**ADDENDUM NO.** 2

Date August 04, 2020

City of Austin

Project Name Domain DCP Switchgear Replacement

C.I.P. No. 7174.070 IFB No.: CLMC802

This Addendum forms a part of the Contract and corrects or modifies original Bid Documents, dated June 29, 2020 (*first advertisement date)*. **Acknowledge receipt of this addendum in space provided on bid form.** Failure to do so may subject bidder to disqualification.

A. Project Manual Revisions:

1. **Specification Table of Contents** – Replace Table of Contents with the attached.
   i. Table of Contents Page 1 of 3: Replaced Section 00020 Invitation for Bids dated 04/03/2020.
   ii. Table of Contents Page 2 of 3: Replaced Section 260180 Electrical Testing dated 07/30/20.
   iii. Table of Contents Page 3 of 3: Replaced Section 260572 Overcurrent Protective Device Short Circuit Study dated 07/30/20.
   iv. Table of Contents Page 3 of 3: Replaced Section 260573 Overcurrent Protective Device Coordination Study dated 07/30/20.
   v. Table of Contents Page 3 of 3: Replaced Section 260574 Overcurrent Protective Device Arc Flash Study dated 07/30/20.
   vi. Table of Contents Page 3 of 3: Replaced Section 262300 Low Voltage Switchgear dated 07/30/20.

2. **Section 00020 – Invitation for Bids –** Replace Section 00020, Invitation for Bids with the attached.
   i. Replaced Page 2 of 5, Part 3 Submission of Bids, Paragraph six (6) with the following paragraph:

      ALL BIDS AND COMPLIANCE PLANS ARE DUE PRIOR TO (Austin time) 2:00 PM on 8/13/2020.

      BIDS WILL BE OPENED AT (Austin time) 3:00 PM on 8/13/2020.

3. **Section 260180 – Electrical Testing –** Replace Section 260180, Electrical Testing with the attached.
   i. Section 1.1.A: Revised section 1.1.A to clarify equipment scope.

4. **Section 260572 – Overcurrent Protective Device Short Circuit Study –** Replace Section 260572, Overcurrent Protective Device Short Circuit Study with the attached.
   i. Section 1.2.A: Revised section 1.2.A to clarify equipment scope.

5. **Section 260573 – Overcurrent Protective Device Coordination Study –** Replace Section 260573, Overcurrent Protective Device Coordination Study with the attached.
   i. Section 1.2.A: Revised section 1.2.A to clarify equipment scope.

6. **Section 260574 – Overcurrent Protective Device Arc Flash Study –** Replace Section 260574, Overcurrent Protective Device Arc Flash Study with the attached.
   i. Section 1.2.A: Revised section 1.2.A to clarify equipment scope.

7. **Section 262300 – Low Voltage Switchgear –** Replace Section 262300, Low Voltage Switchgear with the attached.
   i. Section 2.4.C: Removed section 2.4.C to clarify relay requirements.

B. Drawing Revisions:

1. **Electrical Drawing Package –**
   i. Delete Sheet E300 and replace with attached sheet E300. Added description clarifying existing equipment.

This addendum consists of 58 page(s)/sheet(s).

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James Matlock

Approved by OWNER

Curtis Williams

Approved by ENGINEER/ARCHITECT (as applicable per license requirements)

**END**

STATE OF TEXAS
CURTIS WILLIAMS
99247
LICENSED
PROFESSIONAL ENGINEER
8/4/2020

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## SPECIFICATIONS

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| | | |
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### Special Provisions to City Standard Technical Specifications

Not used

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| **VOL. 2 of 2** | 08/2019 | **MBE/WBE Procurement Program Package** |

**END**

## 1. OVERVIEW AND PROJECT INFORMATION

Following is a summary of information for this Project. Bidder is cautioned to refer to other sections of the Project Manual, Drawings and Addenda (Bid Documents) for further details.

The City of Austin, hereafter called OWNER, is requesting Bids for furnishing all labor, materials, equipment, supervision, and incidentals, and for performing all Work required for the following:

| | |
|---|---|
| Project: | Domain DCP Switchgear Replacement |
| Located at: | 3120 Kramer Ln, Bldg. A, Austin, TX 78758 |
| CIP ID No.: | 7174.070 |
| Solicitation No.: | CLMC802 |

Austin Energy seeks a Contractor to replace the current switchgear at the Domain District Cooling Plant. The work consists of the furnish, install, and commissioning of (2) two new M-T-M, 12.47kV, 3200A double-ended secondary unit substations each with MV interrupter switches, dry-type transformers rated at 2 MVA AA / 2.67 MVA FA, and a secondary distribution switchgear section. Installation of the secondary unit new substations shall occur within second level of the plant electrical room (mezzanine). The work also consists of demolition and removal of (4) existing secondary unit substations with MV interrupter switches, dry-type transformers, and distribution switchgear sections (CU 9A, CU 9B, CU 10A, and CU 10B), along with the demolition and removal of associated housekeeping pads.

The phasing of this installation and demolition shall be executed with efforts to minimize outages to 480V loads as described in the phasing plan. Contractor will provide temporary power to some 480V loads as noted in the design in order to minimize outages.

Contract documents indicate the Work of the contract and related requirements and conditions.

## 2. BID DOCUMENTS

Bid Documents are obtained through the City's Vendor Connection website, log on www.austintexas.gov/financeonline/vendor_connection/index.cfm. A complete set of Bid Documents, including all sections of the Project Manual and Drawings, are included in the attachments section of each solicitation.

All addenda and answers to Bidders' questions will also be posted in the attachments section for each solicitation on the City's Vendor Connection website.

## 3. SUBMISSION OF BIDS

Sealed Bids may be submitted to the Capital Contracting Office Bid Opening Desk located at One Texas Center, 505 Barton Springs Rd., Suite 1045-B, Austin, Texas 78704, or may be submitted electronically (see eResponse, Attachment 1 -Submitting Bids in Austin Finance Online).

Sealed Bid may be mailed using address below:

| **Address for US Mail (If mailed to the physical address, the proposal will be returned unopened)** | |
|---|---|
| City of Austin | |
| Capital Contracting Office | |
| P. O. Box 1088 | |
| Austin, Texas 78767-8845 | |

**NOTE: Bids must either be received and time stamped in the Capital Contracting Office prior to the Due Date and Time or submitted electronically via Austin Finance Online. The time of record for those electronically submitted is the time received in Austin Finance OnLine. It is the responsibility of the Offeror to ensure that their Bid arrives at the reception desk in the Capital Contracting Office or electronically prior to the time and date indicated. Arrival at the City's mailroom, mail terminal, or post office box will not constitute the Proposal arriving on time.**

**Public Bid Opening Update**
Due to the unprecedented event of COVID-19 and to help prevent the further spread, Capital Contracting Office will NOT be conducting an in person bid opening. Bidders must either submit their bids and compliance plans no earlier than 10:00 AM and prior to 2:00 PM on the date bids are due to One Texas Center, 505 Barton Springs Rd., Suite 1045-B, Austin, Texas 78704; or must submit Bids and Compliance Plans electronically via Austin Finance Online prior to 2:00 PM on the day proposals are due. Bids and compliance plans submitted after 2:00 PM on the date bids are due will not be accepted. The Capital Contracting Office will open both the sealed bids and bids received electronically via Austin Finance Online at 3:00 PM on the date bids are due.

Bidders may watch the bid opening online using the following Web link: CCO WEB BID OPENING CLICK HERE

Disclaimer: The result of the bid opening does not become final until all bids are verified, and the bid tab is certified. The pencil bid tab and certified bid tab will be posted in Austin Finance Online at the following link:

https://www.austintexas.gov/financeonline/account_services/solicitation/solicitations.cfm

**ALL BIDS AND COMPLIANCE PLANS ARE DUE PRIOR TO (Austin time) 2:00 PM on 8/13/2020.**
**BIDS WILL BE OPENED AT (Austin time) 3:00 PM on 8/13/2020.**

**ALL BIDS AND COMPLIANCE PLANS NOT RECEIVED PRIOR TO THE DATE AND TIME SET FORTH ABOVE WILL NOT BE ACCEPTED FOR CONSIDERATION.** The time stamp clock in SUITE 1045B is the time of record and is verified with www.time.gov, the official U.S. time. For Bids submitted electronically via Austin Finance Online, the time of record is the time received in Austin Finance Online.

