceway installations shall be in accordance with Division 26 Section "Raceways."

1. Each ground conductor bus connection shall be terminated with individual compression lug and associated individual lug bolt.

2. Split-bolt connection methods shall not be used for any application.

I. Welded connections may have multiple ground conductors to suit mold and may be considered "continuous."

3.2 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic welded or irreversible connectors for outdoor locations. Only when a disconnect type connection is indicated, use a bolted clamp.

C. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each above ground portion of gas piping system downstream from equipment shutoff valve.

D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.3 UNDERGROUND INSTALLATIONS

A. Comply with IEEE C2 grounding requirements.

B. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

C. Drive ground rods to a minimum depth of ten feet, or more if necessary to reach permanent moisture. Ground rods shall be driven at least 2 feet away from the footing.

D. Underground Grounding conductors:

1. Bury at least 24 inches (600 mm) below grade.

2. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

3. Duct Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct bank installation.

E. Perform all connections below grade with exothermic welds **or irreversible compression connections**. Provide corrosion protection in acid soils.

F. Ground Test Station: Set top of well flush with finished grade or floor. Fill with 1-inch- (25-mm-) maximum size crushed stone or gravel to 1 inch below rod ground cable weld.

3.4 SEPARATELY DERIVED SYSTEMS GROUND RING INSTALLATIONS

A. Ground ring: Install at least (3) ground rods spaces one rod length from each other and located at least the same distance from other grounding electrodes, and interconnect with exothermic welds to the system grounding electrode conductor using minimum #3/0 bare copper conductor.

B. Provide ground ring for the following separately derived systems:

1. Electrical Services: The facility service transformer ground ring serves as the electrical service ground ring.

3.5 ELECTRIC SERVICE AND TRANSFORMER GROUNDING INSTALLATIONS

A. Make grounding connections electrically ahead of any overcurrent or disconnect device or tap connection such that disconnection of neutral load conductors does not interfere with or remove the system ground connection. Use separate lugs on the transformer neutral terminal for neutral and main grounding jumper when cable is used for transformer connections.

B. Connect low voltage transformer grounds to an Equipment Room Ground Terminal bar if located in the same room and provided with an adequately sized common grounding electrode conductor; otherwise connect to the nearest accessible structural steel member or other grounding electrode as permitted by the NEC.

3.6 EQUIPMENT ROOM GROUND TERMINAL BAR INSTALLATION

A. Install a complete grounding electrode system with interconnecting cables and terminations at electrical and communications equipment rooms.

B. Install ground terminal bar in equipment rooms where shown on Drawings. Mount bar by anchors and bolts using 1-1/2 inch long insulated spacer between bar and wall. Use a minimum of two (2) supports 18 inch on center. Connect all grounding electrode system conductors, system enclosure ground bus, and other indicated electrode systems to the terminal bar.

C. Low Voltage Electrical Power Conductors and Cables Raceway Applications:

1. Install grounding bushing on all metallic raceways entering buildings, manholes, or vaults, and extend grounding conductor to each associated manhole cable bus and building wall pullbox ground bus. Where non-metallic raceways are used as part of the feeder raceway extension, also extend the grounding conductor through the entire raceway.

3.7 ELECTRICAL EQUIPMENT GROUNDING CONDUCTOR INSTALLATIONS

A. Unless indicated otherwise, form one equipment ground circuit with rigid metallic raceways (e.g. EMT, rigid steel conduit) where used. Install a bonding jumper for continuity around all fittings and terminations where the conductive raceway is made non-continuous (i.e. underground feeder non-metallic raceways).

1. Bond all grounding conductors to boxes or enclosures at each access point utilizing approved grounding kits. Do not use building steel as equipment grounding path.

2. Bond all conductive metallic piping system in each mechanical equipment room as required by NEC utilizing approved clamps. Minimum size of conductors as required by NEC. Locate all connections where access is unrestricted for inspection. Looping of conductor from one system to another is acceptable provided the conductor is without splice and has each end of loop bonded.

B. Provide, in the same raceway with the associated phase and/or neutral conductors, a green colored equipment ground conductor having the same type insulation and connected as described below to provide equipment ground redundancy.

1. Install a ground conductor in each raceway to augment the circuit formed by the metallic raceway system. Bond the conductor to each box or enclosure in which access is

possible utilizing enclosure equipment ground kits, through metallic conduit insulated ground bushings or wedges and/or enclosure threaded grounding studs. Size conductor as specified, shown or required by Code, whichever is larger. Install a raceway grounding bushing and bonding jumper to the enclosure or contained ground bus for the following: each termination of conduits 1 inch trade size and larger at a switchboard, panelboard, or other enclosure, each location where multiple ring knockouts are damaged during conduit installation, each location where conduits are stubbed up into floor mounted enclosures; each conduit termination at a painted enclosure where paint is not removed before installation of raceway and each feeder.

a. All branch circuits shall be provided with an equipment grounding conductor sized per NEC Table 250-122. This includes all lighting and power branch circuits.

b. Provide a ground conductor to all light switches, receptacles, motors, light fixtures and all other branch circuit loads.

c. Install a ground conductor inside all flexible raceways (e.g., flexible steel, liquid tight). Bond the conductor to the enclosure or ground bus in the nearest box or access on either side of the flexible section. Size conductor as specified, indicated, or required by Code, whichever is larger.

d. Install a ground conductor in all sectional raceways with removable covers for access (e.g. plug-in strips, surface raceway systems, and wireways) unless specified otherwise. Size conductor in accordance with the NEC for the largest phase conductor size installed in raceway, or as indicated. Bond all sections of the raceway to the ground conductors. Connect all receptacle ground terminals in the raceway to the ground conductor, and make other ground connections shown on Drawings.

C. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch circuit conductors.

3.8 SURGE PROTECTION DEVICE PROTECTION DEVICE (SPD) GROUND CONDUCTOR INSTALLATIONS

A. Extend separate transient voltage surge suppressor dissipation ground conductors to local equipment ground bus and to common grounding electrode conductors. Size conductors per (SPD) manufacturer recommendations and National Electrical Code. Refer to details on Drawings.

3.9 LABELING

A. Comply with requirements in Division 26 Section "Electrical Identification" for instruction signs. The label or its text shall be green.

1. Install labels on bonding conductor or on bonding conductor raceway every 15 feet. Identify system/service and bonding termination locations.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform inspections and test procedures as required by Division 26 Section "Electrical Inspections and Testing", ANSI/NETA ATS "Grounding Systems" requirements and the following additional requirements:

a. Prepare dimensioned Drawings locating each test well, ground rod, and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

b. Grounding system will be considered defective if it does not pass tests and inspections.

c. Prepare test and inspection reports.

2. Report measured ground resistances that exceed the following values:

   a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

   b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.

   c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

   d. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

   e. Substations: 5 ohms.

3. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

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SECTION 260529

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Provide bases, inertia pads, steel supports, anchor bolts, inserts, etc., for all equipment and apparatus shown on Drawings.

C. Floor mounted electrical equipment shall be installed on 4 inch high floor doweled concrete housekeeping pads with equipment inset 4 inches on all sides. Concrete shall be in accordance with referenced concrete specification section.

D. Solidly anchor steel support channel framework to floor and ceiling slabs and mount the designated equipment thereto.

E. Provide concrete pads for floor mounted equipment such as:

1. Distribution type panelboards when installed below six inches above floor.
2. Floor Mounted Automatic Transfer Switches.

F. Provide steel support channels for wall mounted equipment such as:

1. Disconnect Switches.
2. Individual Circuit Breakers.
3. Panelboards.
4. Raceways.

G. Coordinate and provide concrete pads under wall mounted equipment installed six inches or less from the floor. Provide consideration for maximum protective device height on larger distribution panelboards.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements".

1.4 ACTION SUBMITTALS

A. Product Data:

1. Trapeze hangers.
2. Steel slotted support systems.

B. Shop Drawings:

1. Show fabrication and installation details and include calculations for the following:

a. Trapeze hangers.

b. Steel slotted channel systems.

c. Equipment supports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit, a Division of Tyco.

   b. Line Systems.

   c. Cooper B-Line, Inc.; a Division of Cooper Industries.

   d. ERICO International Corporation.

   e. GS Metals Corporation.

   f. Thomas & Betts Corporation.

   g. Unistrut; Tyco International, Ltd.

   h. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Support device accessories used in exterior or wet locations shall be corrosion resistant hot dip galvanized steel or stainless steel.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti, Inc.

2) ITW Ramset/Red Head; a Division of Illinois Tool Works, Inc.

3) MKT Fastening, LLC.

4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a Division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti, Inc.

4) ITW Ramset/Red Head; a Division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

G. Hangers, supports, and associated fittings for exterior applications or parking structures shall be hot-dip galvanized steel and/or stainless steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with NEC, NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Take care not to weaken concrete or penetrate waterproofing where equipment supports are on concrete construction.

C. Obtain prior approval for installation method where structural steel is required to frame into building structural members for the support of equipment, conduit, etc. Welding is permitted only when approved by Engineer's field representative.

D. Coordinate with the building structural system and with other electrical installations.

E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel or angle iron racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

F. In overhead spaces, boxes shall be supported independently of raceways and raceways independent of the boxes. Support boxes directly from the building structure or by bar hangers.

1. Where bar hangers are used for boxes, attach the bar to raceways on opposite sides of the box and support the raceway with an independent approved type of fastener not more than 24 inches from the box. To clarify, box or raceway removal should not require re-supporting of the other.

G. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

H. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

I. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NEC, NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structural members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
7. To Light Gage Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Coordinate dimensions of concrete housekeeping pads with requirement for equipment supplied.

B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

1. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

2. Drill and grout steel reinforcing bar dowels to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

C. Anchor equipment to concrete base:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install epoxy coated anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533

RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways for electrical wiring. Types of raceways in this Section include the following:

1. Rigid galvanized steel conduit (RGS).
2. Intermediate metal conduit (IMC).
3. Electrical metallic tubing (EMT).
4. Rigid nonmetallic conduit (RNC).
5. Flexible metal conduit.
6. Liquidtight flexible metal conduit.
7. Conduit bodies.
8. Conduit fittings.
9. Wireway and auxiliary gutters.
10. Steel wall duct.

1.2 SEQUENCING AND SCHEDULING

A. Coordinate with other Work, including metal and concrete deck installation, as necessary to interface installation of electrical raceways and components with other Work.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways and all conduit fittings only.

B. Shop Drawings:

1. Layout Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.

    a. Structural members in the paths of conduit groups with common supports.

    b. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

    c. Include plans, elevations, sections, details and attachments to other work.

1.5 CLOSEOUT SUBMITTALS

A. Record Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

B. Rigid Metallic Conduit:

1. Allied, a Division of Tyco.
2. Republic Conduit.
3. Wheatland Tube Co.

C. Rigid Nonmetallic Conduit and Fittings:

1. Allied, a Division of Tyco.
2. Can-Tex.
3. Carlon.
4. Condux.
5. IPEX.
6. National.

D. Flexible Nonmetallic Conduit and Fittings:

1. Arnco Corporation.
2. Endot Industries, Inc.
3. Carlon Plenum-Guard.

4. Kwikpath, IPEX, Inc.

E. Flexible Metal Conduit and Fittings:

1. AFC Cable Systems, a Division of Tyco.
2. Al-flex (Steel).
3. Liquatite.

F. Liquidtight Flexible Metal Conduit and Fittings:

1. AFC Cable Systems, a Division of Tyco.
2. Al-flex.
3. American Flexible Conduit.
4. Anamet, Inc.
5. Electro Flex.
6. Liquatite.
7. PDU Cables.
8. RACO.

G. Conduit Bodies:

1. Appleton Electric Co.
2. Carlon (PVC).
3. Crouse-Hinds Division, Cooper Industries, Inc.
4. Killark Electric Mfg. Co.
5. O-Z/Gedney.

H. Conduit Fittings:

1. Allied, a Division of Tyco.
2. Arlington.
3. Bridgeport Fittings, Incorporated.
4. Cooper Crouse-Hinds.
5. Midwest Electric.
6. O-Z/Gedney.

7. RACO.
8. Steel City.
9. Thomas and Betts.

I. Wireways and Auxiliary Gutters:

1. Hoffman Engineering Co.
2. Lee Products Co.
3. Walker-Parkersburg.

J. Steel Wall Duct:

1. Mono-Systems.
2. Nova
3. Square D.
4. Wiremold.

K. HDPE Conduit:

1. Blue Diamond
2. Carlon
3. Dura-line

2.2 REGULATORY REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

1. National Electrical Manufacturers Association (NEMA):

a.	NEMA, FB1	Fittings for Metallic Conduit
b.	NEMA, RN 1	PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
c.	NEMA, TC2	Schedule 40 and Schedule 80 PVC

d. NEMA, TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing

2. American National Standards Institute (ANSI):

a. ANSI-C80.1 Rigid Steel Conduit

b. ANSI-C80.2 Rigid Steel Conduit, Enameled

c. ANSI-C80.3 Electrical Metallic Tubing, Zinc-coated

d. ANSI-C80.6 Intermediate Metal Conduit (IMC)

3. American Society for Testing Materials (ASTM):

a. ASTM F 512-84 Standard Specification for Smooth Wall Poly Vinyl Chloride (PVC) Conduit and Fittings for Underground Installation

b. ASTM F 52160 Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit based on Controlled Outside Diameter (OD)

D. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, or ETL:

1. UL 1 Flexible Metal Electrical Conduit

2. UL 6 Rigid Metal Electrical Conduit

3. UL 360 Liquidtight Flexible Steel Conduit, Electrical

4. UL 514B Fittings for Conduit and Outlet Boxes

5. UL 651 Schedule 40 and 80 PVC Conduit

6. UL 797 Electrical Metallic Tubing

7. UL 870 Electrical Wireways, Auxiliary Gutters, and Associated Fittings

8. UL 1242 Intermediate Metal Conduit

2.3 METAL CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit: ANSI C80.1.

B. Intermediate Steel Conduit: UL 1242.

C. Electrical Metallic Tubing and Fittings: ANSI C80.3.

D. Flexible Metal Conduit: UL 1, zinc-coated steel.

E. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

F. Provide manufacturer colored conduit where available for conduit less than 2-1/2", otherwise conduit shall be painted. Refer to Division 26 Section "Electrical Identification" for specified colors per system.

2.4 NONMETALLIC CONDUIT AND DUCTS

A. Rigid Nonmetallic Conduit: NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.

B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

C. HDPE Conduit: NEMA TC 3 and UL 651A, Schedule 40 or 80.

D. Conduit and Duct Accessories: Types, sizes, and materials complying with manufacturers published product information. Mate and match accessories with raceway.

2.5 CONDUIT BODIES

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements for feeder runs only. Branch circuit use is prohibited. Provide matching gasketed covers secured with corrosion-resistant screws.

B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways. Use bodies with set screw or compression type hubs for EMT according to fitting application specified below.

C. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.

2.6 CONDUIT FITTINGS

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Die cast fittings are not acceptable.

B. Rigid Galvanized Steel, Intermediate Steel and Rigid Aluminum Conduit: Use threaded type with bushed connections only, unless otherwise approved in writing by engineer. Factory-installed conduit couplings are acceptable.

C. Electrical Metallic Tubing Conduit: Use nylon insulated fittings. Steel body or integral conduit sleeve dual double set-screw type fittings are acceptable for EMT conduits except for kitchens and damp locations where threaded compression types are required. Die cast fittings are not acceptable.

1. Nylon fittings may be eliminated if rounded box teeth type fitting are used (i.e. Cooper Crouse Hinds Space Saver).

2. Colored fittings may be used for conduit 2-1/2” and larger to meet raceway identification requirements of Division 26 Sections "Boxes and Cabinets" and "Electrical Identification."

D. Rigid Nonmetallic Conduit: Use fittings designed specifically for conduit type of same manufacturer.

E. Flexible Metal Conduit: Use nylon insulated throats of the following type:

1. Wedge and screw type.

2. Squeeze on clamp type with one or two screws.

3. Steel multiple-point type for threading into internal wall of conduit.

F. Liquidtight Flexible Conduit: Use threaded grounding cone with steel compression ring and tightening gland, steel body with insulated throat.

G. Unlike Conduit: Use connectors which meet individual conduit fittings requirements for both and are UL listed and labeled for such use.

H. Expansion and Deflection Fittings:

1. Conduit movement in straight line direction:

a. O-Z/Gedney type AX series.

2. Up to 3/4 inch deflection and movement in all directions:

a. O-Z/Gedney type DX series.

3. Deflection and movement beyond 3/4 inch in all directions:

a. O-Z/Gedney type AXDX series.

4. PVC Expansion fittings:

a. Allied

b. Cantex

c. Carlon

I. Conduit Bushings:

1. Rigid Steel and Intermediate Steel Conduit: Threaded, grounded, insulating type with thermosetting or fiber insert in a metal body.

2. Insulated Grounding Bushings or grounding wedges on metallic conduits shall be installed per Division 26 Section "Grounding and Bonding."

3. Conduit Sleeves/Stubs: Nonmetallic insulated UL approved for air handling spaces when installed in air handling plenums.

J. Conduit Seals:

1. Cast in place with pressure ring and sealing grommet:

a. O-Z/Gedney type FSK series with FSKA membrane clamp adapter.

2. Cast in place with two pairs of pressure rings and sealing grommets:

a. O-Z/Gedney type WSK series.

3. For sealing conduits installed in core-drilled, sleeved, or precast holes:

a. O-Z/Gedney type CSM series with CSMC membrane clamp adapter.

b. Thunderline Link-Seal series.

2.7 WIREWAYS AND AUXILIARY GUTTERS

A. General: Electrical wireways and auxiliary gutters shall be generally NEMA 1 construction of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, connectors, tees, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Provide corrosion resistant phosphate primer and baked gray epoxy finish. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC and NEMA standards.

B. Wireway covers shall be hinged type.

2.8 STEEL WALL DUCT

A. Sheet metal duct suitable for installation of diagnostic and treatment equipment cables; with removable covers, partitions and accessories as indicated or required by the equipment manufacturer’s representative.

B. Size: As shown on diagnostic and treatment equipment manufacturer’s layout drawings.

C. The wall duct raceway (body and cover) shall be fabricated from 14-gauge galvanized steel. Galvanized steel shall be of a paintable finish, such that no further preparation except for normal cleaning will be required to paint the raceway.

D. Coverplate widths shall be equal to the body width when raceway is surface mounted and shall exceed the body by 2 inch when the raceway is flush mounted.

E. The wall duct raceway shall be furnished in standard 5 foot lengths. Each 5 foot length shall consist of one body and two 30 inch long coverplates. 18 inch lengths of raceway (with one coverplate) shall also be used when appropriate.

F. When necessary, field modifications shall be made to the product to insure compliance with the manufacturer's layout drawings.

G. Accessories: Provide the necessary accessories as required to make a complete installation. Accessories shall include but not be limited to internal coupling angles, snap-in-place wire retainers and end closures.

H. A non-adjustable partition shall be provided to maintain separation of services.

I. Fittings: All tee, horizontal elbow, internal elbow, external elbow and vertical elbows shall be provided as required. These fittings shall be provided with tunneling to maintain separation of services. Transitions from wall duct to trench duct shall be provided as required. Other miscellaneous fittings shall be provided as required to conform to diagnostic and treatment equipment manufacturer's layout drawings.

PART 3 - EXECUTION

3.1 CONDUIT RACEWAY APPLICATION

A. Rigid Galvanized Steel Conduit:

1. May be used in:

   a. Interior locations.

   b. Direct contact with concrete.

2. Shall be used in:

   a. Exposed exterior locations.

   b. Exposed interior damp or wet locations.

   c. Hazardous locations.

d. Within seven foot area around boilers, incinerators and other heat producing equipment.

e. Exposed interior locations where subject to physical damage.

B. Intermediate Metallic Conduit:

1. May be used in:

a. All applications noted for rigid galvanized steel conduit except hazardous locations.

C. Electrical Metal Tubing:

1. May be used in:

a. Concealed interior locations above ceilings, in hollow studded partitions and in the cores of concrete masonry unit partitions.

b. Exposed interior locations where not subject to physical damage.

c. Low voltage electric and communication room applications.

D. (Schedule 80) Nonmetallic Conduit:

1. May be used in:

a. Direct contact with earth.

b. Locations embedded in concrete.

2. Shall not be used in HVAC plenums or to serve patient care areas.

E. (Schedule 40) Nonmetallic Conduit:

1. May be used in:

a. Direct contact with earth.

b. Locations embedded in concrete.

2. Shall be used in:

a. Parking garages above 7ft of finished floor.

3. Shall not be used in HVAC plenums or to serve patient care areas.

F. HDPE Conduit:

1. May be used in:

    a. Direct contact with earth.

2. Shall not be used for:

    a. Service feeders.

    b. Emergency feeders.

G. Flexible Metal Conduit:

1. May be used in:

    a. Four to six feet long lengths for final connection to luminaries.

    b. Steel studwalls between outlets and from outlet to rigid raceway leaving wall.

2. Shall be used in:

    a. 18 inches to 22 inch long lengths to form a slack "U" between rigid raceway system and:

        1) Busway plug-in devices.

        2) Rotating equipment.

        3) Vibrating equipment.

        4) Equipment requiring adjustments in position.

        5) Transformers.

H. Liquid-tight Flexible Metal Conduit shall be used as specified for flexible metal conduit as follows:

1. Shall be used in:

    a. Final connection to all laboratory equipment.

    b. Damp locations.

    c. Wet locations.

    d. 18 inch to 22 inch long lengths to form a slack "U" between rigid raceway system and motors.

2. Shall not be used in HVAC plenums.

3.2 INSTALLATION

A. General: Install electrical raceways in accordance with manufacturer's written installation instructions, applicable requirements of NEC, NECA1, and as follows:

1. Provide power and wiring raceways to control devices for equipment by this or other Divisions.

2. Minimum conduit raceway size shall be 3/4 inch except switch legs, which may be 1/2 inch and 3/8 inch flexible conduit may be use for final connection to luminaires.

