

ADDENDUM NO. 1

March 18, 2020

This Addendum contains changes to the requirements of the Contract Documents and Specifications. Such changes are to be incorporated into the Construction Documents and shall apply to the work with the same meaning and force as if they had been included in the original document. Wherever this Addendum modifies a portion of a paragraph of the specifications or a portion of any Drawing, the remainder of the Paragraph or Drawing shall remain in force.

NOTE: Provisions of all Contract Documents apply.

The following is additional electrical work newly added to the project and should be included in the Contractor's Bid Proposal Submission:

TECHNICAL SPECIFICATIONS

- Item 1. **ADD** SECTION 26 05 13 - MEDIUM VOLTAGE CABLES, attached.
- Item 2. **ADD** SECTION 26 05 26 - GROUND AND BONDING FOR ELECTRICAL SYSTEMS SYSTEMS, attached.
- Item 3. **ADD** SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS, attached.
ADD SECTION 26 05 73 -OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH STUDY, attached.
- Item 4. **ADD** SECTION 26 12 16 - DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS, attached.
- Item 5. **ADD** SECTION 26 24 13 - SWITCHBOARD, attached.
- Item 6. **ADD** SECTION 26 24 16 - PANELBOARDS, attached.

DRAWINGS

- Item 7. **ADD** DRAWING AD-E1 - DRAWING INDEX-PARTIAL SUB-BASEMENT ELECTRICAL PLAN, attached.
- Item 8. **ADD** DRAWING AD-E2 - PARTIAL ONE-LINE DIAGRAM - EXISTING, attached.
- Item 9. **ADD** DRAWING AD-E3 - PARTIAL ONE-LINE DIAGRAM - NEW, attached.

Attachments: Section 26 05 13
Section 26 05 26
Section 26 05 53
Section 26 05 73
Section 26 12 16
Section 26 24 13
Section 26 24 16
Drawings AD-E1, AD-E2 and AD-E3

****END OF ADDENDUM****

SECTION 26 05 13 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2 and NFPA 70.
- C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Okonite Company.
 - 2. Prysmian Power Cable.
 - 3. Southwire Company.

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- B. Cable Type: Type MV 105.
- C. Conductor Insulation: Ethylene-propylene rubber.
 - 1. Voltage Rating: 15 kV.
 - 2. Insulation Thickness: 133 percent insulation level.
- D. Conductor: Copper.
- E. Comply with UL 1072, AEIC CS8.
- F. Conductor Stranding: Concentric lay, Class B.
- G. Shielding: Copper tape, helically applied over semiconducting insulation shield.
- H. Cable Jacket: Sunlight-resistant PVC, 80-mil minimum, rated for cable-tray use.

2.3 SOLID TERMINATIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M.
 - 2. Raychem.
- B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
 - 1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.

2.4 ARC-PROOFING MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M.
 - 2. nVent (Raychem).
- B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- C. Support cables according to manufacturer's installation instructions.
- D. In cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- E. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
 - 4. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
- B. Prepare test and inspection reports.

END OF SECTION 26 05 13

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Appleton - O-Z/Gedney; Emerson Electric Co., Automation Solutions.
 2. Burndy; Hubbell Incorporated, Construction and Energy.
 3. nVent (ERICO).

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

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2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with zinc-plated bolts.
 - a. Material: Die-cast zinc alloy.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install stranded conductors.
- B. Grounding Bus: Install in electrical equipment rooms.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

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C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.

3.4 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. Ground Rods: Drive rods until tops are 2 inches below finished floor.
- C. 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 bonding so vibration is not transmitted to rigidly mounted equipment.
- D. 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;

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use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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 aboveground portion of gas piping system downstream from equipment shutoff valve.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Perform tests by fall-of-potential method according to IEEE 81.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
 1. Power and Lighting Equipment or System with Capacity of 500 kVA: 5 ohms.

END OF SECTION 26 05 26

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for conductors.
 - 2. Warning labels and signs.
 - 3. Equipment identification labels.
 - 4. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual. 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.

PART 2 - PRODUCTS

2.1 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape.

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- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 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. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
 - 3. Arc Flash Protection Label:
 - a. Items: Arc Flash Protection Label.
 - b. Type: Format 9.
 - c. Color: White on red header/black on white body.
 - d. Height: 5 inches.
 - e. Width: 7 inches.
 - f. Legend: "DANGER – ARC FLASH AND SHOCK HAZARD, APPROPRIATE PPE REQUIRED, HAZARD CATEGORY -1."
 - g. Material: Write-on vinyl with acrylic adhesive.

2.3 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- C. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- D. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

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2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 9 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. 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 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations 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 signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

3.2 IDENTIFICATION SCHEDULE

- A. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Identify system voltage with black letters on an orange background.
 - 2. Apply to exterior of door, cover, or other access.
- B. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Adhesive film label with clear protective overlay. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Stenciled legend 4 inches high.

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- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.

END OF SECTION 26 05 53

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC-FLASH STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes computer-based, fault-current, overcurrent-protective-device coordination study, and arc-flash/incident-energy study. Protective devices shall be set based on results of the protective-device coordination study. Arc-flash hazard labels shall be provided based on results of the arc-flash study.

