



CITY OF THORNTON, COLORADO

PROJECT NO. 12-777J2

SOURCE WATER PUMP STATION

TECHNICAL SPECIFICATIONS

PROCUREMENT PACKAGE 2

ISSUED FOR BID

VOLUME 1 OF 1

DIVISIONS 01-26

NOVEMBER 2025





CITY OF THORNTON, COLORADO
THORNTON WATER PROJECT (12-777J2)

**SOURCE WATER PUMP STATION -
 PROCUREMENT PACKAGE 2**

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SECTION 01_11_00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. Vendor Manufacturer, and Supplier are used interchangeably within the specifications.

1.02 THE WORK

Vendor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

- A. It is the Owner's intent to assign this procurement agreement to an installing contractor at a later time.
- B. Furnish transformers, switchgear, a switchboard, a lighting panel, and a power panel and associated equipment and appurtenances for XFMR-SW1, XFMR-PP1, SWGR-SW, SWGR-UT1, SWBD-SW, LP-SW, and PP-SW as described in the Contract Documents. This includes shop drawings, shipment, delivery, and other requirements that will be coordinated to the satisfaction of the Owner and Engineer.
- C. The following services are required: Shop drawings shall be provided to the Owner and Engineer. Warranty, manufacturer's field services (including installation check, commissioning assistance, training, certification of acceptable installation and operation) to final completion will be coordinated with the installing contractor to the satisfaction of the Owner and Engineer.
- D. All equipment and materials provided under these Contract Documents shall be shipped and delivered at the expense of the Vendor, and all costs relative thereto shall be included in the Contract Price. No shipment shall occur prior to source testing (factory acceptance testing).
- E. Shipment shall be coordinated with the Contractor and shall be shipped and delivered to Source Water Pump Station site in between Rocky Ridge Lake Reservoir No.1 and Water Supply Storage Reservoir No. 3 at approximate latitude and longitude of 40.669260, -105.087194. Shipment on roads within Larimer County will be required to use specific haul routes that will be designated by the installing contractor and approved by Larimer County at a later time.
- F. Heavy equipment traffic will be subject to all weight limit restrictions along adjacent roadways and the Vendor will obtain oversize/overweight permits for delivery of equipment.
- G. Installation of the equipment will be at a later time by the owner selected installing contractor. Vendor is required to coordinate with the installing contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_31_19
PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Meetings that the Vendor is required to participate in for each piece of equipment that is being submitted on, installed, or commissioned.

1.02 QUALIFICATIONS OF MEETING PARTICIPANTS

- A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of entity each represents.

1.03 BASIC MEETING REQUIREMENTS

- A. Location:
 - 1. A video and telephone call-in option will be provided for meetings.
- B. Notification:
 - 1. Meeting leader shall notify attendees of the meeting, including an agenda, prior to the meeting.

1.04 WEEKLY SUBMITTAL STATUS MEETINGS

- A. Engineer or Construction Manager leads the meeting.
- B. Vendor shall attend up to 6 weekly meetings to coordinate submittal requirements and status for equipment.
- C. Location:
 - 1. Video call.

1.05 PRE-INSTALLATION MEETINGS (WILL OCCUR AFTER INSTALLING CONTRACTOR IS ON PROJECT)

- A. Installing contractor leads the meeting.
- B. Vendor shall attend meeting for pre-installation of each piece of their equipment.
- C. Location:
 - 1. Vendor may attend in-person or by video call.

1.06 COMMISSIONING COORDINATION MEETINGS (WILL OCCUR AFTER INSTALLING CONTRACTOR IS ON PROJECT)

- A. Installing contractor leads the meeting.
- B. Vendor shall attend meeting for commissioning of each piece of their equipment.
- C. Location:
 - 1. Vendor may attend in-person or by video call.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_33_00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements and procedures for Submittals to confirm compliance with the Contract Documents.

1.02 GENERAL INSTRUCTIONS

- A. Vendor is responsible to determine and verify field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved Shop Drawings and Contract Document requirements.
- B. Provide Submittals:
 - 1. That are specified or reasonably required for construction, operation, and maintenance of the Work.
 - 2. That demonstrate compliance with the Contract Documents.
- C. Where multiple Submittals are required, provide a separate Submittal for each Specification section.
 - 1. In order to expedite construction, the Vendor may make more than one Submittal per Specification section, but a single Submittal may not cover more than one Specification section:
 - a. The only exception to this requirement is when one Specification section covers the requirements for a component of equipment specified in another section.
 - b. For example, circuit breakers are a component of switchgear. The switchgear Submittal must also contain data for the associated circuit breakers, even though they are covered in a different Specification section.
- D. Prepare Submittals in the English language. Do not include information in other languages.
- E. Present measurements in customary American units (feet, inches, pounds, etc.).
- F. Must be clear and legible, and of sufficient size for presentation of information.
- G. Page size, other than drawings:
 - 1. Minimum: 8-1/2 inches by 11 inches.
 - 2. Maximum: 11 inches by 17 inches.

- H. Drawing sheet size:
 - 1. Maximum: 22 inches by 34 inches.
 - a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
 - b. Minimum font size: 1/8-inch.
 - 2. 11-inch by 17-inch sheet:
 - a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
 - b. Minimum font size: 1/8-inch.
- I. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
- J. Provide Submittal information from only one manufacturer for a specified product. Submittals with multiple manufacturers for one product will be rejected without review.

1.03 SUBMITTAL ORGANIZATION

- A. Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.
- B. For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is used.
- C. Bookmarks:
 - 1. Bookmarks shall match the table of contents.
 - 2. Bookmark each section (tab) and heading.
 - 3. Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
 - 4. At file opening, display all levels of bookmarks as expanded.
- D. Where applicable (i.e., except for Drawings, figures, etc.), Submittal content shall be electronically searchable utilizing the PDF file as submitted.
- E. Thumbnails optimized for fast web viewing.
- F. Sequentially number pages within the tabbed sections:
 - 1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
- G. Attachments:
 - 1. Include with each Submittal a copy of the relevant Specification section.
 - a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
 - b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
 - 2. Include with each Submittal a copy of the relevant Drawing, including relevant addendum updates.
 - a. Indicate either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).

- b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
 - c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.

- H. Vendor: Prepare Submittal information in sufficient detail to show compliance with specified requirements.
 - 1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
 - 2. Coordinate Submittal with other Submittals and with the requirements of the Contract Documents.
 - 3. Check, verify, and revise Submittals as necessary to bring them into conformance with the Contract Documents and actual field conditions.

- I. Vendor: Prepare "Or Equal" Submittal information.
 - 1. Provide standard Submittal requirements.
 - a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
 - 2. Provide reason the specified product is not being provided.
 - 3. Explain the benefits to the Owner for accepting the "Or Equal".
 - 4. Itemized comparison of the proposed "Or Equal" with product specified, including a list of significant variations:
 - a. Design features.
 - b. Design dimensions.
 - c. Installation requirements.
 - d. Operations and maintenance requirements.
 - e. Availability of maintenance services and sources of replacement materials.
 - 5. Reference projects where the product has been successfully used:
 - a. Name and address of project.
 - b. Year of installation.
 - c. Year placed in operation.
 - d. Name of product installed.
 - e. Point of contact: Name and phone number.
 - 6. Define impacts:
 - a. Impacts to other contracts.
 - b. Impacts to other work or products.
 - 7. Vendor and represents the following:
 - a. Vendor bears the burden of proof of the equivalency of the proposed "Or Equal".
 - b. Proposed "Or Equal" is equal or superior to the specified product.
 - c. Vendor will provide the warranties or bonds that would be provided on the specified product on the proposed "Or Equal", unless the Owner requires a Special Warranty.
 - d. Vendor will coordinate installation of accepted "Or Equal" into the Work and will be responsible for the costs to make changes as required to the Work.
 - e. Vendor waives rights to claim additional costs caused by proposed "Or Equal" which may subsequently become apparent.

- J. Vendor: Prepare substitution Submittal information.
1. Provide standard Submittal requirements.
 - a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
 2. Provide reason the specified product is not being provided.
 3. Explain the benefits to the Owner for accepting the substitution.
 4. Itemized comparison of the proposed substitution with product specified, including a list of significant variations:
 - a. Design features.
 - b. Design dimensions.
 - c. Installation requirements.
 - d. Operations and maintenance requirements.
 - e. Availability of maintenance services and sources of replacement materials.
 5. Reference projects where the product has been successfully used:
 - a. Name and address of project.
 - b. Year of installation.
 - c. Year placed in operation.
 - d. Name of product installed.
 - e. Point of contact: Name and phone number.
 6. Define impacts:
 - a. Impacts to Contract Price.
 - 1) Required license fees or royalties.
 - 2) Do not include costs under separate contracts.
 - 3) Do not include Engineer's costs for redesign or revision of the Contract Documents.
 - b. Impacts to Contract Time.
 - c. Impacts to Contract Scope.
 - d. Impacts to other contracts.
 - e. Impacts to other work or products.
 7. Vendor represents the following:
 - a. Vendor shall pay associated costs for the Engineer to evaluate the substitution.
 - b. Vendor bears the burden of proof of the equivalency of the proposed substitution.
 - c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
 - d. Proposed substitution is equal or superior to the specified product.
 - e. Vendor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless the Owner requires a Special Warranty.
 - f. Vendor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
 - g. Vendor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.

1.04 SUBMITTAL IDENTIFICATION NUMBERING

A. Number each Submittal using the format defined in the table below:

	Spec Section Number	Dash	Initial Submittal - Sequential Number	Decimal Point	Subsequent Submittal Revisions Sequential Number
<i>Example 1 Description</i>	<i>Cast-In-Place Concrete</i>		<i>8th initial Submittal</i>		
	03_30_00	-	0008		
<i>Example 2 Description</i>	<i>Cast-In-Place Concrete</i>		<i>8th initial Submittal</i>		<i>First revision to the 8th initial Submittal</i>
	03_30_00	-	0008	.	1

1.05 SUBMITTALS IN ELECTRONIC MEDIA FORMAT

- A. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.
- B. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).
- C. Graphics: Provide graphic Submittals (Drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).

1.06 SUBMITTAL PROCEDURE

- A. Engineer: Review Submittal and provide response:
 - 1. Review description:
 - a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular Submittal, whether or not a stamp or seal is required by the Contract Documents or Laws and Regulations.
 - b. Engineer's review of Submittals shall not release the Vendor from the Vendor's responsibility for performance of requirements of the Contract Documents. Neither shall the Engineer's review release the Vendor from fulfilling purpose of installation nor from the Vendor's liability to replace defective Work.
 - c. Engineer's review of Shop Drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in the Contract Documents.
 - d. Engineer's review does not extend to:
 - 1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by the Vendor.

- 2) Vendor's means, methods, techniques, sequences, or procedures, except when specified, indicated on the Drawings, or required by the Contract Documents.
 - 3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Vendor.
 - e. Engineer can Approve or Not Approve any exception at their sole discretion.
2. Review timeframe:
- a. Except as may be provided in technical Specifications, a Submittal will be returned within 15 days.
 - b. When a Submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the Submittal, give notice of the date by which that Submittal will be returned.
 - c. Engineer's acceptance of progress schedule containing Submittal review times less than those specified or agreed to in writing by the Engineer will not constitute Engineer's acceptance of review times.
 - d. Critical Submittals:
 - 1) Vendor will notify Engineer in writing that timely review of a Submittal is critical to the progress of Work.
3. Schedule delays:
- a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer's review of Submittals unless all of the following criteria are met:
 - 1) Engineer has failed to review and return first submission within the agreed upon time frame.
 - 2) Vendor demonstrates that delay in progress of Work is directly attributable to the Engineer's failure to return Submittal within time indicated and accepted by the Engineer.
4. Review response will be returned to the Vendor with one of the following dispositions:
- a. Approved:
 - 1) No Exceptions:
 - a) There are no notations or comments on the Submittal and the Vendor may release the equipment for production.
 - b) This response does not require more action.
 - 2) Make Corrections Noted - See Comments:
 - a) Vendor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
 - b) Resubmittal not required.
 - 3) Make Corrections Noted - Confirm:
 - a) Vendor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
 - b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.
 - b. Not Approved:
 - 1) Correct and Resubmit:
 - a) Vendor may not proceed with the Work described in the Submittal.

- b) Vendor assumes responsibility for proceeding without approval.
 - c) Resubmittal of complete Submittal package is required within 15 calendar days of the date of the Engineer's Submittal review response.
 - 2) Rejected - See Remarks:
 - a) Vendor may not proceed with the Work described in the Submittal.
 - b) Submittal does not meet the intent of the Contract Documents. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.
 - c. Receipt Acknowledged:
 - 1) Filed for Record:
 - a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.
 - b) This response does not require any more action.
 - 2) With Comments - Resubmit:
 - a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc. Feedback regarding missing information, conflicting information, or other information that makes it incomplete can be made with comments.
- B. Vendor: Prepare resubmittal, if applicable:
- 1. Clearly identify each correction or change made. Provide page references to the changed information within the resubmittal.
 - 2. Include a response in writing to each of the Engineer's comments or questions for Submittal packages that are resubmitted in the order that the comments or questions were presented from the first and subsequent Submittals and numbered consistent with the Engineer's numbering.
 - a. Acceptable responses to the Engineer's comments are listed below:
 - 1) "Incorporated" - Engineer's comment or change is accepted and appropriate changes are made.
 - 2) "Response" - Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by the Engineer.
 - b. Reviews and resubmittals:
 - 1) Vendor shall provide resubmittals which include responses to all Submittal review comments separately and at a level of detail commensurate with each comment.
 - 2) Vendor responses shall indicate how the Vendor resolved the issue pertaining to each review comment:
 - a) Responses such as "acknowledged" or "noted" are not acceptable.
 - 3) Resubmittals which do not comply with this requirement may be rejected and returned without review.

- 4) Vendor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant Submittals.
- 5) Submittal review comments not addressed by the Vendor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Vendor to the satisfaction of the reviewing and approving authority.
- c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for revision and resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.
3. Resubmittal timeframe:
 - a. Vendor shall provide resubmittal within 15 days.
 - b. When a resubmittal cannot be returned within the specified period, Vendor shall notify the Engineer in writing.
4. Review costs:
 - a. Costs incurred by the Owner as a result of additional reviews of a particular Submittal after the second time it has been reviewed shall be borne by the Vendor.
 - b. Reimbursement to the Owner will be made by deducting such costs from the Vendor's subsequent progress payments.

1.07 PRODUCT DATA

- A. Edit Submittals so that the Submittal specifically applies to only the product furnished.
- B. Neatly cross out all extraneous text, options, models, etc., that do not apply to the product being furnished so that the information remaining is only applicable to the product being furnished.

1.08 SHOP DRAWINGS

- A. Indicate project-designated equipment tag numbers for Submittal of devices, equipment, and assemblies.

1.09 SAMPLES

- A. Details:
 1. Submit labeled samples.
 2. Samples will not be returned.
 3. Provide number of sample Submittals as below:
 - a. Total: 3 minimum.
 - 1) Owner: 1.
 - 2) Engineer: 2.
 - 3) Vendor: None.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - VENDOR SUBMITTAL TRANSMITTAL FORM

VENDOR SUBMITTAL TRANSMITTAL FORM

Owner:	Click here to enter text.	Date:	MM/DD/YYYY
Vendor:	Click here to enter text.	Project No.:	XXXXX.XX
Project Name:	Click here to enter text.	Submittal Number:	000
Submittal Title:	Click here to enter text.		
To:	Click here to enter text.		
From:	Click here to enter text.	Click here to enter text.	
	Click here to enter text.	Click here to enter text.	

Specification No. and Subject of Submittal/Equipment Supplier			
Spec ##:	Spec ##.	Subject:	Click here to enter text.
Authored By:	Click here to enter text.	Date Submitted:	XX/XX/XXXX

Submittal Certification
Check Either (A) or (B):
<input type="checkbox"/> (A) We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings with no exceptions.
<input type="checkbox"/> (B) We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings, except for the deviations listed.
Certification Statement: By this Submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved Shop Drawings and all Contract requirements.
Vendor's Reviewer's Signature:
Printed Name:

PM/CM Office Use
Date Received Vendor to PM/CM: _____
Date Received PM/CM to Reviewer: _____
Date Received Reviewer to PM/CM: _____
Date Sent PM/CM to Vendor: _____

SECTION 01_35_73

DELEGATED DESIGN PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Delegated Design procedures.

1.02 GENERAL

- A. Delegated Design - Professional design services assigned to the Vendor by express delegation in the Contract Documents. Work is "Delegated Design" where the Technical Sections require the Vendor to provide professional design services and to submit signed and sealed documents from a registered Professional Engineer.
- B. Vendor's Professional Engineer - The design professional retained by the Vendor to perform Delegated Design.
- C. Owner may require Vendor to provide professional design services for a portion of the Work by express delegation in the Contract Documents.
 - 1. Requirements of Delegated Design component as specified in the Technical Section and as indicated on the Drawings.
 - 2. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that the Vendor must furnish to the Engineer with respect to the Delegated Design.
- D. Vendor shall cause such Delegated Design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal shall appear on Drawings, calculations, Specifications, certifications, and Submittals prepared by such design professional.
 - 1. Vendor shall not be responsible for the adequacy of performance or design criteria specified by the Owner or Engineer.
 - 2. Vendor is not required to provide professional services in violation of applicable Laws and Regulations.
 - 3. Such design professional shall issue certifications of design required by Laws and Regulations.
 - 4. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by the Vendor, a Subcontractor, or others for submittal to the Engineer, then such Shop Drawing or other Submittal shall bear the written approval of Vendor's design professional when submitted by the Vendor to the Engineer.