3. Provide supports for raceways as specified elsewhere in Division 26 Section "Hangers and Supports."

4. Cut square, free of burrs due to field cutting or manufacture, and use bushings approved for use where necessary.

5. Increase conduit raceway size as required due to NEC conductor derating requirements and availability. Minimum feeder conductor sizes, based upon NEC Table 310.16 and 40 percent maximum conduit raceway fill, shall be as shown on Drawings. If raceway type altered, be responsible for associated feeder conduit raceway size per NEC to meet 40 percent maximum fill.

B. Raceway Routing:

1. Separate normal power and generator powered conductors branch circuits, and feeder raceways in separate enclosures and rooms. Do not extend generator powered conductors and feeder raceways through normal power electrical rooms except where shown on Drawings or approved by the Electrical Engineer.

2. Conceal in finished rooms except where exposure is clearly indicated. Provide stainless steel escutcheon plates for all exposed finished wall, floor, and ceiling penetrations.

3. Install raceways exposed in mechanical and electrical equipment rooms and electrical closets. Maintain a minimum 7 ft. head room.

4. Install raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

5. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways.

6. Route raceways as required by job conditions unless dimensioned positions are shown on Drawings. Verify exact locations of all raceways, pull boxes, and junction boxes; resolve any conflicts before installation. Give priority in available space to large steam mains, steam lines that pitch, waste lines, drain lines, large air ducts, and all structural steel, unless indicated otherwise.

a. Maintain raceway and box separations per NEC.

7. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.

8. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. Bends shall exceed minimum bending radii of wire and cable to be run within.

9. Install with not more than three 90-degree bends or more than 100 feet of straight branch circuit conduit between pull boxes. Provide and install all additional pull boxes to meet this requirement.

10. Minimum Spacing: 3 inches between raceways and cold or hot water or waste piping, and 12 inches between raceways and parallel steam pipes and condensate pipes..

11. Do not place raceway less than one inch apart where they cross each other.

12. Install to provide adequate grounding between all outlets and the established electrical system ground.

13. Install to prevent water pockets.

14. Make no horizontal raceway runs in masonry walls.

C. Raceway Installation:

1. Prevent foreign matter from entering raceways by using temporary closure protection.

2. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

3. Raceways embedded in slabs:

a. Refer to Division 03 Section "Cast-in Place Concrete" for limitation on placement of conduit in concrete.

b. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement.

c. Maximum trade size of embedded conduit shall be 1 inch. Minimum spacing between conduits shall be 3 conduit diameters clear.

d. Where conduit runs perpendicular to steel deck flutes, place conduit directly on steel deck. Where conduit runs parallel to steel deck flutes, place on 3/4 inch chair in low flute, with one conduit per flute maximum.

e. Do not place conduit between reinforcing bars and concrete surface. Provide minimum 1-1/2 inch concrete cover over conduits.

f. Do not lap or cross conduits at any point.

g. Do not tie conduits to headed shear studs. Place conduits parallel to beams with headed shear studs at least 18 inches away from studs.

h. Single conduit penetrations shall not be permitted in more than 3 consecutive deck flutes. Submit all variations to the Architect for review prior to the routing of conduits.

i. Where nonmetallic conduit is used, raceways must be converted to rigid galvanized steel conduit or IMC before rising above floor. Refer to Division 26 Section "Grounding and Bonding." Nonmetallic conduit shall not be used for circuits within patient care areas.

4. When installed embedded in concrete, or, in direct contact with the earth:

a. Provide rigid galvanized steel or IMC elbows for vertical rise through the concrete.

b. Provide rigid galvanized steel or IMC conduit for the first ten foot section when leaving or entering a building.

c. Make watertight with asphaltum or other approved compound applied to conduit joints before assembled.

d. Refer to Section 3.1 for conduit applications in concrete or direct contact with the earth.

5. Join raceways with fittings and make joints tight. Use bonding jumpers as required to maintain electrical continuity of the raceway system for all metallic feeder conduits. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Use insulating bushings to protect conductors.

6. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

7. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

8. Complete installation of electrical raceways before starting installation of conductors within raceways.

9. Install a bonding wire in all flexible metal conduits.

10. Install pull wires in empty raceways. Use pulling line having not less than 200 lbs. tensile strength. Leave not less than 12 inches of slack at each end of the pull wire. Tag at each end identifying other end location.

11. Refer to Division 26 Section "Conduit Rough-In Systems" for special raceway installation requirements for telecommunications, systems (low-voltage, signaling systems) cabling.

12. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid galvanized steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs with floor.

13. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceway is installed for such circuits and it passes through concrete, install in a nonmetallic sleeve.

14. If it is necessary to cut holes through webs of beams or girders, call such points to the attention of the Architect with size of hole before proceeding with work. All holes shall be cut no larger than absolutely necessary.

15. Whenever conduit is installed on exposed steel columns, the conduit shall be installed on the column web, and not on the flange.

16. All penetrations through existing floors shall be core drilled and sleeved.

17. All conduit knockouts or holes on electrical apparatus which are not used shall be provided with new plugs to match the NEMA rating of the enclosure.

D. Conduit Fittings:

1. Run with couplings approved for the conduit being used. Running threads and chase nipples will not be accepted in runs of threaded conduit.

2. Generally use mechanical dual set-screw type on EMT conduit except-use threaded compression type on EMT conduit within, kitchens, and damp locations.

3. Install grounding bushings per Division 26 Section "Grounding and Bonding."

E. Raceway Identification:

1. Provide raceway identification per Division 26 Section "Electrical Identification."

F. Expansion-Deflection Fittings:

1. Install in all raceways at the expansion joints of the building in such a manner that the expansion joints of the building will function properly and not stress any electrical raceways. Movement will be required in all directions. Refer to "A" Series Drawings for facility expansion joint locations.

2. Maintain grounding continuity at each expansion-contraction fitting.

G. Conduit Seals:

1. Use type "FSK" cast-in-place where conduit passes through foundation walls less than 60 inches below finished grade.

2. Use type "WSK" cast-in place where conduit passes through foundation walls at 60 inches or more below finished grade.

3. Install watertight seals at all conduits passing through horizontal barriers. These seals may be types "FSK," "WSK," or "CSML." Sleeves shall extend at least two inches above the finished floor with 1/2 inch space around the conduit and this space sealed permanently watertight with a removable material (concrete not acceptable).

4. Install where conduits pass through barriers having a 30 degree F or greater temperature differential in the spaces on either side at anytime, and in conduits entering or leaving supply and return air plenums. Install pliable removable plastic compounded in the

H. Wireways and Auxiliary Gutters:

1. Support horizontally with expansion shields, concrete inserts or masonry shields, as required for wall where wireway is mounted. Provide supports per code.

2. Provide at least 42 inch clear in front of all wireways with front covers.

I. Steel Wall Duct:

1. Review the diagnostic and imaging equipment manufacturer's installation drawings provided and become familiar with all components used. Wall duct shall be installed and used in accordance with appropriate National Electrical Code articles. Derating of power conductors as explained in the National Electrical Code shall govern. The maximum wire fill shall not exceed 40 percent of the interior cross sectional area of the wall duct.

2. Mount wall duct with screws through the sides or back. Screws must be installed so the head of the screw is inside the wall duct body. Exposed threads are not permitted on the inside of the raceway. Overhead runs of wall duct may be mounted directly to structural members or hung via trapeze.

3. Install all wall duct, minus coverplates, before any wiring is placed in any portion of the system. Wall duct and fittings are to be assembled, minus coverplates, using couplings and screws provided by the manufacturer from the inside of the bodies.

4. Field drill coupling holes when necessary to field cut a straight length to suit conditions. Use the coupling as a template for proper hole placement. Do not enlarge diameter of coupling holes when field drilling duct body coupling holes.

5. Field install accessories such as partitions, etc., by match drilling holes in the duct body using holes in items as templates and installing self-tapping screws provided with each item.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.6 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris before installing or pulling conductors.

END OF SECTION

SECTION 260535

BOXES AND CABINETS

PART 1 - **GENERAL**

1.1 SUMMARY

A. This Section provides requirements and specifications for cabinets, boxes, and fittings for electric work, and electrical devices not covered in other sections. Products specified in this Section include:

1. General Purpose Electric Work Boxes.
2. Pull and Junction Boxes.
3. Cabinets.

1.2 COORDINATION

A. Coordinate wall and floor box and cabinet penetration in rated walls to ensure rating is maintained.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Divisions 26 Requirements."

1.4 ACTION SUBMITTALS

A. Shop Drawings:

1. For the following raceway components. Include plans, elevations, sections, details and attachments to other work.

a. Conduit fittings.

b. Back to back recessed box or cabinet installation locations list, if any.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Listing and Labeling: Items provided under this section shall be designed, fabricated, and tested to Underwriter's Laboratories (UL) Standard 514A and 514C, and shall be so listed and labeled.

B. National Electrical Code Compliance: Components and installation shall comply with NFPA 70 "National Electrical Code."

C. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."

2.2 DESIGN CRITERIA

A. Electrical Boxes and Cabinets: Of indicated types, sizes and NEMA enclosure classes. Where not indicated, provide units of types, sizes and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations. Box depth shall exceed depth of installed device by 1/4 inch.

2.3 MATERIALS AND FINISHES

A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.

B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.

C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.

D. Cast Metal for Boxes, Enclosures and Covers: Copper-free aluminum except as otherwise specified.

E. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.

F. Painted Interior Finish: Where indicated, white baked enamel.

G. Fittings for Boxes, Cabinets and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, with ground terminal bushings and box connectors.

2.4 STEEL DEVICE BOXES

A. General:

1. Fabricate from galvanized or cadmium plated pressed sheet steel, with installation provisions, brackets, hardware, etc., as required by the installation.

2. Box depth shall exceed depth of installed device by 1/4 inch.

3. Provide boxes complete with device covers, extension rings, ganged opening covers, etc., suitable for the application.

B. Switch Boxes:

1. Single gang - 2 inch wide by 3 inch high by 2-1/2 inch deep minimum.

2. Multi-gang - 4-inch high by 1-1/2 inch deep minimum by width as required by number of gangs.

C. Outlet, Receptacle, Device, and Junction Boxes:

1. 4 inch square by 1-1/2 inch depth minimum, without clamps for either conduit or tubing.

D. Outlet Boxes (For Data/Communications/Systems Devices):

1. 4 inch square x 2-1/8 inch deep galvanized sheet steel box.

   a. Provide not less than (6) 1 inch trade size knockouts in the 2-1/8 inch deep box.

   b. Box covers shall provide single or double gang finished openings, to match the specified device requirements, and shall be of depth and type required to provide a concealed, flush, installation in finished wall or ceiling construction.

2. Provide boxes with brackets and accessories suitable for installation in the specific wall or ceiling construction.

3. Boxes provided for open cabling and wiring installations (no raceways or conduits entering box) shall be provided with non-metallic bushings in the knockouts used for open cable entries and exits.

4. New outlets within non-rated accessible walls may be installed per the “ring and string” method consisting simply of a plaster mud ring with single gang device opening with pull string to accessible ceiling.

E. Wall and Ceiling Luminaire Boxes:

1. Listed and identified for weight supported.

F. Acceptable Manufacturers:

1. EGS/Appleton Electric.

2. Cooper/Crouse-Hinds.

3. Hubbell/Raco.

4. Thomas & Betts/Steel City.

5. Rand Industries, Inc.

6. Siemon.

2.5 CAST DEVICE BOXES

A. General:

1. Copper-free aluminum or malleable iron with matching cast cover.

B. Switch Boxes:

1. FS or FD series (or equivalent), single, two, multi-gang as required for wiring device arrangement.

C. Outlet, Receptacle, Device, and Junction Boxes:

1. FD series (or equivalent), single, two, multi-gang as required for wiring device arrangement.

D. Acceptable Manufacturers:

1. EGS/Appleton Electric.

2. Cooper/Crouse-Hinds.

3. Hubbell/Bell

4. Hubbell/Killark.

5. O-Z Gedney.

6. Thomas & Betts/Russell Stoll.

2.6 PULL AND JUNCTION BOXES

A. General:

1. NEMA type and size as required by area or as shown, complete with matching cover. Where necessary, gaskets shall be used to prevent entrance of moisture.

B. Galvanized Sheet Steel:

1. Minimum 14 gauge, solder or braze all seams, roll edges at openings and bolt on covers.

C. Cast Iron:

1. Corrosion resistant, hot-dip galvanized and bolt on cast cover utilizing stainless steel screws.

D. Cast Aluminum:

1. Non-rusting, non-sparking, non-magnetic and bolt on cast cover utilizing stainless steel screws.

E. Cast Bronze:

1. Non-rusting, non-sparking, non-magnetic and bolt on cast cover utilizing brass screws.

F. Acceptable Manufacturers:

1. O-Z/Gedney, a General Signal Co.
2. Crouse Hinds; Div. of Copper Industries, Inc.
3. Appleton Electric Co.
4. Hoffman Engineering Co.
5. Lee Products.
6. Hammond Manufacturing.
7. Electromate Corporation.
8. Or approved custom box manufacturer.

2.7 CABINETS

A. Comply with UL 50, "Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations."

B. General: NEMA type and size as required by area, application, or as shown. Cabinet shall consist of a box and a front consisting of a one piece frame and hinged door. Hinged side shall be dependent upon physical application. Arrange door to close against a rabbet placed around the inside edge of the frame, with a uniformly close fit between door and frame. Provide concealed fasteners, not over 24 inches apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24 inches apart and not over 6 inches from top and bottom of door. Louvers for cabinet ventilation shall be provided as

required by application. For flush cabinets, make the front approximately 3/4 inch larger than the box all around. For surface mounted cabinets make front same height and width as box.

C. Doors: Double doors for cabinets wider than 24 inches. Cabinets wider than 48 inches may have sliding or removable doors.

D. Locks: Combination spring catch and key lock, with all locks for cabinets of the same system keyed alike. Locks may be omitted on signal, power and lighting cabinets located within wire closets and mechanical-electrical rooms. Locks shall be of a type to permit doors to latch closed without locking. Latch shall be padlocking type for exterior applications.

E. Galvanized Sheet Steel: Minimum 14 gauge, solder or braze all seams, roll edges at openings and minimum 12 gauge doors to match panelboard enclosures.

F. Sheet Aluminum: Type 5052 H-32 sheet aluminum, minimum 0.125 inch thickness, welded seams, gasketed weathertight door, stainless steel hinge, and stainless steel padlockable latching mechanism.

G. Sheet Stainless Steel: Type 316L sheet stainless steel, minimum 16 gauge thickness for enclosures 20 inch wide and less, otherwise 14 ga. welded seams, gasketed weathertight door, stainless steel hinge, and stainless steel latches and padlockable hardware.

H. Acceptable Manufacturers:

1. Square-D.
2. Chicago Switchboard.
3. Cutler Hammer/Westinghouse.
4. General Electric.
5. Hoffman Engineering Co.
6. Illinois Switchboard.
7. Lee Products.
8. Crenlo, Inc.
9. Hammond Manufacturing.
10. Electromate Corporation.
11. Siemens.
12. Hennessy Products, Inc.
13. Wiegman, a Division of Hubbell, Inc.

2.8 **ACCESSORIES**

A. Ground Provision: Provisions for each box and cabinet, to facilitate bonding to the building ground system.

B. Preformed Acoustical Seal for Outlet Boxes: Manufacturer's standard molded neoprene, durometer A-40 complying with ASTM D2000, formed and cut to fit the electrical device and outlet box. Product effectively increases the STC of outlet boxes by 6 dB as demonstrated by testing representative assemblies according to ASTM E 90 (Small Scale Test).

1. Products: Subject to compliance with requirements, provide the following:

a. STC Architectural Products; Box Seal, info@stcsoundseal.com.

b. Or other approved manufacturer

2. Configurations: To match installed device.

3. Color: Black.

4. Applications: Provide for each outlet in sound-rated partitions in all patient care areas. Coordinate locations with Architect.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install items where indicated and where required to suit code requirements and installation conditions.

B. Maintain the environmental rating of the enclosures. Install in the openings only listed or recognized conduit hubs or conduit and raceway fittings providing the same rating and integrity as the enclosure, in compliance with the installation instructions of the device.

1. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.

2. Use listed connectors to maintain raceway to enclosure grounding and bonding integrity. Cut through paint as applicable. Cutting slots shall not be acceptable for conduit entries into enclosures.

C. Support and fasten items securely in accordance with Division 26 Section "Hangers and Supports."

1. Fasten boxes to or support from building structure. Do not support boxes by raceways.

D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.

E. Remove sharp edges where they may come in contact with wiring or personnel.

F. Refinish and paint enclosures in field due to any field modifications.

3.2 APPLICATIONS

A. Provide electrical identification as indicated in Division 26 Section "Electrical Identification."

B. Cabinets: NEMA Type 1, installed flush, unless noted or indicated otherwise.

C. Boxes and Fittings: Install concealed, unless noted otherwise, with associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements.

1. Interior Dry Locations: Sheet steel, NEMA Type 1.
2. Interior Wet or Damp Locations, or Exposed to Weather: Cast metal, NEMA Type 3R.
3. Outdoor and Indoor Wet Locations: NEMA Type 4x enclosures with type 316L stainless steel. Hot dip galvanized cast iron outlet boxes.
4. Hazardous (Classified) Locations: NEMA Type listed and labeled for the location and class of hazard indicated.

D. Exterior walls shall not be considered dry locations for concealed exterior devices. Sheet steel boxes shall not be used.

E. Galvanized steel boxes may be installed in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior location above 7 feet.
3. Direct contact with concrete except slab on grade.
4. Stud walls of kitchens and laundries.

F. Cast boxes shall be installed in:

1. Exterior locations.
2. Hazardous locations.
3. Within seven feet area around boilers, incinerators and other heat producing equipment.

4. Direct contact with earth.

5. Direct contact with concrete in slab on grade.

6. Wet locations.

G. Sectional Field Gangable Boxes:

1. Shall not be used in any application, unless approved by engineer.

H. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.

3.3 INSTALLATION - BOXES

A. Provide box sizes as required by the National Electrical Code with oversize boxes as shown on Drawings. Obtain special backboxes with associated equipment when available.

B. Provide where required for outlet facility and rough-in requirements. Securely support from building construction with listed and approved rods, hangers, brackets, supports, etc., independent of raceways. Provide backing extension for all steel device boxes in stud walls or support box on two opposite sides such that cover plate and drywall is not stressed to hold box in position.

C. Give priority in available space to large steam mains, steam lines that pitch, waste lines, drain lines, large air duct, and all structural steel, unless shown otherwise.

1. Minimum Spacing: 3 inches between boxes and cold water or waste piping and 6 inches between boxes and parallel steam pipes, condensate pipes, hot water pipes and air ducts.

2. Do not support from ceiling supporting system, or mechanical systems.

3. Do not penetrate or anchor into mechanical ductwork.

D. Install concealed, flush to finished wall, floor or ceiling construction materials except where otherwise shown or specified as surface mounted. To maximize available future wall space, do not assume surface mounted boxes or associated raceways in equipment or electrical rooms.

E. Maintain accessibility to all boxes. For the purposes of this specification section, Z-spline ceilings shall not be considered accessible.

F. Provide and install concealed boxes, so no part is visible, and is completely covered by wall plate, luminaire, etc.

G. Do not cut insulation in walls to install boxes.

H. Do not use 2-sided, through wall boxes.

I. Do not install concealed, flush boxes back to back for both fire and sound rating issues. Drawings are considered diagrammatic. Those installations not approved shall be corrected at no cost to the Owner.

J. Install boxes so that cover or plate will not span different building finishes.

K. Where two or more devices are shown or otherwise specified to be installed at the same location and at the same height, install those devices in a common multi-gang barriered box as appropriate for the device types.

1. Maintain box and raceway separations per NEC. Pullbox barriers will not be acceptable except for special cases brought to the Engineer's attention prior to installation.

L. Where two or more devices are shown or otherwise specified to be installed at the same location but at different height elevations, rough the boxes vertically on a common center line.

M. Install in center of glazed tile, brick, block or other masonry wall material with adjustable mud rings to ensure device and plate are flush with final finish.

N. Close off all unused openings with proper fittings.

O. Install outlet boxes for electric water coolers concealed inside cooler cabinet. Install outlet boxes using rough-in template furnished with cooler.

P. Combination devices (i.e. switch and receptacle) shall be installed in minimum 2 gang box under common wall plate.

Q. Provide box and cabinet barriers to segregate voltages 300 volts and greater and to segregate normal and emergency distribution system branches.

R. Set floor boxes and service fittings level at height to match trim with flooring type.

S. Provide a minimum 2 gang box for all exterior equipment connection boxes.

3.4 INSTALLATION - PULL AND JUNCTION BOXES

A. All boxes shall be concealed and accessible after completion of building.

B. Installation in finished spaces requiring access panels is prohibited except where specifically shown or directed.

3.5 IDENTIFICATION

A. Per Division 26 Section "Electrical Identification."

3.6 BOX COVERS

A. Provide appropriate covers for all boxes dependent upon size, type, and application.

3.7 INSTALLATION - CABINETS

A. Support securely independent from building construction and align with adjacent equipment. Top shall be 6 foot - 2 inches to top of trim.

3.8 GROUNDING AND BONDING

A. Electrically bond metallic cabinets, boxes, enclosures and their associated raceways to the building grounding and system. Where wiring to box or cabinet includes a grounding and bonding conductor, provide a terminal in the interior of the cabinet, box or enclosure, and connect conductor.

3.9 ACOUSTICAL SEAL FOR OUTLET BOXES

A. Place seal over exposed outlet box flush with wall surface with device protruding through preformed or precut opening in seal. Secure in place with outlet cover plate.

3.10 CLEANING AND FINISH REPAIR

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions, and weld marks.

B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.

C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION

SECTION 260543

UNDERGROUND DUCTS

PART 1 - **GENERAL**

1.1 SUMMARY

A. This section includes underground electrical raceway work including the following:

1. Underground raceway and duct banks.

1.2 DEFINITIONS

A. Duct: The general term for electrical conduit and other raceway, either metallic or nonmetallic, specified for use underground or embedded in earth or concrete.