1.2 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination study specialist and arc-flash/incident-energy study specialist.
- D. Other Action Submittals: Submit preliminary study, data, and report for action prior to final approval of power-distribution-equipment submittals. The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form and hard copy in 3-ring binders.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and equipment-evaluation reports.
 - 3. Coordination-study report.
 - 4. Arc-flash/incident-energy-study input data and report.
 - 5. Maintenance procedures according to requirements in NFPA 70E.

1.3 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. Specialist Qualifications—Coordination Study and Arc-Flash/Incident-Energy Study: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

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- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.
- E. Comply with IEEE 1584 and NFPA 70E for arc flash hazard calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
 - 1. ESA Inc.
 - 2. Power Analytics Corporation.
 - 3. SKM Systems Analysis, Inc.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

2.3 REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.

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- C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
 2. Cable size and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Protective-Device Coordination-Study Report Contents:
1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- F. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

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- d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. Comments and recommendations for system improvements.
- G. Arc-Flash Study Output:
1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. 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.
- I. Fault-study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

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2.4 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Flash protection boundary.
 - 4. Hazard risk category.
 - 5. Incident energy.
 - 6. Working distance.
 - 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine-printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent-protective-device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study and arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent-protective-device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent-protective-device submittals, input and output data, and recommended device settings.
 - 2. Impedance of campus-power-distribution service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

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- a. Circuit-breaker and fuse-current ratings and types.
 - b. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - c. Generator kilovolt amperes, size, voltage, and source impedance.
 - d. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - e. Busway ampacity and impedance.
 - f. Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
- a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent-protective-device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Circuit breakers.
 2. Switchboard.
 3. Distribution panelboards.
 4. Branch circuit panelboards.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

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- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:

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- a. Inrush current when first energized.
 - b. Self-cooled, full-load current.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between 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:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.

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3.5 ARC FLASH HAZARD ANALYSIS AND INCIDENT ENERGY STUDY

- A. Comply with NFPA 70E, Annex D. Perform with the aid of a digital computer in order to calculate arc flash incident energy ("AFIE") levels and arc flash protection boundary distances.
- B. Perform in conjunction with a short-circuit analysis and a time-current coordination analysis.
- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
 - 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Results of the arc flash hazard analysis shall be submitted in tabular form and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes, and AFIE levels.
- 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. Include recommendations for reducing AFIE levels and enhancing worker safety.
- K. Report incident energy values based on the incident energy values at all buses within the scope of the study, in addition to incident energy values based on the recommended overcurrent-device setting changes.

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- L. Report shall document equipment labels required for compliance with relevant NFPA standards, as well as UL 969, and must include the following information:
 - 1. Equipment name.
 - 2. AFIE value (cal/cm²).
 - 3. System voltage.
 - 4. Restricted approach boundary.
 - 5. AFIE flash hazard boundary.
 - 6. Hazard risk category.
 - 7. Limited approach boundary.
 - 8. Prohibited approach boundary.

3.6 LABELING

- A. Apply one arc-flash label for panelboards and disconnects and for each of the following locations:
 - 1. Control panels.

3.7 APPLICATION OF WARNING LABELS

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

3.8 DEMONSTRATION

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

END OF SECTION 26 05 73

SECTION 26 12 16 - DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes dry-type, medium-voltage transformers.

1.3 DEFINITIONS

- A. VPI: Vacuum Pressure Impregnation.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For dry-type, medium-voltage transformers.
 - 1. Include plans and elevations showing major components and features.

1.5 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMER

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Olsun Electric's product indicated on Drawings or approved equal by one of the following:
 - 1. Federal Pacific.
 - 2. MGM Transformers.

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2.
- C. Comply with IEEE C57.12.01.

2.3 PERFORMANCE REQUIREMENTS

- A. Windings Material: Copper.
- B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.
- C. Cooling Systems: Comply with IEEE C57.12.01 for cooling class.
 - 1. Self-Cooled Rating, 600-V class: 500 kVA.
- D. Coils Insulation Systems:
 - 1. Primary and secondary coil assemblies shall be manufactured using polyester VPI system.
- E. Winding Connections: Connection of windings and terminal markings shall comply with IEEE C57.12.70.
- F. Bushings shall comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.
- G. Tap Changer: External, for de-energized operation.

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H. Enclosure:

1. Provide with provisions for lifting and anchoring frame to concrete pad.
2. With an integral skid-mounting frame, suitable to allow skidding or rolling of transformer in any direction.
3. Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.
4. Taps: Two 2-1/2-percent, full-capacity taps above and two 2-1/2-percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.