- E. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Vendor under Delegated Design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.
- F. Engineer's review, approval, and other determinations regarding design drawings, calculations, Specifications, certifications, and other Submittals furnished by Vendor pursuant to a Delegated Design will be only for the following limited purposes:
 - 1. Confirming that Submittal is in conformance with the performance and design criteria specified in the Contract Documents.

1.03 VENDOR'S PROFESSIONAL ENGINEER

- A. Vendor or Subcontractor shall retain a licensed Professional Engineer to perform Delegated Design.
- B. Qualifications:
 - 1. Holding a current license to perform the specified design in the same jurisdiction as the Project Site.
 - 2. Experienced in designing similar systems of similar complexity.
- C. Insurance:
 - 1. Provide as required by the Contract Documents.
- D. Responsibilities:
 - 1. Review and design in accordance with system performance and design criteria stated in the Contract Documents.
 - a. Prepare written requests for clarifications or interpretations of performance or design criteria for submittal to the Engineer by the Vendor.
 - 2. Sign and seal design reports, calculations, design drawings and specifications, and other design Submittals for the Delegated Design Work.
 - 3. Review and submit written approval of Submittals related to the Delegated Design Work.
 - 4. Design modifications to the Delegated Design Work as required.
 - 5. Visit the Site, as required, to verify that installation of the Delegated Design Work is in conformance with the Delegated Design Drawings and Specifications.
 - 6. Submit through Vendor to Engineer written, signed, and sealed certification that the installed Delegated Design Work complies with Vendor's Professional Engineer's design.

1.04 SUBMITTALS

- A. Prior to the start of Delegated Design:
 - 1. Vendor's Professional Engineer's qualifications:
 - a. Experience for the Delegated Design.
 - b. Evidence of Professional Engineering license.
 - 2. Vendor's Professional Engineer Professional Liability Insurance certificate.

- B. Delegated Design:
 - 1. Product data:
 - a. Details related to the Delegated Design as specified in Technical Sections to completely describe the system.
 - 2. Design documents with signature and seal from the Vendor's Professional Engineer.
 - a. Design documents include, but are not limited to, Drawings, calculations, Specifications, inspection reports, and certifications.
 - 3. Lists and schedules:
 - a. Prepare and submit lists or schedules of items where Delegated Design is required by the Contract Documents.

- C. Construction services:
 - 1. Vendor's Professional Engineer's comments on Submittals.
 - 2. Other construction documents, as required.

1.05 ENGINEER RESPONSE TO DELEGATED DESIGN SUBMITTALS

- A. Engineer response will be either of the following:
 - 1. Approved:
 - a. Vendor may proceed with the Work.
 - b. Review was for the limited purpose of determining that the document was stamped by a Professional Engineer and that such design is generally consistent with and will not negatively affect the design concept presented in the Contract Documents.
 - 2. Make Corrections Noted - See Comments:
 - a. Vendor may proceed with the Work; however, all notations and comments must be incorporated into the final product.
 - b. Review was for the limited purpose of determining that the document was stamped by a Professional Engineer and that such design is generally consistent with and will not negatively affect the design concept presented in the Contract Documents.
 - 3. Rejected - See Remarks:
 - a. Vendor may not proceed with the Work described in the Submittal.
 - b. Submittal does not meet the intent of the Contract Documents.
 - c. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_41_00

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Regulatory authorities and codes.

1.02 AUTHORITIES HAVING JURISDICTION (AHJ)

- A. Authorities Having Jurisdiction (AHJ) for work within Larimer County:
 - 1. Also referred to as the permitting agency.
 - 2. Building Department: Larimer County.
 - 3. Fire Department: Poudre Fire Authority.
- B. Applicable codes for work within Larimer County:
 - 1. International Code Council (ICC).
 - a. Building code:
 - 1) International Building Code (IBC), 2021.
 - a) Local amendments per Larimer County.
 - 2) International Existing Building Code (IEBC), 2021.
 - a) Local amendments per Larimer County.
 - b. Electrical code:
 - 1) National Fire Protection Association (NFPA), NFPA 70.
 - 2) National Electrical Code (NEC), 2023.
 - a) Local amendments per Larimer County.
 - c. Energy code:
 - 1) International Energy Conservation Code (IECC), 2021.
 - 2) Local amendments per Larimer County.
 - d. Fire code:
 - 1) International Fire Code (IFC), 2021.
 - 2) Local amendments per Larimer County.
 - e. Mechanical code:
 - 1) International Mechanical Code (IMC), 2021.
 - 2) Local amendments per Larimer County.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_60_01
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for products.

1.02 TERMINOLOGY

- A. The words and terms listed below, are not defined terms that require initial capital letters, but, when this Section is referenced in other Specifications, have the indicated meaning:
 - 1. Special tools:
 - a. Special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a system that would not normally be in the Owner's tool kit and that have been specifically made for use on a product for assembly, disassembly, repair, or maintenance.

1.03 SHIPMENT

- A. Prepare products for shipment by:
 - 1. Tagging or marking to match the Shop Drawings or Contract Documents.
 - 2. Including complete packing lists and bills of material with each shipment.
 - 3. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.
 - 4. Securely attach special instructions for proper field handling, storage, and installation before packaging and shipment.
- B. Transport products by methods that avoid product damage.
- C. Deliver products in undamaged condition in the manufacturer's unopened packaging.

1.04 STORAGE

- A. Storage is the responsibility of the installing contractor.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide products by the same manufacturer when units are of similar nature, unless otherwise specified.
- B. Provide like parts of duplicate units that are interchangeable.

- C. Provide equipment or products that have not been in service prior to delivery, except as required by tests.
- D. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
 - 1. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.
- E. Provide products produced by manufacturers regularly engaged in the production of these products.
- F. Provide products that bear approvals and labels as specified such as Factory Mutual (FM), Underwriters Laboratory (UL), or National Sanitation Foundation (NSF International) that are acceptable to the Authority Having Jurisdiction.

2.02 MATERIAL

- A. Dissimilar metals:
 - 1. Separate contacting surfaces with dielectric material.
 - 2. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators, washers, petrolatum tape, or other materials as specified.
 - 3. Dielectric coatings can be used to separate dissimilar metal couples from surrounding environment if isolation of metals is not possible, with approval of the Engineer.
- B. Edge grinding:
 - 1. Sharp projections of cut or sheared edges of ferrous metals which are not to be welded shall be ground to a radius required to ensure satisfactory paint adherence and mitigate any safety hazard.
 - 2. A surface profile will need to be re-established for coating adherence based on coating manufacturer's profile requirements.
- C. Use anti-galling compound on threads of stainless steel fasteners during factory assembly.
- D. Provide anti-galling compound with stainless steel fasteners shipped for field assembly.
- E. Aluminum in contact with concrete or masonry: Apply epoxy mastic.

2.03 PRODUCT SELECTION

- A. When products are specified with names of manufacturers but no model numbers or catalog designations, provide products by one of the named manufacturers that meet or exceed specifications.
- B. When products are specified with names of manufacturers and model numbers or catalog designations, provide products with model numbers or catalog designations by one of the named manufacturers.

- C. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
 - 1. Products specified by brand or trade name, model number, or catalog designation.
 - 2. Products by another named manufacturer proven, in accordance with requirements for an “or equal”, including the Engineer’s approval, to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.

- D. When products are specified with only one manufacturer followed by “or equal,” provide:
 - 1. Products meeting or exceeding specifications by specified manufacturer.
 - 2. Engineer deemed “or equal” evidenced by an approved Shop Drawing or other written communication.

- E. When products are specified by naming 2 or more manufacturers with 1 manufacturer as a “Basis of Design”:
 - 1. Any of the named manufacturers can be submitted.
 - 2. If the product submitted is not by the named “Basis of Design” product and requires a change in the scope (dimensions, configuration, physical properties, etc.), schedule (longer lead time), or budget, the Vendor must submit a substitution request.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_75_17

COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
1. Commissioning.

1.02 DEFINITIONS

- A. Commissioning: The process of planning for, testing of, and start-up of systems, subsystems, equipment, components, and devices of the Work to demonstrate, through documented verification, that the Work has successfully met the Contract Documents. It includes training the Owner's staff on operation and maintenance of the installed Work.
- B. Commissioning Phases: The activities of commissioning are grouped into the phases defined in the following table.
1. Table 1 - Commissioning Phases.

TABLE 1 - COMMISSIONING PHASES		
Planning Phase	Testing and Training Phase	Start-Up Phase
Draft Test Plans	Source Testing: <ul style="list-style-type: none">• Documentation	Start-Up: <ul style="list-style-type: none">• Documentation• Owner Training
	Installation Verification: <ul style="list-style-type: none">• Documentation• Owner Training	
	Functional Testing: <ul style="list-style-type: none">• Documentation• Owner Training	

- C. Component: A part of a system that does not have an electrical connection or internal electronics. Examples: Piping and pressure gauges.
- D. Device: A part of a system that has electrical connections or internal electronics. Examples: Level transmitter or pressure transmitter.
- E. Equipment: A factory or field assembled apparatus that performs an identifiable function. Examples: Pumps, motors, VFDs, MCCs.
- F. Functional Testing: Testing performed on a completed subsystem or system to demonstrate that the system meets the specified requirements. Example systems: Backwash system, dewatering system.

- G. Installation Verification: Testing to demonstrate that equipment or system and associated components or devices have been properly installed. Example equipment: Pumps, meters, and blowers with associated piping.
- H. Manufacturer's Certificate of Functional Compliance: The form completed by the manufacturer to confirm that testing of the installed equipment or system has been performed and the results conform to the specified performance. The form is provided in Attachment C provided at the end of this Section.
- I. Manufacturer's Certificate of Installation Verification: The form completed by the manufacturer to confirm that the equipment or system is installed in conformance with the Contract. The form is provided in Attachment B at the end of this Section.
- J. Manufacturer's Certificate of Source Testing: The form completed by the manufacturer to confirm that the specified source tests have been performed and the results conform to the specified requirements. The form is provided in Attachment A at the end of this Section.
- K. Owner Training: The Owner's staff is trained by the Contractor, with assistance from manufacturer, to operate and maintain the completed Work. This is sometimes referred to as Vendor Specific Training.
- L. Source Testing: Test equipment or products for performance at point of manufacture or assembly for the requirements specified in the Contract Documents. Also referred to as factory testing and factory acceptance testing (FAT).
- M. Start-Up: Operating the Work with process water to verify the Work meets the Contract Documents.
- N. Start-Up Phase: The phase when Start-Up occurs.

1.03 SUBMITTALS

- A. Project Commissioning:
 - 1. Schedules:
 - a. Owner Training Schedule.
 - 2. Test Reports:
 - a. Submit draft Test Reports outline in the Planning Phase, unless specified otherwise.
 - 1) Engineer approval of draft Test Reports outline required for successful completion of Planning Phase.
 - b. Submit final Test Report a maximum of 30 calendar days after testing.
- B. Technical Sections Commissioning:
 - 1. Manufacturer's representative's qualifications.
 - a. Submit to Engineer no later than 30 days in advance of required services.
 - b. Representative's name, phone, and e-mail address:
 - 1) May use 2 representatives: 1 for field testing and 1 for Owner Training.
 - 2) Provide resume stating instructor's technical expertise and instructional technology skills and experience.

2. Test Plans:
 - a. Submit draft Test Plan outlined in the Planning Phase, unless specified otherwise.
 - 1) Engineer approval of draft Test Plans required for successful completion of Planning Phase.
 - b. Submit final Test Plan a minimum of 90 calendar days prior to testing.
 - c. Engineer approval of final Test Plan required prior to start of testing.
3. Test Reports:
 - a. Submit draft Test Reports outline in the Planning Phase, unless specified otherwise.
 - 1) Engineer approval of draft Test Reports outline required for successful completion of Planning Phase.
 - b. Submit final Test Report a maximum of 30 calendar days after testing.
4. Manufacturer's representatives field notes and data.
5. Owner Training:
 - a. Prior to the training session:
 - 1) Training instructor qualifications.
 - 2) Training course materials: Due 30 calendar days prior to initial training session.
 - a) Drafts of training agenda, lesson plan, presentation, handouts, and list of audio-visual aids.
 - b) Format: 1 electronic copy in the format specified by the Owner and 3 hard copies organized in notebooks.

1.04 MANUFACTURER'S REPRESENTATIVES

- A. Qualifications: As specified below and in the Technical Sections:
 1. For Installation and Functional Testing:
 - a. Factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment/system with full authority by the equipment/system manufacturer to issue the certifications required of the manufacturer.
 2. Training instructor qualifications:
 - a. Provide resume stating instructor's technical preparation and instructional technology skills and experience.
 - b. Knowledgeable in the equipment/system for which they are training.
 - c. Experienced in conducting classes.
 - d. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.
 3. Representatives to be approved by Owner and Engineer.
 4. No substitute representatives without written approval by Owner and Engineer.
- B. Duties:
 1. Determine if additional time and/or trips (beyond those specified in the Technical Sections) is required to perform the specified services.
 2. Coordinate services in accordance with the installing contractor's Project schedule, up to and including making multiple trips to the Project Site when there are separate milestones associated with installation of each occurrence of manufacturer's equipment.

3. Perform on-site services as specified in the Technical Sections.
4. Provide daily copies of manufacturer's representatives field notes and data to Contractor.

1.05 PLANNING PHASE

A. Overview of Planning Phase:

1. Obtain Engineer approval of draft Test Plans.

B. Test Plans.

1. Source Test (Factory Acceptance Test):
 - a. As specified in this Section and other Technical Sections.
 - b. Based on approved Shop Drawings.
 - c. Prepared by the Vendor.
 - d. Include the following items for each test:
 - 1) Purpose of the test.
 - 2) Identification of each item of equipment/system to be tested, including system designation, location, tag number, control loop identifier, etc.
 - 3) Description of the pass/fail criteria that will be used.
 - 4) Listing of pertinent reference documents (Contract and industry standards or sections applicable to the testing).
 - a) Credentials of test personnel.
 - 5) Test equipment:
 - a) Include Product Data for the test equipment.
 - b) Appropriate calibration records.
 - (1) Drawings or photographs of test stands and/or test apparatus.
 - 6) Duration: Determine test durations with Owner's input.
 - 7) Detailed step-by-step test procedures.
 - a) Level of detail shall be sufficient for the witness to follow the steps.
 - e. Furnish labor, power, tools, equipment, instruments, and services required for and incidental to testing activities.
2. Test forms minimum requirements:
 - a. Name of product to be tested.
 - b. Test date.
 - c. Names of persons conducting the test.
 - d. Names of persons witnessing the test, where applicable.
 - e. Test data.
 - f. Applicable project requirements as specified in the Technical Sections.
 - g. Check offs for each completed test or test step.
 - h. Place for signature of person conducting tests and for the witnessing person, as applicable.

1.06 TESTING AND TRAINING PHASE

- A. Overview of Testing and Training Phase:
 - 1. General:
 - a. Vendor to support installing contractor in testing the Work to verify it meets the Contract requirements.
 - b. Vendor trains the Owner to operate and maintain the Work.
- B. Source Testing:
 - 1. As specified in the Technical Section.
 - 2. Source Test Plan:
 - a. Engineer approval of Source Test Plan required prior to testing.
 - 3. Witnessed in person:
 - a. If specified in the Technical Section, Vendor shall coordinate testing dates and schedule with Owner and Engineer. Owner's and Engineer's in person witness of testing is at their discretion. The Vendor shall make accommodations for virtual witness testing in lieu of in person testing if requested by Owner or Engineer.
 - 4. Virtual witness testing:
 - a. As specified in the Technical Sections.
 - b. Vendor is responsible for costs associated with virtual witness.
 - c. Provide the following:
 - 1) An agenda detailing start time of each major phase in the procedure defined in the approved Test Plan.
 - 2) A dedicated operator (separate from the test technician) to operate the camera, provide commentary throughout test, and inspect devices at the request of the attendees.
 - d. Online meeting platform: Microsoft Teams.
 - e. Share video through a high-definition camera.
 - f. Establish methods to communicate, convey, and record information clearly even in environments with loud background noise.
 - 1) Electronic feed for screen sharing of the control panel, HMI, or other screens used throughout testing.
 - 2) Provide recording of virtual sharing within 1 day after testing.
 - g. Test run of virtual sharing a minimum of 1 week prior to the test:
 - 1) Use current record documents in PDF format.
 - 2) Provide recording of virtual sharing within 1 day after the test run.
 - 3) Engineer approval of test run virtual sharing is required before Source Testing.
 - 5. If the Source Test is not ready on the scheduled date or if the Source Test fails:
 - a. Vendor is responsible for associated costs:
 - 1) First test costs that are non-refundable, if applicable.
 - 2) Repeat test costs:
 - a) Trip costs, if applicable.
 - 3) Virtual witness costs, if applicable.
 - 6. Source Testing is complete after successful testing, submittal of test report, and Manufacturer's Certificate of Source Testing.
 - 7. Engineer approval of Source Testing Report is required.

- C. Installation Verification:
 - 1. Overview:
 - a. Verifying the installation of equipment to be in accordance with Manufacturer's Instructions.
 - 2. Prerequisite:
 - a. Engineer approval of Source Testing Report.
 - 3. Submit Manufacturer's Certificate of Installation Verification.
 - 4. Engineer approval of Manufacturer's Certificate of Installation Verification is required.

- D. Documentation:
 - 1. Provide records generated during Commissioning Phase of Project, including, but not limited to:
 - a. Training documentation.
 - b. Manufacturer's Certificate of Source Testing.
 - c. Manufacturer's Certificate of Installation Verification.
 - d. Manufacturer's Certificate of Functionality Compliance.
 - e. Test forms and documentation.
 - f. Logs of time spent by manufacturer's representatives performing services on the job site.
 - 2. Engineer approval of documentation is required.