B. Duct Bank: A group of two or more ducts in a continuous run between two points.

C. Concrete Pullbox: A below-the-surface enclosure, with flush to grade access, into which people reach, but do not enter, provided in conjunction with underground raceways, for the purpose of installing wiring.

1.3 COORDINATION

A. Coordinate layout and installation of pullboxes with final arrangement of ducts as influenced by actual final location of other utilities in the field.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.5 ACTION SUBMITTALS

A. Product Data:

1. Duct bank materials, including separators and miscellaneous components.

2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

3. Pull boxes and their accessories.

4. Warning tape.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Submit after utility company review.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

B. Field quality control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Record Documents:

1. Provide color copies (8-1/2" x 11") and electronic format; JPEG or approved other for all underground installation prior to backfill with raceway and manhole identification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to site with ends capped. Store ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.9 FIELD CONDITIONS

A. Existing Utilities: Information on underground utilities and possible obstructions in the path of construction under this section was obtained through investigations during the design of the project. Reports of these investigations are available for informational purposes only. Data in the reports are not intended as representations or warranties of accuracy regarding conditions and locations. The Owner will assume no responsibility of interpretations or conclusions drawn from this information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the listed manufacturers for the project.

2.2 REGULATORY REQUIREMENTS

A. Comply with ANSI C2.

B. Comply with NFPA 70.

2.3 DUCTS AND FITTINGS

A. General: Ducts and duct fittings and accessories for which listing has been obtained by one or more manufacturers shall be UL listed and labeled.

2.4 TYPE

A. Underground duct bank raceways may utilize the following types of conduits, fittings, outlets, and seals in compliance with Division 26 Section "Raceways":

1. Rigid galvanized steel.
2. Intermediate metallic conduit.
3. Coated rigid galvanized steel.
4. PVC Schedule 80.
5. PVC Schedule 40.

B. Special Requirements:

1. Fittings shall be suitable for a watertight installation. The following fittings are among those required:

a. Sweep elbows 4 foot minimum radius. Radius bends, long sweep type. Bend segments and/or 5 degree angle coupling.

b. Terminating vertical elbows at buildings and concrete pads shall be coated, rigid galvanized steel. Terminating bushings shall be insulated grounding type. Provide corrosion protection (red lead or equal) for all cut and threaded ends.

c. Provide coated, rigid galvanized steel conduit for the first 10 foot section when leaving a building or sections passing through floor slabs.

d. Provide end bells for horizontal raceways terminating in a manhole or building.

2. Quantities and sizes - as shown on Drawings.

3. Watertight Seals:

a. Conduits penetrating outer building walls.

1) For conduits penetrating outer building walls, refer to "conduit seals" specified in Division 26 Section "Raceways."

b. Underground concrete encased raceways penetrating outer building walls.

1) For underground concrete encased raceways penetrating outer building walls, utilize duct seal.

2) Approved Duct Seal Manufacturers:

a) Appleton Electric – DUC.

b) Manville Corp. – Duxseal.

c) OZ/Gedney – DUX.

4. Conduit Spacers and Levelers:

a. Vertical PVC interlocking style providing 2 inch minimum vertical and horizontal separation with minimum 2 inch base plate and holes for reinforcing bars.

b. Approved Manufacturers:

1) Cantex

2) Carlon.

3) Condux.

4) Underground Devices, Inc.

5. Underground Raceway Marking Tape:

a. Provide as specified in Division 26 Section "Electrical Identification."

6. Drag Line (Fishwire):

a. Minimum 1/8 inch wide polypropylene monofilament utility rope.

b. Approved Manufacturers/Series:

1) American Synthetic Ropes – Flotorope.

2) Greenlee Tool Co. - 2 Ply Rope 431.

3) Ideal Industries - Pro-Pull Rope.

4) Thomas Industries/Jet Line Products - Rope 232.

2.5 CAST-IN-PLACE CONCRETE

A. Aggregate For Duct Encasement: 3/8 inch maximum size.

B. Strength: 3000 psi minimum 28 day compressive strength.

2.6 NON-METALLIC POLYMER CONCRETE PULLBOXES

A. Shall be listed electrical enclosures, having 4 sides, solid bottom, and removable top. Shall be designed, fabricated, and tested to ANSI/SCTE 77-2002 – Specification for Underground Enclosure Integrity.

B. Material: Enclosures shall be non-metallic, fabricated from a polymer concrete mix of selectively-graded aggregates in combination with a polymer resin, reinforced with fiberglass. Enclosures shall:

1. Be impact resistant — tested per ASTM D-2444.
2. Provide low water absorption — less than 1 percent per ASTM D-570.
3. Be corrosion resistant — resistant to alkalines, acids, weathering and other forms of deterioration.
4. Be nonflammable — will not support combustion.
5. Be nonconductive — no grounding required for the box or cover.

C. Performance Rating: Enclosures, covers, and their accessories, shall be rated **Tier 15**.

D. Color: Enclosure and cover shall be **Grey**.

E. Size: shall be as noted on the drawings.

1. Enclosures shall be sized in accordance with NEC Article 314.28(A) for conductors operating at 600 volts or below, and in accordance with NEC Article 314.71 for conductors operating at over 600 volts.

F. Depth shall be as noted on the drawings.

G. Wiring Entries: Raceways and cable assemblies entering a handhole enclosure underground shall be required to be mechanically connected to the enclosure.

1. The enclosed conductors, splices, and terminations shall be listed as suitable for wet locations.

H. Covers: Shall be inset flush to pullbox top, bolt down type, with not less than 4 stainless steel fasteners, and provided with weathertight gasketing or grommet to prevent the ingress of weather elements.

1. Shall have a permanent identifying mark or logo that prominently identifies the function or application of the enclosure, such as "ELECTRIC."

2. Shall be factory provided with the design Tier level rating embossed on the cover surface.

3. Cover design load rating cannot exceed the design load rating of the enclosure.

I. Referenced Products: Quazite – PG Style, or approved equivalent.

PART 3 - EXECUTION

3.1 PREPARATION

A. Refer to Drawings for special construction and dimensional requirements.

B. Provide all trenching, excavating, backfilling, and concrete required for underground duct bank raceway installations in accordance with Division 02 and Division 03. The exact location of each duct bank raceway shall be determined after careful consideration has been given to the location of other utilities, grading, and paving.

C. Lay out the proposed course and obtain location approvals prior to installations.

D. Obtain installation approval prior to concrete pour.

3.2 CORROSION PREVENTION

A. Protect all metallic materials against corrosion. Exposed metallic parts of outdoor apparatus shall be given a rust-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with the earth, and where connected to dissimilar metal shall be protected by approved fittings and treatment. All parts such as boxes, bodies, fittings, guards, and miscellaneous parts made of ferrous metals but not of corrosion-resistant steel, shall be

zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved. Steel conduits installed underground or under slabs on grade shall be coated with an approved asphaltic paint, plastic coating or shall be wrapped with a single layer of a pressure-sensitive plastic tape, half-lapped. Where pressure-sensitive plastic tape is used, the conduit shall be coated with a primer recommended by the tape manufacturer before applying the tape.

3.3 INSTALLATION UNDERGROUND DUCT BANK RACEWAY

A. General:

1. Raceway Handling:

a. Keep raceways clean of concrete, dirt, or foreign substances during construction. Raceways shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Raceways shall be thoroughly cleaned before being laid. Plastic raceways shall be stored on a flat surface and protected from the direct rays of the sun.

2. Raceway Envelope:

a. Raceways shall be generally direct buried.

b. Raceways shall be reinforced and concrete encased for the following conditions:

1) Service entrances.

2) Emergency Power Feeders.

B. Depth:

1. Existing Grade to Remain:

a. Install raceways more than 30 inches below the existing finished grade unless otherwise indicated or directed.

2. Existing Grade Lower than Finished Grade:

a. Install raceways more than 30 inches below the existing grade unless otherwise indicated or directed.

3. Existing Grade Higher than Finished Grade:

a. Install raceways more than 30 inches below the finished grade unless otherwise indicated or directed.

4. Concrete Encased Raceways:

    a. Install concrete encased raceways more than 30 inches below finished surface unless otherwise indicated or directed.

5. Crossing Obstructions:

    a. Install rigid galvanized steel conduit where top of conduit system is less than 18 inches below finished grade when crossing obstructions (tunnels, steam lines, etc.).

C. Pitch:

1. Pitch raceways to drain into pullboxes and away from buildings and concrete pads sloping not less than 12 inches per 100 feet. Where no manhole exists in run, pitch toward building with closest and safest drain access. On runs between pullboxes where it is impossible to maintain the grade all one way, grade from center so that conduits pitch both directions toward pullboxes.

D. Footings:

1. Direct Buried Raceways:

    a. Tamp and level grade, for pitch desired, the bottom of raceway trenches.

    b. Excavate an additional 3 inches where rock, soft spots, and/or sharp edged materials are encountered, then fill and tamp level with the original bottom with sand or earth free from particles to approximate densities of surrounding firm soil to minimize conduit stress.

2. Concrete Encased Raceways:

    a. Provide footing bed identical to direct buried raceways.

E. Raceway Installation:

1. General:

    a. Maintain and ensure full, even support of raceways throughout their entire length.

    b. Raceway joints may be placed side by side horizontally but shall be staggered a minimum of 6 inches vertically.

    c. Make raceway joints watertight.

    d. Provide perimeter seals where raceways and encasements penetrate walls.

2. Direct Buried Raceways:

   a. Hold lowest horizontal raceways in alignment with earth.

   b. Use a wooden frame or equivalent form to hold ducts in high-tiered banks in alignment prior to backfilling. Thoroughly tamp in 4 to 6 inch layers above raceways with selected earth.

   c. Side fill around raceway layers and hand tamp prior to earth layer tamping. Do not tamp directly on top of raceways.

   d. Remove frame as side fill is placed under raceway layers. If blocks or spacers are used for alignment, remove, fill, and tamp vacant spaces as ducts are laid.

3. Concrete Encased Raceways:

   a. Reinforce encasement with No. 4 bars 12 inches on center parallel with raceway run and No. 4 bar loops 18 inches on center perpendicular to raceway run within perimeter of encasement by 3 inches.

      1) Exception: Parking lot and roadway lighting branch circuit raceways.

   b. Encase raceway with a rectangular or monolithic concrete cross-section providing formwork as necessary. Where connection is made to a previously poured encasement, the new encasement shall be doweled square to the existing encasement.

   c. Provide a minimum of 6 inches of concrete cover around raceway bank perimeter and 2 inches between adjacent raceways.

      1) Exception: For parking lot and roadway lighting branch circuit raceways, provide minimum 3 inch cover.

   d. Avoid pouring a heavy mass of concrete directly on raceway. If unavoidable, protect with a plank. Direct the flow of concrete down the sides of the bank assembly to the bottom, compelling concrete to flow to the center of the bank and to rise up in the middle, thus filling all spaces uniformly. Ensure the absence of voids by working a vibrator or long flat slicing bar or spatula liberally and carefully up and down between the vertical rows of raceways.

F. Identification

   1. Refer to Division 26 Section "Electrical Identification" for installation requirements.

G. Backfilling:

1. Provide a brightly colored corrosion resistant plastic warning tape about 12 inches below top of trench in backfill. The tape shall be suitably inscribed at not more than 10 feet on centers to permit easy identification and location of the raceway run. Refer to Division 26 Section "Electrical Identification."

2. Backfill shall be free from scrap material. Place backfill over raceways in tamped layers of 6 inches maximum each.

3. Patch pavement, sidewalks, curbs, and gutters where existing surfaces are removed for construction. (Match existing construction).

H. Cleaning Raceways:

1. General:

a. Prevent foreign matter from entering all raceways during installation.

2. New Raceways:

a. After installation, clean raceways with tools designed for the purpose.

3. Report and demonstrate to the Owner's representative any defect found in the raceway systems that cannot be eliminated. Be responsible for any damage to cables resulting from imperfections in the raceways.

I. Capping Raceways:

1. Spare Raceways:

a. Seal and label the ends of new and/or existing spare conduits at concrete pad, building wall, and manhole penetrations. Seal with wood or plastic plugs or a contrasting color cement/sand mixture with wick for drainage.

b. Demonstrate to the Owner's representative that raceways installed for future use are clear of obstructions (draw mandrel 1/2 inch less than raceway). Install a drag line in each raceway penetrating through seal and pigtailing minimum 2 feet. Provide wick for drainage.

2. Occupied Raceways:

a. Seal the ends of raceways to be used for this contract until cables are to be installed. After cable installation, seal raceways at slabs, building entrances, and first manhole outside building. Seal with seal duct leaving wick for drainage.

3. Spare Parking Lot and Roadway Raceways:

a. Seal and cap raceway utilizing approved raceway cap fitting.

3.4 INSTALLATION – GROUNDING AND BONDING

A. General:

1. Provide grounding materials per Division 26 Section "Grounding and Bonding."

2. Bond all equipment frames, cable shield, cable racks, ground bus, conduit, and ground rods to the ground wire. Use fusion welds or approved irreversible connectors.

3. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations or shall be protected from corrosion by other suitable means as approved by Engineer. Ground wires (minimum No. 6 AWG) shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

4. Install separate equipment ground conductor for non-metallic raceways per Division 26 Sections "Raceways" and "Grounding and Bonding."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Water Tightness: Make internal inspection of pullboxes three months after completion of construction for indications of water ingress. Where leakage is noted, remove any water found and seal leakage sources. Reinspect after two months and reseal any remaining leakage sources. Repeat process until leakage is corrected.

C. Correct deficiencies and retest as specified above to demonstrate compliance.

END OF SECTION

SECTION 260553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Identification for raceway, busway, and cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Test/Inspection identification labels.
8. Miscellaneous identification products.

1.2 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.4 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated including labeling machines if used.

B. Shop Drawings:

1. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification specific products.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Brady USA, Inc. Industrial Products Division.
2. BW Industries, Inc.
3. Ideal Industries, Inc.
4. Rhino/DYMO, a Newell Rubbermaid Company.
5. Seton Name Plate Corporation.

2.2 REGULATORY REQUIREMENTS

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70 and NFPA 70E.

C. Comply with 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.3 FONT

A. Arial uppercase.

B. Text abbreviations other than equipment identifications permitted only as approved.

2.4 BOX WIRING IDENTIFICATION MATERIALS

A. Self-Adhesive Labels: Field machine printed by thermal transfer or equivalent process with Panelboard Name, Panelboard Room Number, Voltage, System and Circuit No.

2.5 CONDUCTOR, WALL PLATE, AND COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color Coding Conductor Tape: Colored, self adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide. Tape shall not be used for conductor phase identification.

B. Marker Tapes: Vinyl or vinyl cloth, self adhesive wraparound type, with circuit identification text machine printed by thermal transfer or equivalent process.

2.6 FLOOR MARKING TAPE

A. 3 inch (75-mm) wide, 5 mil (0.12 -mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.7 UNDERGROUND RACEWAY MARKING TAPE

A. Provide heavy gauge, not less than 5 mils thick, by 6" (150 mm) wide, polyethylene marking tape with integral metallic detection foil applied therein:

1. Color: APWA Yellow.

2. Wording: "CAUTION BURIED UTILITY LINE BELOW".

B. Acceptable Manufacturers:

1. Seton.

2. Panduit Corp.

3. Emedco.

2.8 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4 inch (6.4 mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch (1 mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4 inch (6.4 mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

2.9 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved text with black letters on white face.

2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Facility Electrical Single-Line:

1. Framed acrylic screw mounted full size record drawing. Mount inside electrical room. Coordinate location with owner prior to mounting.

2. Printed operating instructions may be included as an option to separate signage.

2.10 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Self Adhesive, color coded by system. Minimum letter height shall be 1/2 inch (6.4 mm).

2.11 EQUIPMENT TEST LABELS

A. Adhesive Film Label: Machine printed, color coded by system, by thermal transfer or equivalent process. Minimum letter height shall be 1/2 inch (6.4 mm).

2.12 COMPONENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Self-adhesive, color coded by system. Minimum letter height shall be 1/4 inch 93.2 mm).

2.13 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Per system color coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).

5. Color: Red.

2.14 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 DESIGN CRITERIA

A. Provide electrical distribution branch color coding as follows:

1. Normal:

a.	System ID or Nameplate:	White
b.	Conduit:	No Color
c.	Conductors:	Per associated Section

2. Generator:

a.	System ID or Nameplate:	Blue
b.	Conduit:	Blue
c.	Conductors:	Per associated Section

3. Life Safety:

a.	System ID or Nameplate:	Yellow
b.	Conduit:	Yellow
c.	Conductors:	Per associated Section

4. Equipment:

a.	System ID or Nameplate:	Green
b.	Conduit:	Green
c.	Conductors:	Per associated Section

B. Provide text color to ensure legibility of label.

C. Refer to Division 27 and 28 specifications for systems color coding.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products. Use Drawing nomenclature unless otherwise directed.

B. Location: Install identification materials and devices at locations shown on Drawings or for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Box and Equipment Identification: Attach to box or enclosure cover in locations shown on Drawings or with high visibility.

G. Test and Inspection Identification: Attach to appropriate box, enclosure or device for most convenient viewing to operation and maintenance personnel. Install inside device door in finished areas.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground Raceway Marking Tape: Prior to backfilling of underground raceway, duct and ductbank trenches, install continuous length of underground marking tape directly above buried raceways, ducts and ductbanks, at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of raceways and ducts installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

3.3 APPLICATION

A. Raceway Systems and Cables Identification:

1. Accessible Raceways, AC and MC Cables, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with self-adhesive vinyl label per NEC electrical distribution branch color coding including identification label. Install at box and conduit fittings within 12 inches, each side of joints, and at bushed conduits. Conduits 1” and larger exiting a panelboard shall be labeled with the contained circuit numbers within 12” of exiting the enclosure.

2. Accessible Raceways and Cables of Division 23 through 28 Systems: Identify the systems with preprinted identification label, self-adhesive vinyl tape applied in bands per color coding. Install at box and conduit fittings within 12 inches, each side of joints, and at bushed conduits.

a. Exception: No identification required for raceways and cable with readily

identifiable terminations within the same room.

B. Box Identification:

1. All boxes shall be labeled to indicate the information indicated below. Labeling shall be on the outside of the box cover and clearly visible. For boxes exposed in exterior areas, located identification inside box cover.

   a. Panelboard name.

   b. Panelboard location (room number).

   c. Voltage.

   d. Branch.

   e. Circuit numbers.

2. Provide printed labels with legible color and text for all boxes. Label colors for each system shall be in accordance with 3.1A.

C. Conductor Identification:

1. Phase Identification: Solid color insulation and/or jacket using the colors listed in Division 26 Section "Low Voltage Electrical Power Conductors and Cables (100-600 Volts)" for ungrounded conductors. Field applied color coding electrical tape on black conductors shall not be used.

2. Feeder Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes with more than one circuit use tie on write-on tags or machine printed water and oil resistant labels. Identify source and circuit number of each set of conductors.

3. Branch Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number. Label each conduit/cable grouping with circuit numbers.

4. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.

5. Pull Wires in Empty Raceways: Tag pull wires at each end and in each intermediate box, manhole, or other enclosure identifying other end location using metal tags.

6. Division 23 through 28 Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications.

   a. Identify conductors, cables, and terminals within boxes, enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

   b. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

c. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

D. Wiring Device and Coverplate Identification:

1. General:

a. Wiring devices and coverplates shall be provided with specific identification.

b. ID shall be not less than 1/8 inch tall, uppercase letters and numerals.

1) ID may be machine printed, self-adhesive backed tape, or labels.

2. Wiring Devices:

a. All receptacles and lights switches shall be labeled with the following branch circuit source information:

1) Panelboard name.

2) Panelboard room location.

3) Circuit number.

4) Example: “1LSL1(RM 1234)

CKT #15, 17”

b. Coverplates for fractional horsepower manual motor starters shall be provided with machine printed ID on face reading "DISCONNECT - EQUIPMENT DESIGNATION”. Example: DISCONNECT – EXH. FAN EF01. In addition, provide Panelboard name, panelboard room number and circuit number.

E. Warning Tapes, Labels, and Signs:

1. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

2. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush mounted panelboards and similar equipment in finished spaces.

3. Warning Labels for Identification for Branch Circuit Ungrounded Conductors: Install at all branch circuit panelboards, cabinets, and enclosures per NFPA 70. Apply to interior of door, cover, or other access generally.

a. For 208/120 volt systems, lines and text shall be:

1) "208/120 VOLT SYSTEM"

2) "PHASE A – BLACK"

3) "PHASE B – RED"

4) "PHASE C – BLUE"

4. Warning labels and signs shall include, but are not limited to, the following texts:

a. Low Voltage Room Door Sign: "DANGER-ELECTRICAL HAZARD – AUTHORIZED PERSONNEL ONLY".

b. Service Disconnect Sign: "SERVICE DISCONNECT."

c. Service Disconnect Sign: "AVAILABLE SERVICE FAULT CURRENT = XXXX/DATE: XX/XX/XX" per the coordination study in Division 26 Section "Protective Device Coordination".

d. Generator Disconnect Sign: "GENERATOR XX DISCONNECT."

e. Multiple Power Source Warning (locate at each service and generator disconnect equipment): "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES. STANDBY POWER SOURCE LOCATED IN _____ ROOM LOCATED AT _____ AREA OF BUILDING."

f. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and baked-enamel warning signs. Identify system voltage with black text on an orange background. Apply to exterior of door, cover, or other access.