I. Sound level shall comply with requirements of NEMA TR 1.

J. Capacities and Characteristics:

1. Enclosure: Ventilated power transformer, NEMA 250 Type 1 enclosure.
2. Additional IEEE Standards: Comply with IEEE C57.12.50.
3. Comply with UL 1562 listing requirements.
4. Service Conditions: The transformers shall be suitable for operation under service conditions specified as usual service conditions in IEEE C57.12.01.
5. Connections:
 - a. Primary: Air-filled terminal cabinet for cable connection.
 - b. Secondary: Air-filled terminal cabinet for cable connection.
6. Transformer Ratings:
 - a. Impedance: Not less than 5.75 percent.
 - b. Temperature Rise: 150 deg C.
 - c. Coils Connection:
 - 1) High-Voltage Winding: Delta.
 - 2) Low-Voltage Winding: Wye.
 - d. Voltage and BIL Ratings:
 - 1) Nominal primary phase-to-phase voltage and BIL: 13 200 V, 60 kV.
 - 2) Nominal secondary voltage and BIL: 480Y/277 V, 10 kV.
7. Taps: Two 2-1/2-percent, full-capacity taps above and two 2-1/2-percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.51 requirements.
8. Transformer Accessories:
 - a. Dial-type analog thermometer with alarm contacts.
 - b. At least four stainless-steel ground connection pads.
 - c. Provisions for jacking, lifting, and towing.
 - d. Machine-engraved nameplate made of anodized aluminum or stainless steel.

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2.4 SOURCE QUALITY CONTROL

- A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.91.
- B. Perform the following factory-certified routine tests on each transformer 500 kVA and less for this Project:
 - 1. Turns ratio, polarity, and phase relation on rated voltage connection.
 - 2. Transformer no-load losses and excitation current at 100 percent of ratings. This test may be based on a statistical sample.
 - 3. Applied voltage and induced voltage.
 - 4. Partial discharge.
- C. Perform the following factory-certified tests on each transformer 500 kVA and larger for this Project. Reports shall comply with the minimum information requirements of IEEE C57.12.01:
 - 1. Resistance measurements of all windings on rated voltage tap and at tap extremes.
 - 2. Turns ratio, polarity, and phase relation on rated voltage connection.
 - 3. Transformer no-load losses and excitation current at 100 percent of ratings.
 - 4. Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
 - 5. Applied voltage and induced voltage.
 - 6. Partial discharge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pre-Installation Checks:
 - 1. Verify removal of any shipping bracing after placement.
- B. Verify that ground connections are in place and that requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.
- C. Install transformers on cast-in-place concrete equipment base.
- D. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.
- E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

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3.2 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - 1. For grounding to grounding electrodes, use bare copper cable not smaller than No. 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
 - 2. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.
 - 3. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.

- B. Terminate medium-voltage cables according to Section 26 05 13 "Medium-Voltage Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. General Field-Testing Requirements:
 - a. Comply with provisions of NFPA 70B, Ch. "Testing and Test Methods."
 - b. After installing transformer but before primary is energized, verify that grounding system is tested at specified value or less.

END OF SECTION 26 12 16

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboard rated 600 V and less.
 - 2. Surge protection devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Accessory components and features.
 - 6. Identification.

1.3 ACTION SUBMITTALS

- A. Product Data: For each switchboard, overcurrent protective device, surge protection device, accessory, and component.
- B. Shop Drawings: For each switchboard.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail bus configuration, current, and voltage ratings.
 - 3. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 4. Detail utility company's metering provisions with indication of approval by utility company.
 - 5. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 - 6. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Delegated Design Submittal:
 - 1. For arc-flash hazard analysis.
 - 2. For arc-flash labels.
- D. Field quality-control reports.

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1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1.6 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace doors, lift-out panels, and structures to provide pathway for moving switchboard into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboard until spaces are enclosed and weathertight, wet work in spaces is complete and dry.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, bus work, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.
- B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

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

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1. General Electric.
 2. Eaton.
 3. Schneider Electric USA (Square D).
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. 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.
- D. Comply with NEMA PB 2.
- E. Comply with NFPA 70.
- F. Comply with UL 891.
- G. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.
 2. Branch Devices: Panel mounted.
 3. Sections front and rear aligned.
- H. Nominal System Voltage: 480Y/277 V.
- I. Indoor Enclosures: Steel, NEMA 250, Type 1.
- J. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- K. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- M. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 2. Phase- and Neutral-Bus Material: High-strength, electrical-grade copper.
 3. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

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4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's sections. Provide for future extensions from both ends.
 6. Neutral Buses: 100 percent of the ampacity of phase buses, equipped with mechanical connectors for outgoing circuit neutral cables.
- N. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES

- A. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- B. Features and Accessories:
1. Integral disconnect switch.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Indicator light display for protection status.
 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
 5. Surge counter.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
 2. Line to Ground: 1200 V for 480Y/277 V.
 3. Line to Line: 2000 V for 480Y/277 V.
- E. SCCR: Equal or exceed 42 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

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- a. Long- and short-time pickup levels.
 - b. Long and short time adjustments.
2. MCCB Features and Accessories:
- a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

2.4 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary. Burden and accuracy shall be consistent with connected metering and relay devices.
 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 4. Current Transformers for Neutral Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker.
- 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 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 2. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.

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2.5 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
- C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.7 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Install switchboards and accessories according to NEMA PB 2.1.
- C. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness.
 - 1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 3. Anchor switchboard to building structure at the top of the switchboard.

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- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

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- B. Switchboard will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboard.

1.3 DEFINITIONS

- A. MCCB: Molded-case circuit breaker.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.