- E. Owner Training:
 - 1. Train Owner's staff on the operation and maintenance of the equipment/system.
 - 2. Train on each topic of the approved Operation and Maintenance Manual.
 - a. Include classroom instruction and field demonstration with all necessary tools and test equipment.
 - 3. Training tailored to the skills and job classifications of the staff attending the classes (e.g., plant superintendent, treatment plant operator, maintenance technician, electrician, etc.).
 - 4. Training outcomes:
 - a. Owner's staff can safely operate, maintain, and repair the equipment/systems provided as recommended by the manufacturer.
 - 5. Training plan:
 - a. Manufacturer's representatives to provide both classroom-based learning and field (hands-on) training, based on training module content and stated learning objectives.
 - b. Conduct classroom training at location designated by Owner.
 - c. Scope and sequence:
 - 1) Plan and schedule training in the correct sequence to provide prerequisite knowledge and skills to trainees.
 - a) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
 - 2) If multiple classes are needed to meet the training objectives, they shall be included in the training plan.
 - 6. Owner Training Schedule:
 - a. Schedule Owner's staff training within the constraints of their workloads.
 - 1) Those who will participate in this training have existing full-time work assignments, and training is an additional assigned work task, therefore, scheduling is imperative.

- 2) Owner staff work schedules regularly shift, as treatment facilities are typically operated on an around-the-clock basis.
 - 3) Maximum training hours per week: 4.
 - 4) Days available for training:
 - a) Monday to Friday.
 - b. Training scheduling coordination:
 - 1) Complete Owner Training no sooner than 15 calendar days prior to Functional Testing of each system.
 - c. Class logistics:
 - 1) Delivery time minimum: 2 hours.
 - 2) Delivery time maximum: 4 hours.
 - 3) Class agenda:
 - a) Refreshment break: One 10-minute break.
 - b) Meal break: One 45-minute break, unless otherwise specified.
 - c) Schedule refreshment breaks and meal breaks to meet the class needs and Owner work rules.
 - 4) Schedule specific sessions:
 - a) Minimum of 30 days in advance to allow Owner staffing arrangements to take place.
 - b) At the times requested by the Owner, within the period 7 a.m. to 7 p.m. Monday through Friday.
 - (1) Times scheduled will be at Owner's discretion.
 - c) Owner approval and confirmation required for session schedules.
 - d) Provide minimum of 2 sessions for each class unless otherwise noted.
 - (1) The purpose of having multiple sessions on each class is to accommodate the attendance of as many Owner personnel working different shifts as possible.
 - e) A maximum of 1 session per day for each class.
 - d. Number of students:
 - 1) Estimated class size maximum: 10 staff.
 - 2) Engineer will confirm the headcount 1 week prior to the class so that the instructor can provide the correct number of training aids for students.
7. Submittals:
- a. Submit Training Plan Schedule 60 calendar days before the first scheduled training session, including, but not limited to, lesson plans, participant materials, instructor's resumes, and training delivery schedules.
 - b. Submit training documentation, including the following:
 - 1) Training plan:
 - a) Training modules.
 - b) Scope and sequence statement.
 - c) Contact information for manufacturer's instructors. including name, phone, and e-mail address.
 - d) Instructor qualifications.
 - 2) Training program schedule:
 - a) Format: Bar chart:
 - (1) Include in the Project Progress Schedule.
 - b) Contents:
 - (1) Training modules and classes.

8. Lesson plans:
 - a. Divide training into discrete modules appropriate for the equipment and trades.
 - b. State performance-based learning objectives in terms of what the trainees will be able to do at the end of the lesson.
 - c. Define student conditions of performance and criteria for evaluating instructional success.
 - d. Minimum requirements:
 - 1) Hands-on demonstrations planned for the instructions.
 - 2) Cross-reference training aids.
 - 3) Planned training strategies such as whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies.
 - 4) Attach handouts cross-referenced by section or topic in the lesson plan.
 - 5) Indicate duration of outlined training segments.
 - e. Provide instruction lesson plans for each trade:
 - 1) Detailed component description:
 - a) Identify each component function and describe in detail.
 - b) Identify equipment's mechanical, electrical, and electronic components and features.
 - c) Where applicable, group relative components into subsystems.
 - d) Identify and describe in detail equipment safety features, permissive and controls interlocks.
 - 2) Equipment operation:
 - a) Describe equipment's operating (process) function and system theory.
 - b) Describe equipment's fundamental operating principles and dynamics.
 - c) Identify support equipment associated with the operation of subject equipment.
 - d) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process.
 - e) Cite hazards associated with the operations, exposure to chemicals associated with the component, or the waste stream handled by the component.
 - f) Specify appropriate safety precautions, equipment, and procedures to eliminate, reduce, or overcome hazards.
 - 3) Define Preventative Maintenance (PM) inspection procedures required on equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance).
 - a) Review preventive maintenance frequency and task analysis table.
 - 4) Define equipment Corrective Maintenance (CM) troubleshooting:
 - a) Describe recommended equipment preparation requirements as they relate to specific craft problems.
 - b) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.

- c) Provide component specific troubleshooting checklists as they relate to specific craft problems.
 - d) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.
 - e) Perform at least 2 hands-on demonstrations of common corrective maintenance repairs.
 - 5) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
9. Training instruction format:
- a. Training for operations and maintenance personnel shall be provided as one entity.
 - b. Instructors shall apply adult education best practices, emphasizing learner participation and activity.
 - c. Lecturing should be less than 30 percent of class time.
 - d. Training delivery may include problem solving, question/answer, hands-on instruction, practice, evaluation/feedback tools, and lecture to support training objectives.
 - e. Conduct hands-on instruction according to the following descriptions:
 - 1) Present hands-on demonstrations of at least the following tasks:
 - a) Proper start-up, shutdown, and normal and alternative operating strategies.
 - b) Common corrective maintenance repairs for each group.
 - c) Recommended procedures to check/test equipment/system following a corrective maintenance repair.
 - d) Preventative maintenance points.
 - e) Calibration, if applicable.
 - 2) Use tools and equipment provided by manufacturer to conduct the demonstrations.
 - a) Submit requests for supplemental assistance and facilities with the Vendor and Contractor's proposed lesson plans.
 - 3) Vendor and Contractor remain responsible for equipment disassembly or assembly during hands-on training situations involving equipment disassembly or assembly by Owner's personnel.
 - f. Training aids:
 - 1) Instructors shall provide needed audio-visual devices such equipment (televisions, video recorder/player, computer, projectors, screens, easels, etc.), models, charts, etc., for each class.
 - 2) Instructor to confirm with Engineer in advance of each class that the classroom will be appropriate for the types of audiovisual equipment to be employed.
10. Training sessions:
- a. Provide training sessions for equipment/system as specified in the individual equipment/system section.
 - b. Include the following information in the agenda:
 - 1) Instructor name.
 - 2) Listing of subjects to be discussed.
 - 3) Time estimated for each subject.
 - 4) Allocation of time for Owner staff to ask questions and discuss the subject matter.
 - 5) List of documentation to be used or provided to support training.

- c. Owner may request that particular subjects be emphasized, and the agenda be adjusted to accommodate these requests.
- d. Digitally record audio and video of each training session.
 - 1) Include classroom and field instruction with question and answering periods.
 - 2) Engineer approval required for producer of video materials from one of the following options:
 - a) Qualified, professional video production company or individual.
 - 3) Record in digital format and recording shall become property of the Owner with exclusive rights.
 - a) No video recording agreements will be entered into by the Owner.
 - 4) Media:
 - a) Video quality shall be 720p HD or greater in MPG, AVCHD, AVI, or MP4 format.
 - b) Digital color video format.
 - c) Provide audio portion of the composite CD sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
 - d) Identification: On each copy provide a label with the following information:
 - (1) Name of training.
 - (2) Date video was recorded.
 - e) Display continuous running time.
 - f) At start of each video recording, record training class name, date, and instructor's name.
 - g) Provide audio quality that is not degraded during the recording of the field sessions due to background noise, space, distance or other factors.
 - 5) Vendor and Contractor shall provide a written release from all claims to the recorded training material produced, if required.
- e. Distribute copies of the agenda to each student at the beginning of each training class.
- f. Trainees will keep training materials and documentation after the session.
- g. Distribute Training Evaluation Form following each training session.
 - 1) Training Evaluation Form is included in this Section.
 - 2) Return completed Training Evaluation Forms to Owner's designated training coordinator immediately after session is completed.
 - 3) Revise training sessions judged "Unsatisfactory" by a majority of attendees.
 - a) Conduct training sessions again until a satisfactory rating is achieved.

11. Engineer approval of Owner Training is required.

1.07 START-UP PHASE

A. Overview of Start-Up Phase:

- 1. General:
 - a. Vendor to support Owner with operation of Vendor provided equipment to meet contract requirements.

- B. Start-Up Period:
 - 1. Vendor responsibilities:
 - a. Provide support and troubleshooting for Vendor provided equipment.
 - 2. Prerequisites:
 - a. Engineer approval of Testing and Training Phase.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

Comments: _____

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____, 20 _____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

(Authorized Signature)

If applicable, Witness Name (*print*): _____

(Witness Signature)

ATTACHMENT B - MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify the installation of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

1. Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

ATTACHMENT C - MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify the Functional Testing of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

- 1. Attach test results with collected data and test report.
- 2. Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

WITNESSES:

By Owner's Authorized Representative: _____
(Authorized Signature)

By Engineer's Authorized Representative: _____
(Authorized Signature)

ATTACHMENT D - TRAINING EVALUATION FORM

TRAINING EVALUATION FORM

EQUIPMENT/SYSTEM ITEM: _____

VENDOR/MANUFACTURER: _____

DATE: _____ NAME OF REPRESENTATIVE: _____

- | | | | | |
|--|------------|--------------|----|-----|
| 1. Was representative prepared? | Acceptable | Unacceptable | or | N/A |
| 2. Was an overview description presented? | Acceptable | Unacceptable | or | N/A |
| 3. Were specific details presented for system components? | Acceptable | Unacceptable | or | N/A |
| 4. Were alarm and shutdown conditions clearly presented? | Acceptable | Unacceptable | or | N/A |
| 5. Were step-by-step procedures for starting, stopping, and troubleshooting presented? | Acceptable | Unacceptable | or | N/A |
| 6. Were routine/preventative maintenance items clearly identified? | Acceptable | Unacceptable | or | N/A |
| 7. Was the lubrication schedule (if any) discussed? | Acceptable | Unacceptable | or | N/A |
| 8. Was the representative able to answer all questions? | Acceptable | Unacceptable | or | N/A |
| 9. Did the representative agree to research and answer unanswered questions? | Acceptable | Unacceptable | or | N/A |
| 10. Comments: _____ | | | | |
| _____ | | | | |
| _____ | | | | |
| _____ | | | | |

11. Overall Rating	Satisfactory	Unsatisfactory
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Note:

Sessions judged “Unsatisfactory” by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.

ATTACHMENT E- COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

NO.	TASK	OWNER	VENDOR	INSTALLING CONTRACTOR	ENGINEER
Testing and Training Phase					
Source Testing					
	Source Testing	Witnessed as specified in the Technical Sections.	Lead	No Action	Witnessed as specified in the Technical Sections. Review
	Manufacturer's Certificate of Source Testing	No Action	Lead	No Action	Review
Installation Verification					
	Structural Anchorage Check	Witness	No Action	Lead	Review
	Health and Safety Check	Witness	No Action	Lead	Review
	Manufacturer Requirements Verification	No Action	Lead	No Action	Review
	Contract Documents Verification	No Action	No Action	Lead	Review
	Manufacturer's Certificate of Installation Verification	No Action	Lead	No Action	Review
Functional Testing					
	Checks	Witness	Support	Lead	Witness, Review
	Tests	Witness	Support	Lead	Witness, Review
	Manufacturer's Certificate of Functional Compliance	No Action	Lead	No Action	Witness, Review
System Testing					
	System Testing	Witness	Support	Lead	Witness, Review
Start-Up Phase					
	Start-Up	Lead	Support	Support	Witness, Review
<p><u>Legend:</u></p> <p>Lead: Primarily responsible for organization, coordination, and execution of task work product or result.</p> <p>Support: Assist the lead with organization, coordination, and execution of task work product or result.</p> <p>Witness: Observe and document completion of task work product or result.</p> <p>No Action: Limited or no involvement.</p> <p>Review: Approve for compliance with Contract Documents or reject.</p>					

SECTION 01_78_24

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Preparation and submittal of manual with requirements to operate and maintain the equipment.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Submit draft operation and maintenance manuals prior to shipment of the equipment to the Site.
 - 2. Submit approved operation and maintenance manuals at least 30 days prior to Functional Testing and at least 60 days prior to Owner Training.
 - 3. The Vendor shall provide equipment operation and maintenance manuals to the installing contractor for combination into one project operation and maintenance manual.
 - 4. The Vendor shall coordinate with installing contractor to include information on programming and other required elements into the final operation and maintenance manuals.
 - 5. Make final operation and maintenance manuals available at the Site for use by construction personnel.

1.03 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and the Technical Sections.
- B. Draft operation and maintenance manuals:
 - 1. Quantity:
 - a. Electronic copy in portable document format (PDF) format.
- C. Final operation and maintenance manuals:
 - 1. Revised in accordance with the Owner's and Engineer's comments on the draft operation and maintenance manuals, and to include Functional Testing results and certificates.
 - 2. Quantity:
 - a. Electronic copy in PDF format.
- D. Spare parts list:
 - 1. Provide a consolidated spare part list required in accordance with the Technical Specifications.
 - 2. Engineer and Owner to review list prior to the Contractor's procurement of spare parts.

1.04 PREPARATION

- A. General requirements:
 - 1. Provide dimensions in English units.
 - 2. Assemble material, where possible, in the same order within each volume.
 - 3. Complete forms on computer; handwriting is not acceptable.
 - 4. Delete items or clearly mark out options not provided in the supplied equipment.
 - 5. Cover page shall include the following information:
 - a. Operation and maintenance manual.
 - b. Equipment name.
 - c. Specification Section number.
 - d. Equipment tag number s.
 - e. Owner's name.
 - f. Project number and name.
 - g. Date.

- B. Electronic requirements:
 - 1. File format:
 - a. Entire manual in PDF.
 - 1) Include text and drawing information.
 - 2) Provide a single PDF file.
 - 3) Create PDF from the native format of the document (Microsoft Word, graphics programs, drawing programs, etc.).
 - a) Scanned images are not acceptable.
 - b) At file opening, display the entire cover page.
 - 4) Pagination and appearance to match hard copy.
 - 5) Ensure that page numbers are included on every page of the document.
 - 6) Text searchable throughout the entire document, including drawings.
 - 7) Bookmarks: As specified in Section 01_33_00 - Submittal Procedures.
 - 8) Thumbnails optimized for fast web viewing.
 - b. Drawing requirements:
 - 1) Provide electronic file with drawings in most current version of AutoCAD format.
 - 2) White background.
 - 3) Shapes shall not degrade when closely zoomed.
 - 4) Screening effects intended to de-emphasize detail in a drawing must be preserved.
 - 2. Label media with the following information:
 - a. Operation and maintenance manual.
 - b. Equipment name.
 - c. Specification Section number.
 - d. Equipment tag number.
 - e. Owner's name.
 - f. Project number and name.
 - g. Date.
 - 3. If multiple Submittals are made together, each Submittal must have its own subdirectory that is named and numbered based on the Submittal number.

1.05 CONTENTS

- A. Cover page.
- B. Table of Contents: General description of information provided within each tab section.
- C. Complete Attachment A - Equipment Summary Form.
- D. Programming:
 - 1. Provide package control system annotated PLC code, if applicable.
 - 2. Installing contractor furnished programming.
- E. Description of system and components.
- F. Complete parts list for equipment, including, but not limited to, the following information:
 - 1. Catalog data: Generic title and identification number of each component part of equipment.
 - 2. Include bearing manufacturer, model, and ball or roller pass frequencies for every bearing.
 - 3. Availability.
 - 4. Service locations.
- G. Spare parts list:
 - 1. Recommended number of parts to be stored at the Site and special storage instructions.
- H. Engineering data:
 - 1. Complete set of 11-inch by 17-inch equipment drawings.
 - 2. Exploded view or plan and section views with detailed callouts.
 - 3. Outline, cross-section, and assembly drawings.
 - 4. System drawings: Provide interconnection and wiring diagrams, plan views, panel layouts, bill of materials, etc.
 - 5. Packaged equipment system drawings: Provide instrumentation loop drawings, control schematic diagrams, interconnection and wiring diagrams, plan views, panel layouts, bill of materials, etc.
 - 6. System drawings and data sheets: Include drawings and data furnished by the Engineer and the Vendor; provide "as installed" version.
 - 7. Provide electrical and instrumentation schematic record drawings.
 - 8. Information required by the Technical Specifications.
- I. Description of equipment function, normal operating characteristics, and limiting conditions.
- J. Online resources.
- K. Telephone resources.
- L. Approved Submittals.
 - 1. Markup with any field changes.

- 2. Quality Control Submittals:
 - a. Source Testing and Functional Testing test reports and test data.
 - b. Manufacturer's certificates.
 - c. Performance curves.

- M. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.

- N. Operating procedures:
 - 1. Step-by-step instructions, including, but not limited to, the following:
 - a. Safety precautions and applicable safety data sheets.
 - b. Guidelines.
 - c. Other information as needed for safe system operation and maintenance.

- O. Preventative maintenance procedures:
 - 1. Recommended steps and schedules for maintaining equipment.
 - 2. Troubleshooting.

- P. Storage instructions.

- Q. Lubrication information: Required lubricants and lubrication schedules.

- R. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.