## 4. VENDOR REGISTRATION AND NON-DISCRIMINATION

Prime Contractors must be registered with the OWNER prior to submitting a proposal electronically via Austin Finance Online. All CONTRACTORS must be registered to do business with OWNER prior to the Contract Award. All Subcontractors must be registered with the OWNER prior to execution of a contract. Prime Contractors are responsible for ensuring that their Subcontractors are registered as vendors with the City of Austin. Registration can be done through the OWNER's on-line Vendor Registration system. Log

onto and follow directions: https://www.austintexas.gov/financeonline/account_services/account/login.cfm

The City of Austin, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 U.S.C. §§ 2000d to 2000d-4) and the Regulations, hereby notifies all bidders that it will affirmatively ensure that any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award.

## 5. MBE/WBE PROCUREMENT PROGRAM

All City procurements are subject to the City's Minority-Owned and Women-Owned Business Enterprise Procurement Program found at Chapter 2-9-A of the City Code, as amended. The Program provides Minority-Owned and Women-Owned Business Enterprises (MBEs/WBEs) or Disadvantaged Business Enterprises (DBEs) full opportunity to participate in all City contracts. Goals for MBE/WBE or DBE participation are stated for each solicitation. Information on achieving the goals or documenting good faith efforts to achieve the goals are contained in the MBE/WBE Procurement Program Package or DBE Procurement Program Package attached to the solicitation. When goals are established, Bidders are required to complete and return the MBE/WBE or DBE Compliance Plan with their Bid. If a Compliance Plan is not submitted prior to the date and time set forth in the solicitation, the Bid will not be accepted for consideration. (See Section 00820 for MBE/WBE requirements on "no goal" solicitations.)

## 6. BID GUARANTY

All Bids shall be accompanied by an acceptable Bid guaranty in an amount of not less than five percent (5%) of the total Bid, as specified in Section 00100, Instructions to Bidders.

## 7. BONDS AND INSURANCE

Performance and payment bonds when required shall be executed on forms furnished by OWNER. Each bond shall be issued in an amount of one hundred percent (100%) of the Contract Amount by a solvent corporate surety company authorized to do business in the State of Texas, and shall meet any other requirements established by law or by OWNER pursuant to applicable law.

Minimum insurance requirements are specified in Section 00810, Supplemental General Conditions.

## 8. WAGE COMPLIANCE

Minimum wage rates have been established and are specified in Section 00830, Wage Rates and Payroll Reporting.

## 9. CONTRACT TIME

Contract Time is of the essence and all Work shall be substantially completed within **Two-Hundred Forty-Three (243) Calendar Days** after date specified in the Notice to Proceed, in accordance with the Bid Form, Section 00300. Any delays related to Covid-19 will be addressed with the award winning contractor on a case by case basis.

Final completion shall be achieved within **Thirty (30) Calendar** Days after substantial completion.

Liquidated damages are **One-Thousand Five-Hundred Dollars ($1,500) per Calendar Day** for failure to substantially complete the work and **Six-Hundred Forty Dollars ($640) per Calendar Day** for failure to achieve final completion within **Thirty (30) Calendar Days** after substantial completion, in accordance with the Bid Form, Section 00300.

## 10. OWNER'S RIGHTS

OWNER reserves the right to reject any or all Bids and to waive any minor informality in any Bid or solicitation procedure (a minor informality is one that does not affect the competitiveness of the Bid).

## 11. PRE-BID CONFERENCE

A **mandatory** Pre-Bid Conference will be held on **7/07/2020, 10:30AM** (Austin time), via webinar and teleconference. Bidders may participate in the virtual pre-bid conference by clicking this link: Click Here .

Attendance is **mandatory** unless otherwise stated. Bidders must attend any mandatory Pre-Bid Conference and are encouraged to attend any non-mandatory Pre-Bid Conference to ensure their understanding of OWNER's bidding and contracting requirements, particularly MBE/WBE or DBE Procurement Program requirements. If the Pre-Bid Conference is mandatory the **Bidder must virtually arrive and sign-in via Microsoft Forms** by either using the QR code which will be displayed on the introduction slide or by clicking on the provided link that will be posted into the live stream question and answer field. If you have trouble accessing the link or QR code please send an email to Steven.Cocke@austintexas.gov providing the following information: Your name, email address, the firm you are representing, whether you are a prime firm or subcontractor, and also indicate if your firm is a MBE/WBE or DBE. **Bidder must sign in to the meeting using one of the methods above within fifteen (15) minutes** of the scheduled start time of the meeting, otherwise the Bidder will not be allowed to submit a Bid for the project.

A **mandatory** Pre-Bid Site Visit will be held on **07/07/2020, 12:00PM** (Austin time), via webinar. Bidders may participate in the virtual pre-bid site visit by clicking this link: Click Here .

## 12. ANTI-LOBBYING AND PROCUREMENT

On June 14, 2018, the Austin City Council adopted Ordinance No. 20180614-056 replacing Chapter 2.7, Article 6 of the City Code relating to Anti-Lobbying and Procurement. The policy defined in this Code applies to Solicitations for goods and/or services requiring City Council approval under City Charter Article VII, Section 15 (Purchase Procedures). The City requires Offerors submitting Offers on this Solicitation to certify that the Offeror has not in any way directly or indirectly had communication restricted in the ordinance section 2-7-104 during the No-Lobbying Period as defined in the Ordinance. The text of the City Ordinance is posted on the Internet at:

https://assets.austintexas.gov/purchase/downloads/New_ALO_Ordinance_No_20180614-056.pdf

## 13. AUTHORIZED CONTACT PERSONS

The persons listed below may be contacted for information regarding the Invitation for Bid.

PROJECT MANAGER: James Matlock, phone 512-322-6273, email James.Matlock@austinenergy.com

CAPITAL CONTRACTING OFFICE CONTACT: Steven Cocke, phone 512-974-7998, email Steven.Cocke@austintexas.gov

SMALL & MINORITY BUSINESS RESOURCES DEPARTMENT CONTACT: Rachelle Delouis, phone 512-974-1295, email Rachelle.Delouis@austintexas.gov

**END**

SECTION 26 01 80 - ELECTRICAL TESTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Contractor shall furnish instruments, labor, wiring and incidentals to perform field tests and make necessary adjustments for **new** electrical systems and equipment. Contractor shall record all test data. This Section applies only to new equipment provided under this contract.

B. Contractor shall confirm all systems and equipment are in satisfactory working order and ready for normal service at the completion of tests.

C. Testing shall be performed according to the guidelines set forth by National Electrical Testing Association NETA-ATS, this Section, and manufacturer's or industry standard testing procedures.

D. Contractor shall perform tests by and under the supervision of fully experienced and qualified personnel. Contractor shall confirm tests and advise each respective manufacturer's representative of tests on their equipment prior to beginning tests.

E. Each section of Division 26 that has products or systems listed herein shall include this Section by reference, and therefore is incomplete without the required tests stated herein.

1.2 REFERENCE

A. ANSI/IEEE STD 141, Recommended Practice for Electric Power Distribution for Industrial Plants.

B. ANSI/IEEE STD 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems.

C. NETA ETT, Standard for Certification of Electrical Testing Personnel.

D. NETA ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

E. NFPA 70 – National Electrical Code.

F. ISO 10012-1, Quality Assurance Requirements for Measuring Equipment

## 1.3 SUBMITTALS

A. Contractor shall submit all items in accordance with the requirements of Section 01300 “Submittals” and this Section.

B. Contractor shall submit test report forms for review a minimum of 14 business days prior to requesting a final review by Owner’s Engineer.

C. Inspection, Test, and Calibration Reports

1. All inspections, tests, and calibrations shall be reported in writing on report forms approved by Owner’s Engineer. The recorded data form shall have the signatures of the persons conducting the tests, authorized witnesses, and the Owner’s Engineer.