1.5 INFORMATIONAL SUBMITTALS

- A. Panelboard schedules for installation in panelboards.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 36 months from date of Substantial Completion.

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PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.
- D. Enclosures: Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Height: 84 inches (2.13 m) maximum.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
- E. Incoming Mains Location: Top.
- F. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
- H. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- I. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- J. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

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- K. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

2.2 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. General Electric.
 - 2. Eaton.
 - 3. Schneider Electric USA (Square D).
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: Lugs only.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame: Bolt-on circuit breakers or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.

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g. Field-Adjustable Settings:

- 1) Long- and short-time pickup levels.
- 2) Long and short time adjustments.

3. MCCB Features and Accessories:

- a. Standard frame sizes, trip ratings, and number of poles.
- b. Breaker handle indicates tripped status.
- c. UL listed for reverse connection without restrictive line or load ratings.
- d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
- e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.4 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install panelboards and accessories according to NEMA PB 1.1.
- C. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box.

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- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Make grounding connections.
- G. Install filler plates in unused spaces.
- H. 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; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.

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- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 24 16

ELECTRICAL DRAWING INDEX		
NUMBER	NAME	REVISIONS
		# DATE
AD-E1	DRAWING INDEX-PARTIAL SUB-BASEMENT ELECTRICAL PLAN	
AD-E2	PARTIAL ONE-LINE DIAGRAM - EXISTING	
AD-E3	PARTIAL ONE-LINE DIAGRAM - NEW	

ELECTRICAL KEYED NOTES	
E1	CIRCUIT CEILING MOUNTED LIGHT FIXTURES TOGETHER WITH 2#10, #10E.G. - 1/2" CONDUIT AND RECONNECT TO EXISTING LIGHTING BRANCH CIRCUIT IN THE AREA.
E2	CIRCUIT CEILING MOUNTED LIGHT FIXTURE WITH 2#10, #10E.G. - 1/2" CONDUIT TO AN EXISTING EMERGENCY LIGHTING BRANCH CIRCUIT IN THE AREA.
E3	CIRCUIT CEILING MOUNTED LIGHT FIXTURES TO EXISTING LIGHTING CONTROL BRANCH CIRCUIT. EXTEND CONDUIT, CONDUCTORS, HARDWARE AND SUPPORTS AS NECESSARY FOR RECONNECTION.
ED1	DISCONNECT AND REMOVE FEEDER FOR EXISTING TRANSFORMER T-3 AND EXISTING PANEL MDP-1N. REMOVE EXISTING TRANSFORMER T-3 AND SECONDARY CIRCUIT BREAKER CB-3.
ED2	RELOCATE EXISTING CIRCUIT BREAKER FOR EXISTING PANEL PP-N1 FROM MDP-1N TO MDP-2N. REMOVE MDP-1N CIRCUIT BREAKERS AND INTERIOR. CONNECT PP-N1 FEEDER AT RELOCATED CIRCUIT BREAKER.
ED3	DISCONNECT AND REMOVE CEILING MOUNTED LIGHT FIXTURE. REMOVE CONDUIT, CONDUCTORS, SUPPORTS AND HARDWARE BACK TO THE EXTENT POSSIBLE TO ALLOW FOR RECONNECTION TO NEW CEILING MOUNTED LIGHT FIXTURES. PROTECT REMAINING CONDUIT AND CONDUCTORS DURING CONSTRUCTION.
ED4	DISCONNECT EXISTING LIGHTING CONTROL BRANCH CIRCUIT FROM LIGHT FIXTURES. REMOVE ASSOCIATED CONDUIT, CONDUCTORS, SUPPORTS AND HARDWARE BACK TO THE EXTENT POSSIBLE TO ALLOW FOR RECONNECTION TO NEW CEILING MOUNTED LIGHT FIXTURES. PROTECT REMAINING CONDUIT AND CONDUCTORS DURING CONSTRUCTION. EXISTING WALL MOUNTED LIGHTING CONTROL SHALL REMAIN.

PHASE I SUMMARY

GENERAL NOTES
A. PUT ALL BUILDING ELECTRICAL LOADS ON NORTH TRANSFORMER BANK.

CONSTRUCTION PHASING NOTES

- INSTALL NEW 15KV 2/0 FEEDERS FROM G&W SWITCHWAY 5 TO NORTH TRANSFORMER BANK. INSTALL UNISTRUT RACKING ABOVE EXISTING S&C SWITCHGEAR.
- CORNELL MVC TO OPEN G&W SWITCHWAY 5.
- CORNELL EH&S TO PULL OIL SAMPLES FROM ALL 6 TRANSFORMERS FOR PCB TESTING.
- REMOVE EXISTING 15KV CABLES BETWEEN G&W SWITCHWAY 5 AND S&C SWITCHGEAR.
- INSTALL TEMPORARY PLYWOOD BARRIER TO PROTECT NORTH BANK TRANSFORMER BUSHINGS FROM ACCIDENTAL CONTACT.
- REMOVE EXISTING CABLES BETWEEN S&C SWITCHGEAR AND NORTH TRANSFORMER BANK.
- CONNECT ONE END OF NEW 2/0 CABLES TO G&W SWITCHWAY WITH 600A DEAD BREAK ELBOWS AND THE OTHER END TO THE HIGH SIDE OF THE NORTH TRANSFORMER BANK USING AIR TERMINATIONS.
- OPEN MAIN SECONDARY BREAKER ASSOCIATED WITH EAST TRANSFORMER BANK.
- CLOSE 480V TIE BREAKER.
- CORNELL MVC TO CLOSE G&W SWITCHWAY 5. CHECK ROTATION.