- S. Manufacturer's technical reference manuals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - EQUIPMENT SUMMARY FORM

EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM: _____
2. MANUFACTURER: _____
3. EQUIPMENT TAG NUMBER(S): _____
4. LOCATION OF EQUIPMENT: _____
5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): _____

6. NAMEPLATE DATA:

- Horsepower: _____
- Amperage: _____
- Voltage: _____
- Service Factor (S.F.): _____
- Speed: _____
- ENC Type: _____
- Capacity: _____
- Other: _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE:

- Name: _____
- Address: _____
- Telephone Number: _____

8. MAINTENANCE REQUIREMENTS:

Maintenance Operation	Frequency	Lubricant (if applicable)	Comments
(List each operation required. Refer to specific information in manufacturer's manual, if applicable)	(List required frequency of each maintenance operation)	(Refer by symbol to lubricant list as required)	

9. LUBRICANT LIST:

Reference Symbol	Conoco Phillips	Exxon/Mobil	BP/Amoco	Other (List)
(Symbols used in Item 8 above)	(List equivalent lubricants, as distributed by each manufacturer for the specific use recommended)			

10. SPARE PARTS (recommendations): _____

11. COMMENTS: _____

12. GENERAL INFORMATION:

Date Accepted:* _____

Expected Life:* _____

Project Name and Number: _____

Design Engineer: _____

13. WARRANTY:

Start Date: _____

Expiration Date: _____

Prorated: _____

SECTION 01_78_36
WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Warranty and bonds requirements.

1.02 WARRANTY REQUIREMENTS

- A. See General Conditions 61 and 62 for project warranty requirements.

1.03 BONDS

- A. Not Used

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_81_50

DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Design criteria for use in the selection of equipment and appurtenances specified in Technical Sections of these Specifications and indicated on the Drawings.
 - 2. Criteria for design of systems, components and equipment fabricated off site and shipped to the construction site for installation by others.
- B. The criteria in this Section apply throughout the Work, unless additional criteria, or more restrictive criteria, are indicated.
 - 1. Additional criteria and requirements relevant to specific locations, specific materials, and specific equipment are indicated on the Drawings and in the Technical Sections.

1.02 REFERENCES

- A. American Society of Civil Engineers (ASCE):
 - 1. 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures. (ASCE 7).
 - 2. Local amendments: Larimer County, Colorado.
- B. International Code Council (ICC):
 - 1. International Energy Conservation Code (IECC).
 - 2. International Plumbing Code (IPC).

PART 2 PRODUCTS

2.01 DESIGN CRITERIA - SITE INFORMATION

- A. Site name: Source Water Pump Station.
 - 1. Street address:
 - a. Coordinates (approximate): Latitude 40.669527; Longitude -105.088229.
 - 2. Site elevation (approximate):
 - a. 5141.5 feet (NAVD 88).

2.02 DESIGN CRITERIA - REGULATORY REQUIREMENTS

- A. Requirements of authorities having jurisdiction over the Project are included in Section 01_41_00 - Regulatory Requirements.

2.03 DESIGN CRITERIA - OPERATING ENVIRONMENT

- A. Drawings and Technical Sections include additional criteria and requirements relevant to specific locations, materials, and equipment.
- B. Outdoor conditions:
 - 1. International Energy Conservation Code (IECC): Climate Zone 5B.
 - 2. Site climatic data location: 724697 Fort Collins, Colorado.
 - 3. Temperature criteria: As specified in the following Table: Design Temperatures - Outdoor Criteria in Accordance with ASHRAE Fundamentals Handbook.

Table: Design Temperatures - Outdoor Criteria in Accordance with ASHRAE Fundamentals Handbook	
Reference Location:	Fort Collins, Colorado, USA
Condition	Criteria
Daily mean range:	25.5 degrees Fahrenheit.
Winter:	At or above this temperature 99.6 percent of the time: -4 degrees Fahrenheit dry bulb.
Summer:	At or above this temperature 0.4 percent of the time: 94 degrees Fahrenheit dry bulb.

- C. Indoor conditions:
 - 1. Humidity:
 - a. Moisture/humidity conditions: As specified, and as defined in individual equipment sections.

2.04 DESIGN CRITERIA - STRUCTURAL

- A. General:
 - 1. Criteria for structural design of:
 - a. Equipment at locations subject to seismic events.
 - b. Equipment exposed to outdoor environments.
- B. Delegated Design:
 - 1. As specified in Section 01_35_73 - Delegated Design Procedures.
 - 2. Structural engineering design shall be performed by a Professional Engineer licensed in the State of Colorado.
- C. Structure risk category:
 - 1. Develop design loads and provide detailing in accordance with the provisions of ASCE 7 and the building code specified in Section 01_41_00 - Regulatory Requirements, based on the Structure Risk Category indicated in Table: Project Structures - Risk Category and Seismic Design Information.

- D. Seismic loads:
1. Seismic design parameters: Basic parameters - ASCE 7:
 - a. Ground motion MCE_R , 5 percent damped:
 - 1) Short periods, $S_s = 0.198$ g.
 - 2) 1 second period, $S_1 = 0.056$ g.
 - b. Peak ground acceleration, MCE_G :
 - 1) Peak ground acceleration, $PGA = 0.105$ g.
 - c. Mapped long-period transition period:
 - 1) $TL = 4$ seconds.
 2. Structures - General:
 - a. Seismic Design Category (SDC): As indicated in the following Table:
Project Structures - Risk Category and Seismic Design Information.

Table: Project Structures - Risk Category and Seismic Design Information						
Area	Description	Risk Category	Site Class	S_{DS}	S_{D1}	Seismic Design Category⁽¹⁾
All	All Structures	IV	C	0.172	0.056	C
Notes:						
(1) Seismic Design Category for Delegated Design, and for seismic certification of electrical and mechanical equipment as required by ASCE 7.						

- b. Structure response modification coefficient, R :
 - 1) In accordance with ASCE 7 and the requirements of the Technical Sections.
 3. Non-structural components - General:
 - a. Includes:
 - 1) Mechanical and electrical equipment.
 - b. Seismic design requirements for non-structural components are based on the Seismic Design Category (SDC) of the structure or facility where the equipment is installed.
 - c. Design components in accordance with the requirements of ASCE 7, Table 13.2-1.
 - d. Component amplification factor (a_p), response factor (R_p), and overstrength factor for anchorage to concrete (Ω_o):
 - 1) Mechanical and electrical components and systems: In accordance with ASCE 7, Table 13.6-1, unless otherwise indicated in the Technical Sections for these items.
 - e. Component importance factor, I_p :
 - 1) In accordance with the following Table: Component Importance Factor for Seismic Design, I_p .
 - 2) For items not listed in Table: Component Importance Factor for Seismic Design, I_p , designate importance factor in accordance with the provisions of ASCE 7, Chapter 13, and submit to the Engineer for review prior to developing calculations and details related to that component.

Table: Component Importance Factor for Seismic Design, I_p		
Structure Seismic Design Category	Components	I_p
All	All equipment and components	1.5

- E. Wind loads:
1. Design structures and non-structural components that are exposed to wind to withstand design wind loads.
 - a. Reduction of wind loads based on shielding effects of surrounding structures or components is not allowed.
 - b. Design for wind loading is not required for non-structural components and for non-building structures located inside enclosed buildings.
 2. Design parameters:
 - a. Basic wind speed:
 - 1) 130 miles per hour (33 feet, 3 second gust).
 - b. Exposure category: C.
 - c. Topographic factor, K_{zt} : 1.0.
- F. Operational loads:
1. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), surge or “water hammer,” and other load conditions.
 2. Design for loads indicated by the equipment manufacturer.
 3. Design for loads indicated in the Technical Sections for equipment and appurtenances.
- G. Serviceability considerations:
1. Deflection, unless otherwise indicated on the Drawings, or specified:
 - a. Beam deflection as fraction of span:
 - 1) Equipment supports: $L/450$.

PART 3 EXECUTION

3.01 GENERAL

- A. Design approach and criteria in accordance with:
1. Regulatory requirements, including, but not limited to, the building code specified in Section 01_41_00 - Regulatory Requirements.
 2. Reference standards and project-specific design criteria listed in this Section.
 3. Specific requirements for individual elements and components of the Work as specified in subsequent Technical Sections.
- B. In the event of conflicts between design criteria, contact Engineer for interpretation.

3.02 DELEGATED DESIGN

- A. Calculations:
 - 1. Where submittal of calculations is required:
 - a. Provide complete calculations, including sketches to illustrate the design concepts being evaluated, and details to fully describe proposed construction.
 - 2. Requirements for wind design calculations will be waived for the following:
 - a. Equipment and components located inside structures, and away from the effects of wind loads.
- B. Shop Drawings:
 - 1. Describing components and manufacturer's requirements for connections.

END OF SECTION

SECTION 26_05_00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for electrical:
 - a. Basic design and performance criteria.
 - b. Prescriptive requirements for common components.
- B. Contract Drawings:
 - 1. Schematic diagrams:
 - a. Controls are shown as de-energized.
 - b. Add relays, where required, to provide necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
 - c. Mount devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted.
 - 2. Plan drawings:
 - a. Electrical drawings show desired locations, arrangements, and components of the electrical Work in a diagrammatic manner.
 - b. Locations and sizes of equipment are approximate only.

1.02 REFERENCES

- A. Abbreviations:
 - 1. FAT: Factory acceptance test that is also referred to as source test.
 - 2. ICSC: Instrumentation and controls subcontractor.
 - 3. PCIS: Process control and instrumentation system.
- B. Standards:
 - 1. American National Standards Institute (ANSI).
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
 - 3. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code (NEC).
 - 4. Underwriters Laboratories, Inc. (UL).

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. LCP: Local control panel: Operator interface panel that may contain pilot type control devices, operator interface devices, control relays, etc., and does not contain a PLC or RIO.

2. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
3. Space: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment.
 - a. Furnish hardware to accommodate installation of future circuit breakers, instruments, relays, and controls.
 - b. Wire relay and circuit breaker control power and network connections to the compartment and provide terminations.
 - c. Space for future devices shall include:
 - 1) All necessary bus.
 - 2) Device supports and mounting equipment.
 - 3) Device connections to bus work.
 - 4) Wire troughs or raceway space.
4. Spare: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that physically contains a device with no load connections to be made.
5. Unequipped space: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.
6. Vendor control panel (VCP): Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.

1.04 DELEGATED DESIGN (NOT USED)

1.05 SUBMITTALS (NOT USED)

1.06 QUALITY ASSURANCE

A. General:

1. Furnish equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Shipping precautions:

1. After completion of shop assembly and successful factory testing, pack equipment in protective crates, and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
2. Place dehumidifiers, when required, inside the polyethylene coverings.
3. Skid-mount the equipment for final transport.
4. Provide lifting rings for moving without removing protective covering.
5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS (NOT USED)

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Equipment mounting and anchoring:
 - 1. Design equipment for dead load, running loads, loads during start-up, seismic load specified in Section 01_81_50 - Design Criteria, and other loads as required for proper operation of equipment.
 - a. For equipment with an operating weight of 400 pounds or greater and equipment that is supported higher than 4 feet above the floor, provide calculations for:
 - 1) Operating weight and location of the centroid of mass for the equipment.
 - 2) Forces and overturning moments.

2.03 MANUFACTURERS (NOT USED)

2.04 MATERIALS

- A. Enclosures:
 - 1. Provide enclosures for electrical, instrumentation, and control equipment, regardless of Supplier or Subcontractor furnishing the equipment, that meet the requirements of NEMA Standard 250.
 - a. Provide metallic enclosures unless specifically indicated otherwise.
- B. Stainless steel:
 - 1. Where stainless steel is indicated or used for any portion of the electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
 - 2. Provide exposed screws of the same alloys.
 - 3. Use stainless steel hardware, when chemically compatible, in all chemical areas or areas requiring NEMA Type 4X construction.
 - 4. Do not use stainless steel in any area containing chlorine, gas or solution, chlorine products or ferric chloride.

- C. Plant area electrical work requirements:
1. Provide electrical materials in accordance with the following table, unless otherwise specifically indicated on the Drawings.

Table 1. Electrical Material Requirements		
Plant Area	Environment: W = Wet D = Damp C = Clean/dry X = Corrosive H = Hazardous	NEMA Enclosure Type
Electrical and Control Room	C	1
Pump Room	W	4X SST
Outdoor	W, X	4X SST

PART 3 EXECUTION

- 3.01 EXAMINATION (NOT USED)**
- 3.02 PREPARATION (NOT USED)**
- 3.03 INSTALLATION (NOT USED)**
- 3.04 OWNER TRAINING (NOT USED)**
- 3.05 ADJUSTING (NOT USED)**
- 3.06 CLEANING (NOT USED)**

END OF SECTION

SECTION 26_05_53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Identification of electrical equipment, devices and components.
 - 2. Material, manufacturing and installation requirements for identification devices.

1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
- B. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC).
- C. Occupational Safety and Health Administration (OSHA).

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Nameplates:
 - a. Color.
 - b. Size:
 - 1) Outside dimensions.
 - 2) Lettering.
 - c. Material.
 - d. Mounting means.

1.05 QUALITY ASSURANCE (NOT USED)

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Nameplates:
 - 1. Provide for control panel operator devices (e.g., pushbuttons, selector switches, pilot lights, etc.):
 - a. Same material and same color and appearance as the device nameplates to achieve an aesthetically consistent and coordinated system.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Nameplates:
 - 1. Provide for each piece of electrical equipment, device, control panel, and control panel components.
 - 2. Identical style, color, and material throughout the facility.
 - 3. Device nameplates information:
 - a. Equipment tag number as indicated on the Drawings.
- B. Wire numbers:
 - 1. Vendor to coordinate the wire numbering system with the installing contractor so that every field wire has a unique number associated with it for the entire system:
 - a. Correspond to the terminal block number to which they are attached in the control panel.
 - b. Internal panel wires on a common terminal shall have the same wire number.

2.03 MANUFACTURERS

- A. Nameplates and signs:
 - 1. One of the following or equal:
 - a. Brady.
 - b. Seton.

2.04 MATERIALS

- A. Nameplates:
 - 1. Colors:
 - a. Warning: White-center, red face.
 - b. Other: Black-center, white face.
 - 2. Laminated plastic engraving stock:
 - a. 3/32-inch thick material.
 - b. 2-ply.
 - 3. With chamfered edges.
 - 4. Lettering:
 - a. Block style engraved characters of adequate size to be read easily from a distance of 6 feet.
 - b. Minimum letter height: 1/8 inch.

- B. Signs:
 - 1. Automatic equipment and high voltage signs:
 - a. Suitable for exterior use.
 - b. In accordance with OSHA regulations.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Nameplates:
 - 1. Attach to equipment with rivets, bolts, or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
 - 2. Provide for each disconnecting means with the following:
 - a. Equipment served, voltage, and fuse size as required.
 - b. Identification of the circuit source that supplies the disconnecting means.
 - 3. On NEMA Type 4, NEMA Type 4X, or NEMA Type 7 enclosures, use epoxy-based cement to attach nameplates.
 - 4. Aligned and level or plumb to within 1/64 inch over the entire length:
 - a. Misaligned or crooked nameplates shall be remounted or provide new enclosures at the discretion of the Engineer.
- B. Signs and labeling:
 - 1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
 - a. Fasten warning signs with round head stainless steel screws or bolts.
 - b. Locate and mount in a manner to be clearly legible to operations personnel.
 - 2. Furnish and install permanent and conspicuous warning signs on equipment (front and back), doorways to equipment rooms, pull boxes, manholes, etc., where the voltage exceeds 600 volts.
 - 3. Furnish and install warning signs on equipment that has more than one source of power.
 - a. Warning signs to identify every panel and circuit number of the disconnecting means of external power sources.
 - 4. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking.
 - a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.
 - 5. Label service entrance equipment, switchgear, switchboards, MCCs, panelboards, and transfer switches with the available short circuit current, equipment label, and date of application in accordance with NEC. Coordinate with Section 26_05_74 - Electrical System Studies for available fault current data.

3.04 FIELD QUALITY CONTROL (NOT USED)

END OF SECTION

SECTION 26_05_74

ELECTRICAL SYSTEM STUDIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Short-circuit fault analysis studies.

1.02 REFERENCES

- A. American National Standards Institute (ANSI).
- B. National Fire Protection Association (NFPA):
 - 1. 70E - Standard for Electrical Safety in the Workplace.

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. Initial short-circuit fault analysis: An analysis done based on the Drawings and utility information. The purpose is to identify the available fault current at each piece of equipment to make sure it is properly rated.

1.04 DELEGATED DESIGN

- A. Signed and sealed electrical system study reports.

1.05 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Credentials of the individual(s) performing the study and the individual in responsible charge of the study.
- C. General:
 - 1. Format and quantity:
 - a. A complete set of electronic files, including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports, in PDF format.
 - 2. One-line diagrams:
 - a. The following information shall be included at a minimum:
 - 1) Motor horsepower.
 - 2) Transformer data:
 - a) kVA.
 - b) Configuration.
 - 3) Cable data:
 - a) Insulation.

- b) Size.
 - c) Length.
- b. Fully legible at 11-inch by 17-inch size.

- D. Sharing of short-circuit fault analysis between vendors for electrical equipment.
 - 1. The City of Thornton is bidding 2 packages of electrical equipment that will both be installed by a future contractor for a pump station. The vendors that are supplying equipment for both packages shall coordinate and share information so that studies are consistent. The City of Thornton will share contact information of the vendors for each package. Each vendor is responsible to coordinate with the other on sharing and coordinating information.

- E. Initial short-circuit fault analysis:
 - 1. Based on the Contract Documents and electric utility information.
 - 2. Include a description of all operating scenarios.
 - 3. One-line diagrams.
 - 4. Indicate the estimated available short-circuit current at the line side terminals of each piece of equipment covered by the scope of the study.
 - a. Measure conductor lengths from the Drawings. Use of arbitrary short conductor lengths is not allowed.
 - b. Provide a list of assumptions used in the initial study.