2. Qualifications, including pertinent experience of the personnel or agency to meet federal OSHA criteria for accreditation of testing laboratories Title 29, Part 1907 or membership in the National Electrical Testing Association shall be provided by the Contractor or Manufacturer’s Representative.

3. Detailed test procedures including the blank test data sheet showing the equipment tested, date and time of testing, testing agency’s name and address, details of test done, theoretical values of test results according to the standards referenced, test values obtained, remarks and signatures of testing agency, remarks and signature of witnessing engineer, acceptance signatures, etc. shall be provided.

4. Contractor shall provide test data per Section 01400 Quality Control Services and this Section.

D. Contractor shall submit a detailed procedure for de-energizing and energizing all electrical equipment.

E. Contractor shall furnish two individually bound copies of test data, unless provided electronically. Contractor shall neatly type and arrange data and include with the data: date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken, both prior to and after any corrections are made to the system. Contractor shall record all failures and corrective action taken to remedy incorrect situation.

F. Owner’s Engineer will retain one copy. Remaining copies will be returned to Contractor for inclusion in the operation and maintenance manuals.

# PART 2 - PRODUCTS

Not used.

# PART 3 - EXECUTION

## 3.1 GENERAL

A. Contractor shall provide all functional testing as required for startup and commissioning the electrical system.

B. Contractor shall review and comply with existing site safety standards before starting tests.

C. Contractor shall provide test equipment calibrated per ISO 10012-1, Quality Assurance requirements for measuring equipment, Part-1, Methodological Confirmation Systems for Measuring Equipment.

D. Owner's Engineer reserves the right to require the Contractor to perform any test which is not indicated herein, but which is required for the safety of personnel and for safe and proper operation of the equipment.

E. The installation of the system is to be complete before acceptance testing is performed.

F. Preliminary testing is required for some system components to assure integrity before installation. The Contractor shall be responsible for providing this testing.

G. Contractor shall make the system ready for start-up commissioning after testing.

H. All tests will be performed by Contractor or Manufacturer's Qualified Representative. All tests will be witnessed by Contractor. Owner's Engineer will determine the acceptability of the test results, and reserves the right to witness test specific equipment.

I. Contractor shall test all wiring and connections for continuity, terminal designation numbers, grounds and short circuits before the fixtures, devices, and equipment are connected.

J. Contractor shall check 100% of all wiring connections for tightness. Retighten all connections, if any connections are found loose. Use the equipment manufacturer's instructions to determine bolt torque requirements. If manufacturer's instructions are not available or non-existent, use NEC 110 and UL Standards 486 as applicable.

K. Contractor and the electrical testing service company (Subcontractor) shall be jointly and fully responsible to replace any component or equipment that is damaged during the tests, at no cost to the Owner.

L. Contractor shall compare field test data to the factory test data where applicable. Any discrepancies must be recorded as such and reported immediately to the Owner's Engineer.

M. Acceptance tests shall be scheduled at least two weeks (14 calendar days) in advance of the commencement of the test and shall proceed with minimum interruption to the electrical systems.

## 3.2 MEDIUM VOLTAGE METALCLAD SWITCHGEAR

A. Inspection

1. The Owner's Engineer reserves the right to inspect the product during manufacturing and before shipment. Owner's Engineer shall have access to the facilities for inspection of work. Contractor should notify the Owner's Engineer (3) weeks prior to shipment to schedule inspection.

2. The Contractor shall keep the Owner's Engineer informed in advance of time of starting work and its progress in various stages. This does not absolve the Contractor of responsibility to notify the Owner's Engineer when the unit is ready for inspection.

B. Factory Testing

1. All testing shall be performed by trained personnel of the equipment manufacturer using the test procedures of the equipment manufacturer. Personnel shall have a minimum of three years experience in performing these tests.

2. The switchgear shall be assembled, wired, adjusted, and tested at the respective factory to ensure the accuracy of the wiring and the functioning of all equipment.

3. A certified test report of all standard production tests shall be shipped with each assembly.

4. Factory tests as outlined below shall be witnessed by the Owner's Engineer. The Contractor and Manufacturer shall notify the Owner's Engineer 3 weeks prior to the date tests are to be performed.

5. All switchgear furnished shall be designed, manufactured, and tested in accordance with the latest applicable standards of Section 261326 Medium Voltage Metalclad Switchgear and this Section and Manufacturer's commissioning instructions.

6. In case of "type (prototype) tests," certified test results may be accepted at the discretion of the Owner's Engineer.

7. As a minimum, the Manufacturer's Qualified Representative shall perform the following tests on each cubicle of the switchgear:

    a. Temperature rise test of bus bars, breakers, and contactors
    b. Dielectric test – power frequency voltage and impulse voltage withstand tests
    c. Contact resistance measurement
    d. Mechanical operation test
    e. Sequence test where applicable
    f. Determine circuit breakers minimum operating control voltage
    g. Electrical operation and all wiring tests
    h. Breaker clearance and mechanical adjustment check tests. These mechanical checks shall include contact wipe for stab points and leveling, and alignment checks of the circuit breakers in the cubicles.

Manufacturer's Qualified Representative shall adjust the breaker clearance after all other tests are completed.

i. Programming and functional tests of relays and metering devices.

j. Instrument transformer tests per referenced standards.

C. Field Testing

1. Check level of switchgear after it has been fully assembled and installed at chiller plant site. Switchgear shall be level within the Manufacturer's tolerances.

2. Tighten all fasteners which join together sections of the switchgear to the Manufacturer's specifications.

3. Inspect assembly work for correct fit, finish, alignment, and function. Include all equipment doors, access openings, catches, and locks.

4. Verify that all circuits into and out of the switchgear, whether power, controls, or grounding, are terminated at the correct location in the switchgear. Verify the tightness of the terminations and connections. Retighten or replace any terminations found to be loose. Use Manufacturer's instructions to determine torque requirements.

5. Verify circuit breaker size and type per the drawings.

6. Verify correct operation, function, and readout of metering devices and displays.

7. Verify protective relay settings are adjusted to values indicated by Engineer.

8. As a minimum, the Manufacturer shall perform the following tests on each cubicle of the switchgear per Manufacturer's instructions.

   a. Check bus work for continuity, proper phasing, and clearances

   b. Check all bolted bus connections for proper bolt torque and installation of removable insulating boots.

   c. Measure the resistance of the circuit breaker contacts and the bus work.

   d. Check and adjust the auxiliary switches of the breakers

9. Check all electrical connections per the one-line diagrams and other drawings, specifications, and standards, and Manufacturer's commissioning instructions.

10. Check for proper grounding per the contract documents, the National Electrical Code, and the Manufacturer's recommendations.

11. Submit the data determined in the tests.

D. Other Equipment

1. Test transformers that are integral to unit substations. Refer to unit substation specification.

2. Test all existing medium voltage circuit breakers affected by the new work or that have new cable connections.

## 3.3 LOW VOLTAGE SWITCHGEAR

A. Inspection

1. The Owner's Engineer reserves the right to inspect the product during manufacturing and before shipment. Owner's Engineer shall have access to the facilities for inspection of work.

2. The Vendor shall keep the Owner's Engineer informed in advance of time of starting work and its progress in various stages. This does not absolve the Vendor of responsibility to notify the Owner's Engineer when the unit is ready for inspection. The Vendor shall notify Owner's Engineer (3) weeks prior to testing to schedule a witness.

B. Testing

1. The switchgear line-up shall be completely assembled and factory sealed.

2. All switchgear furnished shall be designed, manufactured, and tested in accordance with the latest applicable standards of Section 262300 Low Voltage Switchgear.

3. In case of "type (prototype) tests," certified test results may be accepted at the discretion of the Owner.

4. As a minimum, the Vendor shall perform the following tests on each cubicle of the switchgear:

   a. Vendor standard factory-based electrical and mechanical equipment tests and inspections.

## 3.4 POWER AND CONTROL WIRE AND CABLE – 600V

A. Perform a preliminary test on wire and cable before it is removed from the shipping reel. Whenever the insulation resistance of any wire or cable is determined to be less than the value calculated per 50 meg-ohms, determine the cause and remove any damaged wire or cable.