PHASE II SUMMARY

GENERAL NOTES
A. REMOVE DE-ENERGIZED EQUIPMENT FROM PHASE I AND INSTALL NEW ELECTRICAL EQUIPMENT.

CONSTRUCTION PHASING NOTES

- THE THREE EAST BANK TRANSFORMERS ARE TO BE DRAINED INTO 55 GALLON BARRELS FOR DISPOSAL.
- REMOVE AND DISPOSE THE S&C SWITCHGEAR AND EAST BANK TRANSFORMERS.
- INSTALL NEW DRY-TYPE, 500KVA TRANSFORMER AND NEW 480V SECONDARY SWITCHBOARD.
- INSTALL RACEWAY AND CABLES BETWEEN NEW TRANSFORMER SECONDARY BUSHINGS AND LINE SIDE OF NEW 480V SWITCHBOARD. NEW PRIMARY CABLES INSTALLED IN PHASE 1 SHALL BE USED TO ENERGIZE THE NEW TRANSFORMER.
- REMOVE CMU BLOCKS BETWEEN TRANSFORMER VAULT AND SECONDARY GEAR ROOM TO ALLOW FOR INSTALLATION OF NEW SECONDARY CABLES.
- INSTALL NEW SECONDARY CABLES FROM NEW 480V SWITCHBOARD TO SPLICE POINT ABOVE OLD SWITCHGEAR.

PHASE III SUMMARY

GENERAL NOTES
A. PUT ALL BUILDING LOADS ON NEW TRANSFORMER AND NEW 480V SWITCHBOARD.

CONSTRUCTION PHASING NOTES

- CORNELL MVC TO OPEN G&W SWITCHWAY 5 TO DE-ENERGIZE ENTIRE BUILDING.
- SWING THE 15KV CABLES FROM THE HIGH SIDE OF THE NORTH BANK TRANSFORMERS TO THE HIGH SIDE OF THE NEW DRY-TYPE TRANSFORMER AND MAKE CONNECTIONS.
- PERFORM ALL 480V FEEDER SPLICES AT THE JUNCTION BOX ABOVE THE OLD 480V SWITCHBOARD.
- VERIFY ALL FEEDER BREAKER RELAY SETTINGS ARE PROPERLY PROGRAMMED.
- CORNELL MVC TO CLOSE G&W SWITCHWAY 5, CHECK FOR ROTATION.
- DRAIN NORTH BANK TRANSFORMER OIL INTO 55 GALLON DRUM AND DISPOSE. REMOVE NORTH BANK TRANSFORMERS AND DISPOSE.

LUMINAIRE SCHEDULE - LED												
TYPE	LUMINAIRE DESCRIPTION	LUMENS	WATTAGE	CRI	COLOR TEMPERATURE	VOLTAGE	DRIVER(S)		ACCEPTABLE MANUFACTURERS	MODEL NUMBER	MOUNTING	NOTES
							TYPE	QTY				
S	LED, 2.5IN X 4FT SURFACE MOUNTED LINEAR LIGHT FIXTURE	4000	45 W	80	3500	120 V	0 - 10V DIMMING	1	PHILIPS DAY-BRITE FLUXSTREAM LED STRIP SERIES	FSS440L835-UNV-DIM	SURFACE	