1.06 QUALITY ASSURANCE

- A. Qualifications of the entity responsible for electrical system studies:
 - 1. Short-circuit fault analysis shall be performed with the aid of a digital computer program:
 - a. Point-to-point calculations are not acceptable.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Include the electric utility information on the minimum and maximum available fault current, minimum and maximum utility impedances, utility protective device settings, including manufacturer and model number, interrupting ratings, X/R ratios, and model information one level above the point of connection:
 - a. Utility tolerances and voltage variations.
 - b. Coordinate with the utility for changes to their protective devices and settings to achieve a coordinated system between the utility and the Owner.
 - 2. Obtain equipment layouts and configurations from the manufacturer's final Submittal requirements as required.

- B. Use medium-voltage cable reactance based on typical dimensions of shielded cables with 133 percent insulation levels, unless otherwise indicated.

- C. Meetings:
1. Electrical system study meetings:
 - a. As specified in Section 01_31_19 - Project Meetings.
 - b. The individual conducting the electrical system studies leads the meeting.
 - c. Meet with the Owner and Engineer 1 time.
 - d. First meeting:
 - 1) Discuss the scope of the studies.
 - 2) Confirm electrical system operating modes.
 - 3) Confirm assumptions to be used in the electrical system study with the Owner, including, but not limited to:
 - a) Maximum protective device fault clearing time.
 - 4) Discuss the Owner's operational requirements for both normal operation and maintenance.
- D. Sequencing:
1. Below is an outline of the typical work sequence. Proposed changes to the work sequence may be reviewed and approved by the Engineer.
 - a. First system study meeting.
 - b. Submit the initial short-circuit fault analysis study before submittal of any electrical equipment.
 - 1) Only the initial short-circuit results will be reviewed.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. General study requirements:
1. Scope:
 - a. Short-circuit fault analysis shall include all equipment in the power distribution system, including, but not limited to:
 - 1) Utility equipment (utility transformer and primary protective device).
 - 2) Available utility fault contribution current.
 - 3) All electrical equipment, including:
 - a) Dry-type transformers.
 - b) 240- and 208-volt panelboards.
 - 4) Motors.
 - b. Study scenarios:
 - 1) Include all possible electrical system configurations, for example:
 - a) Operation on normal (utility) source.
 2. Motors:
 - a. Each motor shall be individually modeled:
 - 1) Grouping of motors for fault contribution current is not acceptable.
 - b. Motors with variable frequency drives (VFDs) may be assumed to have no contribution to fault current.
 3. Use the equipment, bus, and device designations as indicated on the Drawings for all studies.

- B. Short-circuit fault analysis study additional requirements:
1. Calculate 3-phase bolted fault, line-to-line fault, line-to-ground fault, double line-to-ground fault, short-circuit 1/2 cycle momentary symmetrical and asymmetrical RMS, 1-1/2 to 4 cycle interrupting symmetrical RMS, and 30-cycle steady-state short-circuit current values at each piece of equipment in the distribution system.
 2. Evaluate bus bracing, short-circuit ratings, fuse interrupting capacity and circuit-breaker-adjusted interrupting capacities against the fault currents, and calculate X/R values:
 - a. Identify and document all devices and equipment as either inadequate or acceptable.
 3. Calculate line-to-ground and double line-to-ground momentary short-circuit values at buses having ground-fault devices.
 4. Provide calculation methods, assumptions, one-line diagrams, and source impedance data, including utility X/R ratios, typical values, recommendations, and areas of concern.

2.03 MANUFACTURERS

- A. Electrical system study software: One of the following or equal:
1. Operation Technology, Inc., ETAP.
 2. SKM Systems Analysis, Powertools.

2.04 EXISTING PRODUCTS (NOT USED)

2.05 MATERIALS (NOT USED)

2.06 MANUFACTURED UNITS (NOT USED)

2.07 EQUIPMENT (NOT USED)

2.08 COMPONENTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 OWNER TRAINING (NOT USED)

3.05 FIELD QUALITY CONTROL (NOT USED)

3.06 ADJUSTING (NOT USED)

END OF SECTION

SECTION 26_09_13

ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Power meters and accessories.

1.02 REFERENCES

- A. American National Standard Institute (ANSI):
 - 1. C12.20 - Electricity Meters - 0.2 and 0.5 Accuracy Classes.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C57.13.6 - Standard for High Accuracy Instrument Transformers.

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. FS - Full scale.
 - 2. SSM - Solid state multifunction power meter.
 - 3. THD - Total harmonic distortion.

1.04 DELEGATED DESIGN (NOT USED)

1.05 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Power meter data, including, but not limited to:
 - a. Power requirements.
 - b. Communications protocols.
 - c. Input/outputs.
 - d. Dimensions.
 - e. Measurement functions.
 - f. Front panel controls.
 - g. Display characteristics.
 - 2. Accessory data:
 - a. Test switch dimensions and wiring diagrams.
- C. Owner Training Submittals:
 - 1. As specified in Section 01_75_17 - Commissioning.

- D. Operation and maintenance manuals:
 - 1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
 - 2. Descriptive and technical bulletins and sales aids edited to reflect only the equipment to be provided and covering each of the components in the system.
 - 3. A maintenance section including instruction leaflets and technical data necessary to setup, change setup and maintain the power meters.
 - 4. Original licensed copies of software and software manuals.

- E. Configuration files and reports:
 - 1. Settings, including, but not limited to:
 - a. Device tag name.
 - b. IP addresses.
 - c. Alarm settings.
 - d. Time synchronization settings.
 - e. Security settings.
 - 2. Configuration files are to be provided in the selected manufacturer's native format.
 - 3. Configuration reports are to be submitted in .PDF format, listing each configured parameter setting and description of each parameter.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.10 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

2.03 MANUFACTURERS

- A. One of the following or equal:
 - 1. ABB.
 - 2. Allen-Bradley.
 - 3. Eaton.
 - 4. Electro Industries/GaugeTech Power Meters.
 - 5. GE Multilin.
 - 6. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

A. Power meters:

1. Power meter type 1 (SSM1) device shall be used in MCCs, SWBD and shall include at a minimum:
 - a. Individual phase currents, within 0.5 percent FS.
 - b. Phase-to-phase and phase-to-neutral voltages, within 0.5 percent FS.
 - c. Watts, VARs, VA, within 1 percent FS.
 - d. Watt-hours, VAR-hours, VA-hours, within 1 percent FS.
 - e. PF (apparent and displacement), within 2 percent FS.
 - f. Frequency, within 1 percent hertz.
 - g. Demand:
 - 1) Ampere, within 0.5 percent FS.
 - 2) Watt, VAR, VA, within 1 percent FS.
 - h. Minimum and maximum values:
 - 1) Volts (L-L), volts (L-N), current, watts, VARS, VA.
 - 2) Power factor:
 - a) Apparent.
 - b) Displacement.
 - c) Frequency.
 - i. Synch-input kilowatts utility.
 - j. LCD with LED backlight.
 - k. Communications:
 - 1) Modbus TCP.

2.08 ACCESSORIES

A. Current transformers:

1. Ring type:
 - a. Suitable for service within low or medium voltage equipment as indicated on the Drawings.
 - b. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the equipment of the application.
2. Current ratio: As indicated on the Drawings.
3. Rated in accordance with IEEE C57.13.6 with accuracy of the current transformers suitable for relay accuracy class and rated for 200 percent burden for the required connected devices.
4. Identify polarity with standard marking or symbols.
5. Capable of carrying rated primary current continuously without damage.
6. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.
7. 3 CTs for 3-wire systems. 4CTs for 4-wire systems.

- B. Test switches:
 - 1. Ten-pole:
 - a. 3 voltage poles, for phase voltage:
 - 1) 600 V rated.
 - b. Four 30 A, non-shorting current poles, for neutral current and let-thru phase currents.
 - c. Three 30 A, shorting current poles, for shorting phase currents.
 - 2. Base to be made of electrical grade plastic.
 - 3. Barriers between poles for pole isolation and separation.
 - 4. Clear cover encapsulating the test switch to enable visual verification of each switch position.
 - 5. Knife-blade type switches, accepting a horizontal gang interlocking bar.
 - 6. Screw type terminals on each switch.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Install power meters in accordance with the manufacturer's instructions in the electrical equipment as indicated on the Drawings.

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 OWNER TRAINING

- A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

END OF SECTION

SECTION 26_12_20

LIQUID FILLED PAD MOUNTED TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Medium voltage, outdoor, liquid-filled pad mounted transformers.

1.02 REFERENCES

- A. American National Standards Institute (ANSI).
- B. ASTM International (ASTM).
- C. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. C57.12.00 - IEEE Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.
 - 2. C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers.
 - 3. C57.12.26 - IEEE Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers.
 - 4. C57.12.28 - IEEE Standard for Pad-Mounted Equipment-Enclosure Integrity.
 - 5. C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers.
 - 6. C57.91 - IEEE Guide for Loading Mineral-Oil-Immersed Power Transformers up to and including 100 MVA with 65 degrees or 55 degrees Average Winding Rise.
 - 7. C57.93 - IEEE Guide for Installation of Liquid-immersed Power Transformers.
 - 8. C57.98 - IEEE Guide for Transformer Impulse Tests.
 - 9. C57.106 - IEEE Guide for Acceptance and Maintenance of Insulating Mineral Oil in Electrical Equipment.
 - 10. C57.147 - IEEE Guide for Acceptance and Maintenance of Natural Ester Fluids in Transformers.
- D. National Electrical Manufacturers Association (NEMA):
 - 1. TR-1 - Transformers, Regulators, and Reactors.
- E. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC).
- F. U.S. Department of Energy (DOE):
 - 1. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment.

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Complete installation instructions.
 - 2. Complete storage and handling instructions.
 - 3. Kilovolt-ampere rating, including derating calculations.
 - 4. Primary/secondary connections.
 - 5. Primary voltage and available taps.
 - 6. Secondary voltage.
 - 7. BIL rating.
 - 8. Temperature rise.
 - 9. Lightning arrester data.
 - 10. %Z, %X, %R, X/R.
 - 11. Efficiency.
 - 12. Gross weight.
 - 13. Torque values for bolted connections for secondary cable connections.
 - 14. Manufacturer's suggested hi-potential test procedures and test levels for field testing:
 - a. Initial field test.
 - b. Subsequent maintenance tests.
 - 15. Certification from the manufacturer stating the transformer design complies with IEEE C57.12.00.
 - 16. Type of oil.
 - 17. Gallons of oil.
 - 18. Weight of oil.
 - 19. Complete MSDS sheets. There is no C57 standard for ANSI or IEEE.
 - 20. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01_81_50 - Design Criteria:
 - a. Manufacturer's statement of seismic qualification with substantiating test data.
 - b. Manufacturer's special seismic certification with substantiating test data.
- C. Shop Drawings:
 - 1. Complete detailed, dimensioned drawings showing the equipment being furnished, with pertinent information, including the following:
 - a. Dimensions and locations of conduit entrance windows.
 - 2. Complete nameplate schedule, except impedance.
- D. Calculations:
 - 1. Detailed calculations or details of the actual physical testing performed on the transformers to prove the transformers are suitable for the seismic requirements at the Project Site.
- E. Installation instructions:
 - 1. Provide manufacturer's installation instructions.

- F. Quality Control Submittals:
 1. Manufacturer's representative qualifications.
 2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
 3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
 4. Test reports.

- G. Operation and maintenance manuals:
 1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
 2. Complete as-built dimensioned and scaled drawings for transformer.
 3. Recommended periodic maintenance requirements.
 4. Maintenance instructions, including schedules, parts identification, troubleshooting, assembly instructions, parts list, and predicted life of parts subject to wear and deterioration.
 5. Recommended field test levels and procedures before installation and for maintenance purposes after being placed in service.
 6. Periodic and preventative maintenance torque values for bolts.
 7. List of recommended preventative maintenance tests, test frequencies, test procedures, acceptable test result ranges and disposal recommendations for utilized mineral oil in accordance with IEEE C57.106 or natural ester fluids in accordance with IEEE C57.147.
 8. Copies of factory test reports.

1.05 QUALITY ASSURANCE

- A. Manufacturer qualifications:
 1. Manufacturer shall be in the business of regularly manufacturing the specified transformers for a minimum of 10 years with a satisfactory performance record.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship transformers to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment:
 1. Each transformer shall be shipped with a global positioning system (GPS) unit to record the shipping route.
 2. Provide monitoring of the acceleration the transformer experiences during shipment:
 - a. GPS unit can record the acceleration.
 - b. Utilize a G-force gauge that indicates that the acceleration has exceeded allowed values.
 3. Transformers that experience vertical accelerations greater than 3 G or horizontal accelerations greater than 5 G shall not be accepted.

- B. Furnish temporary equipment heaters within the transformer to prevent condensation from forming.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Conduct factory acceptance test and submit certified test results for the Engineer's review.
 - 2. Ship equipment to Project Site after successful completion of factory acceptance test.
 - 3. Submit manufacturer's certification that equipment has been properly installed and is fully functional for the Engineer's review.
 - 4. Commissioning as specified in Section 01_75_17 - Commissioning.

1.09 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Outdoor oil-filled, pad mounted transformers for operation on a 60 hertz system with voltage and kilovolt-ampere ratings as indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.
- B. Pad mounted transformers shall be compartmental type, designed for outdoor installation on a concrete pad.

2.03 MANUFACTURERS

- A. One of the following or equal:
 - 1. Asea Brown Boveri (ABB).
 - 2. Eaton/Cooper Power Systems.
 - 3. Schneider Electric.

2.04 MATERIALS

- A. Windings:
 - 1. Primary and secondary windings shall be high conductivity copper.
- B. Insulating fluid:
 - 1. Envirotemp FR3.
 - 2. Insulating fluid shall meet or exceed the requirements of the appropriate IEEE and ASTM fluid standards.

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

- A. Transformer and associated terminal compartments designed and constructed to be tamper-resistant:
 - 1. No externally removable screws, bolts, or other devices.

- B. Ratings:
 - 1. 3-phase, 60 hertz.
 - 2. Self-cooled.
 - 3. 65-degree Celsius rise.
 - 4. Primary voltage as indicated on the Drawings.
 - 5. Primary connection as indicated on the Drawings.
 - 6. Secondary voltage as indicated on the Drawings.
 - 7. Secondary connection as indicated on the Drawings.
 - 8. Kilovolt-ampere rating as indicated on the Drawings.
 - 9. Basic impulse insulation level (BIL) in accordance with IEEE C57.98:
 - a. 1.2 kV Class: 30 kV.
 - b. 2.5 kV Class: 45 kV.
 - c. 5.0 kV Class: 75 kV.
 - d. 8.7 kV Class: 75 kV.
 - e. 15 kV Class: 95 kV.
 - 10. Sound levels:
 - a. In accordance with NEMA TR1.
 - b. Measurement procedure in accordance with IEEE 57.12.90.
 - 11. Efficiency:
 - a. Transformers 2,500 kVA and less shall have an efficiency rating in accordance with DOE 10 CFR Part 431.
 - 12. Short-circuit capacity:
 - a. Mechanical short-circuit capability in accordance with IEEE C57.12.90.
 - 13. Thermal short-circuit capability in accordance with IEEE C57.12.00.

2.07 COMPONENTS

- A. Core and coil:
 - 1. Manufactured from burr-free, grain-oriented silicon steel laminations and stacked to eliminate gaps in the corner joints.
 - 2. Insulated with B-stage, epoxy coated, diamond pattern, insulating paper, thermally cured under pressure to ensure proper bonding of conductor and paper.
 - 3. Clamped and braced to resist distortion caused by short-circuit stresses within ratings or by shipping and handling and to prevent the shifting of core laminations.
 - 4. Vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system:
 - a. Energize the windings under vacuum to heat the coils and drive out moisture.
 - b. While under a vacuum and the coils are heated, fill the tank with preheated, filtered and degassed insulating fluid.

- B. Tank:
1. Conforming to the enclosure integrity requirements in accordance with IEEE C57.12.28.
 2. Equipped with extra-heavy duty, welded-in-place lifting lugs and jacking pads:
 - a. Provide adequate cross-bracing of the base to allow skidding or rolling in any direction.
 3. Capable of withstanding a pressure of 7 pounds per square inch gauge without permanent distortion, and 15 pounds per square inch gauge without rupturing.
 4. Provide a pressure relief valve as a means to relieve pressure in excess of pressure resulting from normal operation:
 - a. Cracking pressure: 10 pounds per square inch gauge within 2 psig.
 - b. Resealing pressure: 6 pounds per square inch gauge minimum.
 - c. Zero leakage from reseal pressure to 8 pounds per square inch gauge.
 - d. Flow at 15 pounds per square inch gauge: 35 scfm minimum.
- C. Terminal compartments:
1. Conforming to the enclosure integrity requirements in accordance with IEEE C57.12.28.
 2. Full-height, air filled primary and secondary terminal compartments with hinged doors shall be located side-by-side separated by a steel barrier, with the primary compartment on the left, complete with tamper resistant hardware.
 3. Hinges and pins to be passivated Type 304 stainless steel or equivalent corrosion-resistant metal.
 4. Doors and compartment hood shall be removable:
 - a. Removable doorsill on compartments shall be provided to permit rolling or skidding of unit into place over conduit stubs in foundations.
 5. Doors in both the high-voltage section and the low-voltage section shall be able to be latched in the open position.
 6. Entire terminal compartment for the transformer shall be bolted to the transformer so that the terminal compartment may be unbolted from the transformer and the transformer removed without disturbing conduits that enter the compartment from the side or top.
 7. Minimum of 30-inches deep.
 8. Secondary compartment:
 - a. Enclose the secondary termination bushings and provide for incoming cable from below the compartment.
 - b. Compartment shall also house:
 - 1) Liquid level indicator.
 - 2) Drain valve with sampling device.
 - 3) Dial type thermometer.
 - 4) Pressure relief valve.
 - 5) Vacuum pressure gauge.
 - c. Door to low-voltage section shall have a 3-point latching mechanism with pad-locking provision.
 9. Primary compartment:
 - a. Enclose the high voltage bushings and provide for incoming cables from below the compartment:
 - 1) Coordinate primary bushing size with incoming cables size as indicated on the Drawings.