1. Use a 1000 $V_{DC}$ megger for testing the wire and cable.

B. Test wire and cable as follows:

1. Perform an insulation resistance and continuity test on each conductor after the wire and/or cable is installed and before the final terminations is completed.

2. Perform tests to assure the continuity of each conductor/circuit. Continuity can be established with zero megohms when tested with a megger, calculated DC resistance based upon the length of the conductor when tested with an ohm-meter or audible sound when tested with a continuity tester.

C. Submit the data determined in the wire and cable insulation resistance tests.

## 3.5 GROUNDING SYSTEMS

A. Perform a continuity test as specified in Section 260526 – Grounding and Bonding for Electrical Systems, to verify that all cables and connections have a low-resistance.

B. Submit the data determined in the grounding system tests.

## 3.6 PANELBOARDS

A. Make an overall inspection of the panelboard with particular attention to the following:

1. Conductor identification and tightness of connections.
2. Conduit installation and grounding of conduit and panelboard.
3. Verify circuit breaker size and type as per the drawings.

B. Perform an insulation resistance test on the panel, testing each bus bar phase to ground and phase to phase.

1. For 600 Volts and lower, use a 1000 $V_{DC}$ megger on each bus to determine the insulation resistance. The minimum acceptable insulation resistance is 50 megohms.
2. Correct any low insulation resistance problems.

C. Submit the data determined in the panelboard tests.

## 3.7 LOW VOLTAGE CIRCUIT BREAKERS

A. Tighten all fasteners which join together switchgear enclosure doors to the manufacturer's specification.

B. Inspect all assembly work for correct fit, finish, alignment and function. Include all equipment doors, access openings, catches and locks.

C. Verify that all circuits into and out of the switchgear section, whether power, control or grounding, are terminated at the correct location in the switchgear. Verify the tightness of the terminations and connections. Retighten or replace any found to be loose. Use equipment manufacturer's instructions to determine fastener torque requirements.

D. Verify circuit breaker size and type by the drawings.

E. Verify correct operation, function and readout of metering devices and displays.

F. Tests:

1. All circuit breakers installed shall be tested in accordance with the latest applicable standards of NETA, IEEE, and per the manufacturer's testing and commissioning instructions.

2. Provide factory testing and reports for batteries, charger, and best battery selectors.

3. All testing shall be performed by trained personnel of the equipment manufacturer using the test procedures of the equipment manufacturer. Personnel shall have a minimum of three years experience in performing these tests.

4. As a minimum, the Contractor shall perform the following tests on each cubicle of the switchgear, and per manufacturer's commissioning instructions.

   a. Check bus work for continuity, and proper phasing and clearances.

   b. Check all bolted bus connections for proper bolt torque and installation of removable insulating boots.

   c. Measure the resistance of the circuit breaker contacts and the bus work.

   d. Check and adjust the auxiliary switches of the breaker.

G. Check all electrical connections per one-line diagrams and other drawings, specifications and standards, and the manufacturer's commissioning instructions.

H. Check for proper grounding per the contract documents, the National Electrical Code and the manufacturer's recommendations.

I. Submit the data determined in the tests.

END OF SECTION

SECTION 26 05 72 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices. The study shall include incoming medium voltage power feeders to new unit substations. It shall extend downstream from the new unit substations to include all existing loads to be re-fed from unit substations and end at the first downstream 120/208Vac distribution panel, or lowest downstream 480Vac load if no 120/208Vac panel exists, as provided in the existing SKM model, and is indicated in contract documents. Owner will provide existing SKM model to successful bidder.

1.3 DEFINITIONS

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

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

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

D. SCCR: Short-circuit current rating.

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

1.4 ACTION SUBMITTALS

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

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

1. Short-circuit study input data, including completed computer program input data sheets.

2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

   a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
   b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Short-Circuit Study Software Developer, Short-Circuit Study Specialist, and Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

## 1.6 QUALITY ASSURANCE

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

B. Short-Circuit 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. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE

A. Available Manufacturers: Computer software analysis to be incorporated into the Work shall include one of the following:

1. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551.

C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

### 2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

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

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Comments and recommendations for system improvements, where needed.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
5. 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.

F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.

G. Short-Circuit Study Output:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

   a. Voltage.
   b. Calculated fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. Equivalent impedance.

2. Momentary 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. Calculated asymmetrical fault currents:

      1) Based on fault-point X/R ratio.
      2) Based on calculated symmetrical value multiplied by 1.6.
      3) Based on calculated symmetrical value multiplied by 2.7.

3. 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.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.

1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified

technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

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

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

## 3.2 SHORT-CIRCUIT 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. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the main incoming service, extending down to the system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. To emergency system low-voltage load buses where fault current is 10 kA or less

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

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

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

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:

1. Electric utility's supply termination point.
2. Incoming medium voltage switchgear.
3. Double-ended unit substation primary and secondary terminals.
4. Low-voltage switchgear.
5. Switchboards.
6. Motor-control centers.
7. Enclosed busways.
8. Control panels.
9. Standby generators and automatic transfer switches.
10. Distribution panelboards
11. Branch circuit panelboards.
12. Lighting relay panels.
13. Disconnect switches.

## 3.3 ADJUSTING

A. Make modifications to equipment as required to accomplish compliance with short-circuit study.

## 3.4 MODEL

A. Provide a functioning model in SKM format to the owner upon completion. Verify and match owner’s SKM version.

B. Model shall include all libraries that match components used in the model.

## 3.5 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes computer-based, Overcurrent Protective Device Coordination Study and Emergency Power System Selective Coordination Study to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping. The study shall include incoming medium voltage power feeders to new unit substations. It shall extend downstream from the new unit substations to include all existing loads to be re-fed from unit substations and end at the first downstream 120/208Vac distribution panel, or lowest downstream 480Vac load if no 120/208Vac panel exists, as provided in the existing SKM model, and is indicated in contract documents. Owner will provide existing SKM model to successful bidder.

1. Study results shall be used to determine coordination of fully-rated overcurrent protective devices.
2. Study results shall be used to determine selective coordination of the emergency power systems per NFPA 70 – National Electrical Code.

1.3 DEFINITIONS

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

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

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

D. SCCR: Short-circuit current rating.

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

1.4 ACTION SUBMITTALS

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

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

1. Coordination-study and emergency power system selective coordination study input data, including completed computer program input data sheets.
2. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Coordination Study Software Developer, Coordination Study Specialist, and Field Adjusting Agency.

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

## 1.6 CLOSEOUT SUBMITTALS

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

1. Include the following:

a. The following parts from the Protective Device Coordination Study and Emergency Power Selective Coordination Study Reports:

1) One-line diagrams.
2) Protective device coordination studies.
3) Time-current coordination curves.

b. Power system data.

## 1.7 QUALITY ASSURANCE

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

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

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

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

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE

A. Available Manufacturers: Computer software analysis to be incorporated into the Work shall include one of the following:

1. SKM Systems Analysis, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. 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.

D. 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. Additional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

### 2.2 PROTECTIVE DEVICE COORDINATION STUDY AND EMERGENCY POWER SYSTEM SELECTIVE COORDINATION REPORT CONTENTS

A. Executive summary.

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

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable sizes and lengths.
3. Transformers kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboards, motor-control centers, busways, distribution panelboards and branch circuit panelboard designations.

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

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

F. Protective Device Coordination Study:

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

a. Phase and Ground Relays:

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

b. Circuit Breakers:

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

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

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

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

    a. Power utility's overcurrent protective device.
    b. Medium-voltage equipment overcurrent relays.
    c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    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, distribution panelboard and branch circuit panelboard.
5. Provide adequate time margins between device characteristics such that selective operation is achieved.
6. Comments and recommendations for system improvements.