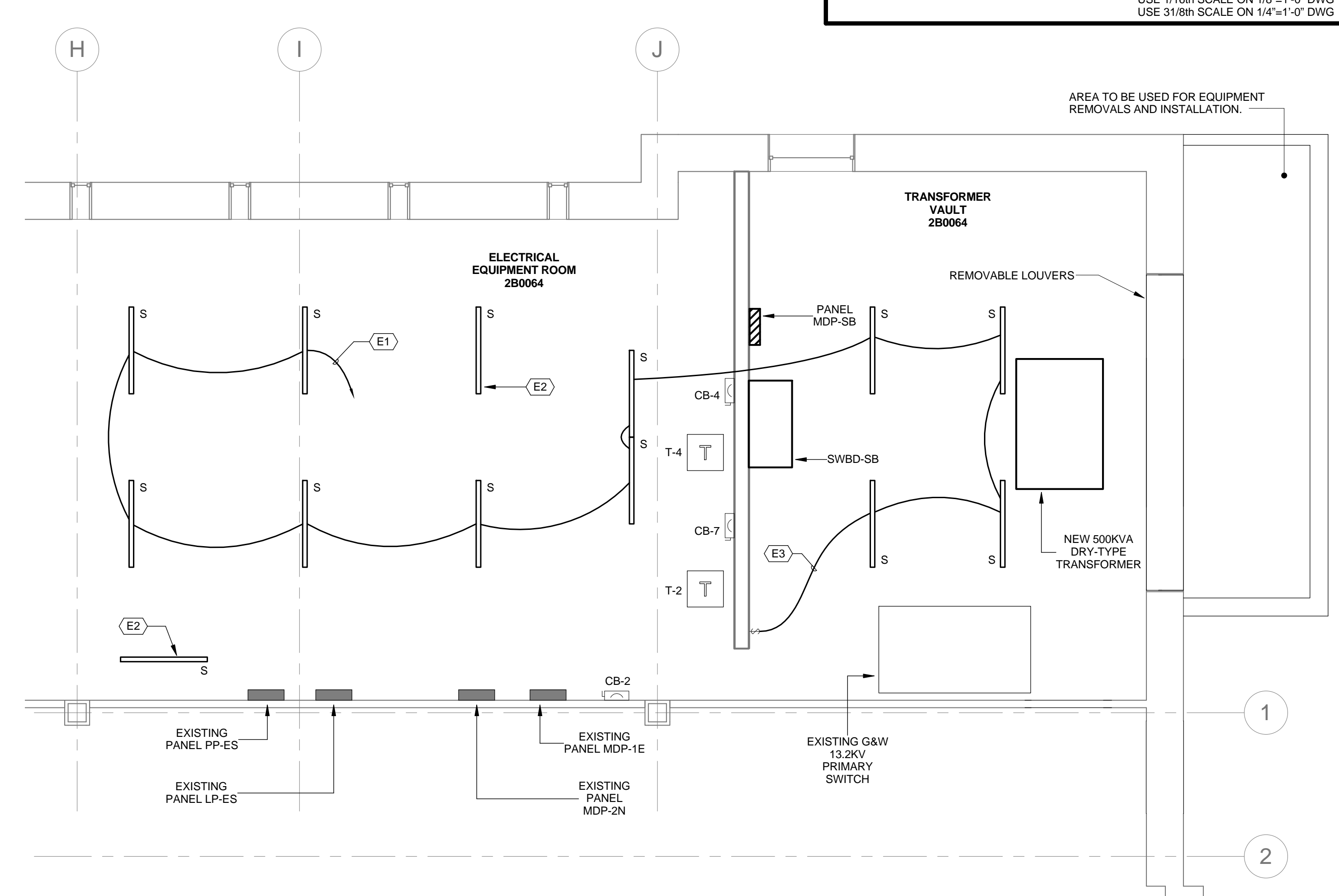
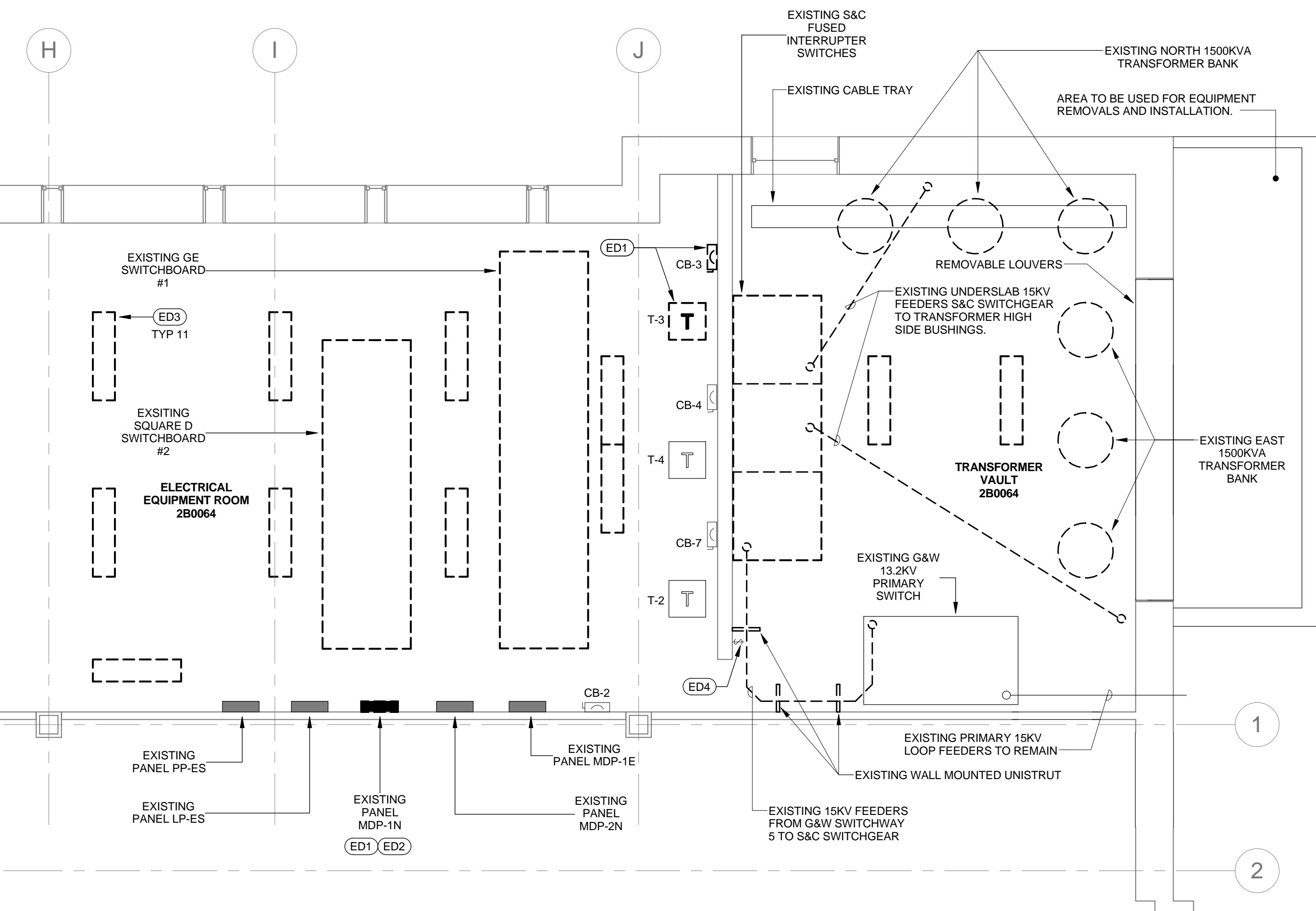
PLAN SETUP