- b. Compartment shall also house:
 - 1) Dead front lightning arresters.
 - 2) No-load tap changer.
 - c. Accessible only after the door for the secondary compartment has been opened. Door shall be held closed by a captive bolt; access to this bolt shall be provided only when the door to the low-voltage section is opened.
 - 10. Primary terminals and parking stands:
 - a. Dead front construction, in accordance with IEEE C57.12.26, utilizing high voltage elbows for connections to primary cable and lightning arresters.
 - b. Terminal arrangement with 6-bushing wells:
 - 1) 3 for terminating primary power cables.
 - 2) 3 for connecting lightning arresters.
 - 3) 6 parking stands.
 - c. Supporting structure within cabinet to support cables and eliminate mechanical stress on insulators.
 - 11. Secondary terminals (480-V):
 - a. 4 low voltage spade bushings with 2 holes for each cable, in accordance with IEEE C57.12.26.
 - b. Extend low voltage bushings as necessary to accommodate the cable arrangement indicated on the Drawings or indicated on the conduit schedule:
 - 1) Extension via a fully rated, tin-plated, copper bus system braced to withstand the available fault current.
 - c. Neutral brought out through an insulated bushing and externally grounded to the tank with a removable ground strap.
 - d. Supporting structure within cabinet to support cables and eliminate mechanical stress on insulators.
 - 12. Secondary terminals (5 kV):
 - a. Dead front construction, in accordance with IEEE C57.12.26, utilizing high voltage elbows for connections to primary cable and lightning arresters.
- D. De-energized tap changer:
- 1. Furnish with full capacity high-voltage taps:
 - a. Two 2-1/2 percent taps above and below rated voltage.
 - 2. Labeled to indicate that the transformer must be de-energized before operating the tap changer as required by IEEE C57.12.10.
 - 3. Externally operated no-load tap changer switch with snap action switch and lever handle.
 - 4. Padlocking provision in each tap position.
 - 5. Position indication.

2.08 ACCESSORIES

- A. Lightning arresters:
 - 1. High voltage dead front design for elbow connection.
 - 2. Metal oxide varistor arresters.
 - 3. Distribution class arresters.
 - 4. Rating as indicated on the Drawings and/or consistent with the distribution voltage.

- B. Tank ground pads:
 - 1. 2 stainless steel pads, welded to the tank wall, with unpainted surfaces:
 - a. 1 pad in primary compartment.
 - b. 1 pad in secondary compartment:
 - 1) If additional load ground connections are required, a tin-plated, copper equipment ground bus shall be bolted to the pad.
- C. Dial-type thermometer:
 - 1. Direct stem mounted in a closed well so that the thermometer can be removed without breaking the tank seal:
 - a. Well shall be threaded into a fitting that is welded to the transformer tank wall.
 - 2. Thermometer shall have a marking hand which is moved by the indicating hand to indicate maximum oil temperature:
 - a. Marking hand shall be externally resettable.
- D. Sampling device:
 - 1. Provide for external sampling of the transformer insulating fluid.
 - 2. Threaded into a fitting that is welded to the transformer tank wall.
 - 3. Piped such that valve and sample point are external to the termination cabinet:
 - a. NEMA Type 4X stainless steel box supported to transformer to house sample device.
- E. Liquid level gauge:
 - 1. Dial-type liquid level gauge.
- F. Vacuum pressure gauge:
 - 1. 10 pounds per square inch gauge vacuum to plus 10 pounds per square inch gauge scale.
- G. Pressure relief device:
 - 1. Located in the air space in the transformer tank to provide a method of relieving internal tank pressure.
 - 2. Self-relieving.
 - 3. Indicating.
 - 4. Operating pressure: 10 within 2 pounds per square inch gauge.
- H. Nameplates:
 - 1. Provide nameplate as specified in Section 26_05_53 - Identification for Electrical Systems and the following:
 - a. Provide complete nameplates identifying equipment, caution, voltage, etc.
 - b. Provide complete nameplates for both inside and outside of the transformer terminal compartments.
 - c. Provide diagrammatic nameplate.
- I. Bolted 8-inch (minimum) diameter round handhold on cover.
- J. Lifting lugs at each corner of tank for lifting complete transformer.

- K. Jacking facilities at each corner of base for jacking the complete transformer.
- L. Base designed for rolling or skidding in any direction.

2.09 FABRICATION

- A. Tanks:
 - 1. Construction: Sealed tank construction with welded cover. Permanently locate an inorganic gasket between the cover and the tank flange during the welding of the transformer cover to prevent the entrance of weld spatter into the tank.
 - 2. Large handhole with bolted cover and protected with a weather cover.
 - 3. 4 lifting hooks.
 - 4. Jacking pads.
 - 5. Fluid sample valve.
 - 6. Designed for 7 pounds per square inch gauge without permanent distortion; 12 pounds per square inch gauge when silicone oil insulating fluid is specified.

2.10 FINISHES

- A. In accordance with IEEE C57.12.28, including the following performance requirements:
 - 1. Salt spray test.
 - 2. Crosshatch adhesion test.
 - 3. Humidity test.
 - 4. Impact test.
 - 5. Oil resistance test.
 - 6. Ultraviolet accelerated weathering test.
 - 7. Abrasion resistance: Taber® Abraser.
 - 8. Topcoat: Liquid polyurethane coating to seal and add ultraviolet protection.
 - 9. Color: Munsell Green 7GY.

2.11 SOURCE QUALITY CONTROL

- A. Source Testing:
 - 1. Perform the following factory tests as required by IEEE C57.12.00 and in accordance with IEEE C57.12.90:
 - a. No-load (85 degrees Celsius) losses at rated current. (Maximum allowable no-load losses: 10 percent).
 - b. Total (85 degrees Celsius) losses at rated current. (Maximum allowable total losses: 6 percent).
 - c. Percent impedance (85 degrees Celsius) at rated current.
 - d. Excitation current (100 percent voltage) test.
 - e. Winding resistance measurement tests.
 - f. Turns ratio tests using tap settings.
 - g. Polarity and phase relation tests.
 - h. Temperature test.
 - 2. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Installation Verification:
 - 1. Furnish Manufacturer's Certificate of Installation Verification.

3.04 FIELD QUALITY CONTROL

- A. As specified in Section 26_05_00 - Common Work Results for Electrical.
- B. Provide the services of a manufacturer's authorized representative:
 - 1. Inspect installation before start-up.
 - 2. Witness energization.
- C. Energize transformer according to the manufacturer's recommended procedure and in accordance with IEEE C57.91.

3.05 OWNER TRAINING (NOT USED)

3.06 ADJUSTING (NOT USED)

END OF SECTION

SECTION 26_13_01

5-KILOVOLT MEDIUM VOLTAGE METAL CLAD SWITCHGEAR

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. 5-kilovolt class metal clad switchgear.
 - 2. Vacuum interrupter power circuit breakers.

1.02 REFERENCES

- A. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. C37.06 - IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V.
 - 2. C37.20.6 - IEEE Standard for 4.76 kV Rated Ground and Test Devices Used in Enclosures.
 - 3. C62.11 - IEEE Standard for Metal Oxide Surge Arresters of AC Power Circuits (> 1 kV).
- B. National Electrical Manufacturers Association (NEMA).
- C. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC).
- D. Underwriters Laboratories, Inc. (UL).

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Manufacturer of switchgear.
 - 2. Manufacturers of components and accessories.
 - 3. Weight of each circuit breaker of different frame sizes.
 - 4. Dimensions:
 - a. Height.
 - b. Length.
 - c. Width.
 - d. Weight.
 - 5. Nameplate schedule.
 - 6. Bill of material.

7. Description of operation:
 - a. Metering system.
 - b. Protective relaying.
 8. Ratings:
 - a. Voltage.
 - b. Phase.
 - c. Current.
 - d. Interrupting rating (circuit breakers and fuses).
 - e. Momentary current rating.
 9. List of recommended spare parts.
 10. Lightning arrester data.
 11. Name of dealer's repair facility and parts stocking agreement with the factory:
 - a. Agreement shall outline in detail the manufacturer's parts stocking requirements and the method by which the manufacturer's representative verifies that the stock is at an acceptable level.
 - b. Agreement shall outline the method by which the manufacturer determines that the service personnel meet factory standards.
 12. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01_81_50 - Design Criteria:
 - a. Manufacturer's statement of seismic qualification with substantiating test data.
 - b. Manufacturer's special seismic certification with substantiating test data.
- C. Shop Drawings:
1. Layout drawings:
 - a. Provide fully dimensioned, to scale, equipment layout drawings which include:
 - 1) Equipment furnished: Plan, front and side views.
 - 2) Shipping splits.
 - 3) Bus layout.
 - 4) Interfaces with other equipment.
 - 5) Minimum distances to walls and breaker "roll-out" distances.
 - 6) Bottom conduit windows.
 - b. Complete, detailed, and scaled switchgear layout:
 - 1) Front panel.
 - 2) Sub-panels.
 - 3) Interior panels.
 - 4) Assembly drawings cross-section as a minimum for each cubicle with major dimensions indicated.
 2. Complete electrical wiring diagrams:
 - a. Indicate wire numbers.
 3. Complete interface and point-to-point connection diagrams for metering system.
 4. Internal schematics, elementary diagrams, and wiring diagrams of each unit or compartment, including wiring identification and terminals.
 5. Internal cell-to-cell interconnection wiring diagrams, including wiring identification and terminal numbers.

6. Complete 1-line and 3-line diagrams for each switchgear line-up:
 - a. Identify components comprising the switchgear assembly, including, but not limited to, circuit breakers, control power and instrument transformers, meters, relays, control devices, monitoring devices, and terminal blocks.
 - b. Clearly indicate device electrical ratings on the Drawings.

- D. Calculations:
 1. DC power and current requirements needed to operate the 5-kilovolt metal-clad switchgear circuit breakers and protective relays.
 2. Detailed calculations or details of the actual physical testing performed on the switchgear to prove the switchgear is suitable for the seismic requirements at the Project Site.

- E. Installation instructions:
 1. Provide manufacturer's installation instructions.

- F. Quality Control Submittals:
 1. Manufacturer's representative qualifications.
 2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
 3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
 4. Test reports.

- G. Owner Training Submittals:
 1. As specified in Section 01_75_17 - Commissioning.

- H. Operation and maintenance manuals:
 1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
 2. Operating instructions:
 - a. Detail the operational functions of custom controls that have been placed on the front panel of the switchgear and internal PLC programming, if applicable.
 3. Maintenance manual:
 - a. Furnish maintenance manuals with instructions for maintenance of the equipment and data identifying the parts.
 - b. Include information needed to maintain the switchgear, including, but not limited to, the following:
 - 1) Instructions for testing, adjustment, and start-up.
 - 2) Detailed control instructions that outline the function and operation of every control device.
 - 3) Schematic and wiring diagrams:
 - a) Showing internal and external connection.
 - b) Furnish in a reduced 11-inch by 17-inch fully legible format.

1.05 QUALITY ASSURANCE

- A. Sections and devices shall be UL listed and labeled.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship the switchgear and associated equipment to the Project Site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment.
- B. Furnish temporary equipment heaters within the switchgear to prevent condensation from forming.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Conduct the initial short-circuit fault analysis study as specified in Section 26_05_74 - Electrical System Studies and submit results for the Engineer's review.
 - 2. After successful review of the initial fault current study, submit complete equipment Submittal.
 - 3. Ship equipment to Project Site.
 - 4. Conduct Owner Training sessions.
 - 5. Commissioning as specified in Section 01_75_17 - Commissioning.

1.09 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide medium-voltage 5-kilovolt class metal-clad switchgear as specified in the Contract Documents and indicated on the Drawings.
- B. Provide complete and functional lineups of switchgear with associated controls.
- C. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.
- B. General:
 - 1. Metal-clad, 5-kilovolt switchgear designed and manufactured in accordance with the reference standards listed in this Section.

2. Switchgear and major components to be products of a single manufacturer, including, but not limited to:
 - a. Circuit breakers.
 - b. Related equipment specified in the Contract Documents or indicated on the Drawings.
 3. In addition to the specified basic equipment common to switchgear sections, equip the various individual sections with instruments, protective relays and control devices as indicated on the Drawings and/or specified below.
 4. Arrange the equipped sections side by side to form continuous switchgear lineups as indicated on the Drawings.
 5. Doors:
 - a. Provide snake-skin cable management sleeve or spiral wire-wrap on wires where they pass from the interior of the cabinet past the door hinge to door-mounted devices.
- C. Description of sections:
1. Breaker compartment:
 - a. Main, tie, or feeder breaker as indicated on the Drawings.
 - b. Protective relays and other protective devices and interlocks as indicated on the Drawings.
 - c. Multi-function solid state meters as indicated on the Drawings.
 - d. Current transformers: Quantity and ratios as indicated on the Drawings.
 2. Space for future devices:
 - a. Provide spaces as indicated on the Drawings.
 - b. As specified in Section 26_05_00 - Common Work Requirements for Electrical.
 3. Transformer compartment:
 - a. Voltage transformers: Fused, with quantities, ratio, and configuration as indicated on the Drawings.
 - b. Control power transformers: Fused with voltage ratings as indicated on the Drawings.

2.03 MANUFACTURERS

- A. One of the following or equal:
1. ABB.
 2. Eaton.
 3. Powell.
 4. Schneider Electric.
- B. Circuit breakers: Same manufacturer as metal-clad switchgear.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

- A. Voltage ratings:
1. As indicated on the Drawings.
 2. Basic impulse insulation level: Minimum 60 kilovolts.

- B. Main bus:
1. High conductivity, tin-plated copper:
 - a. Flat bar with rounded edges.
 - b. Suitably braced and supported on high dielectric strength insulators.
 2. Continuous current carrying capacity as indicated on the Drawings.
 3. Insulate each bus with fluidized bed epoxy flame retardant and track resistant insulation.
 4. Mount insulated bus on flame retardant, track resistant supports and brace to withstand magnetic stresses developed by fault currents equal to the close and latch rating of the circuit breakers.
 5. Bus connections:
 - a. Plated.
 - b. Bolted with Belleville spring washers.
 - c. Install insulated boot over joint.
 6. Document temperature rise of the bus and connections by design tests.
- C. Ground bus:
1. Tin-plated copper bar, 1/4 inch by 2 inches minimum, extended through each section:
 - a. Firmly secure to each vertical section.
 - b. Provide termination lugs for termination of copper ground cable at each end of the bus.
 2. Ground each section directly to ground bus.
- D. Stationary structure:
1. Utilize unit type construction in formation of housing in order to provide a rigid, self-supporting and self-contained enclosure for each circuit breaker unit and other units comprising switchgear:
 - a. Fabricate each stationary structure of heavy, formed, smooth, and level steel sheets and structural members, bolted or welded to form a rigid assembly with hinged steel panel suitable for mounting of instruments, meters, relays, and control devices.
 - b. Provide bolted, hinged front and rear cubicle doors with locks.
 2. Dead front construction with rear access via lockable, hinged doors.
 3. Sections shall be approximately 95 inches high, 36 inches wide, front and rear aligned:
 - a. Maximum dimensions as indicated on the Drawings.
 4. Isolate circuit breaker units, bus, instrument and control transformers, and outgoing cables within separate compartments formed by sheet steel barriers:
 - a. Mount heavy close-fitting bus supports at bus openings between units:
 - 1) Supports shall form a barrier to isolate each unit from adjacent units.
 - b. Provide each compartment with a separate cover for individual servicing without exposing the circuit in adjacent compartment.
 5. Provide automatic shutters to isolate the circuit breaker compartment from the bus when the circuit breaker unit is moved to the TEST or WITHDRAWN position.
 6. NEMA type:
 - a. Type 1 gasketed:
 - 1) Switchgear sections shall have an open bottom in the rear for cable terminations.

7. Front access to devices accessible through a formed, bolted, hinged removable cover:
 - a. Captive knurled type knob screws are to hold covers in place.
 8. Provide switchgear with lifting channels having provisions for attachment of crane slings to facilitate lifting and handling each shipping-assembly unit:
 - a. Remove lifting channels after equipment is installed.
- E. Cable compartment:
1. Support circuit breaker disconnecting contacts by means of flame-retardant, track-resistant polyester glass or porcelain supports.
 2. Provide cable terminals:
 - a. NEMA 4-hole pads suitable for connection and termination of 5 kilovolt shielded cables.
 3. Design switchgear so that high voltage, low voltage, control and instrumentation cables can enter the switchgear from either the top or bottom.
 4. Provide cable supports with provisions for stress relief cones and cable bends.
- F. Removable element:
1. Provide a racking screw and moving block for breaker insertion and withdrawal:
 - a. Capable of holding the breaker in the CONNECTED position.
 2. Utilize master jigs to determine accurately the correct stud locations of the removable and the stationary elements.
 3. Provide means for mechanically locking the removable element in any position:
 - a. Shall not interfere with the operation of the breaker and its mechanism.
 4. Provide a ground shoe to ground the breaker in all positions.
 5. Provide breaker CONNECTED position indication.
 6. Provide interlock on each circuit breaker unit to prevent circuit breaker from being removed from CONNECTED position and from being placed in CONNECTED position while breaker is closed:
 - a. If the circuit breaker is closed, the interlock shall trip the breaker before it can be placed into or removed from the CONNECTED position.
 7. Accurately align stud and socket primary disconnecting devices:
 - a. Furnish tin-to-tin pressure contacts to prevent harmful temperature rise due to oxidation, together with nonmagnetic corrosion-resisting springs to provide high-pressure line contacts.
 - b. Mount stationary contact in a 1-piece glass, polyester, or porcelain shell to provide ample insulation from the framework.
 - c. Mount movable contact on the circuit breaker stud to ensure direct contact.
 8. Provide secondary disconnecting devices for bringing control leads to circuit breaker operating mechanism and auxiliary switches on removable element:
 - a. Spring mount self-aligning receptacles on stationary framework.
 - b. Mount the plugs on the removable element.
 - c. Contacts in the receptacles shall be recessed to ensure against accidental short-circuit of control or secondary wiring.
 9. Mechanism-operated compartment switch:
 - a. Provide up to 12 normally closed and up to 15 normally open contacts.
 - b. Switches shall be activated by breaker mechanism.
 10. Truck operated cell switch:
 - a. Provide normally closed switch contacts to indicate the breaker is in the CONNECTED position.