H. Emergency Power System Selective Coordination Study: The Study shall also include the following:

1. Confirmation of selective coordination of all overcurrent devices associated with supplying utility and generator/UPS to emergency loads in accordance with all applicable requirements of NEC Article 100 and Paragraphs 700.27 and 701.18. Study shall be based on coordination to 0.01 seconds. Study shall be based on the actual electrical equipment and overcurrent protective devices being submitted for the project.
2. Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.
3. Circuit breakers shall indicate manufacturer and type and have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current.
4. Fuses shall have fuse manufacturer and type indicated. Fuse curves shall be identified as either total clearing time or damage time as applicable.
5. High voltage relays shall indicate manufacturer and type and have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.45 second time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.
6. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.
7. Confirmation that the proposed overcurrent protection devices, set or selected as recommended, will provide the specified selective coordination. Should the overcurrent

devices proposed for the project not be capable of providing the specified selective coordination, the report shall include recommendations for overcurrent protective device changes required to provide the specified coordination and calculations, plots, recommended settings as specified herein for the recommended overcurrent device changes to provide the specified selective coordination.

8. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine project Overcurrent Protective Device and Emergency Power System Selective Coordination submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated in the Drawings.

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

### 3.2 PROTECTIVE DEVICE COORDINATION STUDY AND EMERGENCY POWER SYSTEM SELECTIVE COORDINATION STUDY

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

B. Comply with IEEE 399 for general study procedures.

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

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

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

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. To emergency system low-voltage load buses where fault current is 10 kA or less.

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

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

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

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

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

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

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

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

1. Electric utility's supply termination point.
2. Incoming medium voltage switchgear.
3. Double-ended unit substation primary and secondary terminals.
4. Low-voltage switchgear.
5. Switchboards.
6. Motor-control centers.
7. Enclosed busways.
8. Control panels.
9. Standby generators and automatic transfer switches (ATS).
10. Distribution panelboards.
11. Branch circuit panelboards.
12. Lighting relay panels.
13. Disconnect switches.
14. Emergency switchboards.
15. Emergency distribution panelboards.
16. Emergency branch circuit panelboards.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, switchboards, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

## 3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

## 3.4 MOTOR-STARTING STUDY

A. Perform a motor-starting study to analyze the transient effect of the system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.

B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141 and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

## 3.5 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the overcurrent protective device study and emergency power system selective coordination study.

1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

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

who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

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

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes RMS symmetrical.

## 3.6 FIELD ADJUSTING

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

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

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

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

## 3.7 MODEL

A. Provide a functioning model in SKM format to the owner upon completion. Verify and match owner’s SKM version.

B. Model shall include all libraries that match components used in the model.

## 3.8 DEMONSTRATION

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

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

END OF SECTION

SECTION 26 05 74 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near all electrical equipment. The study shall include incoming medium voltage power feeders to new unit substations. It shall extend downstream from the new unit substations to include all existing loads to be re-fed from unit substations and end at the first downstream 120/208Vac distribution panel, or lowest downstream 480Vac load if no 120/208Vac panel exists, as provided in the existing SKM model, and is indicated in contract documents. Owner will provide existing SKM model to successful bidder.

1.3 DEFINITIONS

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

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

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

D. SCCR: Short-circuit current rating.

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

1.4 ACTION SUBMITTALS

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

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

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

a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Software Developer, Arc-Flash Study Specialist, and Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584-2018 and NFPA 70E.

## 1.6 CLOSEOUT SUBMITTALS

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

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

## 1.7 QUALITY ASSURANCE

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

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

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

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

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Manufacturers: Computer software analysis to be incorporated into the Work shall include one of the following:

1. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584-2018 and NFPA 70E.

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

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagrams, 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, switchboards, motor-control centers and panelboard designations.

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

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

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

G. Arc-Flash Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.

f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

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.

## 2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "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. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

## 3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

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

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

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

E. Include all medium-voltage and low-voltage equipment locations – Normal and Emergency Power Systems.

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 1584-2018, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

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

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584-2018 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

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

## 3.4 LABELING

A. Apply one arc-flash label for 12,470-Volt AC, 600-Volt AC, 480-Volt AC, and 208-Volt AC electrical equipment on each of the following:

1. Medium-voltage Switchgear.
2. Double-ended unit substations.
3. Low-voltage Switchgear.
4. Low-voltage Switchboard.
5. Enclosed Busways.
6. Motor Control Centers.
7. Distribution Panelboards.
8. Branch Circuit Panelboards.
9. Lighting Relay Panels.
10. Disconnect Switches.
11. Automatic Transfer Switches.
12. Control Panels.

## 3.5 APPLICATION OF WARNING LABELS

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

## 3.6 MODEL

A. Provide a functioning model in SKM format to the owner upon completion. Verify and match owner’s SKM version.

B. Model shall include all libraries that match components used in the model.

## 3.7 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

SECTION 26 23 00 - LOW-VOLTAGE SWITCHGEAR

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. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.

B. Related Sections include the following:

1. Section 260526 Grounding and Bonding for Electrical Systems

2. Section 260180 Electrical Testing

3. Section 261116 Secondary Unit Substations with Switchgear Secondary

1.3 DEFINITIONS

A. ATS: Acceptance Testing Service.

B. GFCI: Ground-fault circuit interrupter.

1.4 ACTION SUBMITTALS

A. Provide all submittals for fully assembled unit substation transformer closed-coupled to low voltage switchgear.

B. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Engineering Power Studies must be submitted and approved by EOR prior to final approval of the switchgear shop drawings and prior to any release of equipment for manufacture.

C. Shop Drawings: For each type of switchgear and related equipment.

1. Dimensioned plans, elevations, sections, three-line diagram, and details, including required clearances and service space around equipment. Include the following:

a. Tabulation of installed devices with features and ratings.

b. Enclosure types and details.
c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
e. Current rating of buses.
f. Short-time and short-circuit current rating of switchgear assembly.
g. Nameplate legends.
h. Mimic-bus diagram.
i. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
j. Three-line diagram to include field connection points.

2. Wiring Diagrams: Power, signal, metering, and control wiring.

D. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Manufacturer Seismic Qualification Certification: For switchgear, overcurrent protective devices, accessories, and components:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Qualification Data: For testing agency.

D. Field quality-control test reports.

E. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 260152 "Operation and Maintenance Manuals," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

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: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
   2. Indicating Lights: Six of each type installed.
   3. Touchup Paint: Three containers of paint matching enclosure finish, each 0.5 pint.

## 1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent third-party agency which can function as an unbiased testing authority professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated. An organization having a designation of InterNational Electrical Testing Association (NETA) accredited Engineering and Testing Firm (Testing Firm) meets the previous criteria. Prior to bidding, the name of the proposed testing organization shall be submitted to EOR for approval.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated.

D. 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.

E. Comply with NFPA 70.

F. The switchgear shall bear a UL 1558 label.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

## 1.10 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for unit substation transformer, transition sections, and low voltage switchgear, including clearances between equipment, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
   1. Overall unit substation transformer, medium voltage switch sections, and low voltage switchgear: Not to exceed 38 feet, 6 inches
   2. Overall equipment depth: Not to exceed 6 feet, 2 inches

C. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: Not exceeding 40 deg C.
   2. Altitude: Not exceeding 3300 feet.

## 1.11 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cutler-Hammer, Inc.; Eaton Corporation.
   2. Square D; Schneider Electric.

## 2.2 RATINGS

A. Refer to drawings for equipment ratings.

## 2.3 FABRICATION

A. Factory assembled and tested and complying with IEEE C37.20.1/UL1558.

B. Indoor Enclosure Material: Steel.

C. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

D. Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment. Construct barrier to prevent arc event from traveling through the rear of the lineup (not arc resistant).

E. Provide a glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus. Construct barrier to prevent arc event from traveling through the rear of the lineup (not arc resistant).

F. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.

G. Circuit-breaker compartments shall be equipped to house drawout type circuit breakers and shall be fitted with hinged outer doors.

H. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear. Doors shall have hasp for padlock.

I. Label front and rear sections to match.

J. Provide in the cell when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protects against incidental contact.

K. Auxiliary Cubicles: All auxiliary cubicles shall be front accessible and isolated from main bus. Include the following:
   1. SPD cubicle(s). Separate SPD required on each side of any double-ended switchgear.

L. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
   1. Bus transition sections.
   2. Incoming-line pull sections.
   3. Hinged front panels for access to metering, accessory, and blank compartments.
   4. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.

      a. Set pull box back from front to clear circuit-breaker lifting mechanism.
      b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
      c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

M. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.

1. Main Phase Bus: Uniform capacity the entire length of assembly.
2. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector (compression) terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
4. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
5. Use copper for connecting circuit-breaker line to copper bus.
6. Contact Surfaces of Buses: Silver plated.
7. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
8. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector (compression) for feeder and branch-circuit ground conductors, minimum bus size 1/4 by 2 inches.
9. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
10. Neutral bus equipped with pressure-connector (compression) terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
11. Neutral Disconnect Link: Bolted, uninsulated, minimum 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
12. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
13. Bus-Bar Insulation: Individual bus bars coated with factory-applied flame-retardant insulation.
    a. Insulation Thickness: 5mils, minimum.
    b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

## 2.4 COMPONENTS

A. Metering Cubicle:
1. Compartment shall include CT's on a shorting block and voltage connection brought to an insulated (finger safe) fuse block with disconnect (install voltage connection ahead of the main).

B. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
    a. Provide a quantity of (3) THREE per meter.
2. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.

C. Surge Protective Devices (SPD): Distribution class, metal-oxide-varistor type. Comply with ANSI/IEEE C62.42.1-2002, C62.41.2-2002, C62.45-2002, NEMA LS-1 and NEC Article 285 and be UL listed under UL 1449 and UL 1283.
   1. Install in cable termination compartments and connect in each phase of circuit.
   2. Coordinate rating with circuit voltage.
   3. Coordinate minimum surge rating current capability with Engineering Services and other downstream devices.
   4. SPD shall include visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
   5. SPD shall be installed in accordance with the manufacturer's installation manual using recommended breaker and wire sizes.

D. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections. Breaker compartments for future use as indicated as "spare" on the drawings, shall be fully equipped with draw-out assemblies, current carrying parts, wiring, and other accessories.

E. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:
   1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
   2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
      a. Secondary windings connected through a relay or relays to control bus to affect an automatic transfer scheme.

   3. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.

F. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
   1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   2. Conductors sized according to NFPA 70 for duty required.
   3. All control wire shall be type SIS. Control wiring shall be 14 AWG for control circuits and 12 AWG for current transformer circuits. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of pre-punched wire lances or nylon non-adhesive anchors. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips and provisions for #10 AWG field connections. Each control wire shall be marked to the origin zone/wire name/destination zone over the entire length of the wire using a cured ink process. Provide wire markers at each end of all control wiring. Plug-in terminal blocks shall be provided for all shipping split wires. Terminal connections to remote devices or sources shall be front accessible via doors above each circuit breaker.

G. Provide internal space heater(s) within the switchgear enclosure. These shall be powered by internal CPT's.

H. Control Power Supply: Control power transformer (CPT) supplying 120-V control circuits through secondary disconnect devices and accessories. Dual CPT's shall be provided with Automatic Throw-over Scheme.

## 2.5 CIRCUIT BREAKERS

A. Description: Comply with IEEE C37.13 and UL 1066.

B. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   1. Normal Closing Speed: Independent of both control and operator.
   2. Slow Closing Speed: Optional with operator for inspection and adjustment.
   3. Stored-Energy Mechanism: Electrically charged, with optional manual charging].
   4. Electrically operated breakers shall be complete with 125 VDC motor operators. The charging time of the motor shall not exceed 6 seconds.
   5. Operation counter.

D. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

   1. Trip unit shall be Eaton Digitrip RMS 1150 or pre-approved equal.
   2. The trip unit shall include a display panel, containing a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.
   3. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
      a. All circuit breakers shall have adjustments for long delay pickup and time
      b. All circuit breakers shall have individual adjustments for short delay pickup and time, and include I2t settings
      c. All circuit breakers shall have an adjustable instantaneous pickup
      d. All circuit breakers shall have individually adjustable ground fault current pickup and time, and include I2t settings or ground alarm only
   4. The trip unit shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be +/- 2% of full scale.
   5. The trip unit shall be equipped to permit communication via a network twisted pair for remote monitoring and control.
   6. The display for the trip units shall be a 24-character LED display.
   7. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.
   8. The unit shall be capable of monitoring the following data:
      a. Instantaneous value of phase, neutral and ground current
      b. Instantaneous value of line-to-line voltage

c. Minimum and maximum current values
d. Watts, vars, VA, watthours, varhours and VA hours

9. The energy-monitoring parameter values (peak demand, present demand, and energy consumption) shall be indicated in the trip unit's alphanumeric display panel.
10. The trip unit shall display the following power quality values: crest factor, power factor, percent total harmonic distortion, and harmonic values of all phases through the 31st harmonic.
11. An adjustable high load alarm shall be provided, adjustable from 50 to 100% of the long delay pickup setting.
12. The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.
13. Programming may be done via a keypad at the faceplate of the unit or via the communication network.
14. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short-time pickup adjustment shall be dependent on the long delay setting.
    a. Programmable long-time setting
    b. Programmable long-time delay with selectable I2t or I4t curve shaping
    c. Programmable short-time setting
    d. Programmable short-time delay with selectable flat or I2t curve shaping, and zone selective interlocking
    e. Programmable instantaneous setting
    f. Programmable ground fault setting trip or ground fault setting alarm
    g. Programmable ground fault delay with selectable flat or I2t curve shaping and zone selective interlocking
15. The trip unit shall have the following advanced features integral to the trip unit:
    a. Adjustable under-voltage release
    b. Adjustable overvoltage release
    c. Reverse load and fault current
    d. Reverse sequence voltage alarm
    e. Under-frequency
    f. Over-frequency
    g. Voltage phase unbalance and phase loss during current detection
16. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
17. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
18. Field-adjustable, time-current characteristics.
19. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
20. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable $I^2t$ operation.
21. Pickup Points: Five minimum, for instantaneous-trip functions.
22. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
    a. Three-wire circuit or system.
    b. Four-wire circuit or system.

c. Four-wire, double-ended substation.

23. Trip Indication: Labeled, battery-powered LED lights or mechanical targets on trip device to indicate type of fault. A reset button shall be provided to turn off the LED indication after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status.

E. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

F. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:

1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
   a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
   b. Disconnected Position: Primary and secondary devices and ground contact disengaged.

G. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover from the arc chutes to ground.

H. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

I. Operating Handle: One for each circuit breaker capable of manual operation.

J. Electric Close Button: One for each electrically operated circuit breaker.

K. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

L. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.

M. Shunt-Trip Devices: Where indicated.

N. Fused Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:

1. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
2. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.
3. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.
4. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.

O. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

P. Zone Selective Interlocking on all circuit breakers.

Q. Provisions to mount remote racking operator to cell.

R. Communication shall be Ethernet / IP.

S. All circuit breakers shall be electrically operated and contain all components required for remote monitoring, opening, and closing via owner's BoP PLC network.

T. All circuit breaker lugs shall be compression type and capable of accepting 600kCMIL conductors.

U. Dashboard Interface: Electrical Sub-contractor is responsible for providing a complete and functional dashboard interface system. Manufacturer shall provide a single dashboard interface that connects all meters, trip units, relays, breakers, and diagnostic sensors within the switchgear. The dashboard shall have a single point of connection for the owner's network to access. Once accessed, the dashboard shall display all information in a user-friendly format that allows the user to monitor, collect, diagnose, and control the switchgear system.

V. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage. These values shall be set according to the device coordination study. Time delay shall be set and coordinated with Medium Voltage Switchgear that employs an automatic throw-over scheme. Coordinate with Owner's Facility Personnel.

## 2.6 MAIN – TIE – MAIN

A. Provide kirk-key interlocks for Main-Tie-Main Circuit Breakers. Externally mounted to prohibit circuit-breaker operation. Key shall be removable only when circuit breaker is in the "off" position.