1) Equipment with Multiple Power or Control Sources: Apply to front of equipment including, but not limited to, the following:

a) Transfer switches.

b) Controls with external control power connections.

g. Fused and Non-Fused Motor Disconnect Switches: Install baked enamel warning sign with white legend on red background with minimum 3/8 inch high lettering with the following designation – "DANGER, DO NOT USE TO START OR STOP MOTOR. USE FOR ISOLATION ONLY."

h. Back-Fed Switches and Circuit Breakers: Where switches and devices such as knife switches, circuit breakers, molded-case switches, and contactors are installed such that the load side of the switch device could energize with the switch open due to back feeding, provide a warning plate with the wording "WARNING – LOAD SIDE OF SWITCH MAY BE ENERGIZED BY BACKFEED", shall be installed on the switch.

i. Arc Flash Hazard Warning: Per NFPA 70 requirements.

F. Instruction Signs:

1. Operating Instructions: Install engraved instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction

signs with approved legend where instructions are needed for system or equipment operation. Equipment requiring instructions shall include but not be limited to:

a. Switchgear Automatic Throw-Over (ATO)

b. Switchgear Main-Tie-Main

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer, load shedding, key interlocks or emergency operations.

3. Electrical Assembly Single-Line: Install at end of assembly having no future extension provisions or as otherwise shown on Drawings within sight of assembly.

G. Equipment Identification Labels:

1. Apply equipment identification labels of engraved, laminated acrylic or melamine label on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text in field designating the equipment served. Provide colored labels to identify the equipment by electrical distribution branch using the colors reference in Section 3.1A above. Text shall match terminology and numbering of the Contract Documents and shop drawings. Electrical equipment nameplates shall also designate the voltage and line side source (i.e. FED FROM: PANEL "_____", CKT # "____" ROOM # "____") in smaller 1/8 inch (3.2 mm) text. Smaller nameplate text may be used where adequate nameplate mounting space is not available, but in no case shall the text be smaller than 1/8-inch (3.2 mm). Apply adhesive labels for each unit of the following categories of electrical equipment and those scheduled on Drawings for electrical equipment and panelboard designations. Transfer switches shall include three (3) labels; emergency and normal source and load identification text. Three-phase equipment shall also include identification of the phase rotation.

a. Automatic transfer switch.

b. Battery chargers.

c. Boxes (Pull, Junction, or Branch Circuit) when given specific designation on Drawings.

d. Disconnect switches.

e. Distribution panelboards protective devices.

f. Emergency generator control system relays and protective devices.

g. Emergency power off (EPO) stations.

h. Ground buses and terminal bars.

i. Metering equipment.

j. Other systems.

k. Panelboards.

1) Designate the electrical distribution branch (i.e. “Normal”, “Life Safety”, etc.).

2) Designate the voltage (i.e. 208Y/120V).

3) Designate the fed from Source and room number of the source.

l. Pushbuttons.

m. Strip terminal cabinets.

n. Surge protection devices.

o. Switchboards and associated protective devices.

1) Designate the electrical distribution branch (i.e. “Normal”, “Life Safety”, etc.).

2) Designate the voltage (i.e. 208Y/120V).

3) Designate the fed from Source and room number of the source.

p. Switchgear and each front cover device in a switchgear lineup.

1) Designate the electrical distribution branch (i.e. “Normal”, “Life Safety”, etc.).

2) Designate the voltage (i.e. 208Y/120V).

3) Designate the fed from Source and room number of the source.

q. Separately mounted circuit breakers.

r. Transfer switch.

2. Refer to appropriate sections for other identification marking requirements and nomenclature.

3. Attach identification after finish painting.

4. Refer to sample label sheets following this section.

H. Component Identification Labels:

1. Apply component identification labels to distribution panelboard, switchgear, unit substation, switchboard, and MCC assemblies as follows:

a. Assembly Nameplate: Apply per equipment identification label requirements except 1-inch (80 mm) identification text.

b. Protective Device Load Label: Apply 1/4-inch (20 mm) text on plate per system color coding identifying load served.

c. Miscellaneous Component Labels: Apply 1/4-inch (20 mm) black text on white plate identifying components and instruments mounted on front or within the assembly such as relays, fuses, switches, terminal blocks.

I. Equipment Test Labels:

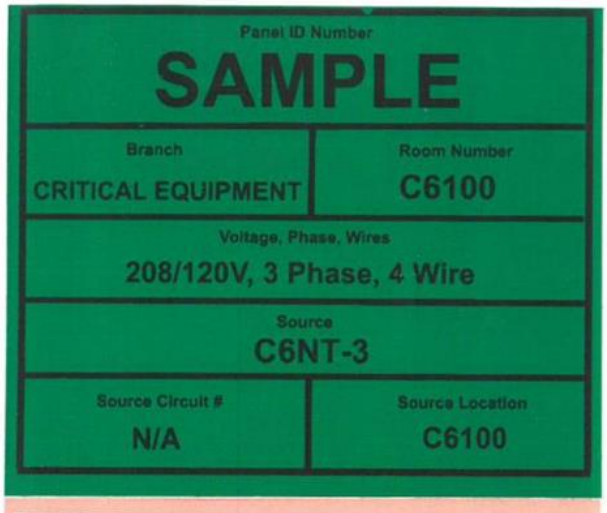
1. Apply equipment test labels of adhesive film label on each major unit of electrical equipment and components identified to be tested in Division 26 Section "Electrical Inspections and Testing" and associated Sections, after satisfactory completion of tests and inspections.

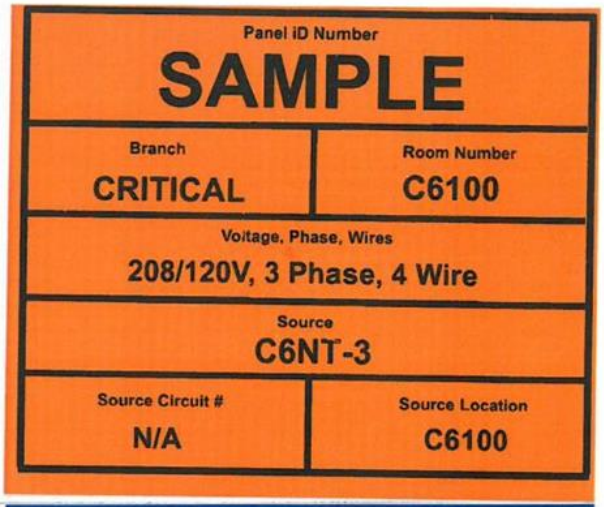
2. Indicate test results, responsible agency, representative and date.

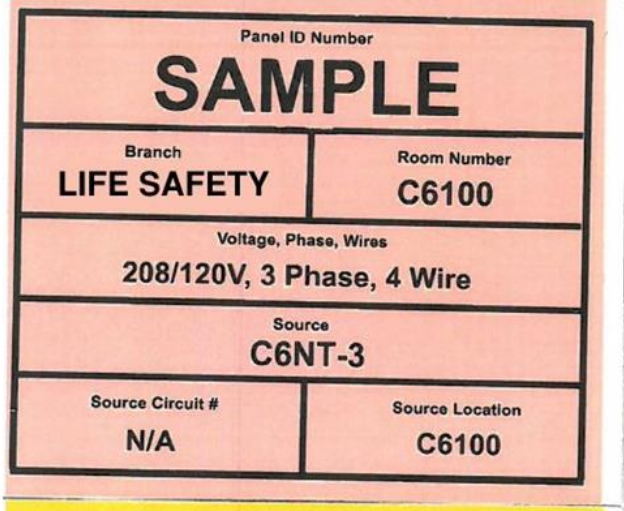
3. For bar coded equipment, also provide test data within equipment software menu.

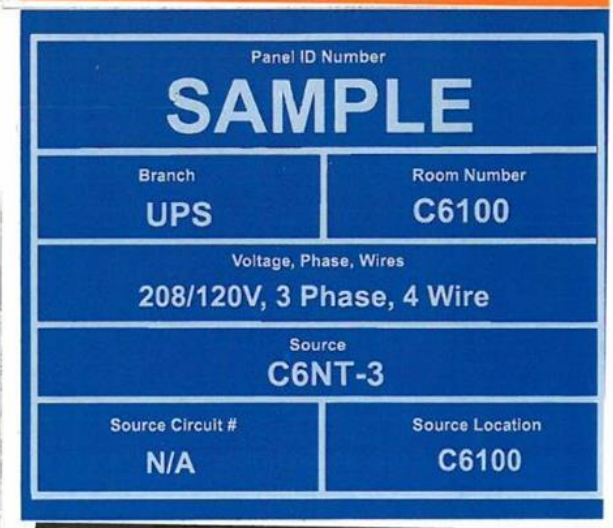
SAMPLE LABELS: Utilize colors noted in the specification not the sample pictures.

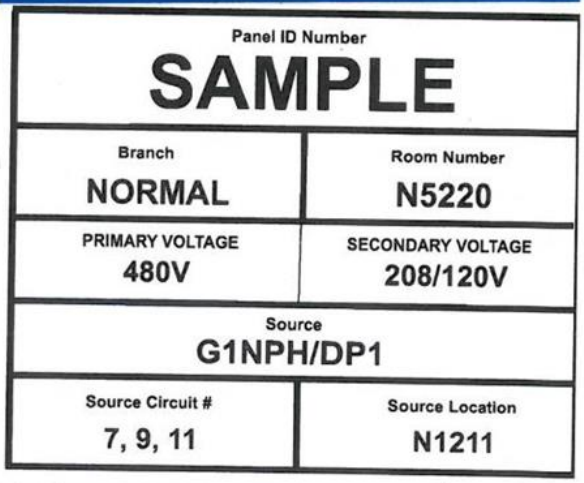
J. Panelboards:











K. Junction and Pull Box Labels:

L. Load Labels:

Disconnect 9TN1	
Branch Normal	Room Number H9251
Voltage, Phase, Wires 480v, 3 Phase, 3 Wire	
Source MSWBDNH1	
Source Circuit # 25-27-29	Source Location HM102A

EF - CFAC - 5A	
Branch Critical	Room Number HM100
Voltage, Phase, Wires 480v, 3 Phase, 3 Wire	
Source MLEH2	
Source Circuit # 31 - 33 - 35	Source Location HM100

Disconnect 9TC1	
Branch Critical	Room Number
Voltage, Phase, Wires 408v, 3 Phase, 3 Wire	
Source MSWBDCH1	
Source Circuit # 31-33-35	Source Location HM102

M. Transfer Switches:

1ATSE8	
Branch Normal	Room Number H1114
Voltage, Phase, Wires 480/277v, 3 Phase, 4 Wire	
Source 1USSHVN1	
Source Circuit # N/A	Source Location H1112

1ATSE8	
Branch GENERATOR	Room Number H1114
Voltage, Phase, Wires 480/277v, 3 Phase, 4 Wire	
Source 1LVSG1	
Source Circuit # N/A	Source Location H1114

1ATSE8	
Branch CRITICAL	Room Number
Voltage, Phase, Wires 480/277v, 3 Phase, 4 Wire	
Load MPEH4	
Source Circuit # N/A	Source Location HM100

N. Major Unit Electrical Equipment:

O. Devices:

1LNPL(Rm3803)
Ckt #15,17

END OF SECTION

SECTION 260573

PROTECTIVE DEVICE COORDINATION STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes computer based voltage protective device coordination studies, associated reports and the setting of these devices. Studies include:

1. Fault Current.
2. Coordination.
3. Load Flow and Voltage Drop.
4. Arc Flash Hazard.
5. Project state registered Professional Engineer seal and signature.

B. Series ratings of protective devices are not acceptable.

C. Requirements of Division 26 Sections apply to this Section for electrical distribution systems, electrical identification, and general requirements.

1.2 COORDINATION OF WORK

A. Adjustment or replacement of protective device equipment to meet the approved protective device coordination submittal shall be the responsibility of Division 26 at no additional cost.

1. Coordinate Submittal Schedule:

a. Submittals of protective device equipment shall be subject to the approval of the protective device coordination submittal, even if not so noted or commented on those protective device equipment submittals. The coordination responsibility remains with Division 26.

b. The protective device coordination submittal shall be submitted prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

c. Proceed with coordination study and arc flash study only after relevant equipment submittals have been assembled. Protective devices not submitted for approval with coordination study may not be used in study. Protective devices submitted prior to this coordination study will be reviewed, but final approval contingent upon this study results.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 01 Specification Sections, and Division 26 Section "Basic Division 26 Requirements".

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program used for the studies.
2. For protective devices used in the study, include coordination charts, tables and related data.
    a. Time-current curves unreadable due to too much or too little required information will be rejected.

B. Delegated Design Services:

1. Study/Calculations.
2. PE Stamp.

C. Protective Device Coordination Studies Report:

1. Executive Summary.
2. Introduction:
    a. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
3. Single Line Diagram, showing the following:
    a. Equipment designations to match Contract Documents.
    b. Protective device ratings and recommended settings.
    c. Conductor, busway and raceway sizes, lengths and types.
    d. Transformer ratings and recommended tap settings.
    e. Motor and generator ratings.
    f. Switchgear, switchboard, motor control center, and panelboard ratings.
4. Study Input Data: As described in "Power System Data" Article.
5. Fault Current Study:

a. Low Voltage Fault Report: Three phase and unbalanced fault calculations, showing the following for each overcurrent device location:

1) Voltage.

2) Calculated fault current magnitude and angle.

3) Fault point X/R ratio.

4) Equivalent impedance.

b. Momentary Duty Report: Three phase and unbalanced fault calculations, showing the following for each overcurrent device location:

1) Voltage.

2) Calculated symmetrical fault current magnitude and angle.

3) Fault point X/R ratio.

4) Calculated asymmetrical fault currents:

a) Based on fault point X/R ratio.

b) Based on calculated symmetrical value multiplied by 1.6.

c) Based on calculated symmetrical value multiplied by 2.7.

c. Interrupting Duty Report: Three phase and unbalanced fault calculations, showing the following for each overcurrent device location:

1) Voltage.

2) Calculated symmetrical fault current magnitude and angle.

3) Fault-point X/R ratio.

4) No AC Decrement (NACD) ratio.

5) Equivalent impedance.

6) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.

7) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

d. Equipment Evaluation Report.

6. Coordination Study:

   a. 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:

         a) Power utility's overcurrent protective device.

         b) Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

         c) Transformer full load current, magnetizing inrush current, and ANSI through fault protection curves.

         d) Cables and conductors damage curves.

         e) Ground fault protective devices.

         f) Motor starting characteristics and motor damage points.

         g) Generator short circuit decrement curve and generator damage point.

         h) The largest feeder circuit breaker in each motor control center and panelboard.

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

   b. 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.

      1) Phase and Ground Relays:

         a) Device tag.

b) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.

c) Recommendations on improved relaying systems, if applicable.

2) Circuit Breakers:

a) Adjustable pickups and time delays (long time, short time, ground).

b) Adjustable time-current characteristic.

c) Adjustable instantaneous pickup.

d) Recommendations on improved trip systems, if applicable.

3) Fuses: Show current rating, voltage, and class.

c. Equipment Evaluation Report:

1) Comments and recommendations for system improvements.

7. Arc Flash Hazard Analysis:

a. Incident Energy and Flash Protection Boundary Calculations:

1) Arcing fault magnitude.

2) Protective device clearing time.

3) Duration of arc.

4) Arc flash boundary.

5) Working distance.

6) Incident energy.

7) Hazard risk category.

8) Recommendations for arc flash energy reduction.

b. Owner Equipment Recommendations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination study and arc flash study, specialist who shall be a professional engineer registered in the state of the project and names of at least three (3) similar studies performed over the past year.

1. Demonstrate capabilities in providing equipment, services, and training to reduce Arc Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.

2. Demonstrate experience in providing equipment labels in compliance with NEC Section 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

B. Miscellaneous Submittals: Submittals for system certification, testing, and record drawings shall be per Division 01.

C. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 01 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Engineer for review.

1.6 CLOSEOUT SUBMITTALS

A. Record Documents:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 70 to Owner, Engineer, and authorities having jurisdiction.

2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 70 to Owner, Engineer, and authorities having jurisdiction.

a. Hard copies on paper to Owner (3), Engineer (1), and authorities having jurisdiction (1).

b. Complete Buildings Record Drawings: Coordinate through the Construction Manager a complete set of record drawings depicting as-left protective device settings.

c. Electronic copy of all record documents in PDF format.

d. Electronic copies of the working data files for the analysis software used for the calculations.

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 not acceptable.

B. Fault Current 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 and Arc Flash Study Specialist Qualifications: An organization experienced in the application of computer software used for electrical short circuit analysis and coordination studies having performed successful studies of similar magnitude on electrical distribution systems using similar devices. The coordination study shall be performed under the supervision of a project state registered professional electrical engineer, in accordance with ANSI/IEEE Standard 242, "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems."

D. Field Data Gathering Qualifications:

1. Gather and tabulate the following input data to support protective devices studies:

a. 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.

E. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise testing specified in Part 3.

F. Comply with ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems for study requirements and field testing.

1. Perform study, as required by this Section, Division 26 Section "Basic Division 26 Requirements", and ANSI/NETA ATS "Power System Studies" requirements.

a. Follow-up thermographic survey shall not be required.

b. Prepare test and inspection reports.

G. Field Testing: Refer to Division 26 Section "Electrical Inspections and Testing" for field inspections and testing requirements related to this Section including:

1. Electrical Acceptance Testing Responsibilities.

2. General Electrical Field Quality Control.

3. Testing Agency Qualifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE STUDY PROVIDERS

A. Protective Device Coordination Studies Provider: Subject to compliance with requirements, study shall be commissioned by Division 26 and supplied by successful supplier of panelboards per Division 26 Section "Panelboards."

2.2 WORK RESULTS

A. The study shall include all new distribution equipment supplied under this contract.

B. Devices to be included in this study shall include all components downstream of the utility company and generator plant service(s).

C. The study shall include all new distribution equipment under this contract. Make necessary device adjustments.

D. Include associated utility company requirements.

E. Study all cases of systems switching configurations and generator plant operations that could result in maximum fault or other derangement conditions.

2.3 REGULATORY REQUIREMENTS

A. Comply with NFPA 99 and NEC articles 620, 700, 701, 708 and 517 for selectivity requirements.

B. Comply with IEEE 399 for general study procedures.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 1584 for arc flash calculation guidelines.

2.4 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

1. Electrical Systems Analysis, Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

2.5 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399 and IEEE 551.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall provide plotting and diagramming time-current characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Additional Program Features:
    a. Arcing faults.
    b. Simultaneous faults.

c. Explicit negative sequence.

d. Mutual coupling in zero sequence.

e. Arc flash hazard analysis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine project low voltage protective device submittals for compliance with electrical distribution system coordination and arc flash requirements and other conditions affecting performance.

3.2 PREPARATION - POWER SYSTEM DATA

A. Obtain all data necessary to conduct the overcurrent protective device studies.

1. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

2. Comply with recommendations in IEEE 241 and IEEE 551 for the amount of detail required to be acquired in the field.

B. Gather and tabulate input data to support the protective device coordination studies:

1. Equipment Data:

a. Use equipment designation identification tags that are consistent with the Contract Documents and report single line diagram.

b. Full load current load data.

c. Special load considerations, including motor starting inrush currents and frequent starting and stopping. Include motor X/R ratios for all elevators and motors 50 HP and greater.

d. Product data sheets enforcing the single line diagram data including:

1) Time current curves.

2) Equipment manufacturers, types, ratings, plugs, and adjustable setting ranges.

e. New Equipment Product Data:

1) Submittal data.

a) Include protective devices specified in Division 26 or other Divisions.

2. Source Data:

a. Power sources and ties with understanding of the modes of potential operation.

b. Electric utility company's protective devices types, ratings, and settings.

1) Special electric utility company protective device stipulations and settings.

3. Source Impedance Data:

a. Electric utility company's fault current contribution at the point of service.

b. Full fitout generator plant fault current contribution. Include future generator(s) contribution based upon identical set(s) to the new generator sets.

c. Include motor fault contribution characteristics.

d. Include impedance X/R ratios.

4. Distribution Data:

a. Electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

b. Short circuit current at each system bus, three phase, and line-to-ground.

c. Full load current of all loads.

d. Data sheets to supplement electrical distribution system diagram, cross referenced with tag numbers on diagram, showing the following:

1) Electric Utility Data:

a) Ratings, types, and settings of utility company's overcurrent protective devices.

b) Special overcurrent protective device settings or types stipulated by utility company.

c) Electric Utility Company source impedance data.

2) Special operating mode and load considerations, including starting inrush currents and frequent starting and stopping.

3) Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

4) Motor full load current, locked rotor current, service factor, starting time, type of start, and thermal damage curve.

5) Generator thermal damage curve. Refer to Division 26 Section "Engine Generator Sets" for generator protection requirements.

6) 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.

7) Manufacturer and type, ampere tap adjustment range, time delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

8) Panelboards, switchboards, motor control center ampacity, and SCCR in amperes rms symmetrical.

9) 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.

3.3 FAULT CURRENT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short circuit currents according to IEEE 551.

C. Base study on the device characteristics supplied by device manufacturer.

D. Begin short circuit current 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.

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

F. The calculations shall include the ac fault current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low 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.

G. Calculate short circuit momentary and interrupting duties for a three phase bolted fault at each of the following:

1. Electric utility company’s supply termination point.

2. Incoming switchgear.

3. Unit substation primary and secondary terminals.

4. Low voltage switchgear.

5. Motor control centers.

6. Control panels.

7. Standby generators and automatic transfer switches.

8. Branch circuit panelboards.

9. Disconnect switches.

H. Calculate momentary and interrupting duties on the basis of maximum available fault current.

I. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.

2. Low Voltage Fuses: IEEE C37.46.

3. Circuit Breakers: IEEE C37.13.

J. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on single line diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase to ground faults.

K. Equipment Evaluation Report: Prepare a report on the adequacy of protective devices and conductors by comparing fault current ratings of these devices with calculated fault current momentary and interrupting duties. Describe adequacy of electrical equipment to withstand short circuit stresses.

3.4 COORDINATION STUDY

A. Perform coordination study and prepare a written report using the results of fault current study approved computer software program, and manufacturer's selectivity tables when necessary.

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices. Overcurrent protection devices on the Life Safety Branch shall be selectively coordinated with their supply side for all fault durations. Devices on the Normal, Critical, and Equipment branches shall be selectively coordinated for the period of time that a fault's duration exceeds 0.1 seconds.