DOCUMENT REDUCTION/MAGNIFICATION SCALE

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IF LINE MEASURES 2" (67% COPY):
USE 3/16" SCALE ON 1/8"=1'-0" DWG
USE 3/8" SCALE ON 1/4"=1'-0" DWG

IF LINE MEASURES 1.5" (50% COPY):
USE 1/16" SCALE ON 1/8"=1'-0" DWG
USE 3/16" SCALE ON 1/4"=1'-0" DWG



PARTIAL SUB-BASEMENT DEMOLITION PLAN - ELECTRICAL
SCALE: 1/4" = 1'-0"

PARTIAL SUB-BASEMENT ELECTRICAL PLAN
SCALE: 1/4" = 1'-0"

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Revision Schedule		
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DRAWING
INDEX-PARTIAL
SUB-BASEMENT
ELECTRICAL
PLAN

AD-E1



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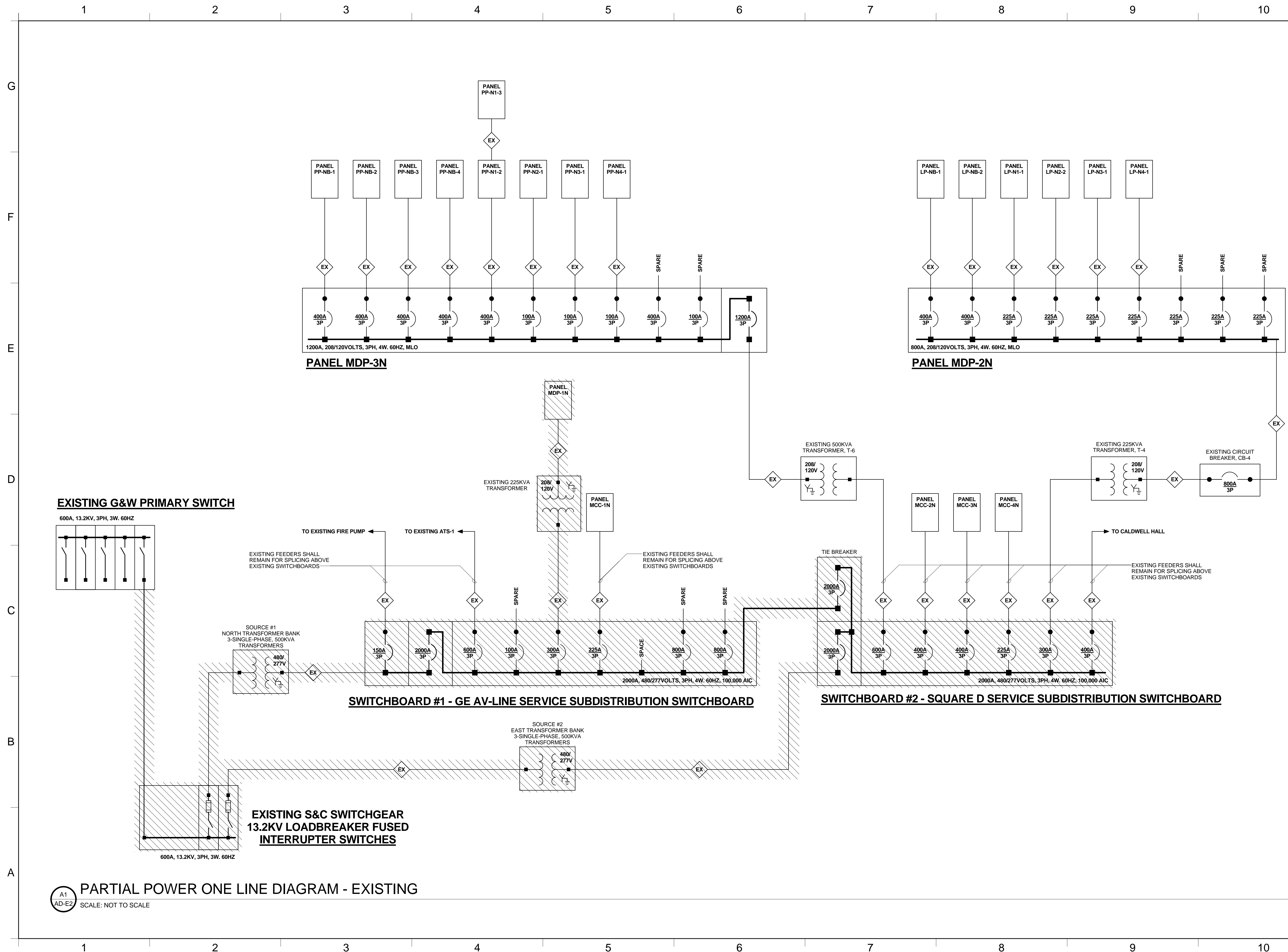
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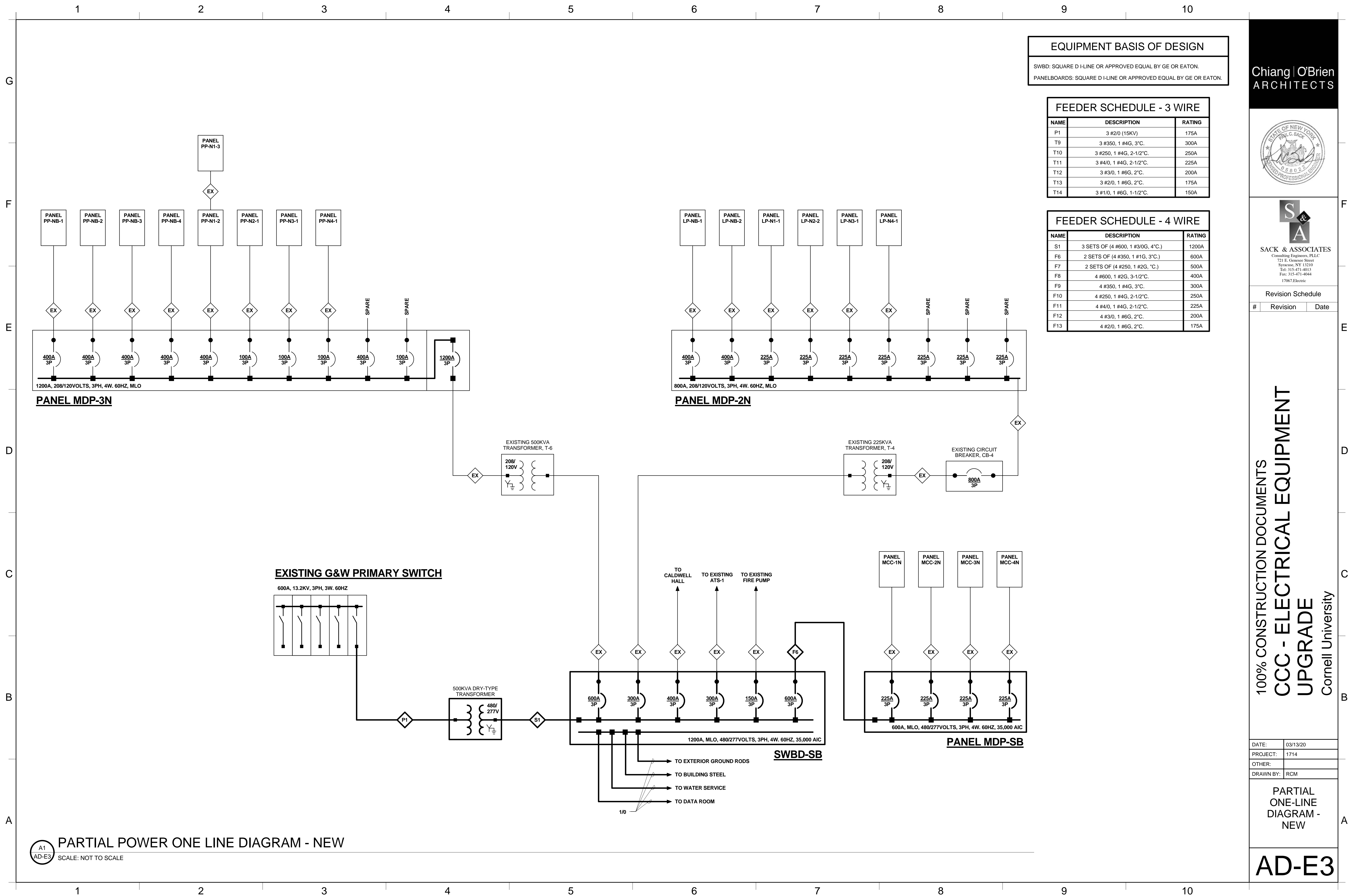
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PARTIAL
ONE-LINE
DIAGRAM -
EXISTING

AD-E2



PARTIAL POWER ONE LINE DIAGRAM - EXISTING
SCALE: NOT TO SCALE



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Revision Schedule

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PARTIAL
 ONE-LINE
 DIAGRAM -
 NEW

AD-E3

A1 PARTIAL POWER ONE LINE DIAGRAM - NEW
 SCALE: NOT TO SCALE