2.07 COMPONENTS

- A. Circuit breakers:
1. Power circuit breaker unit, including:
 - a. 1 set of primary disconnecting devices with automatic shutters.
 - b. 1 set of secondary disconnecting devices.
 2. Oilless, vacuum Type 3 pole:
 - a. Horizontal draw-out type capable of being withdrawn on rails.
 - b. Electrically and mechanically trip-free with anti-pumping features.
 3. Ratings: In accordance with IEEE C37.06, with the following minimum ratings, for indoor breakers with K equal to 1:
 - a. Voltage:
 - 1) Operating voltage: As indicated on the Drawings.
 - 2) Maximum design voltage: 4.76 kilovolts.
 - 3) 60 hertz withstand test voltage: 60 kilovolts.
 - 4) Basic impulse insulation level: 60 kilovolts minimum.
 - b. Current:
 - 1) Continuous current rating: As indicated on the Drawings.
 - 2) Short circuit current/peak closing and latching current at rated maximum kilovolts:
 - a) 1,200-amp continuous current rating:
 - (1) 31,500/82,000amps.
 - c. Rated interrupting time: 5 cycles.
 4. Operation:
 - a. Operable by means of a stored-energy mechanism, normally charged by a universal motor, which can be charged by a manual handle for emergency closing or test.
 - b. Mechanism closing speed of the contacts to be independent of both control voltage and operator.
 - c. Provide contact wear gap indicator for each vacuum interrupter to indicate available contact life, which requires no tools and is easily visible when breaker is removed from its compartment.
 5. Provide secondary disconnecting contacts that automatically engage in the OPERATING and TEST position to complete circuits as required.
 6. Provide 2 sets of normally open, "a", and 2 sets of normally closed, "b", circuit breaker auxiliary contacts wired to terminal strips.
 7. Breaker control voltage:
 - a. Open/Trip: 125 VDC.
 - b. Close: 125 VDC.
 8. Circuit breakers of equal rating shall be interchangeable.
- B. Relays and instrument transformers:
1. Provide protective relays complete with devices and associated circuitry necessary to perform the required functions specified in the Contract Documents or indicated on the Drawings.
 2. As specified in Section 26_13_05 - Protective Relays.
- C. Control power transformers:
1. Provide on rollout drawers in designated cells as an integral part of the switchgear assembly as indicated on the Drawings.

2. Sized by the switchgear manufacturer to have a minimum capacity of 125 percent of the load served.
 3. Protected by both primary and secondary fuses. Protect primary side with current limiting fuses.
- D. Control wiring:
1. Switchgear wire:
 - a. Type SIS, single-conductor, stranded copper, rated 600 volts.
 - b. Provide flexible stranding for swinging panels.
 - c. Minimum wire size:
 - 1) Number 14 for control circuits.
 - 2) Number 12 for voltage and current transformer circuits.
 2. Route outgoing control wires to master terminal blocks with suitable numbering strips numbered in agreement with the manufacturer's detailed wiring diagrams:
 - a. Terminate control wiring in molded, screw-type terminal blocks.
 - b. Provide a minimum of 10 percent spare terminal blocks for each unit.
 - c. Compression type terminal blocks are not acceptable.
 3. Terminate foreign circuits entering the switchgear on "pull-apart" terminal blocks.
 4. Number wiring with machine-printed tag devices at both ends consistent with the manufacturer's detailed wiring diagrams:
 - a. Duplication of wire numbers and terminal block numbers is not acceptable.
 - b. Uniquely number every wire.
 5. When a power source other than the source that is interrupted is present in the switchgear compartment, provide a switch for each remote source inside the compartment to isolate the source in accordance with the NEC.
 6. Terminate control wire with insulated barrel, ring type connectors:
 - a. Manufacturers: The following or equal:
 - 1) Stakon.
- E. Lightning arresters:
1. Heavy-duty distribution class MOV type surge arresters, 5-kilovolt class, for installation on the specified nominal voltage system.
 2. Provide brackets, wiring, and other hardware as necessary for cubicle mounting.
 3. Designed and manufactured in accordance with the latest edition of IEEE C62.11.
- F. Miscellaneous:
1. Furnish wiring, voltage bus, necessary fuses, and terminal blocks within each unit.
 2. Requirements for items mounted on panels:
 - a. Semi-flush mounting for 1/8-inch panels, unless otherwise noted.
- G. The following electrical safety devices:
1. Maintenance mode switch.

2.08 ACCESSORIES

- A. Metering system:
1. Provide metering as indicated on the Drawings and as specified in Section 26_09_13 - Electrical Power Monitoring.

- B. Nameplates:
 - 1. Provide nameplates to identify:
 - a. Switchgear units:
 - 1) Label front and rear doors of each cubicle.
 - b. Door mounted components.
 - c. Interior mounted devices.
 - 2. As specified in Section 26_05_53 - Identification for Electrical Systems.
 - 3. Engraved with the circuit number and circuit name as indicated on the Drawings.
- C. Warning signs:
 - 1. Voltage:
 - a. Provide a minimum of 2 warning signs on the front of the switchgear lineup and 2 on the back.
 - b. Red laminated plastic engraved with white letters approximately 1/2 inch high.
 - c. Signs shall read:
 - 1) "WARNING-HIGH VOLTAGE-KEEP OUT".
 - 2. Arc flash:
 - a. Provide 1 warning sign for each switchgear compartment.
 - b. Signs shall have read a minimum of:
 - 1) "DANGER-ELECTRIC ARC FLASH HAZARD".
 - 2) Signs shall meet the requirements of the NEC.
- D. Portable lifting device for removing the breaker from the breaker cell.
- E. 1 transfer truck (turning dolly) for removing and transporting circuit breakers.
- F. 1 circuit breaker remote control station for opening and closing the circuit breakers with 20-foot minimum cord and plug.
 - 1. Remote circuit breaker racking mechanism: Cord and plug: 50-foot minimum.
 - 2. 120 VAC powered.
 - 3. Connection of the mechanism shall be made with the circuit breaker compartment door closed.
 - a. Mechanism shall rack the breaker to the test or disengaged position with the breaker compartment door closed.
- G. Manual levering crank.
- H. Rail extensions and rail clamps: 1 set.
- I. Ground and test device:
 - 1. Designed for insertion into the switchgear for the following functions:
 - a. Grounding circuits for maintenance work.
 - b. Apply potential for cable testing.
 - c. Provides access to bus and line circuits for phase testing.
 - 2. The stored energy closing mechanism shall be the same as the circuit breakers.
 - 3. Furnish with a remote close device with a 50-foot cable.
 - 4. Provide front panel indication of contact status.

- 5. Momentary and 4-second current carrying capacities equal to or greater than the breakers.
 - a. No automatic tripping of the device shall be provided.

- J. Secondary couplers for operating a power circuit breaker in the DISCONNECTED position.

- K. Mimic bus:
 - 1. Laminated plastic material fastened to the front surface of the switchgear reflecting bus routing and power devices.

- L. Test blocks and plugs:
 - 1. Molded polycarbonate material.
 - 2. Make-before-break connections for CT circuits.
 - 3. Provide cover for each test block.
 - 4. Manufacturers: One of the following or equal:
 - a. ABB, FT-1.
 - b. Multilin, PK-2.

- M. Circuit breaker indicating lights and control switches:
 - 1. Indicating lights:
 - a. Low voltage LED:
 - 1) Green for "OPEN."
 - 2) Red for "CLOSED."
 - 2. Control switches:
 - a. Rotary cam operated switchgear rated type with means for maintaining contact position.
 - b. Contacts to be silver-to-silver, enclosed in removable protective covers.
 - c. Manufacturers: One of the following or equal:
 - 1) Electroswitch.
 - 2) General Electric Co., Type SB.

- N. Provide preformed insulating boots for cable landing pads and lugs. Cable termination boots shall have the same dielectric withstand rating as the switchgear.

- O. Switchgear control panel VCP-111 located in the Control Room.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

- A. Manufacturer's standard epoxy paint applied to chemically cleaned and primed steel for internal and external parts:
 - 1. Coating to have corrosion resistance of 300 hours to 5 percent salt spray.
 - 2. Paint complete assembly with a 1.5- to 2.0-mil thick exterior finish spray coat of manufacturer's standard gray paint before shipment.

2.11 SOURCE QUALITY CONTROL

- A. Source Testing:
 - 1. Coordinate date of testing with Owner 60 days in advance. Make testing facility available to Owner if Owner desires to witness the testing in-person.
 - 2. Test the complete switchgear at the manufacturer's establishment:
 - a. Completely assemble, wire and test the switchgear.
 - b. Perform detailed inspections before and after assembly to ensure correctness of design and workmanship.
 - 3. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.
 - 4. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Provide the services of a qualified manufacturer's representative to:
 - 1. Make control connections across the shipping splits.
 - 2. Install and align circuit breakers.
- B. Furnish Manufacturer's Certificate of Installation Verification

3.04 FIELD QUALITY CONTROL

- A. As specified in Section 26_05_00 - Common Work Results for Electrical.
- B. Provide the services of a qualified manufacturer's representative to:
 - 1. Be present at the Project Site when the switchgear arrives.
 - 2. Act as an advisor in assisting the Contractor regarding the unloading and move-in operations.
 - 3. Furnish the services of a factory-certified technician during the start-up and adjustment period to ensure that items furnished are in proper operating condition:
 - a. Technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.

3.05 OWNER TRAINING

- A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

3.06 ADJUSTING (NOT USED)

END OF SECTION

SECTION 26_13_02

15-KILOVOLT MEDIUM VOLTAGE METAL CLAD SWITCHGEAR

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. 15-kilovolt class metal clad switchgear.
 - 2. Vacuum interrupter power circuit breakers.

1.02 REFERENCES

- A. American National Standard Institute (ANSI).
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. C37.06 - IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V.
 - 2. C37.20.6 - IEEE Standard for 4.76 kV to 38 kV Rated Ground and Test Devices Used in Enclosures.
 - 3. C62.11 - IEEE Standard for Metal Oxide Surge Arresters of AC Power Circuits (>1kV).
- C. National Electrical Manufacturers Association (NEMA).
- D. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC).
- E. Underwriters Laboratories, Inc. (UL).

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Manufacturer of switchgear.
 - 2. Manufacturers of components and accessories.
 - 3. Weight of each circuit breaker of different frame sizes.
 - 4. Dimensions:
 - a. Height.
 - b. Length.
 - c. Width.
 - d. Weight.
 - 5. Nameplate schedule.
 - 6. Bill of material.

7. Description of operation:
 - a. Metering system.
 - b. Protective relaying.
 8. Ratings:
 - a. Voltage.
 - b. Phase.
 - c. Current.
 - d. Interrupting rating (circuit breakers and fuses).
 - e. Momentary current rating.
 9. List of recommended spare parts.
 10. Lightning arrester data.
 11. Name of dealer's repair facility and parts stocking agreement with the factory:
 - a. Outline in detail the manufacturer's parts stocking requirements and the method by which the manufacturer verifies that the stock is at an acceptable level.
 - b. Outline the method by which the manufacturer determines that the service personnel meet factory standards.
 12. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01_81_50 - Design Criteria:
 - a. Manufacturer's statement of seismic qualification with substantiating test data.
 - b. Manufacturer's special seismic certification with substantiating test data.
- C. Shop Drawings:
1. Layout drawings:
 - a. Furnish fully dimensioned, to scale, equipment layout drawings which include:
 - 1) Equipment furnished: Plan, front and side views.
 - 2) Shipping splits.
 - 3) Bus layout.
 - 4) Interfaces with other equipment.
 - 5) Minimum distances to walls and breaker "roll-out" distances.
 - 6) Bottom conduit windows.
 - b. Complete, detailed, and scaled switchgear layout:
 - 1) Front panel.
 - 2) Sub-panels.
 - 3) Interior panels.
 - 4) Assembly drawings, cross-section as a minimum for each cubicle with major dimensions indicated.
 2. Complete electrical wiring diagrams:
 - a. Indicate wire numbers.
 3. Complete interface and point-to-point connection diagrams for metering system.
 4. Internal schematics, elementary diagrams, and wiring diagrams of each unit or compartment, including wiring identification and terminals.
 5. Internal cell-to-cell interconnection wiring diagrams, including wiring identification and terminal numbers.

6. Complete 1-line and 3-line diagrams for each switchgear line-up:
 - a. Identify components comprising the switchgear assembly, including, but not limited to, circuit breakers, control power and instrument transformers, meters, relays, control devices, monitoring devices, and terminal blocks.
 - b. Clearly indicate device electrical ratings on the Drawings.

- D. Calculations:
 1. DC power and current requirements needed to operate the 15 kilovolt metal-clad switchgear circuit breakers and protective relays.
 2. Detailed calculations or details of the actual physical testing performed on the switchgear to prove the switchgear is suitable for the seismic requirements at the Project Site.

- E. Installation instructions:
 1. Provide manufacturer's installation instructions.

- F. Quality Control Submittals:
 1. Manufacturer's representative qualifications.
 2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
 3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
 4. Test reports.

- G. Owner Training Submittals:
 1. As specified in Section 01_75_17 - Commissioning.

- H. Operation and maintenance manuals:
 1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
 2. Operating instructions:
 - a. Detail the operational functions of custom controls that have been placed on the front panel of the switchgear and internal PLC programming, if applicable.
 3. Maintenance manual:
 - a. Furnish maintenance manuals with instructions for maintenance of the equipment and data identifying the parts.
 - b. Include information needed to maintain the switchgear, including, but not limited to, the following:
 - 1) Instructions for testing, adjustment, and start-up.
 - 2) Detailed control instructions that outline the function and operation of every control device.
 - 3) Schematic and wiring diagrams:
 - a) Showing internal and external connections.
 - b) Furnished in a reduced 11-inch by 17-inch fully legible format.

- I. Certification letter:
 1. Provide a letter from the electric utility stating that the utility metering compartment meets all utility requirements or provide switchgear Shop Drawings that have been reviewed, stamped, and signed by the electric utility.

1.05 QUALITY ASSURANCE

- A. Where indicated on the Drawings as service entrance equipment, the switchgear shall be UL labeled and listed "Suitable for Service Entrance."
- B. Sections and devices shall be UL listed and labeled.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship the switchgear and associated equipment to the Project Site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment.
- B. Furnish temporary equipment heaters within the switchgear to prevent condensation from forming.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Conduct the initial short-circuit fault analysis study as specified in Section 26_05_74 - Electrical System Studies and submit results for the Engineer's review.
 - 2. After successful review of the initial fault current study, submit complete equipment Submittal.
 - 3. Ship equipment to Project Site after successful completion of factory acceptance test.
 - 4. Conduct Owner Training sessions.
 - 5. Commissioning as specified in Section 01_75_17 - Commissioning.

1.09 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide medium voltage 15 kilovolt class metal-clad switchgear as specified in the Contract Documents and indicated on the Drawings.
- B. Provide complete and functional lineups of switchgear with associated controls.
- C. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_18_50 - Design Criteria and as indicated on the Drawings.
- B. Non-conditioned spaces:
 - 1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.
- C. Outdoor installations:
 - 1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.
- D. General:
 - 1. Metal-clad, 15 kilovolt switchgear designed and manufactured in accordance with the reference standards listed in this Section.
 - 2. Switchgear and major components to be products of a single manufacturer, including, but not limited to:
 - a. Circuit breakers.
 - b. Related equipment specified in the Contract Documents or indicated on the Drawings.
 - 3. In addition to the specified basic equipment common to switchgear sections, equip the various individual sections with instruments, protective relays and control devices as indicated on the Drawings and/or specified below.
 - 4. Arrange the equipped sections side by side to form continuous switchgear lineups as indicated on the Drawings.
 - 5. Doors:
 - a. Provide snake-skin cable management sleeve or spiral wire-wrap wires where they pass from the interior of the cabinet past the door hinge to door-mounted devices.
- E. Description of sections:
 - 1. Incoming line compartment:
 - a. Hinged door with lockable handle, bolted closed.
 - b. Dimensions, ratings, spacing, and standards must conform to the requirements of the electric utility.
 - c. Service entrance cables to enter the incoming line compartment, in a manner as indicated on the Drawings.
 - d. Incoming line termination pads suitable for the size and number of conductors as indicated on the Drawings and/or conduit schedule.
 - e. Lightning arresters.
 - 2. Utility metering compartment:
 - a. Integral utility current and voltage transformer cabinet for utility company metering.
 - b. Switchgear to include space for mounting electric utility's voltage and current transformers.
 - c. Instrument transformers to be supplied in accordance with the electric utility's requirements.

- d. Switchgear manufacturer to obtain necessary approvals from the utility company.
 - e. Bolted hinged door with lockable handle.
 - f. Metering compartment barriers, rear, top, bottom, and sides.
 - g. Dimensions, ratings, spacings, and standards must conform to the requirements of the electric utility.
 - h. Current and voltage transformers shall be configured for cold sequence metering.
- 3. Breaker compartment:
 - a. Main, tie, or feeder breaker as indicated on the Drawings.
 - b. Protective relays and other protective devices and interlocks as indicated on the Drawings.
 - c. Multi-function solid state meters as indicated on the Drawings.
 - d. Current transformers: Quantity and ratios as indicated on the Drawings.
 - 4. Space for future devices:
 - a. Provide spaces as indicated on the Drawings.
 - b. As specified in Section 26_05_00 - Common Work Requirements for Electrical.
 - 5. Transformer compartment:
 - a. Voltage transformers: Fused, with quantities, ratio, and configuration as indicated on the Drawings.
 - b. Control power transformers: Fused with voltage ratings as indicated on the Drawings.