C. Comply with IEEE 141 and IEEE 242 time intervals.

D. 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 shall protect transformer according to IEEE C57.12.00, for fault currents.

E. 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.

F. 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 fault 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 manufactures or from listed standards indicating conductor size and fault current.

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

H. Coordination Study Report: Prepare a written report indicating the following results of the coordination study.

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.

b. Relay current transformer ratios; and tap, time dial, and instantaneous pickup values.

c. Circuit breaker sensor rating; and long-time, short-time, and instantaneous settings.

d. Fuse current rating and type.

e. Ground fault relay pickup and time delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:

a. Device tag.

b. Single line reference schematic diagram.

c. Voltage and current ratio for curves.

d. Three phase and single phase damage points for each transformer.

e. No damage, melting, and clearing curves for fuses.

f. Cable damage curves.

g. Transformer inrush points.

h. Maximum fault current cutoff point.

i. Generator short circuit decrement curve and generator damage point.

3. Completed data sheets for setting of overcurrent protective devices.

4. Equipment Evaluation Report: Study shall include a narrative identifying any potential coordination short falls and recommendations for change.

3.5 PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

3.6 ARC FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Use the fault current study output and the field verified settings of the overcurrent devices.

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 generator plant 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 low voltage equipment locations, except 240V ac and 208V ac systems 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.

J. Field Labeling and Signage:

1. Provide complete arc flash hazard warning signage per NFPA 70 Article 110-16 at each new**, modified, and existing** switchgear, switchboard, panelboard, MCC, ATS, and other electrical distribution equipment.

2. Comply with Division 26 Section "Electrical Identification" for warning labels and signs.

a. Coordinate with Electric Utility Company and provide available fault current warning sign in compliance with NEC.

3. Calculated available fault current values and date calculated shall be entered:

a. Into the FH Master One Line

b. Into each panel schedule file and printed schedule.

K. Owner Equipment Recommendations:

1. Provide complete personal protective equipment (PPE) recommendations for each location and class.

2. Provide three (3) manufacturer’s data and contacts for each class of personal protective equipment for their purchase consideration.

3.7 FIELD QUALITY CONTROL

A. Inspection and Tests:

1. Perform inspections and test procedures as required by Division 26 Section "Electrical Inspections and Testing", ANSI/NETA ATS "Power Systems Studies", Sections for associated study components, "System Functional Tests", and "Thermographic Survey" requirements, and the following additional requirements:

a. Follow-up thermographic survey shall not be required.

b. Prepare test and inspection reports.

END OF SECTION

SECTION 262413

SWITCHBOARDS

PART 1 - **GENERAL**

1.1 SUMMARY

A. This Section includes service and distribution switchboards rated 600 V and less.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground fault circuit interrupter.

C. RFI: Radio frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.3 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Layout Drawings: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.

b. Bus configuration, current, and voltage ratings.

c. Short circuit current rating of switchboards and overcurrent protective devices.

d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.

e. Utility company's metering provisions with indication of approval by utility company.

f. Mimic bus diagram.

g. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.8 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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

5. Fuses for Fused Power Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

6. Touch-up Paint: Three half pints.

1.9 QUALITY ASSURANCE

A. Source Limitations: Obtain switchboards through one source from a single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1. Assembly Selection: The Drawings indicate sizes, profiles, and dimensional requirements of assembly equipment. Equipment having equal performance characteristics and complying with indicated maximum dimensions and profiles may be considered, provided deviations do not change the design concept intended performance, or code/future extension provision clearances. The burden of proof of equality is on the proposer a minimum of 10 days prior to bid.

C. Field Testing: Refer to Division 26 Section "Electrical Inspections and Testing" for field inspections and testing requirements related to this Section including:

1. Electrical Acceptance Testing Responsibilities.

2. General Electrical Field Quality Control.

3. Testing Agency Qualifications.

D. Comply with ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems for field testing.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections or lengths that can be moved past obstructions in delivery path.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.11 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Basis of Design: Eaton Corporation

2. Acceptable Equivalents/ Manufacturers as approved by Engineer.

2.2 REGULATORY REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

C. Comply with NFPA 70.

D. Comply with UL 891.

2.3 SWITCHBOARDS DESIGN CRITERIA

A. Front Accessible Switchboard: Front and rear aligned, with features as follows:

1. Main Devices: Fixed, individually mounted.

2. Branch Devices: Panel or Fixed, individually mounted.

B. Nominal System Voltage: As scheduled on Drawings.

C. Main Bus Continuous Ampere Rating: As scheduled on Drawings.

D. Enclosure: Steel, NEMA 250, Type 1 or 3R, as indicated on Drawings.

E. Enclosure Finish for Outdoor Units: Factory applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.

F. Enclosure Finish for Indoor Units: Factory applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Barriers: Between adjacent switchboard sections.

H. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

I. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.

J. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

K. Pull Box on Top of Switchboard:

1. Ensure adequate ventilation to maintain temperature in pull box within same limits as switchboard.

2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.

3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.

4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

L. Buses and Connections: Three phase, four wire, unless otherwise scheduled on Drawings.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin plated, high strength, electrical grade aluminum alloy.

a. If bus is aluminum, use copper- or tin plated aluminum for circuit-breaker line connections.

b. If bus is copper, use copper for feeder circuit breaker line connections.

2. Load Terminals: Insulated, rigidly braced, silver plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit breaker positions at full ampere rating of circuit-breaker position.

3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) minimum-size, hard drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

4. Contact Surfaces of Buses: Silver plated.

5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

6. Disconnect Links:

a. Isolate neutral bus from incoming neutral conductors.

b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

7. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

2.4 OVERCURRENT PROTECTIVE DEVICES (OCPDs)

A. Comply with requirements of Division 26 Section "Protective Devices" for types of OCPDs shown on Drawings. Provide indicated features, ratings, characteristics, and settings.

B. Future Devices: Where provision for future overcurrent protective devices or space is indicated, equip compartments with mounting brackets, supports, bus connections, and necessary

appurtenances, designed for the OCPD types and ampere ratings indicated for future installation of devices.

1. Bus space for future circuit breakers shall not be less than the 25% of the initial installed number of branch circuit breakers. Bus shall extend the full height of the section mounting space

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.

3. Control Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

4. Current Transformers for Neutral and Ground Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.

B. Multifunction Digital Metering Monitor: Microprocessor based unit suitable for three or four wire systems and with the following features:

1. Switch selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

d. Megawatts: Plus or minus 2 percent.

e. Megavars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.

h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.

i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.6 RATINGS

A. Provide nominal system voltage, continuous main bus amperage, and short-circuit current ratings as shown on Drawings. Series ratings of protective devices is not acceptable.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Spare Fuse Cabinet: Suitably identified, wall mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.8 IDENTIFICATION

A. General: Refer to Division 26 Section "Electrical Identification."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

B. Install switchboards on concrete bases.

1. Anchor switchboards to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports" and "Vibration Controls."

2. Bolt switchboards to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

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

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on end of the switchboards or as shown on Drawings.

F. Install overcurrent protective devices, surge protective devices, and instrumentation.

1. Set field adjustable switches and circuit-breaker trip ranges.

G. Install spare fuse cabinet.

3.3 IDENTIFICATION

A. Provide as specified in Division 26 Section "Electrical Identification."

3.4 GROUNDING

A. Connections: As indicated. Tighten connections to comply with tightening torques specified in UL 486A and 486B.

B. Ground equipment to main electrical ground bus indicated. Provide minimum 5-ohm ground resistance at switchboard location.

3.5 FIELD QUALITY CONTROL

A. Protection:

1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

B. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Inspection and Tests:

1. Perform inspections and test procedures as required by Division 26 Section "Electrical Inspections and Testing", ANSI/NETA ATS Sections for associated switchboard components, "System Functional Tests", and "Thermographic Survey" requirements and the following additional requirements.

a. Follow-up thermographic survey shall not be required.

b. Prepare test and inspection reports.

D. Adjusting:

1. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

2. Set field-adjustable circuit-breaker trip ranges as specified in Section "Overcurrent Protective Device Coordination Study."

E. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make appropriate circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24 hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 volt or less.

1.2 DEFINITIONS

A. Lighting and Appliance Panelboard: A panelboard with thermal magnetic circuit breaker branches, bolt-in type only, designed for heavy commercial use, operating at 600 V and below, 3-phase versions, equipped as either surface or flush mounting. Panelboard shall have more than 10 percent of its overcurrent devices rated 30 amperes or less for which neutral connections are provided.

B. Distribution Power Panelboard: A panelboard with thermal magnetic circuit breakers or fusible switches, bolt-in type, designed for heavy commercial use, operating at 600 V and below, 3-phase version, equipped as surface mounting with cabled connections between sections. Panelboard shall have less than 10 percent of its concurrent devices rated 30 amperes or less for which neutral connections are provided.

C. Surge Protection Device (SPD): A device to reduce the effect of voltage spikes to sensitive electronic equipment by shunting these disturbances to earth ground.

D. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic 26 Division Requirements."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings:

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

    a. Enclosure types and details for types other than NEMA 250, Type 1.

    b. Bus configuration, current, and voltage ratings.

c. Short-circuit current rating of panelboards and overcurrent protective devices. Series rated protective devices are not acceptable.

d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring diagrams detailing control wiring and differentiating between manufacturer- installed and field-installed wiring.

3. Panelboard SPD data, circuit breaker disconnects, and dimensioned room layouts ensuring proper NEC clearances and coordination.

a. Installation instructions shall be reviewed to determine whether the system requires an external overcurrent device in order to maintain the systems UL 1449 3rd Edition listing.

b. A UL 1449 3rd Edition stipulation is required for all submittals. The stipulation will verify the use of additional fusing via manufacturer's signature.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality control test reports including the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Include copy of typed directions depicting branch circuit loads.

B. Record Documents:

1. Panelboard Schedules: Created in Froedtert Hospital standard spreadsheet format and printed for installation in panelboards.

2. Deliver electronic files to Owner in PDF and Excel format.

3. Refer to sample at the end of this section.

4. Provide color coded graphical plan for each panelboard indicating the area served by the panelboard

1.7 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. Keys: Two (2) spares for each type of panelboard cabinet lock.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Field Testing: Refer to Division 26 Section "Electrical Inspections and Testing" for field inspections and testing requirements related to this Section including:

1. Electrical Acceptance Testing Responsibilities.

2. General Electrical Field Quality Control.

3. Testing Agency Qualifications.

G. Comply with ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems for field testing.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

1.10 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Basis of Design: Eaton Corporation

2. Acceptable Equivalents/ Manufacturers as approved by Engineer.

2.2 PANELBOARDS, GENERAL REQUIREMENTS

A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as shown on Drawings. Comply with Division 26 Section "Protective Devices," with OCPDs adapted to panelboard installation. Tandem circuit breakers shall not be used. Multipole breakers shall have common trip.

B. Supports and Bracing for Buses: Adequate strength of all panelboard components, including OCPD's, for short circuit current ratings as shown on Drawings. The minimum ratings shall be 10,000 AIC for 120/208 volt equipment and 14,000 AIC for 277/480 volt equipment. Series ratings of protective devices shall not be acceptable.

C. Enclosures: Cabinets, flush or surface mounted as shown on Drawings. NEMA Type 1 enclosure, except where the following enclosure requirements are shown on Drawings. Backboxes shall be made from galvanized steel. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. Provide at least four interior mounting studs with adjustable nuts.

D. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover. (Exception: Elevator Room fused switch panelboards).

E. Directory Frame: Metal, mounted inside each panelboard door.

F. Typed directory card completely filled out including "SPARE" and "SPACE" loads.

G. Bus: Tin-plated Aluminum or Copper

H. Main and Neutral Lugs: Mechanical type.

I. Main Circuit Breaker (when scheduled): Mounted physically separate from branch breaker lineups (not in same row) to allow for full branch circuit pole quantity.

J. Branch Circuit Devices: Arranged for double row construction.

K. Equipment Ground Bus: Adequate for feeder and branch circuit equipment ground conductors. Bond to box with bolted or welded connection.

L. Gutter: Generally, conform to UL 61.

M. Extra Gutter Space: Arrangement as shown on Drawings or as required for installation.

N. Auxiliary Gutter: Conform to UL 870, "Wireways, Auxiliary Gutters, and Associated Fittings."

O. Provision for Future Devices: Equip with mounting brackets, bus connections and extensions, and necessary appurtenances, for the OCPD ampere ratings shown on Drawing schedules for future installation of devices.

1. Bus space for future circuit breakers shall not be less than the 25% of the initial installed number of branch circuit breakers. Bus shall extend the full height of the section mounting space.

P. Plug-in type load center type panelboards shall not be used.

2.3 LIGHTING AND APPLIANCE PANELBOARDS

A. General: Conform to above article "Panelboards, General Requirements" except as follows:

1. Circuit Breakers for Switching Lights at Panelboards: Indicated type SWD.

2. Circuit Breakers for Equipment Marked HACR Type: Indicated HACR type.

3. Interiors: Provide physical means to prevent installation of more OCPDs than the quantity for which the enclosure was listed.

4. Main, Neutral, and Ground Lugs and Buses: Have mechanical connectors for conductors.

5. Branch OCPDs: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

6. Doors: In panel front, with concealed hinges. Secure with flush catch and cylindrical tumbler lock, all keyed alike. The flush lock shall not protrude beyond the front of the door.

2.4 POWER DISTRIBUTION PANELBOARDS

A. Doors: The flush lock shall not protrude beyond the front of the door. Doors over 48 inches high hinged, and shall be provided with, built-in locks, and three point latch (top, bottom and center).

B. Branch-Circuit Breakers: Where OCPDs are shown on Drawings to be circuit breakers, use bolt-on breakers where available. Plug-in type circuit breakers may be used where fastened in place and require mechanical release for removal.

C. Install metering equipment as shown on Drawings and as per Division 26 Section "Electric Power Management Systems."

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: Arranged to permit testing of functions of solid-state trip devices without removal from panelboard.

C. Branch Circuit Terminal Cabinet: Locate a junction/pull box above each panelboard and terminate all branch circuits on DIN rail mounted insulated screw terminal blocks. Connect the cabinet to the panelboard box via two short conduits aligned with each side wire gutter of the panelboard. Provide equipment ground terminal bar with enough openings for each pole of the panelboard and extend the feeder equipment grounding conductor to this bar from the panelboard ground bar. Neutral conductors shall be terminated on insulated terminal blocks separate from the phase conductor terminal blocks

2.6 IDENTIFICATION

A. General: Refer to Division 26 Section "Electrical Identification," for labeling materials and methods.

B. Manufacturer's Nameplate Information:

1. Voltage.
2. Phase.
3. Ampacity.
4. Manufacturer.
5. A.I.C. Symmetrical.
6. UL Listing.
7. Service Entrance Label (as applicable).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports" and "Vibration Controls."

C. Mount top of trim 78 inches above finished floor, unless otherwise indicated.

D. Mount large distribution and column type panelboards minimum 6-inches above floor. When top and bottom dimensional requirements cannot be met, install on concrete bases.

1. For distribution panelboards on concrete bases, anchor according to manufacturer’s written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports" and "Vibration Controls".

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

F. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

G. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install filler plates in unused spaces and plug any unused, open cabinet knockouts.

I. Install breaker handle clips in on position at breakers servicing fire alarm equipment.

J. Stub four (4) 1-inch empty conduits from recessed panelboards into accessible ceiling space or space designated to be ceiling space in the future.

K. For each 120/208V branch circuit panelboard, provide eight (8) spare circuits to a junction box located above the panel to allow for future extension without need for a shutdown. Wire shall be safely terminated and labeled with circuit number and identified as “Spare/Future.” The associated protective device(s) shall be turned off and appropriately identified as “Spare/Future” and to include a description of where the existing wires are terminated.

L. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

1. Provide "Fire Alarm System" component identification label at breakers servicing fire alarm equipment.

B. Create a typed directory to indicate installed circuit loads. Label circuit locations with room numbers (not occupancy) and spares. Obtain written approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Inspection and Tests:

1. Perform inspections and test procedures as required by Division 26 Section "Electrical Inspections and Testing", ANSI/NETA ATS Sections for associated panelboard components,

"System Functional Tests", and "Thermographic Survey" requirements and the following additional requirements.

a. Follow-up thermographic survey shall not be required.

b. Prepare test and inspection reports.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make appropriate circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24 hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.6 SAMPLE PANEL SCHEDULE

Location					
Building					Room Number
					0
Panel		Voltage	Branch	Fed From Panel	Fed From Room
		120/208V	Normal		#REF!
Circuit #	Load		Ø	Circuit #	Load
1,3,5			A	2,4,6	
	Panel EX123		B		
	Room 4321	100 amp			
	Serves Kitchen Tray Line		C		
7	Receptacles West and North Walls		A	8	
	Room 2924	20 amp			
9	Receptacle East Wall		B	10	
	Room 2924	20 amp			
11	Receptacles		C	12	
	Rooms 2925,2923, & 2922	20 amp			
13			A	14	
15			B	16	
17			C	18	
19			A	20	
21			B	22	
23			C	24	
25			A	26	
27			B	28	
29			C	30	
31			A	32	
33			B	34	
35			C	36	
37			A	38	
39			B	40	
41			C	42	
Revision Date:			Last Project:		#REF!

END OF SECTION

SECTION 262713

ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes equipment for utility company's electricity metering.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.3 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual.

B. Shop Drawings:

1. Layout Drawings: Dimensioned plans and sections or elevation layouts.

2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.4 INFORMATIONAL SUBMITTALS

A. None required.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electricity-metering equipment to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Field Testing: Refer to Division 26 Section "Electrical Inspections and Testing" for field inspections and testing requirements related to this Section including:

1. Electrical Acceptance Testing Responsibilities.

2. General Electrical Field Quality Control.

3. Testing Agency Qualifications.

B. Comply with ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems for field testing.

1.7 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power and communication services.

2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 REGULATORY REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2.3 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

1. Manufacturers:

a. Basis of Design: AMP and Milbank

b. Acceptable Equivalents/ Manufacturers as approved by Engineer.

2. Housing: NEMA 250, Type 1 or 3R enclosure as indicated.

3. Voltage: As indicated on drawings.

4. Minimum Short-Circuit Rating: As indicated on drawings but not less than 10,000 amperes symmetrical at rated voltage.

5. Main Disconnect Device: Circuit breaker or fusible switch, as indicated.

6. Meter Socket: Type as approved by utility company, with rating coordinated with indicated tenant feeder circuit rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install equipment for utility company metering. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

3.2 FIELD QUALITY CONTROL

A. Inspection and Tests:

1. Perform inspections and test procedures as required by Division 26 Section "Electrical Inspections and Testing", ANSI/NETA ATS "Instrument Transformers", "Metering Devices", "System Functional Tests", and "Thermographic Survey" requirements and the following additional requirements.

a. Follow-up thermographic survey shall not be required.

b. Prepare test and inspection reports.

END OF SECTION

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SECTION 262800

PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes circuit breakers, fusible disconnect devices and fuses rated 600 volts and less. Application, installation, and other related requirements for overcurrent protective device installations in other distribution equipment is specified in other Division 26 sections.

1.2 DEFINITIONS

A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

B. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.3 LEGEND

A. AIC = Amperes interrupting capacity (K = 1000).

B. BIL = Basic impulse level (K = 1000).

C. Chg = Interchangeable.

D. HID = Switching duty rated for HID or fluorescent fixtures.

E. Non = Non-interchangeable.

F. SWD = Switching duty rated at 20 ampere rating for fluorescent fixtures.

1.4 COMPATIBILITY

A. All protective devices in new assemblies shall be of the same manufacturer.

B. Series ratings of OCPDs are not acceptable.

C. A complete coordination study in accordance with Division 26 Section "Protective Device Coordination" shall be commissioned and paid for by Division 26. Series ratings of OCPD are not acceptable.

1.5 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.6 ACTION SUBMITTALS

A. Product Data: For fuses, fusible and non-fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. Testing Agent Qualifications.

B. Field Quality Control Test Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
4. Manufacturer's field service report.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to Kenosha County requirements include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.
3. Include final fuse type and ratings as well as served equipment list for all installations.
4. Include "as-designed" and "as-left" OCPD adjustable settings list for all installations.
5. Include key interlock sequence of operation per assembly.

B. Record Documents.

1.9 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed protective devices, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Series rating of OCPDs is not acceptable.

E. Field Testing: Refer to Division 26 Section "Electrical Inspections and Testing" for field inspections and testing requirements related to this Section including:

1. Electrical Acceptance Testing Responsibilities.

2. General Electrical Field Quality Control.

3. Testing Agency Qualifications.

F. Comply with ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems for field testing.

1.10 PROJECT CONDITIONS

A. Environment Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg. F (minus 30 deg. C) and not exceeding 104 deg. F (40 deg. C).

2. Altitude: Not exceeding 6600 feet (2010 m).

1.11 COORDINATION

A. Coordinate layout and installation of protective devices and their associated enclosures and components with other construction, including conduit, piping, equipment and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.12 REFERENCES AND STANDARDS

A. Enclosures:

1. NEMA 250-85 - Enclosures for Electrical Equipment (1,000 Volts, maximum).

B. Molded Case and Insulated Case Circuit Breakers:

1. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures.

2. NEMA AB1 - Molded Case Circuit Breakers.

C. Cartridge Type Fuses:

1. NEMA FU1 - Low Voltage Cartridge Fuses.

2. UL 198C - High-Interrupting Capacity Fuses, Circuit Limiting Type.

3. UL 198E - Class R Fuses.

D. Disconnect Switches:

1. UL 98-87 - Enclosed and Dead Front Switches.

2. NEMA K-85 - Enclosed Switches.

3. UL 977-84 - Fused Power Circuit Devices.

PART 2 - PRODUCTS

2.1 THERMAL-MAGNETIC MOLDED CASE CIRCUIT BREAKERS

A. Manufacturers:

1. Basis of Design: Eaton Corporation.

2. Acceptable Equivalents/ Manufacturers as approved by Engineer.

B. Construction:

1. Tripping Mechanisms: Inverse time delay thermal element for long-time overload tripping and an instantaneous magnetic trip element set to operate at 7 to 10 times the long-time trip setting for high fault current tripping in each phase. Common trip for multiple breakers without the use of handle ties. Trip-free over center quick-make, quick-break switching mechanism shall provide distinctive handle positions to self-indicate automatic tripping.