## 2.7 ACCESSORIES

A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
   1. Racking handle to manually move circuit breaker between connected and disconnected positions.
   2. Portable full function test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. Circuit-Breaker Removal Apparatus [one for each switchgear lineup]: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments. Unit shall be a hydraulic foot-pump platform lift, Beech Engineering (Division of Miller Products Inc.) Model PS-2460, or approved equal by Genie, Vestil, or Wesco. 72" overall height, rated load of 1000lbs., minimum lift height of 60", and platform measuring a minimum of 20"X20".

C. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

D. Storage Cabinet: Floor-mount with padlock and hasp, for storing equipment and breakers. Unit shall be 60”H x 24”D x 36”W, capable of 900lb/shelf built by Durham, Lyon, Stronghold, or approved equal.

E. Padlocks: Provide Best #11B772-L, with core #1C7F1-626, in quantity as follows:
   1. One (1) for each rear hinged section
   2. One (1) for each draw-out breaker cubicle and cubicle space
   3. One (1) for each storage cabinet
   4. Two (2) spare, place in storage cabinet.

F. IR Viewports: Provide UL recognized infrared (IR) viewports (windows) to permit infrared thermographic scanning without the need to expose personnel to energized equipment. Provide sufficient quantity of IR viewports to scan each circuit breaker, and all cable terminations. Viewports shall pass flammability and impact resistance requirements of UL 508A, UL 746C and ANSI C37.20.2 and shall be arc flash rated. IR viewports shall be Fluke CLV or approved equal.

G. Breaker Remote Racking Device: Switchgear manufacturer shall provide one (1) portable breaker remote racking device per lineup. Device shall mount to the face of the gear at any breaker location and allow the operator to stand up to 30 feet from the equipment as breaker is engaged or disengaged.

## 2.8 MIMIC BUS

A. Mimic Bus: Provide switchgear with continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
2. Medium: Engraved phenolic graphics.
3. Color: Red and contrasting with factory-finish background.

B. System Power One-Line Diagram(s): Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
1. Frame size of each circuit breaker.
2. Trip rating for each circuit breaker.
3. Plug rating for each circuit breaker.
4. Conduit and wire size for each feeder.

## PART 3 - EXECUTION

### 3.1 COORDINATION

A. Contractor shall furnish and install housekeeping pad in accordance with structural drawings and Manufacturer's equipment submittal. Contractor shall verify location of bottom feeders with Manufacturer's equipment submittal prior to core drilling.

### 3.2 FACTORY TESTING

A. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.

B. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.

C. A certified test report of all standard production tests shall be shipped with each assembly.

D. Factory test as outlined above shall be witnessed by the Owner's Representative.
1. The manufacturer shall notify the Owner's Engineer three (3) weeks prior to the date the tests are to be performed
2. The manufacturer shall include the cost of transportation and lodging for up to three (3) Owner's Representatives. The cost of meals and incidental expenses shall be the Owner's responsibility
3. Provide cost as a line item to the bid in case the trip is canceled or declined.

### 3.3 EXAMINATION

A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.4 INSTALLATION

A. Comply with applicable portions of NECA 400.

B. Anchor switchgear assembly to 4-inch, channel-iron floor sill embedded in concrete base and attach by bolting.
   1. Sills: Select to suit switchgear; level and grout flush into concrete base.
   2. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
   3. Verify pad location is level to within 0.125 inches per three feet of distance in any direction.
   4. Leveling Rails: Consult with Engineering Services if leveling rails will be required.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

## 3.5 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

B. Provide engraved nameplate on each upright section, matching for both front and rear, as well as on each cubicle door.

C. Diagram and Instructions:

   1. Aluminum frame and mount under clear acrylic plastic in location as noted on the drawings. Size shall be minimum of 30” x 42”.
      a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
      b. System Power Single-Line Diagram(s): Provide 30”x42”, laminated copy of the single-line diagram(s) adjacent to the switchgear. Mount in aluminum frame under plexi-glass.

   2. Storage for Maintenance: Place a copy of maintenance manual in the storage cabinet required per 2.7 Accessories.

## 3.6 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems" and per details on the drawings.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Contractor shall confirm in writing that all bus bars are torqued to the manufacturer's recommendations.

## 3.7 FIELD QUALITY CONTROL

A. Refer to Electrical Acceptance Testing section for additional requirements.

B. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect switchgear installation, including wiring, components, connections, and equipment.
   2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in electrical Sections.
   3. Complete installation and startup checks according to manufacturer's written instructions.
   4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
   5. Report results in writing.

D. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

E. Perform the following field tests and inspections and prepare test reports:

   1. Perform each visual and mechanical inspection and electrical test stated in current NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
      a. Switchgear.
      b. Circuit breakers.
      c. Protective relays.
      d. Instrument transformers.
      e. Metering and instrumentation.
      f. Ground-fault systems.
      g. Battery systems.
      h. Surge Protective Devices.
      i. Capacitors.
   2. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion or at a mutually agreed upon date prior to bond expiration.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

## 3.8 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to results in Section 260573 " FAULT & COORDINATION STUDY & ARC FLASH HAZARD ANALYSIS."

## 3.9 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. 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.

## 3.10 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturers stipulated service conditions.

## 3.11 TRAINING

A. The Manufacturer shall provide a training session for up to five (5) of the Owner’s Representatives for one (1) normal workday for at least six (6) hours at the Owner’ site, or other location determined by the Owner.

B. The training session shall be conducted by the Manufacturer. The training program shall consist of the instruction of the operation of the assembly, circuit breakers, racking devices, relays, test switches, and major components within the assembly.

END OF SECTION

## NOTES

A. DRAWINGS INDICATE APPROXIMATE QUANTITY AND ORIENTATION OF TRANSFORMERS, TIE BUSES, EQUIPMENT PADS, ETC. TO BE REMOVED. THE ELECTRICAL CONTRACTOR SHALL VERIFY LOCATION AND QUANTITY OF ITEMS TO BE REMOVED. NO ALLOWANCE WILL BE MADE BECAUSE OF THE ELECTRICAL CONTRACTOR'S UNFAMILIARITY WITH THESE DETAILS. REFER TO E100 FOR MORE DETAIL.

B. CONTRACTOR SHALL PROVIDE A SALVAGE VALUE FOR ALL EQUIPMENT SCHEDULED FOR DEMOLITION. ALL SALVAGE SHALL REMAIN THE PROPERTY OF THE OWNER UNLESS INDICATED OTHERWISE. ANY SALVAGE NOT DESIRED BY THE OWNER SHALL BECOME THE PROPERTY OF THE CONTRACTOR AND SHALL BE REMOVED FROM THE PREMISES.

C. CONTRACTOR SHALL COORDINATE WITH HVAC TO REMOVE MECHANICAL DUCTWORK THAT INTERFERES WITH THE INSTALLATION OF NEW SWITCHGEAR. IF REMOVED, MECHANICAL DUCTWORK SHALL BE REPLACED IN A MANNER THAT IS ACCEPTABLE TO THE OWNER AND DOES NOT INTERFERE WITH NEW ELECTRICAL EQUIPMENT.

D. EQUIPMENT AND CIRCUITRY REPRESENTED WITH THIN DASHED LINES ARE EXISTING TO BE REMOVED. CIRCUITRY REPRESENTED WITH SOLID LINES ARE EXISTING TO REMAIN. EQUIPMENT REPRESENTED WITH HEAVY DASHED LINES ARE EXISTING TO REMAIN.

E. PRIOR TO THE REMOVAL OF ANY EQUIPMENT SCHEDULED FOR DEMOLITION, CONTRACTOR SHALL CONSULT WITH AUSTIN ENERGY TO DETERMINE PATH OF EGRESS FOR ASSOCIATED CIRCUITRY AND CONDUIT. ASSOCIATED CIRCUITRY IS DEFINED AS ALL WIRE, CONDUIT, J-BOXES, DEVICE BOXES, WIRING DEVICES, COVER PLATES, ETC. ASSOCIATED WITH THE ITEM SCHEDULED FOR REMOVAL.