2. Enclosure: Bakelite, epoxy, glass-fibered reinforced polyester or similar material required to obtain interrupting rating.

3. Mounting: Bolt-in. Rating labels shall be visible when breaker is installed.

4. Terminal Lugs: Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connections.

C. Ratings:

1. Trip: As scheduled.

2. Frame: Provide as scheduled as minimum requirement.

3. AIC: Provide as scheduled as minimum requirement.

D. Special Features: Interchangeable trip settings, shunt trip, undervoltage trip, alarm switch, auxiliary switch, motor operator, etc., as shown on Drawings.

1. Molded case switch shall have manual only tripping mechanism.

2.2 SOLID-STATE MOLDED CASE CIRCUIT BREAKERS

A. Manufacturers:

1. Basis of Design: Eaton Corporation.

2. Acceptable Equivalents/ Manufacturers as approved by Engineer.

B. Construction:

1. Standard Tripping Mechanism: Solid-state tripping elements with associated current monitor and flux transfer shunt trip in two or three pole applications. Sensors shall be provided for each pole. Long-time trip settings shall be adjustable using rating plug and dials covering a minimum range of 50 – 100 percent of the specified rating. Hand held battery operated programmers are acceptable; however, provide a minimum of (2) programmers, a wall mountable galvanized steel storage box and provide a minimum of (2) 4 hour additional training sessions for the Owner. The magnetic trip unit shall have adjustable short-time and instantaneous trip characteristics. Trip unit shall be common for all poles, trip-free, over center quick-make quick-break switching and consist of a manual trip button and trip indicators. The trip device shall be insensitive to temperature changes between minus 20 degrees C and plug 55 degrees C. The long-time delay, short-time pickup, short-time delay and instantaneous pickup shall be fully adjustable using dials, with the following minimum characteristics, based on the coordination study, settings and adjustments may override specification generalities:

    a. Long-time pickup (0.5 – 1) x plug rating.

    b. Long-Time Delay:

        1) 600 amps and below (2-14 seconds).

        2) Above 600 amps (2-24 seconds).

    c. Short-time pickup (2-8) x plug rating.

    d. Short-Time Delay:

        1) 600 amp frame and below (0.1 – 0.2 seconds) including I^2t out/in.

        2) 800 – 1600 amp frame (0.1 - 0.4 seconds) including I^2t out/in.

2. Enclosure: Bakelite, epoxy, glass-fibered reinforced polyester or similar material required to obtain interrupting rating. Provide sealable tamperproof cover over adjustment controls.

3. Mounting: Bolt-in or drawout as indicated.

4. Terminal Lugs: Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connection.

C. Ratings:

1. Trip: As scheduled.

2. Frame: Provide as scheduled as minimum requirement.

3. Sensor-Clip shall match frame size.

4. AIC: Provide as scheduled as minimum requirement.

D. Special Features: Interchangeable trip settings, shunt trip, undervoltage trip, bell alarm, auxiliary switch, motor operator, etc., as shown on Drawings.

1. Molded case switch shall have manual only tripping mechanism.

2.3 SEPARATELY ENCLOSED CIRCUIT BREAKERS

A. Enclosure:

1. Flush or surface as shown on Drawings.

2. Type shall suit area per NEMA requirements.

a. Indoor – NEMA 1

b. Wet Locations - NEMA 3R

c. Parking decks & areas subject to salt spray – 316 stainless steel enclosure

3. Ground wire lug of suitable size shall be bolted to the enclosure. Neutral bar on four wire systems shall be ungrounded.

4. Nameplate centered on front shall identify load served.

B. Breaker characteristics shall be as previously specified.

2.4 CARTRIDGE TYPE FUSES

A. Make: Copper Industries, Inc. - Bussmann, Chase-Shawnut, Economy, Littlefuse.

B. Fuses, General:

1. General: Provide fuses of types, classes, and current ratings as indicated. Voltage ratings shall be consistent with the circuits on which used.

2. Fuses for Direct Current Circuits: Marked for such use by the manufacturer on the fuse label.

C. Application of Fuses:

1. General: Apply fuses as indicated and as follows:

2. New General Purpose Fusible Switches: Apply the following class types:

a. 0 - 600 Amperes: Class RK1, dual element time delay; LPN-RK, LPS-RK.

b. 601 - 1,200 Amperes, Motor or Transformer Circuit: Class L, time delay; Lo-Peak KRPC.

c. 601 - 1,200 Amperes, Noninductive Circuit: Class L, fast acting.

3. Motor Fused Disconnect Switches and Combination Controllers: Class RK1, dual element time delay; LPN-RK, LPS-RK.

4. General-Purpose Switches: Apply the following classes and types:

a. 30 - 600 Amperes: Class RK1, dual element time delay; LPN-RK, LPS-RK.

b. 601 - 1,200 Amperes: Class L, time delay; Lo-Peak KRPC.

2.5 DISCONNECT SWITCHES

A. General:

1. Disconnect switches for 120 VAC equipment shall be manual fractional horsepower motor controllers, as specified in Division 26 Section "Motor Controllers," with engraved coverplate identifying load served.

2. Other disconnect switching shall be as specified below.

B. Manufacturers:

1. Basis of Design: Eaton Corporation.

2. Acceptable Equivalents/ Manufacturers as approved by Engineer.

C. Construction:

1. Heavy duty type, fused and/or non-fusible as shown on Drawings.

2. Interior Construction: Switch blades fully visible in the off position when the enclosure door is open. Fuseholders for specified fuse, rejection type.

3. Switch Mechanism: Quick make, quick break with positive interlock to prevent opening of enclosure door when operating handle is in the on position and to prevent closing of the switch mechanism with the door open. Operating handle shall be an integral part of enclosure base, have provisions for three padlocks in the off position, and the means to indicate whether the switch is on or off by its position. Vertical operating handles shall be up in the on position.

4. Terminal Lugs: Suitable for quantity of wire to be attached, front removable with terminal shields; mechanical type for copper wire, compression type for aluminum wire.

D. Ratings:

1. Amperes: 30 - 1200.

2. Voltage: 240 or 600.

3. Poles: 2, 3, or 6.

4. AIC: Match fuse or upstream protective device.

5. Horsepower Rated: 30 - 600 amps.

E. Enclosure:

1. Surface mounted type.

2. Type shall suit area per NEMA requirements.

a. Indoor – NEMA 1

b. Wet Locations - NEMA 3R

c. Parking decks & areas subject to salt spray – 316L stainless steel enclosure

3. Ground wire lug of suitable size shall be bolted to the enclosure. Neutral bar on four wire systems shall be ungrounded.

4. Nameplates on front shall identify load service as well as proper fuse application warning.

2.6 FUSEHOLDERS

A. Provide fuseholders to accommodate the fuses specified. Coordinate installation with assembly manufacturers as applicable.

1. Terminal Lugs: Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connection.

2.7 ACCESSORIES

A. Provide breaker accessories for general operation and maintenance of specified breakers. Include items listed below and items recommended by manufacturer:

1. Test kit for each type of drawout, solid state, and power air breaker.

2. Handle extensions for low voltage devices 1200 amperes and larger.

3. Drawout sticks.

4. Special adjustment tools.

B. Provide fuse accessories for general operation and maintenance of specified fuses. Include items listed below and items recommended by manufacturer.

1. Fuse pullers.

2. Fuse pull rings.

3. Handling poles with extensions.

4. Pole grapplers, prongs, clamps, etc.

C. Provide quantities of circuit protective accessories in locations necessary for effective general operation.

D. Provide breaker handle clips in on position at all breakers serving fire alarm equipment. Include equipment identification label "Fire Alarm System" at breaker per Division 26 Section "Electrical Identification."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install circuit protective devices in assemblies at or above the minimum interrupting rating and frame size shown on Drawings. Circuit breaker frame size shall be the largest ampere rating if not specified in the rating schedules.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration Controls."

C. Install separately enclosed circuit breakers and disconnect switches at six feet above floor unless otherwise noted. Support independent of stud partitions.

D. Install fused disconnect switches as shown on Drawings and Schedules, complete with fuses recommended by the manufacturer of the equipment served. Ensure proper AIC ratings for protection of the switch and equipment. Submit final fuse ratings as part of O&M Manual submission. Series ratings of OCPD are not acceptable.

E. Install distribution equipment circuit protective devices at factory.

F. Leave all spare devices in the off position.

3.2 IDENTIFICATION

A. Identify components in accordance with Division 26 Section "Electrical Identification."

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between OCPDs and control/indication devices as specified in Division 26 Section "Low Voltage Electrical Power Conductors and Cables" for hard wired connections.

3.4 CONNECTIONS

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.5 GROUNDING

A. Provide equipment grounding connections for individually mounted OCPD units as indicated, as required by NEC, and per Division 26 Section "Grounding and Bonding." Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.6 FIELD QUALITY CONTROL

A. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

B. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.

C. Pretesting: Upon completing installation of the system, perform the following preparations for independent tests:

1. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.

2. Make continuity tests of circuits.

3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.

4. Provide manufacturer's instructions for installation and testing of OCPDs to test personnel.

D. Test and Inspections:

1. Perform inspections and test procedures as required by Division 26 Section "Electrical Inspections and Testing", ANSI/NETA ATS "Switches, Air, Low Voltage", Circuit Breakers, Air Insulated Case/Molded Case", "Circuit Breakers Air, Low Voltage Power", "Ground-Fault Protection System", "System Functional Tests" and Thermographic Survey" requirements including optional requirements and the following additional requirements:

a. Limit tests to:

1) All non branch circuit breakers.

b. Follow-up 12-month thermographic survey shall be required.

c. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPDs and train Owner's maintenance personnel.

B. Conduct a minimum of one half day of training in operation and maintenance as specified under "Instructions to Owner Employees" in the "Project Closeout" Section of these Specifications. Include both classroom training and hands-on equipment operation and maintenance procedures.

C. Schedule training with at least seven (7) days' advance notification.

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SECTION 26 32 13

STANDBY POWER GENERATOR

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

A. Applicable provisions of Division 0 and Division 1 shall govern work in this Section.

1.02 DESCRIPTION

A. Provide (1) diesel powered, standby, electrical power generator. Installation shall include generator, weatherproof sound attenuation level 2 enclosure with stair, exhaust silencer, fuel piping, (1) annunciators, necessary engine and alternator controls including permissive and protection relaying functions, alarm and status communications and all accessories. 48 hours at full capacity sub-base fuel-oil storage tank shall be provided by manufacturer. Manufacturer shall provide (2) 100% rated main circuit breakers, (1) 2500A and (1) 800A.

B. The generator set vendor shall be responsible for the coordination of the entire emergency system, to include a new 800kW/1000kVA generator and the associated fuel system, new transfer switches, and all required controls, wiring and programming for a complete working system.

1.03 QUALITY ASSURANCE

A. Equipment and installation shall conform to the requirements as follows:

1. U.S. Environmental Protection Agency (EPA): Design Criteria of Mechanical, Electrical, and Fluid System and Component Reliability.
2. U.S. Environmental Protection Agency (EPA): Tier Two Emission Standards for Off Road Mobile and Stationary Engines in a non-attainment area.
3. National Fire Protection Association (NFPA).
4. NFPA – 30. Flammable and Combustible Liquids Code.
5. NFPA – 37. Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
6. NFPA-70 - National Electrical Code (NEC), and Wisconsin amendments thereto.
7. NFPA-101 Life Safety Code.
8. NFPA- 110 Standard for Emergency and Standby Power
9. Underwriter's Laboratories (UL) Standard 2200
10. IEEE 446-1995 – Recommended Practice for Emergency Standby Power Systems for Industrial and commercial Applications
11. Community Noise Ordinances

12. American National Standards Institute ANSI Y32.2.
13. National Electrical Manufacturers Association (NEMA) MG-1.

B. The following production tests shall be completed on the engine/generator assembly:
   1. Mechanical operation test.
   2. Ground tests.
   3. Control wiring tests.
   4. Operation test.

C. Engine/generator set shall be product of a manufacturer who shall warranty complete engine/generator package with accessories as described herein.

1.04 SUBMITTALS

A. Shop drawing submittal shall include the following documents as a minimum:

1. Manufacturer's cut sheets of all system equipment. Information to be included on cut sheets shall be sufficient to determine compliance with these specifications.
2. Manufacturers catalog cut sheets for all engine generator accessories
3. Dimensional drawings of all system equipment. As a minimum, drawings shall show all critical dimensions, weights and shall show all field connection points.
4. Drawing shall show overall height, width and depth of installation including enclosure.
5. Fuel piping isometric with pipe sizes, pipe materials, valves, and calculations shown shall be coordinated with mechanical contractor.
6. Technical specifications for the engine and the alternator including electrical ratings, heat rejection information, ventilation requirements, fuel system requirements, alternator characteristics, radiated sound pressure levels, vibration and torsional moments,
7. Sound rating information for sound attenuation enclosure.
8. Starting batteries, including battery sizing calculations.
9. Battery charger drawings and technical specifications
10. Single line diagram in accordance with ANSI Y32.2 indicating connections and controls.
11. Submit test reports including:
12. Certified test reports of prototype, production, and field tests.
13. Submit to the owner, manufacturer's instructions for start-up, performing cleaning, operating, and maintaining standby power systems.

1.05 FUEL TANK REGISTRATION

A. New fuel tank must be registered by the building Owner. As part of this contract, the electrical contractor shall assist the Owner in this registration process. Such assistance shall include, but not be limited to, providing any necessary drawings, descriptions, cut

sheets or other documentation related to the tank and its installation that the Owner will require to be included with his registration papers.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Basis of Design: Cummins Great Lakes.
   2. Kohler Power Systems
   3. MTU Onsite Energy
   4. Caterpillar
   5. Acceptable Equivalents/ Manufacturers as approved by Owner, submit as substitution request per Division 1.
   6. Requirements in this specification for generator physical size, fuel supply requirements, engine exhaust requirements, radiator exhaust requirements, etc. are based on a generator of the electrical KW required as distributed by Cummins. By furnishing a generator from a different distributor, even if approved on the shop drawings by the engineer, the contractor assumes the responsibility for insuring the unit will fit in the space allocated and that all support systems are adequate for a complete, functioning system. If changes are required to fuel lines, exhaust piping, exhaust ductwork, screening, louvers, etc. from what is shown on the plans to accommodate the generator being supplied, the electrical contractor shall include any costs associated with these changes in his bid, including work required to be performed by other contractors.

2.02 ENGINE/GENERATOR RATINGS

A. Rate standby engine/generator set at not less than 800 kW, 1,000 kVA standby duty at 0.8 pf, 208V, 3 ph, 4 wire, 60 Hz. Base rating on operation when equipped with operating accessories at 1,000 ft elevation and 27 C. ambient temperature. Ventilating system is designed for maximum 11 C. rise above room ambient of 40 C. maximum. Provide with code required ground fault indication.

B. Regulator system filtered to be compatible with and capable of regulating generator output to permit starting of and running of the loads as shown on the drawings, simultaneously with a maximum of 20% voltage dip at locked rotor current with return to steady state in less than 2 sec. Steady state is defined as operation with terminal voltage remaining constant within ± ½ of 1% of rated voltage.

2.03 ENGINE CONSTRUCTION AND RATINGS

A. Engine speed of 1,800 rpm.

B. Water cooled with plant-mounted radiator.

C. Inline four stroke cycle compression ignition diesel.

D. Naturally aspirated.

E. Size at approximately 1½ hp per KW and approximately 504 cubic inch displacement.

F. Heavy duty industrial type.

G. No. 2D diesel fuel.

H. 12 v dc positive engagement, solenoid shift, starting motor.

2.04 ENGINE ACCESSORY EQUIPMENT

A. Governor to maintain frequency regulation not to exceed 5% (3 Hz) from no load to full rated load. Governor control system shall be compatible with and be capable of regulating engine speed to permit starting of and simultaneous running of connected loads as shown on drawings.

B. Lubrication break-in oil.

C. Electric fuel solenoid shut-off valve with standard fuel filter on engine.

D. Oil drain extension through side of skid base.

E. Heavy-duty air cleaner.

F. Lube oil filter with replaceable elements.

G. Overspeed cut-out.

H. Low oil pressure cut-out.

I. High coolant temperature cut-out.

J. Flexible fuel connections.

K. Seamless, flanged stainless steel, flexible exhaust connection.

L. Engine coolant heater, 150 watt, 120V, single phase with adjustable thermostat.

M. Welded steel skid type base securely mounted with anchored mounting bolts and with integral spring vibration isolators. The proper quantity and size of spring isolators shall be provided to assure that the isolators are not totally compressed during operation.

2.05 ENGINE COOLING EQUIPMENT

A. Unit Mounted Radiator.

B. Pusher type fan.

C. Duct flange.

D. Sized for 50% ethylene-glycol solution at 40 C. ambient and 1,000 ft elevation.

E. Ethylene-glycol antifreeze with rust inhibitor to -40 C.

2.06 GENERATOR CONSTRUCTION

A. 3-ph, 60 Hz.

B. Single bearing.

C. Synchronous type.

D. 12 lead reconnectable.

E. Drip-proof construction.

F. Radio suppression.

G. Class F Insulated.

H. Brushless, direct-connected type exciter with shaft mounted diodes and built-in permanent magnets to eliminate field flashing.

I. SCR type automatic voltage regulator to provide ± 1% voltage regulation from no load to full load.

J. Application of one-step load of 95% of rated load shall not result in voltage dip of more than 20% with recovery to within ± ½ of 1% in less than 2 sec.

K. Regulator shall be filtered to eliminate the effect of SCR loads on the regulator.

2.07 GENERATOR PERFORMANCE

A. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.

B. Some manufacturers may be required to provide an oversized engine-generator set in order to meet parameters in first subparagraph below. This could impact space, noise, ventilation, cooling, and other parameters.

C. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.

D. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

E. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

F. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

G. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

H. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

I. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

J. Provide permanent magnet excitation for power source to voltage regulator.

K. Retain subparagraph below if required start time is 10 seconds or less.

L. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.08 ENGINE/GENERATOR CONTROLLER

A. Digital engine management of fuel rate, timing control, engine protection and diagnostics.

B. Alternator overcurrent protection.

C. NEMA Type 3R enclosure, vibration isolated on generator enclosure.

D. Plug-in design circuitry for quick replacement.

E. Fused DC circuits.

F. Complete 2-wire start/stop control to operate on activation of remote contact from automatic transfer switch.

G. Design starting system for restarting in event of false engine start by permitting engine to completely stop and then re-engage starter.

H. Overcranking protection designed to open cranking circuit after 60-sec (adjustable) if engine fails to start.

I. Circuitry to shut down engine when signals for high coolant temperature, low oil pressure, overcrank or overspeed are received, with reset button.

J. 5 minute time delay on engine shutdown after retransfer to normal to allow unloaded running cool down.

K. Three position automatic/off/test selector switch.

L. Emergency stop switch.

M. Indicating lights to signal:

N. Selector switch OFF - Red (flashing).

O. Overcrank - red.

P. High coolant temperature - red.

Q. Overspeed – red.

R. Low oil pressure - red.

S. Test button for indicating lights.

T. Voltmeter 3½ inch 2% accuracy.

U. Ammeter 3½ inch 2% accuracy.

V. Voltmeter-ammeter phase selector switch.

W. 35 amp high rate battery charging circuit to operate while plant runs.

X. Direct reading pointer type frequency meter 3½ inch, 3 Hz accuracy.

Y. Panel illumination lights with on/off switch.

Z. Battery monitoring system.

AA. Battery charging ammeter.

BB. Oil pressure gauge.

CC. Coolant temperature gauge.

DD. Running time meter.

EE. Plug-in voltage regulator with voltage adjusting rheostat.

FF. Unpowered normally open auxiliary interlock contacts wired to terminal block.

GG. Generator failure signal to remote location.

HH. Generator run signal to remote location.

II. Two auxiliary interlocks for 120V air louver control.

JJ. Two line circuit breakers or line sensing field circuit breaker, one molded case, reset-able type, 2500 amp, 3 pole, 600V, in NEMA 1 enclosure, and one molded case, reset-able type, 800 amp, 3 pole, 600V, in NEMA 1 enclosure, and unit mounted. Circuit breakers shall be UL or CSA listed for use as service equipment.

2.09 GENERATOR REMOTE ANNUNCIATOR

A. Provide (2) wall mounted generator remote annunciators, as shown on the plans, one at the main switchboard by the main entrance and one in the maintenance shop, as required by NFPA 110 with the following indicator lights:
   1. Engine temperature pre-alarm.
   2. High Engine Temperature
   3. Battery Charger Fault
   4. Line Power
   5. Oil pressure pre-alarm.
   6. Low Oil Pressure
   7. Low Battery Volts
   8. Generator Power
   9. Low Water Temperature
   10. Emergency Stop
   11. Auxiliary
   12. System Ready
   13. Low Fuel
   14. Overspeed
   15. Overcrank
   16. Generator not-in-auto.

B. Additional features/functions shall include:
   1. Alarm Horn
   2. Alarm Silence
   3. Lamp Test
   4. Annunciator shall have stainless steel front for flush mounting.
   5. 24 VDC power for the annunciator shall be provided by generator set starting batteries or station battery, with negative ground signals. A dedicated ground wire must be provided to the annunciator.
   6. Unit shall have field replaceable fuse for short circuit protection.

7. Backbox shall have knockouts for conduit connection.
8. Removable legend plates for engraving alarm or status labels.
9. Switchable lenses and alarm horn function for maximum flexibility.

2.10 STARTING BATTERIES

A. Two 12 volt dc.

B. 225 amp-hr.

C. Lead Calcium type.

D. 20-hr rate.

E. Stranded copper battery cables.

F. Free standing metal rack with acid resistant paint.

G. Provide battery blanket heater.

2.11 AUTOMATIC BATTERY CHARGER

A. Automatic battery charger shall have a transistor controlled magnetic amplifier circuit to provide continuous taper charging.

B. Maintain constant voltage output with ac line fluctuations of ± 10%.

C. Two ranges, float at 2.17 v dc and equalize at 2.33 v dc.

D. Automatic ac line compensation.

E. Automatic overload protection current limiting.

F. Current limiting circuit to limit the current to the rating of the charger.

G. Silicone diode full-wave rectifiers.

H. Automatic surge suppressors.

I. DC ammeter and voltmeter.

J. Fused AC input and DC output.

K. 6 amp DC output minimum, size to carry DC continuous load current and simultaneously recharge the battery within 4-hrs.

L. NEMA 1 enclosure for wall mounting.

2.12 EXHAUST EQUIPMENT

A. Exhaust Silencer.

B. Maxim M41 or Kittell.

C. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturers backpressure requirements.

D. 5 inch with 90 degree inlet.

E. Companion flanges and gaskets.

F. Provide with drain plug at bottom of muffler opposite of exhaust outlet.

G. Exhaust piping. Black steel with condensate drip pocket and drain valve.

H. Insulation.

I. Insulate piping and silencer with Johns-Manville "Metal-On," Eagle-Pitcher "Tab-lok"

J. Aluminum cover over insulation.

K. Insulation rated for 650 C.

2.13 FUEL SUPPLY EXTERNAL ABOVE GROUND DIESEL TANK

A. Capacity: 48 hours at 100% capacity

B. Approval: UL Listed

C. Material: Double wall construction.

D. Threaded piping hubs.

E. Oil supply line inside tank with foot valve.

F. Provide all fuel required for testing and shutdowns and a final fill up to 2500 gallons of No. 2 Diesel fuel to ensure owner is left with a full subbase tank after final acceptance.

G. Venting as follows:
   1. Inner tank – primary venting
   2. Inner tank - secondary venting
   3. Interstitial space venting

H. Levelometer.

I. Acceptable Manufacturers: Petrometer or Meriam.

J. Remote gauge hydrostatic system.

K. Calibrated in gallons. 0-6000 gal.

L. Hand pump air source.

M. Copper or plastic tube for remote wall mounting near day tank.

N. Cast iron air bell.

O. Duplex fill pumps sized to exceed maximum flow of fuel drawn by engine mounted fuel supply pump at 110 percent of rated capacity including fuel returned from the engine.

P. Reversing fuel pump

Q. Fill pipe: Black iron pipe, black malleable iron fittings.

R. Two inch ID minimum.

S. Fuel spill containment basin. At fill location, provide fill pipe with spill containment basin fitting. Fitting shall be all steel, have 7 gallon capacity minimum, and shall have an internal drain to return fuel from basin to base tank. Provide with hinged, lockable, watershed cover.

T. Tank monitoring equipment:

U. Equipment shall monitor the interstitial space of the double wall storage tank.

V. Equipment will detect the presence of liquid (water or diesel fuel) and the presence of hydrocarbons from diesel fuel.

W. Connection points for future remote below grade fuel tank supply and return piping.

2.14 OUTDOOR WEATHERPROOF SOUND ATTENUATION ENCLOSURE

A. Provide a vandal-resistant, weatherproof Level 2 sound attenuating aluminum enclosure housing, wind resistant up to 100 mph (160 km/h) with outdoor steel access stairs. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Prefabricated or pre-engineered enclosure with the following features:
   1. Construction: Aluminum, integral structural-steel-framed building with perforated aluminum lining erected on concrete foundation.
   2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
   3. Space Heater: Thermostatically controlled and sized to prevent condensation.
   4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.

5. Hinged Doors: With padlocking provisions. Revise first subparagraph below if forced ventilation rather than convection ventilation is required.
6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
8. Muffler Location: Internal to enclosure.
9. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for
   2 hours with ambient temperature at top of range specified in system service conditions.
10. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
11. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
12. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
13. AC lighting system and connection point for operation when remote source is available.
14. DC lighting system for operation when remote source and generator are both unavailable.
15. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.
16. Provide (2) break glass type remote stop stations per NFPA 110 with auxiliary contacts wired to generator remote annunciator. One located on the exterior of the weather proof enclosure and one remote located as shown on plans.
17. Insulated walls to provide sound attenuation as required by the local municipality. Sounds ratings shall be based on full load condition of engine/generator in a single unit operation and meet the minimum requirements of 70dBA at 7 meters.
18. The enclosure shall be equipped with a 100A 208/120-volt three-phase load center for the battery charger, jacket water heater(s), lighting, receptacles, and enclosure unit heater. Provide Eaton (or approved equal) 100A MCB 30 circuit panel with 20% spare circuit breakers. The load center shall be mounted within the enclosure and allow for a single entry point for commercial power supply conduit and wiring by the installing contractor. The placement of this load center shall be shown on the submittal drawings. All internal conduit and wiring to the various ancillary equipment supplied with the package and shall be pre-wired in accordance with all governing codes pursuant to this application. The load center shall be considered as part of the emergency load and shall derive its power source downstream from the load transfer switch specified elsewhere.

2.15 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

B. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

C. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.

D. Minimum Additional Travel: 50 percent of required deflection at rated load.

E. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

F. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

PART 3 - EXECUTION

A. INSPECTION
   1. Examine area to receive engine/generator to assure adequate clearance for engine/generator installation.
   2. Verify that mounting area is level and free of irregularities.
   3. Start work only after unsatisfactory conditions are corrected.

B. INSTALLATION
   1. Engine-generator.
      a. Install engine/generator in accordance with manufacturer's written instructions and NEC.
      b. Lubrication and break-in oil to be supplied and installed by supplier's or manufacturer's technician at time of start-up.
      c. Anti-freeze with rust inhibitor (set to -40 C.) to be supplied and installed by supplier's or manufacturer's technician at time of start-up.
      d. Starting batteries and charger.
      e. Locate freestanding battery rack near engine starter and connect cables with suitable lugs.
      f. Wall mount battery charger near batteries and extend battery charging wires in conduit under floor.
      g. Provide all diesel fuel required for testing, shutdowns and a final full sub base take at final acceptance.
   2. Exhaust system.
      a. Install a black steel piping system in accordance with industry standards.
      b. Provide with drip pocket to collect condensation and drain valve.
      c. Size pipe as recommended by engine manufacturer.
      d. Pitch horizontal piping downward away from engine, minimum of 8 ft above floor, with outside rainguard.
      e. Insulate silencer and piping. Do not insulate flexible connection.

f. Cover insulation with aluminum cover.
g. Use sweep elbows on exhaust system. Minimum inside radius shall be three times the inside pipe diameter.
h. Exhaust piping shall specifically conform to the requirements of NFPA 37 whether specifically indicated on the plans or not.

3. Structural foundation.
   a. Provide reinforced concrete foundation as detailed on the plans. Coordinate with the manufacturers shop drawings as to the overall dimensions, unit weights and the locations and sizes of openings required through the foundation.

C. FIELD TESTS PRIOR TO START UP
1. Megger check of phase-to-phase and phase-to-ground insulation levels. Do not megger check solid-state equipment.
2. Ground continuity.
3. Short circuit.
4. Perform additional tests according to engine/generator manufacturer's instructions.
5. Test tank and piping with 3 psig air for 2 hrs.

D. CLEANING
1. Clean equipment and equipment room floor prior to start- up.
2. Touch up scratches or marred surfaces to match original finish.

E. SUPPLIER'S OR MANUFACTURER'S SERVICES
1. Retain services of engine/generator set manufacturer's factory trained technician employed by engine/generator set manufacturer or his authorized distributor to perform following services:
   a. Installation services.
      1) Visit project site to review installation requirements with Contractors involved. Visit shall be made prior to permanently installing equipment and/or making mechanical or electrical connections.
      2) Visit site and meet with all concerned Contractor s to ensure installation is properly coordinated. Electrical Contractor to coordinate meeting to ensure presence of all parties concerned.
   b. Testing services.
      1) In addition to normal factory tests, perform on-site installation acceptance tests on the standby power generator. A building load test and a full load test shall be performed as outlined in NFPA 110, chapter 5. Document all parameters as indicated in NFPA 110 and submit to the engineer for review and acceptance. Additional testing and documentation required by the authority having jurisdiction shall also be performed.
      2) Include a minimum of three simulated power failures in the presence of transfer switch manufacturer's start-up representative.
      3) Test remotely connected engine/generator status indication signals.
      4) Test transfer switch.
   c. Instructional services.

1) Provide a video recorded comprehensive demonstration to Owner or maintenance personnel and Engineer of system maintenance and operation after load bank test and after engine/generator set is electrically connected to automatic transfer switch. Provide owner with DVD of recording.

F. PRODUCT DELIVERY, STORAGE, AND HANDLING
1. Lift engine/generator using eyes, yokes and skids provided by manufacturer.
2. Do not store indoor type equipment exposed to weather.
3. Protect from work of other trades.

END OF SECTION

SECTION 263600

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic Transfer Switches (ATS):

a. Isolation By-Pass Transfer (IBTS) Switches.

b. Closed Transition Transfer Switches (CTTS).

2. Manual Transfer Switches (MTS).

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1. Final transfer switch approval subject to approved Division 26 Protective Device Coordination study.

1.3 ACTION SUBMITTALS

A. Product Data: Submit wiring diagrams, manufacturers catalog sheets, and rating data including the following:

1. Transfer Switch Data:

a. Contactor manufacturer confirmation.

b. Catalog cut sheets.

c. Withstand and close-in ratings.

d. Operating and maintenance instructions.

e. Complete control and power wiring diagrams.

f. Certified test results on identical switches.

g. Access requirements to isolation by-pass type switches.

B. Shop Drawings:

1. Layout Drawings: Provide room equipment layout drawings assuring proper clearances.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. Source Quality Control Test Reports:

    a. Certified summary of prototype unit test report.

    b. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

    c. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.

    d. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

    e. Report of sound generation.

2. Warranty: Special warranty specified in this section.

3. Qualification Data: For Installer, Manufacturer and Testing Agency

B. Field Quality Control Test Reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences.

2. List of all factory settings of relays; provide relay setting and calibration instructions, including software, where applicable.

1.6 CODES AND STANDARDS

A. DHHS (HRS-M-HF) 84-1.

B. IEEE Orange Book.

C. NEC Article 250, 445, and 695.

D. NEC Article 700, 701 and 702.

E. NFPA 99, Health Care Facilities.

F. NFPA 101, Life Safety Code.

G. NFPA 110, Emergency and Standby Power Systems for Level 1 emergency power supply system.

H. UL 1008, Standard for Automatic Transfer Switches.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Manufacturer: The transfer switches and all major items of auxiliary equipment shall be manufactured in the United States by manufacturers currently engaged in the production of such equipment. The equipment shall be standard factory produced units, factory assembled and tested and shipped to the job site by the engine generator assembler or his authorized dealer having a parts and service facility in the area.

2. Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than four hours from time of notification.

B. Source Limitations: Obtain transfer switch equipment through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Warranty:

1. Submit with the drawing submittals, written warranty by the transfer switch manufacturers for a period of two (2) years or 1500 operating hours, whichever occurs first, covering 100 percent of defective materials and labor. Multiple warranties for individual components will not be acceptable. The warranty period shall begin upon acceptance of the installation by the Owner.

E. Assembly Selection: The Drawings indicate sizes profiles, and dimensional requirements of engine generator sets and assembly equipment. Equipment having equal performance characteristics and complying with indicated maximum dimensions and profiles may be considered, provided deviations do not change the design concept intended performance, or code/future extension provision clearances. The burden of proof of equality is on the proposer a minimum of 10 days prior to bid.

F. Comply with ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems for field testing.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.

2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Transfer Switch Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: ASCO Power Technologies
2. Russ Electric
3. Cummins Great lakes.
4. Acceptable Equivalents/ Manufacturers as approved by Owner, submit as substitution request per Division 1.
5. Requirements in this specification for transfer switch physical size are based on a transfer switches as distributed by Cummins. By furnishing transfer switches from a different distributor, even if approved on the shop drawings by the engineer, the contractor assumes the responsibility for insuring the unit will fit in the space allocated and that all support systems are adequate for a complete, functioning system. If changes are required to from what is shown on the plans to accommodate the transfer switches being supplied, the electrical contractor shall include any costs associated with these changes in his bid, including work required to be performed by other contractors.

B. The emergency generator control system, associated batteries and battery chargers, and automatic transfer switches shall be supplied by the engine-generator set manufacturer for unit responsibility.

C. Submit proof from the manufacturers of the engine-generator set and transfer switches of qualified service capability, acceptable to the Engineer, in the area where the system will be installed.

2.2 AUTOMATIC TRANSFER SWITCHES (ATS)

A. General:

1. Automatic transfer switches shall consist of a power transfer module and a control module, interconnected to provide complete automatic operation. Automatic transfer switches shall be mechanically held and electrically operated by a single electrical operator energized from the source to which the load is to be transferred. The switch shall be rated for continuous duty and be inherently double throw. The switch shall be mechanically interlocked to ensure only one of two possible positions - normal or emergency, except for switches serving motor loads which are addressed in this Section.
2. The automatic transfer switches shall be rated to withstand the RMS symmetrical short circuit and 3 cycle withstand ratings current generally available at the automatic transfer switch terminals with the type of overcurrent protection as scheduled and in conjunction with the approved coordination study.

B. Operation:

1. Each automatic transfer switch shall sense partial or complete loss (less than 85 percent) of normal voltage in any phase. After a time delay of 1 second (adjustable 0.0 to 6 seconds) a starting signal shall be transmitted over a 2-wire circuit to the EGS starting controls.

2. All phases of the normal sources shall be monitored line-to-line. Close differential voltage sensing shall be provided on all phases. The pick-up voltage shall be adjustable from 85 percent to 100 percent of nominal and the dropout voltage shall be adjustable from 75 percent to 98 percent of the pick-up value. The transfer to emergency will be initiated upon reduction of normal source to 85 percent of nominal voltage and retransfer to normal shall occur when normal source restores to 95 percent of nominal on all phases.

3. All phases of the emergency source shall be monitored for voltage and frequency for return to normal if the emergency source becomes unstable. The pick-up voltage shall be adjustable from 85 percent to 100 percent of nominal and set at 90 percent. The pick-up frequency shall be adjustable from 90 percent to 100 percent and set at 57 hertz.

4. For delayed emergency loads, each transfer switch shall have a time delay on transfer to emergency. Initially set at zero but field adjustable up to 2 minutes for controlled timing of load transfer to emergency.

5. When normal power returns, each transfer switch shall, after a time delay, retransfer to "normal" side. The time delay shall be adjustable from 0-30 minutes and set at 30 minutes. If during this period, the generator voltage should fail, each transfer switch shall immediately return to "normal."

6. Generator cool-down shall be provided by a time delay relay providing for unloaded running of the generator for a period of 0 to 10 minutes and set at 5 minutes.

7. Motor load transfer switches shall be factory equipped with the programmed transition feature. This feature shall provide a field adjustable time delay during which time the load is isolated from both power sources, to allow residual voltage of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. The programmed transition feature shall have an adjustable time of 0 to 7.5 seconds. All transfer switches without programmed transition feature shall be capable of addition of the programmed transition feature in the field without transfer switch replacement. Transfer methods that use the phase relationships between the two power sources to control a transfer initiation time are also acceptable in both directions.

C. Materials:

1. Each automatic transfer switch shall be rated for continuous duty when enclosed in a (non-ventilated distribution switchboard or) surface, wall-mounted in NEMA 1 enclosure. It shall be rated for all classes of loads, including inductive and non-inductive at 480 volts, and tungsten lamp at 250 volts. The switch portion shall be designed, built, and tested to close on an in-rush current up to an including 20 times the continuous rating of the switch and rated to close on and withstand a fault current as indicated without welding or excessive burning of contacts.

2. Transfer switches shall meet all provisions of the latest version UL1008.

3. All main contacts shall be silver composition, wiping action type. Switches rated 600 amperes and above shall have separately removable arcing contacts. The operating transfer time in either direction shall not exceed one-sixth (1/6) of a second.

4. All control module relays, timers, control wiring, and accessories shall be front accessible. Inspection of all contacts (movable and stationary) shall be possible from the front of the enclosure without disconnection of drive linkages or power conductors. All control wires shall be terminated with tubular sleeve type markers or be permanently marked on both ends. Control modules shall be:

    a. Manufacturer's front accessible LCD/keypad programmable microprocessor-based design meeting requirements herein.

    b. Hardwired through each automatic transfer switch for external control connections. Software based interconnection to common monitor/control contacts are not acceptable.

5. Automatic transfer switches utilizing components of molded-case circuit breakers are not acceptable. Automatic transfer switches utilizing contactors, or part thereof which have not been intended for continuous duty or repetitive load transfer switching are not acceptable.

6. Transfer switches containing neutral conductors shall be provided with solid neutral bar for neutral termination.

7. The short circuit, withstand and close in capability shall meet or exceed the ratings scheduled on Drawings for all poles of a three or four pole switch when operating at rated voltage.

8. Each Transfer Switch shall have:

    a. An enclosure with internal copper ground bar with lugs for incoming ground wires.

    b. Provisions for electrically disconnecting the control section from the transfer section to permit safe access for maintenance or service during periods of normal operation.

c. Front Panel Devices: Provide devices mounted on front of main cabinet door consisting of switch position indicator lamps: normal (white), emergency (red), normal source available (green), emergency source available (red), and toggle switches to provide the following positions and functions:

1) Test - Simulated normal power loss to control unit for testing of generator set, including transfer of load. Controls shall include provisions to automatically return the system to the normal power source if the generator set fails during any test or exercise period.

2) Normal - This is a normal operating position and it restores the load to the normal source after test and after time delays.

3) Retransfer - Momentary position to over-ride retransfer time delay and cause immediate return to normal source after test or actual outage. (This feature may be push-button activated).

d. In-phase Monitor Transfer feature: Provide in-phase monitors on all automatic switches except for delayed transition switches. Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 10 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources area within 2Hz of nominal frequency and 70% or more of nominal voltage.

e. Terminal blocks with identification of all external connections, cross-referenced to the schematic wiring diagram.

f. A laminated engraved nameplate on the front of the enclosure, carrying its designation.

g. For other than bypass/isolation type transfer switches, a UL listed manual operator shall be provided in accordance with UL1008, arranged so that the transfer switch can be manually operated under load without opening the enclosure door. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. Failure to comply with this requirement shall require contractor to supply and coordinate an isolation/bypass type transfer switch installation at no cost to Owner.

D. Accessories:

1. Exercise timer to start generator set and transfer load on transfer switch having closest proximity to associated generator set. Set timer to run generator for 25 minutes under load and 5 minutes unloaded.

2. Start contacts for the engine control shall be gold type, dry contacts wired to easy access terminal block and compatible with the generator set control equipment furnished.

3. Two normally opened and two normally closed auxiliary contacts rated 10 amps, 250 volts, 60 hertz, AC (for remote monitoring of the switch position).

4. Operation Counter.

5. Preferred source selection switch for non-emergency applications of the ATS, located inside the switch cabinet.

6. Connectivity Module to allow remote monitoring of transfer switch power meter and control functions via serial or Ethernet connections.

7. Alarm output to the BAS indicating ATS in maintenance (bypass) mode.

8. Provide other accessories as scheduled on Drawings.

9. Transfer inhibit function on the life safety and equipment branch ATS's. The transfer inhibit shall maintain the emergency switch position for Life safety and equipment branch while on emergency power from the service entrance rated ATS. The Life safety and equipment branch ATS's will only return to normal power when normal power is restored to the service entrance rated ATS.

E. Power Monitor:

1. Furnish Power Monitors for the load side of all ATS's to monitor all functions specified below.

2. The Power Monitors shall be listed to UL 3111-1, CSA, CE Mark, and industrially rated for an operating temperature range of -20°C to 60°C.

3. The Power Monitor shall be accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

4. The Power Monitor shall be capable of operating without modification at nominal frequencies of 45 to 66 Hz and over a control power input range of 20 – 32VDC.

5. Each Power Monitor shall be capable of interfacing with an optional communications module to permit information to be sent to central location for display, analysis, and logging.

6. The Power Monitor shall accept inputs from industry standard instrument transformers (120 VAC secondary PT's and 5A secondary CTS.) Direct phase voltage connections, 800 VAC and under, shall be possible without the use of PT's.

7. The Power Monitor shall be applied in single, 3-phase, or three & four wire circuits. A fourth CT input shall be available to measure neutral or ground current.

8. All setup parameters required by the Power Monitors shall be stored in nonvolatile memory and retained in the event of a control power interruption.

9. The following metered readings shall be communicated by the Power Monitor, via serial or ethernet communication:
    a. Current, per phase RMS and neutral (if applicable)
    b. Current Unbalance %
    c. Voltage, phase-to-phase and phase-to-neutral
    d. Voltage Unbalance %
    e. Real power (KW), per phase and 3-phase total
    f. Apparent power (KVA), per phase and 3-phase total
    g. Reactive power (KVAR), per phase and 3-phase total
    h. Power factor, 3-phase total & per phase
    i. Frequency
    j. Accumulated Energy, (MWH, MVAH, and MVARH)
10. The following energy readings shall be communicated by the Power Monitor:
    a. Accumulated real energy KWH
    b. Accumulated reactive energy KVAH
    c. Accumulated apparent energy KVARH
11. The Power Monitor shall flush mount to an enclosure.
12. The Power Monitor shall be furnished with a Modbus gateway device to permit remote monitoring of all parameters via the BAS.
13. The Power Monitors shall be equipped with an optional continuous duty, long-life, 4 line x 20 character LCD backlit display to provide local access to the following metered quantities:
    a. Current, per phase RMS and neutral (if applicable)
    b. Current Unbalance %
    c. Voltage, phase-to-phase and phase-to-neutral
    d. Voltage Unbalance %
    e. Real power, per phase and 3-phase total
    f. Apparent power, per phase and 3-phase total
    g. Reactive power, per phase and 3-phase total
    h. Power factor, 3-phase total & per phase

i. Frequency

j. Accumulated Energy, (MWH, MVAH, and MVARH)

14. Displaying each of the Power Monitor quantities shall be accomplished through the use of menu scroll buttons.

15. For ease in operator viewing, the display shall remain on continuously, with no detrimental effect on the life of the Power Monitor.