F. CONDUIT FOR ITEMS SCHEDULED FOR REMOVAL AND IN ACCESSIBLE AREAS SHALL BE EMPTIED AND SEALED OR OTHERWISE TERMINATED IN A SAFE MANNER ACCEPTABLE TO THE OWNER.

G. ELECTRICAL CIRCUITS WITH A PORTION OF THE LOAD REMOVED SHALL HAVE THE REMOVED LOAD'S ASSOCIATED CIRCUITRY TERMINATED IN SUCH A MANNER THAT THE REMAINING LOAD REMAINS ACTIVE AND IN FIRST CLASS OPERATING CONDITION.

H. THE ELECTRICAL SUBCONTRACTOR SHALL CONSULT THE SPECIFICATIONS FOR FURTHER INFORMATION.

I. HOLES AND DAMAGED AREAS CAUSED BY REMOVAL OF ANY OF THE ABOVE ITEMS SHALL BE REPAIRED TO MATCH EXISTING SURFACES. IN ADDITION, OPENINGS CREATED BY THE REMOVAL OF THESE ITEMS THROUGH FIRE RESISTANCE RATED WALLS SHALL BE FIRESTOPPED.

J. WHERE CONDUIT AND CONDUCTORS ARE INDICATED TO BE REMOVED, CONDUIT SHALL BE REMOVED TO POINT OF CONCEALMENT AND WIRING REMOVED ENTIRELY.

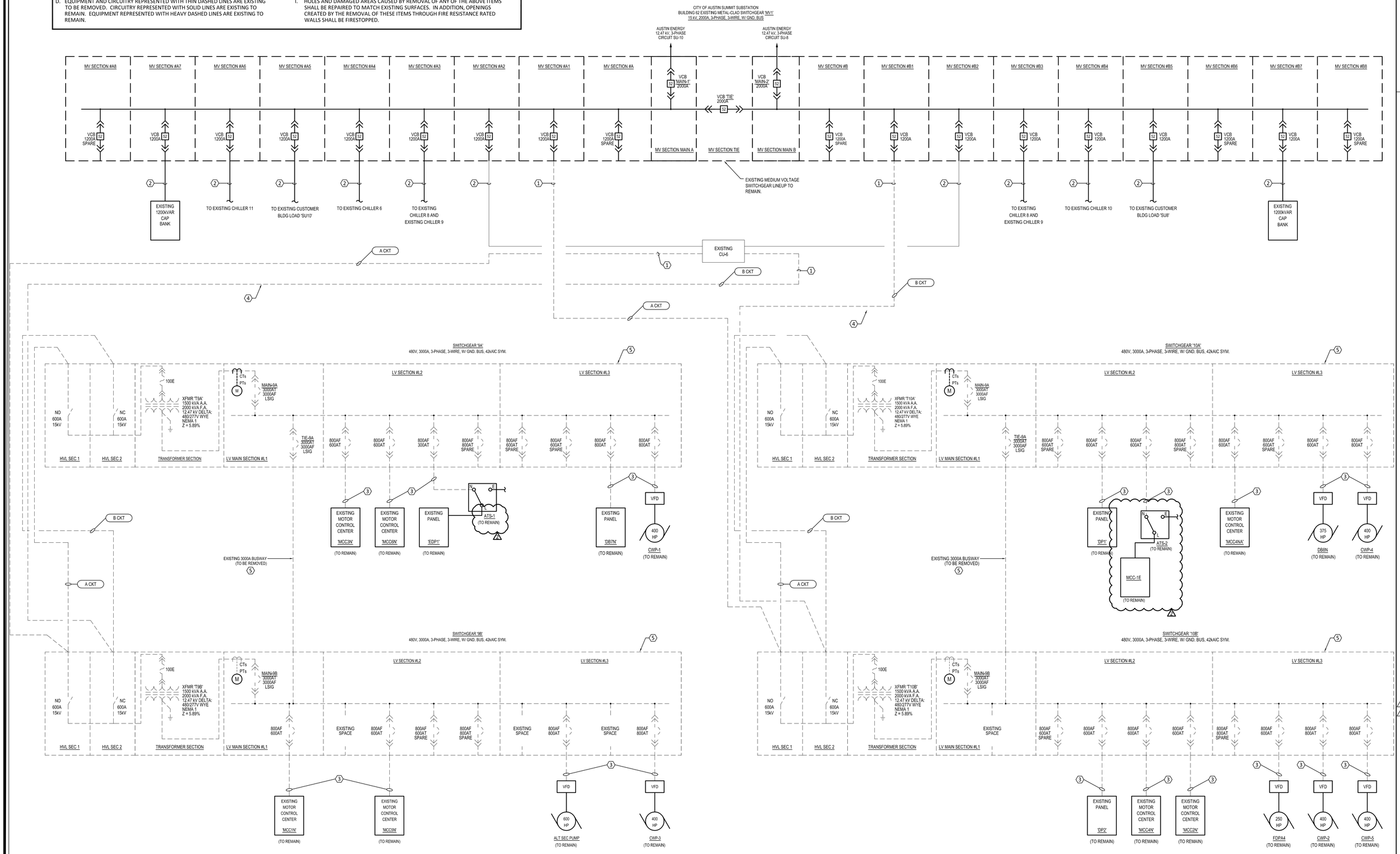
K. ALL UNUSED OPENINGS IN BOXES, EQUIPMENT PADS, RACEWAYS, AUXILIARY GUTTERS, CABINETS, EQUIPMENT CASES AND HOUSINGS SHALL BE CLOSED TO AFFORD PROTECTION SUBSTANTIALLY EQUIVALENT TO THE WALLS OF THE EQUIPMENT (REFER TO NEC).

L. IF A CONDUIT RUN IS EXPOSED OR A SURFACE RACEWAY LEFT WITHOUT A MOUNTING SURFACE DUE TO THE REMOVAL OF A PARTITION, THE CONDUIT SHALL BE REROUTED AS ACCEPTABLE TO THE OWNER / ENGINEER AND SUPPORTED IN ACCORDANCE WITH NEC REQUIREMENTS.

M. NEW DOUBLE-ENDED UNIT SUBSTATIONS SHALL BE INSTALLED PRIOR TO DEMOLISHING EXISTING UNIT SUBSTATIONS.

## KEYED NOTES

1. REFER TO SHEET E600 FOR PHASING PLAN FOR TRANSFER OF MEDIUM-VOLTAGE FEEDERS TO NEW UNIT SUBSTATIONS. EXISTING MEDIUM VOLTAGE FEEDERS ARE 3#500MCM, 1#4/0 GR. IN 5"C.
2. EXISTING LOADS TO REMAIN UNCHANGED.
3. AFTER CIRCUITRY HAS BEEN ROUTED FROM THE NEW SWITCHGEAR TO THE EXISTING LOADS, DISCONNECT LOADS ONE AT A TIME FROM OLD SWITCHGEAR AND TRANSFER TO NEW SWITCHGEAR. AFTER LOADS HAVE BEEN TRANSFERRED, DEMO CIRCUITRY ASSOCIATED WITH OLD LOAD CONNECTIONS.
4. ONCE LOADS HAVE BEEN TRANSFERRED TO NEW SWITCHGEAR, DISCONNECT CIRCUIT B FROM OLD SWITCHGEAR AND DEMO ASSOCIATED CIRCUITRY.
5. AFTER ALL LOADS AND FEEDERS HAVE BEEN DISCONNECTED, REMOVE OLD SWITCHGEAR, TRANSFORMERS, AND TIE BUSES.




**1** ELECTRICAL ONE-LINE DIAGRAM - DEMOLITION
N.T.S.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# AUSTIN ENERGY'S DOMAIN DISTRICT COOLING PLANT SWITCHGEAR REPLACEMENT

**AUSTIN ENERGY**
**3120 KRAMER LANE**
**AUSTIN, TEXAS 78758**

JACOBS JOB NUMBER:
**WJXM7204**

DATE ISSUED:
**05/04/2020**
FOR CONSTRUCTION

ISSUES/REVISIONS:

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|---|---|---|
| | IFC | 05/04/2020 |
| 1 | ADD 1 | 07/16/2020 |
| 2 | ADD 2 | 07/30/2020 |

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