16. Setup for system requirements shall be allowed from the front of the Power Monitor. Setup provisions shall include:

    a. CT rating (xxxxx: 5)

    b. PT rating (xxxxxxx:120) (if applicable; 24000V maximum)

    c. System type (single; three phase; 3 and 4 wire)

    d. Communication parameters

17. Reset of the following electrical parameters shall also be allowed from the front of the Power Monitor:

    a. Real energy (MWH), apparent energy (MVAH) and reactive energy (MVARH).

18. All reset and setup functions shall have means for protection against unauthorized/accidental changes.

F. Isolation/By-Pass Capability:

1. Automatic transfer switches shall be the isolation/bypass (IBTS) type as shown on Drawings. The IBTS configuration will allow either the normal or the emergency source to be connected directly to the load to allow the normal automatic transfer switch to be isolated and deenergized for maintenance, testing, or repair. Permanently mounted external operating handles shall be used. Positive mechanical interlocks shall prevent source to source interconnections. Bypass contacts shall be make-before-break or break-before-make, quick-make, quick-break with the operating mechanism, load-break capability and electrical ratings identical to the main automatic transfer switch. The automatic transfer switch shall be full drawout construction with no need for any electrical or mechanical disconnections. The IBTS configuration shall operate as a manual transfer switch when the ATS is removed. The IBTS switch shall be fully mechanical and not dependent upon relays, interlocked circuits, separate contactor or operator dependent timing for safe operation. Other features:

    a. All bus interconnections shall be silver plated.

    b. All operating handles shall be permanently attached.

    c. Provide two sets of auxiliary contacts, each for remote monitoring of switch placed in normal bypass and emergency bypass modes for associated front cover pilot

lights and remote monitoring. Provide associated pilot lights for each made of operation. One set of contacts shall be for future customer use.

G. Closed-Transition Switching Capability:

1. The transfer switch shall be of the closed-transition transfer switch (CTTS) type to transfer the load in a make-before-break action between the utility and standby generating system sources. Both sources shall be connected to the load, in phase, for a maximum period of 100 milliseconds through the use of an in-phase monitor. This operation shall not alter the speed or require active control of the emergency generator sets. The transfer shall occur only when the two sources are within +/- 5 electrical degrees maximum and +\- 5% maximum voltage differences to limit generator synchronizing currents.

2. A fail-safe feature to force the 2nd available source open and signal an alarm condition shall be made in the event closed transition (opening of the original source) does not occur within the 100 millisecond time limitation. Operation of this feature shall require manual reset.

    a. If both operators should fail simultaneously while their contacts are both closed, a dry contact shall close to shunt trip remote source protective devices.

3. Local Electrical Utility Co. approval of the specific CTTS for this project must be accompanied with Shop Drawing submission prior to acceptance.

4. Closed-Transition shall only be permitted where all downstream distribution equipment is adequately rated for the combined short circuit contribution from both sources.

H. Load Shedding:

1. Each automatic transfer switch shall be classified by priority according to the type of load they serve (Priority 1, 2, 3, 4) requiring special functional characteristics. Also, transfer switches feeding motor loads will differ from those feeding non-inertia loads. Refer to transfer switch schedule on Drawings for identification of functions required, as well as for voltage and current rating and current withstand rating.

2. Load Limit Operations:

    a. Each automatic transfer switch of Priority 2, 3, or 4, shall be permitted to transfer to "emergency" only when the permissive circuit from the Paralleling Switchgear System is closed.

    b. There shall be no such restrictions on re-transfer to "normal."

3. Load Shed Operations:

    a. Each automatic transfer switch of Priority 2, 3, or 4, when in "emergency" position, shall transfer to an "open" or "normal" position if the permissive circuit opens.

    b. If the switch has transferred to "open" position, and if normal 3-phase power returns, the switch shall transfer to "normal" position without time delay.

c. Each switch of Priority 2, 3, or 4, shall have an additional pilot light indicating "load shed" position.

I. Tests:

1. Certified independent laboratory test data on a switch of the same design and rating shall be provided to confirm the following switching abilities:

a. Overload and endurance per Tables 21.2 and 23.2 of UL1008 when enclosed according to Paragraph 1.6.

b. Temperature rise tests after the overload and endurance tests to confirm the ability of the transfer switches to carry their rated current within the allowable temperature limits of the insulation in contact with current-carrying parts.

c. No welding of contacts. Transfer switch must be operable by the normal means after the withstand current tests.

d. Dielectric tests at 1960 Volts, RMS, minimum after the withstand current test, per UL1008.

2. All transfer switches shall be subjected to the following factory tests:

a. The complete automatic transfer switch shall be tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

b. The complete automatic transfer switch shall be subjected to a dielectric strength test per NEMA Standard ICS 1-109-05.

c. The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472-1974 (ANSI C37.90a-1974) and the impulse withstand voltage test in accordance with NEMA Standard ICS-1-109.

2.3 MANUAL TRANSFER SWITCHES (MTS)

A. Manual (or non-automatic) transfer switches shall comply with all requirements of automatic transfer switches except:

1. MECHANICALLY/HELD MANUALLY OPERATED: Operation shall be by non-removable external manual handle, operable only with door closed.

2. Manual transfer switches shall be provided with quick-make, quick-break switching action mechanisms with no passes or intermediate position stops during switching sequence.

3. Manual transfer switches shall not initiate a generator start sequence or have front panel toggle switches.

4. Pilot lights on front panel shall indicate switch position: Normal (white), emergency (red), normal source available (green), emergency source available (red).

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls."

B. Install transfer switch(es) where shown.

1. Anchor floor mounted transfer switches to 4 inch concrete base and attach by bolting.

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

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets and temporary blocking of moving parts from transfer switch units and components.

3.2 COORDINATION

A. Coordinate together with equipment suppliers and other Divisions, their equipment operational voltages and controls for proper generating system operation including all new engine generator sets and transfer switches. Provide any necessary auxiliary equipment shall provide for, but not be limited to:

1. Engine start, paralleling switchgear control system, remote annunciator(s) and transfer switch relays and controls.

2. Proper access about IBTS type automatic transfer switches.

3. Remote EGS annunciator interconnection.

4. Wiring and programming necessary to connect new transfer switches to Transfer Switch Monitoring system.

3.3 MANUFACTURER'S SUPERVISION

A. Provide manufacturer's field labor for supervision, testing, Owner operating personnel training and instructions and related services during installation.

B. Obtain a signed statement from the service representative for the transfer switches that the installation is acceptable before the first start up. A copy of the statement shall be submitted to the Engineer.

3.4 FIELD QUALITY CONTROL

A. Inspection and Tests – General:

1. Perform inspections and test procedures as required by Division 26 Section "Electrical Inspections and Testing", ANSI/NETA ATS Sections "Emergency Systems, Engine Generator", Emergency Systems, Automatic Transfer Switches" Sections for other emergency power systems components, "System Functional Tests", and "Thermographic Survey" requirements and the following additional requirements:

   a. Follow-up thermographic survey shall be required.

   b. Prepare test and inspection reports.

   c. Prior to acceptance of the installation, in addition to the factory test, the equipment shall be field tested to show it is free of any defects and will start automatically and be subjected to full load test. To accomplish the field load test, be responsible for providing the necessary load banks as a part of this Contract.

B. Inspections and Tests – Transfer Switches:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.

   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers and safety features.

   c. Verify that manual transfer warnings are properly placed.

3. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

   b. Simulate loss of phase-to-ground voltage for each phase of normal source.

   c. Verify time-delay settings.

   d. Verify pickup and dropout voltages by data readout or inspection of control settings.

   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

f. Perform contact-resistance test across main contacts and correct values exceed 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdowns.

4. Perform complete and partial outages wing transfer switches. Observe availability of generator power to emergency loads and branches ensuring load and control functions are commonly energized.

5. Ground Fault Tests: Coordinate with testing of ground fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

6. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

7. Test each transfer switch operationally by opening the "normal" source, to insure proper load transfer, and to insure that all control and monitor signals are properly transmitted.

a. Verify proper elevator control signaling.

b. Provide auxiliary contacts in the switch to:

1) Indicate switch position at Generator Control System.

C. Provide nameplates per Division 26 Section "Electrical Identification."

END OF SECTION

SECTION 264313

SURGE PROTECTION DEVICES FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes a parallel connected surge protection device (SPD) system for low voltage (120 to 600V) power distribution equipment.

B. This section does not include surge arresters and lightning arresters for low voltage and medium voltage duty, which are specified as accessories to substations and switchgear.

1.2 DEFINITIONS

A. Nominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

I. TYPE 1 DEVICE: Installed on the line or load side of main overcurrent protective device. Includes all overcurrent protective devices and safety disconnect switches inside SPD.

J. TYPE 2 DEVICE: Installed on the load side of main overcurrent protective device. It may require external overcurrent protective device.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.4 ACTION SUBMITTALS

A. Product Data: For each SPD component and accessory specified.

B. Shop Drawings:

1. Layout Drawings: Including dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, weights, performance ratings, etc. Include the following:

a. Enclosure type of NEMA type to match equipment to be protected.

b. Features, characteristics, ratings and factory settings.

c. Wiring diagrams detailing differentiating between factory and field installed wiring.

d. Circuit breaker disconnect product information and location.

e. Dimensioned room layouts assuring proper NEC clearances and coordination.

f. Equipment manual indicating installation, start-up and operating instructions for the system. The manual shall include information to determine whether the system requires an external overcurrent device in order to maintain the systems UL 1449 3rd Edition listing.

g. UL 1449 Ratings: Documentation of system's UL 1449 3rd Edition listing and VPRs.

h. Test Data: Documentation of life cycle testing, overcurrent protection, UL 1449 3rd Edition, noise attenuation, and surge current capacity.

i. Warranty information.

j. Fuse time current characteristics and data.

k. UL listing and labeling for lightning protection master label.

2. Factory Quality Control Test Reports.

1.5 INFORMATIONAL SUBMITTALS

A. Special Warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. The SPD shall be warranted for 10 years.

B. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code."

C. UL Compliance and Labeling: Listed per UL 1449 3rd Edition, Type 1 and Type 2 Devices, and UL 1283.

D. ANSI/IEEE Compliance: Comply with ANSI/IEEE C62.1, C62.41 and C62.45.

E. IEEE Compliance: Comply with Standard 1100 (Emerald Book) latest Edition.

F. NFPA 780, UL 96, and UL 96A Compliance: UL listed and labeled for electric service entrance lightning protection certification. Listing and labeling other than UL is not acceptable to meet UL lightning protection master label.

G. Field Testing: Refer to Division 26 Section "Electrical Inspections and Testing" for field inspections and testing requirements related to this Section including:

1. Electrical Acceptance Testing Responsibilities.

2. General Electrical Field Quality Control.

3. Testing Agency Qualifications.

1.8 PROJECT CONDITIONS

A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).

2. Humidity: 0 to 85 percent, noncondensing.

3. Altitude: Less than 6,600 feet (2000 m) above sea level.

1.9 COORDINATION

A. Coordinate location of integral mounted surge suppressors with switchgear provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Basis of Design:

a. Eaton Type – 1 SPD.

2. Acceptable Equivalents/ Manufacturers as approved by Owner, submit as substitution request per Division 1.

2.2 SWITCHGEAR SPD CHARACTERISTICS

A. Unit Operating Voltage: The nominal unit operating voltage and configuration shall be as shown on Drawings, but is generally 208Y/120V. UL 1449 3rd Edition – Type 1.

B. Maximum Continuous Operating Voltage (MCOV): The maximum continuous operating voltage (MCOV) of all suppression components utilized in the unit shall not be less than 125 percent of the facility's nominal operating voltage for 120 volt nominal systems and not less than 115 percent of the facility's nominal operating voltage for 208, 277, and 480 volt nominal systems.

C. Operating Frequency: The operating frequency range of the unit shall be 47 to 63 Hertz.

D. Protection Modes: The modes of protection shall be line-to-line (phase) line-to-neutral, line-to-ground and neutral-to-ground.

E. SPD shall be UL listed and labeled for compliance with UL 96A when used in conjunction with a lightning protection system requiring a master labeling.

F. Single and Maximum Repetitive Surge Current Capacity: Based on the ANSI/IEEE C62.41 standard 1.2 x 50 microsecond, 20 KV open circuit voltage and an 8 x 20 microsecond 10 KA Category 3 current waveform, the maximum repetitive surge current capacity, in amps, of the unit shall be no less than as follows:

Maximum Surge Current Rating

Modes of Protection	L-L(Three)	L-N (Three)	L-G (Three)	N-G
Single Pulse Surge Current Capacity (Amps)	200,000	100,000	100,000	100,000
Repetitive Surge Current Capacity (Impulses)	5,500	5,500	5,500	5,500

G. Performance Ratings: The unit's published performance ratings shall be the UL 1449 3rd Edition (2009) Listed VPR. The maximum UL 1449 3rd Edition (2009) VPR shall be, for each mode of protection, as follows:

	VPR			
System Voltage	L-L	L-N	L-G	N-G
208Y/120	1200	800	800	800
480Y/277	2000	1200	1200	1200

H. Fuse Documentation: If the system is fused, the fuses must be capable of allowing the suppressor's maximum rated transient current to pass through suppressor, as a minimum 1000 times, without fuse operation. If any external current limiting devices are required, those devices shall be detailed and included, its impact on surge current capability and clamping level shall be provided. All overcurrent protection circuits shall be monitored and provide indication of suppression operability failure.

1. Provide complete time current characteristics, let through test data and test documentation establishing coordinate protective function for SPD component.

2. Provide UL listing for fuses utilized in SPD.

I. Provide status LED indicators on front of enclosure indicating that each MOV array in each mode of protection is in full working order.

J. Provide Form-C contact for remote monitoring of protection status by the building BAS. Failure of any surge diversion module or the opening of any current limiting device shall signal monitoring system.

K. Suppression / Filter System:

1. High-Performance Suppression System per ANSI/IEEE C62.41 Category C3: The unit shall include an engineered parallel connected, solid-state high-performance suppression system, utilizing field replaceable arrays of fused non-linear voltage dependent metal oxide varistors (MOVs) with similar operating characteristics. The suppression systems components shall optimally share surge currents in a seamless, low-stress manner assuring maximum performance and proven reliability. The suppression system shall not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow to or system upset of connected loads. The suppression system shall not incorporate any other components which may degrade performance or reliability of the suppression system. Suppression response shall be 0.5 nanoseconds or less. The system shall be tested to 3500 sequential ANSI/IEEE C62.41 Category C3 waveforms without failing or degrading the UL 1449 VPR by more than 10 percent.

MCOV Table for MOVs:

Voltage	MCOV
120V	150V
220V	275V
277V	320V
480V	640V

2. High-Frequency Extended Range Tracking Filter: The unit shall include a UL 1283 high-frequency extended range tracking filter. The filter shall reduce fast rise-time, high-frequency, error producing transients and electrical line noise to harmless levels thus eliminating disturbances which may lead to system upset.

Filtering Attenuation Table

100 Khz	40 dB
1 Mhz	30 dB
10 Mhz	35 dB
100 Mhz	50 dB

3. Integral Circuit Breaker for Suppression / Filter System: The unit shall require the associated switchgear, switchboard and distribution panelboard assembly to have an

integral circuit breaker as a means of disconnecting the suppression / filter system for maintenance and/or test purposes without interruption of power to the facility's distribution system. The breaker shall be 3-pole for three-phase applications and shall be padlockable.

4. Suppression / Filter System Components: All internal wiring associated with the suppression / filter system and subject to surge currents shall utilize low-impedance copper bus bar and/or #8 AWG copper conductor or larger. All internal connections associated with the suppression / filter system and subject to surge currents shall be made with compression solderless-type lugs and shall be bolted to the bus bars in order to reduce overall system impedance. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in surge current-carrying paths.

2.3 PANELBOARD SPD CHARACTERISTICS

A. Unit Operating Voltage: The nominal unit operating voltage and configuration shall be as shown on Drawings. UL 1449 3rd Edition – Type 2.

B. Maximum Continuous Operating Voltage (MCOV): The maximum continuous operating voltage (MCOV) of all suppression components utilized in the unit shall not be less than 125 percent of the facility's nominal operating voltage for 120 volt nominal systems and not less than 115 percent of the facility's nominal operating voltage for 208, 277, and 480 volt nominal systems.

C. Operating Frequency: The operating frequency range of the unit shall be 47 to 63 Hertz.

D. Single and Maximum Repetitive Surge Current Capacity: Based on the ANSI/IEEE C62.41 standard 1.2 x 50 microsecond, 20 KV open circuit voltage and an 8 x 20 microsecond 10 KA Category 3 current waveform, the maximum repetitive surge current capacity, in amps, of the unit shall be no less than as follows:

Maximum Surge Current Rating:

Modes of Protection	L-L(Three)	L-N (Three)	L-G (Three)	N-G
Single Pulse Surge Current Capacity (Amps)	100,000	50,000	50,000	50,000
Repetitive Surge Current Capacity (Impulses)	3,500	3,500	3,500	3,500

E. Performance Ratings: The unit's published performance ratings shall be the UL 1449 3rd Edition (2009) Listed VPR. The maximum UL 1449 3rd Edition (2009) VPR shall be, for each mode of protection, as follows:

	VPR			
System Voltage	L-L	L-N	L-G	N-G
208Y/120	1200	800	800	800
480Y/277	1800	1200	1200	1200

F. Fuse Documentation: If the system is fused, the fuses must be capable of allowing the suppressor's maximum rated transient current to pass through suppressor, as a minimum 1000 times, without fuse operation. If any external current limiting devices are required, those devices shall be detailed and included, its impact on surge current capability and clamping level shall be provided. All overcurrent protection circuits shall be monitored and provide indication of suppression operability failure.

1. Provide complete time current characteristics, let through test data and test documentation establishing coordinate protective function for SPD component.

2. Provide UL listing for fuses utilized in SPD.

G. Provide status LED indicators on front of enclosure indicating that each MOV array in each mode of protection is in full working order.

H. Provide Form-C contact for remote monitoring of protection status by the BAS.. Failure of any surge diversion module or the opening of any current limiting device shall signal monitoring system.

I. Suppression / Filter System:

1. High-Performance Suppression System per ANSI/IEEE C62.41 Category C3: The unit shall include an engineered parallel connected, solid-state high-performance suppression system, utilizing field replaceable arrays of fused non-linear voltage dependent metal oxide varistors (MOVs) with similar operating characteristics. The suppression systems components shall optimally share surge currents in a seamless, low-stress manner assuring maximum performance and proven reliability. The suppression system shall not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow to or system upset of connected loads. The suppression system shall not incorporate any other components which may degrade performance or reliability of the suppression system. Suppression response shall be 0.5 nanoseconds or less. The system shall be tested to 3500 sequential ANSI/IEEE C62.41 Category C3 waveforms without failing or degrading the UL 1449 VPR by more than 10 percent.

MCOV Table for MOVs:

Voltage	MCOV
120V	150V
220V	275V
277V	320V
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2. High-Frequency Extended Range Tracking Filter: The unit shall include a UL 1283 high-frequency extended range tracking filter. The filter shall reduce fast rise-time, high-frequency, error producing transients and electrical line noise to harmless levels thus eliminating disturbances which may lead to system upset.

Filtering Attenuation Table

100 Khz	40 dB
1 Mhz	30 dB
10 Mhz	35 dB
100 Mhz	50 dB

3. Suppression / Filter System Components: All internal wiring associated with the suppression / filter system and subject to surge currents shall utilize low-impedance copper bus bar and/or #8 AWG copper conductor or larger. All internal connections associated with the suppression / filter system and subject to surge currents shall be made with compression solderless-type lugs and shall be bolted to the bus bars in order to reduce overall system impedance. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in surge current-carrying paths.

4. The SPD shall have a remote enclosure type to match panelboard to be SPD protected and be close-nippled directly to the panelboard.

5. Provide 3-pole, 30A circuit breaker in associated panelboard and #8 AWG conductors to the SPD unit unless required otherwise by SPD manufacturer.

J. SCCR: Equal or exceed 100 KA.

K. Inominal: 20 KA.

2.4 IDENTIFICATION

A. General: Refer to Division 26 Section "Electrical Identification" for labeling materials.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount service entrance SPD meeting specified requirements and NEC code clearances.

B. Connect switchgear SPD through a circuit breaker type disconnect installed within the assembly for the SPD device or SPD shall be provided with an integral disconnect. Assure padlocking provision of the associated circuit breaker. Provide short and straight lead lengths between the suppressor and associated electrical assembly breaker. Provide SPD conductor per manufacturer's recommendations but not to exceed 10 feet in total length. Tape leads tightly together to reduce their self-inductance. Size breaker and leads per manufacturer's recommendations. Make no sharp bends in leads. Install all conductors within the assemblies and/or within interconnecting conduit with grounding bushings.

C. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Assure grounding of the SPD enclosure and shunt tie to equipment ground (not isolated ground).

E. SPDs shall be installed at all:

1. Life Safety Branch distribution and branch panelboards.
2. Elevator distribution and branch panelboards.
3. UPS system distribution and branch panelboards.
4. Switchgear.
5. Switchboards.

3.2 IDENTIFICATION

A. Install SPD device nameplates per Division 26 Section "Electrical Identification."

3.3 COORDINATION

A. Where multiple SPD devices are supplied for this Project, provide documentation for proper coordinated protection between two (2) or more SPD units in series.

3.4 TESTING

A. Provide completed field inspection and checklist from manufacturer's representative with certification that unit is installed correctly and operational.

END OF SECTION