2.03 MANUFACTURERS

- A. One of the following or equal:
 - 1. ABB.
 - 2. Eaton.
 - 3. Powell.
 - 4. Schneider Electric.
- B. Circuit breakers: Same manufacturer as metal-clad switchgear.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

- A. Voltage ratings:
 - 1. As indicated on the Drawings.
 - 2. Basic impulse insulation level: Minimum 95 kilovolts.
- B. Main bus:
 - 1. High conductivity, tin-plated copper:
 - a. Flat bar with rounded edges.
 - b. Suitably braced and supported on high dielectric strength insulators.
 - 2. Continuous current carrying capacity as indicated on the Drawings.
 - 3. Insulate each bus with fluidized bed epoxy flame retardant and track resistant insulation.

4. Mount insulated bus on flame retardant, track resistant supports and brace to withstand magnetic stresses developed by fault currents equal to the close and latch rating of the circuit breakers.
 5. Bus connections:
 - a. Plated.
 - b. Bolted with Belleville spring washers.
 - c. Install insulated boot over joint.
 6. Document temperature rise of the bus and connections by design tests.
- C. Ground bus:
1. Tin-plated copper bar, 1/4 inch by 2 inches minimum, extended through each section:
 - a. Firmly secure to each vertical section.
 - b. Provide termination lugs for termination of copper ground cable at each end of the bus.
 2. Ground each section directly to ground bus.
- D. Stationary structure:
1. Utilize unit type construction in formation of housing in order to provide a rigid, self-supporting and self-contained enclosure for each circuit breaker unit and other units comprising switchgear:
 - a. Fabricate each stationary structure of heavy, formed, smooth, and level steel sheets and structural members, bolted or welded to form a rigid assembly with hinged steel panel suitable for mounting of instruments, meters, relays, and control devices.
 - b. Provide bolted, hinged front and rear cubicle doors with locks.
 2. Dead-front construction with rear access via lockable hinged doors.
 3. Approximately 95-inches high, widths as required, front and rear aligned:
 - a. Maximum dimensions as indicated on the Drawings.
 4. Isolate circuit breaker units, bus, instrument and control power transformers, and outgoing cables within separate compartments formed by sheet steel barriers:
 - a. Mount heavy close-fitting bus supports at bus openings between units:
 - 1) Supports shall form a barrier to isolate each unit from adjacent units.
 - b. Provide each compartment with a separate cover for individual servicing without exposing the circuit in adjacent compartment.
 5. Provide automatic shutters to isolate the circuit breaker compartment from the bus when the circuit breaker unit is moved to the TEST or WITHDRAWN position.
 6. NEMA Type:
 - a. Type 3R, non-walk-in enclosure:
 - 1) Hinged doors front and back.
 - 2) Peaked or slanting roof.
 - 3) Enclosing NEMA Type 1 gasketed switchgear.
 - 4) Switchgear sections shall have removable plates in the rear bottom for field drilling of conduit openings.
 7. Switchgear sections shall have removable plates in the rear bottom for field drilling of conduit openings. Front access to devices through a formed, bolted, hinged removable cover:
 - a. Captive knurled type knob screws are to hold covers in place.

8. Provide switchgear with lifting channels having provisions for attachment of crane slings to facilitate lifting and handling each shipping-assembly unit:
 - a. Remove lifting channels after equipment is installed.

- E. Cable compartment:
 1. Support circuit breaker disconnecting contacts by means of flame-retardant, track-resistant polyester glass or porcelain insulator.
 2. Provide cable terminals:
 - a. NEMA 4-hole pads suitable for connection and termination of 15 kilovolt shielded cables.
 3. Design switchgear so that high voltage, low voltage, control and instrumentation cables can enter the switchgear from either the top or bottom.
 4. Provide cable supports with provisions for stress relief cones and cable bends.

- F. Removable element:
 1. Provide a racking screw and moving block for breaker insertion and withdrawal:
 - a. Capable of holding the breaker in the CONNECTED position.
 2. Utilize master jigs to determine accurately the correct stud locations of the removable and the stationary elements.
 3. Provide means for mechanically locking the removable element in any position:
 - a. Lock shall not interfere with the operation of the breaker and its mechanism.
 4. Provide a ground shoe to ground the breaker in all positions.
 5. Provide breaker "CONNECTED" position indication.
 6. Provide interlock on each circuit breaker unit to prevent circuit breaker from being removed from CONNECTED position and from being placed in CONNECTED position while breaker is closed:
 - a. If the circuit breaker is closed, the interlock shall trip the breaker before it can be placed into or removed from the CONNECTED position.
 7. Accurately align stud and socket primary disconnecting devices:
 - a. Furnish tin-to-tin plated pressure contacts to prevent harmful temperature rise due to oxidation, together with nonmagnetic corrosion-resisting springs to provide high-pressure line contacts.
 - b. Mount movable contact on the circuit breaker stud to ensure direct contact.
 8. Provide secondary disconnecting devices for bringing control leads to circuit breaker operating mechanism and auxiliary switches on removable element:
 - a. Spring mount self-aligning receptacles on stationary framework.
 - b. Mount the plugs on the removable element.
 - c. Contacts in the receptacles shall be recessed to ensure against accidental short-circuit of control or secondary wiring.
 9. Mechanism-operated compartment switch:
 - a. Provide up to 12 normally closed and up to 15 normally open contacts.
 - b. Switches shall be activated by breaker mechanism.
 10. Truck operated cell switch:
 - a. Provide normally closed switch contacts to indicate the breaker is in the "CONNECTED" position.

2.07 COMPONENTS

- A. Circuit breakers:
1. Power circuit breaker unit, including:
 - a. Primary disconnecting devices with automatic shutters.
 - b. Secondary disconnecting devices.
 2. Oilless, vacuum type 3 pole.
 3. Horizontal draw-out type capable of being withdrawn on rails.
 4. Electrically and mechanically trip-free with anti-pumping features.
 5. Ratings: In accordance with IEEE C37.06, with the following minimum ratings for indoor breakers with K equal to 1:
 - a. Voltage:
 - 1) Operating voltage: As indicated on the Drawings.
 - 2) Maximum design voltage: 15 kilovolts RMS.
 - 3) Withstand test voltage: 60 hertz, 36 kilovolts.
 - 4) Basic impulse insulation level: 95 kilovolts minimum.
 - b. Current:
 - 1) Continuous current rating: As indicated on the Drawings.
 - 2) Short circuit current/peak closing and latching current at rated maximum kilovolts:
 - a) Continuous current rating: 1,200 amp:
 - (1) Amps: 20,000/52,000.
 - c. Rated interrupting time: 5 cycles.
 6. Operation:
 - a. Operable by means of a stored-energy mechanism, normally charged by a universal motor, which can be charged by a manual handle for emergency closing or test.
 - b. Mechanism closing speed of the contacts to be independent of both control voltage and operator.
 - c. Provide contact wear gap indicator for each vacuum interrupter to indicate available contact life, which requires no tools and is easily visible when breaker is removed from its compartment.
 7. Provide secondary disconnecting contacts that automatically engage in the "OPERATING" and "TEST" position to complete circuits as required.
 8. Provide 2 sets of normally open, "a", and 2 sets of normally closed, "b", circuit breaker auxiliary contacts wired to terminal blocks.
 9. Breaker control voltage:
 - a. Open/Trip: 125 VDC.
 - b. Close: 125 VDC.
 10. Circuit breakers of equal rating shall be interchangeable.
- B. Relays and instrument transformers:
1. Provide protective relays complete with devices and associated circuitry necessary to perform the required functions specified or indicated on the Drawings.
 2. As specified in Section 26_13_05 - Protective Relays.
- C. Control power transformers:
1. Provide on rollout drawers in designated cells as an integral part of the switchgear assembly as indicated on the Drawings.

2. Sized by the switchgear manufacturer to have a minimum capacity of 125 percent of the load served.
 3. Protected by both primary and secondary fuses. Protect primary side with current limiting fuses.
- D. Control wiring:
1. Switchgear wire:
 - a. Type SIS, single-conductor, stranded copper, rated 600 volts.
 - b. Provide flexible stranding for swinging panels.
 - c. Minimum wire size:
 - 1) Number 14 for control circuits.
 - 2) Number 12 for voltage and current transformer circuits.
 2. Route outgoing control wires to master terminal blocks with suitable numbering strips numbered in agreement with the manufacturer's detailed wiring diagrams:
 - a. Terminate control wiring in molded, screw-type terminal blocks.
 - b. Provide a minimum of 10 percent spare terminal blocks for each unit.
 - c. Compression type or insulation displacement type terminal blocks are not acceptable.
 3. Terminate foreign circuits entering the switchgear on "pull-apart" terminal blocks.
 4. Number wiring with machine-printed tag devices at both ends consistent with the manufacturer's detailed wiring diagrams:
 - a. Duplication of wire numbers and terminal block numbers is not acceptable.
 - b. Uniquely number every wire.
 5. When a power source other than the source that is interrupted is present in the switchgear compartment, provide a switch for each remote source inside the compartment to isolate the source in accordance with the NEC.
 6. Terminate control wire with insulated barrel, ring type connectors:
 - a. Manufacturers: The following or equal:
 - 1) Stakon.
- E. Lightning arresters:
1. Heavy-duty distribution class MOV type surge arresters, 15-kilovolt class, for installation on the specified nominal voltage system.
 2. Provide brackets, wiring, and other hardware as necessary for cubicle mounting.
 3. Designed and manufactured in accordance with the latest edition of IEEE C62.11.
- F. Miscellaneous:
1. Furnish wiring, voltage bus, necessary fuses, and terminal blocks within each unit.
 2. Requirements for items mounted on panels:
 - a. Semi-flush mounting for 1/8-inch panels unless otherwise noted.
- G. The following electrical safety devices:
1. Maintenance mode switch.

2.08 ACCESSORIES

- A. Metering system:
1. Provide metering as indicated on the Drawings as specified in Section 26_09_13 - Electrical Power Monitoring.

- B. Nameplates:
1. Provide nameplates to identify:
 - a. Switchgear units:
 - 1) Label front and rear doors of each cubicle.
 - b. Door mounted components.
 - c. Interior mounted devices.
 2. As specified in Section 26_05_53 - Identification for Electrical Systems.
 3. Engraved with the circuit number and circuit name as indicated on the Drawings.
- C. Warning signs:
1. Voltage:
 - a. Provide a minimum of 2 warning signs on the front of the switchgear lineup and 2 on the back.
 - b. Red laminated plastic engraved with white letters approximately 1/2 inch high.
 - c. Signs shall read:
 - 1) "WARNING-HIGH VOLTAGE-KEEP OUT".
 2. Arc flash:
 - a. Provide 1 warning sign for each switchgear compartment.
 - b. Signs shall have read a minimum of:
 - 1) "DANGER ELECTRIC ARC FLASH HAZARD".
 - 2) Signs shall meet the requirements of the NEC.
- D. Space heaters:
1. Fused, thermostatically controlled, strip type, operated at half voltage:
 - a. Power 500-volt or 250-volt rated heaters at 240 volts or 120 volts, respectively.
 2. Power from the switchgear control power transformer as indicated on the Drawings.
 3. Provide each with a dedicated circuit breaker.
 4. Sized to prevent condensation from developing in the switchgear.
- E. Lights and receptacles:
1. Provide lights, mounted and switched inside the outer NEMA Type 3R shell.
 2. Provide GFCI receptacles mounted inside the NEMA Type 3R shell.
 3. Powered from a control power transformer as indicated on the Drawings.
- F. Portable lifting device for removing the breaker from the breaker cell.
- G. 1 circuit breaker remote control station for opening and closing the circuit breakers with 20-foot minimum cord and plug.
- H. Remote circuit breaker racking mechanism: Cord and plug: 50 foot minimum.
1. 120 VAC powered.
 2. Connection of the mechanism shall be made with the circuit breaker compartment door closed.
 - a. Mechanism shall rack the breaker to the test or disengaged position with the breaker compartment door closed.
- I. Manual levering crank.

- J. Rail extensions and rail clamps: 1 set.
- K. Ground and test device:
 - 1. Designed for insertion into the switchgear for the following functions:
 - a. Grounding circuits for maintenance work.
 - b. Apply potential for cable testing.
 - c. Provides access to bus and line circuits for phase testing.
 - 2. The stored energy closing mechanism shall be the same as the circuit breakers.
 - 3. Furnish with a remote close device with a 50-foot cable.
 - 4. Provide front panel indication of contact status.
 - 5. Momentary and 4-second current carrying capacities equal to or greater than the breakers.
 - a. No automatic tripping of the device shall be provided.
- L. Secondary couplers for operating a power circuit breaker in the "DISCONNECTED" position.
- M. Circuit breaker indicating lights and control switches:
 - 1. Indicating lights:
 - a. Low voltage LED:
 - 1) Green for "OPEN".
 - 2) Red for "CLOSED".
 - b. Control switches:
 - 1) Rotary cam-operated switchgear-rated type with means for maintaining contact position.
 - 2) Contact silver-to-silver, enclosed in removable protective covers.
 - 3) Manufacturers: One of the following or equal:
 - a) ABB, Type SB.
 - b) Electroswitch.
- N. Mimic bus:
 - 1. Laminated plastic material fastened to the front surface of the switchgear reflecting bus routing and power devices.
- O. Test blocks and plugs:
 - 1. Molded polycarbonate material.
 - 2. Make-before-break connections for CT circuits.
 - 3. Provide cover for each test block.
 - 4. Manufacturers: One of the following or equal:
 - a. ABB, FT-1.
 - b. Multilin, PK-2.
- P. Provide preformed insulating boots for cable landing pads and lugs. Cable termination boots shall have the same dielectric withstand rating as the switchgear.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

- A. ANSI 61 paint applied to chemically cleaned and primed steel for internal and external parts:
 - 1. Coating to have corrosion resistance of 300 hours to 5 percent salt spray.
 - 2. Paint complete assembly with a 1.5- to 2.0-mil thick exterior finish spray coat of manufacturer's standard gray paint before shipment.
 - 3. Finish NEMA Type 3R enclosures with an ultraviolet resistant paint.

2.11 SOURCE QUALITY CONTROL

- A. Source testing:
 - 1. Witnessed, virtual only.
 - 2. Test the complete switchgear at the manufacturer's establishment:
 - a. Completely assemble, wire and test the switchgear.
 - b. Perform detailed inspections before and after assembly to ensure correctness of design and workmanship.
 - 3. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.
 - 4. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Provide the services of a qualified manufacturer's representative to:
 - 1. Make control connections across the shipping splits.
 - 2. Install and align circuit breakers.
- B. Furnish Manufacturer's Certificate of Installation Verification.

3.04 FIELD QUALITY CONTROL

- A. As specified in Section 26_05_00 - Common Work Results for Electrical.
- B. Provide the services of a qualified manufacturer's representative to:
 - 1. Be present at the Project Site when the switchgear arrives.
 - 2. Act as an advisor in assisting the Contractor regarding the unloading and move-in operations.
 - 3. Furnish the services of a factory-certified technician during the start-up and adjustment period to ensure that items furnished are in proper operating condition:
 - a. Technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.

3.05 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

3.06 ADJUSTING (NOT USED)

END OF SECTION

SECTION 26_13_05

PROTECTIVE RELAYS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
1. Protective relays.
 2. Current transformers.
 3. Voltage transformers.

1.02 REFERENCES

- A. Abbreviations:
1. CPT: Control power transformer.
 2. CT: Current transformers.
 3. FPS: Feeder protection system.
 4. GPS: Generator protection system.
 5. PF (pf): Power factor.
 6. PU (pu): Per unit.
 7. VT: Voltage transformers.
- B. Standards:
1. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 1588 - IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.
 - b. 1613 - IEEE Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power.
 - c. C37.90.1 - IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
 - d. C37.90.2 - IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
 - e. C37.118 - IEEE Standard for Synchrophasor for Power Systems.
 - f. C57.13 - IEEE Standard Requirements for Instrument Transformers.
 2. International Electrotechnical Commission (IEC):
 - a. 60068 - Environmental testing.
 - b. 60255 - Measuring relays and protection equipment.
 - c. 60870 - Telecontrol equipment and systems.
 - d. 61131 - Programmable controllers.
 - e. 61850 - Communication networks and systems for power utility automation.
 3. Underwriters Laboratories, Inc. (UL).

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. HMI: Human machine interface is a software application that presents information to an operator or user about the state of a process, and to accept and implement the operators control instructions. Typically, information is displayed in a graphical format.
 - 2. LOI: Local operator interface is an operator interface device consisting of an alphanumeric or graphic display with operator input functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface, or a display on the face of the protective relay.

1.04 DELEGATED DESIGN (NOT USED)

1.05 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Manufacturer of relay.
 - 2. Descriptive literature.
 - 3. Relay ANSI device functions.
 - 4. Power requirements and connections.
 - 5. Communications provisions and connections.
 - 6. Controls.
 - 7. Mounting.
 - 8. Nameplate schedule.
 - 9. Itemized bill of material, including manufacturer, complete model number, and options included.
 - 10. Description of operation.
 - 11. Cut sheets for components, electrical devices, and mechanical devices:
 - a. Catalog information.
 - b. Descriptive literature.
 - c. External power and signal connections.
 - 12. List of recommended spare parts.
 - 13. Name, address, telephone number, and cell phone number of relay manufacturer's authorized local field service technician.
- C. Shop Drawings:
 - 1. Provide complete terminal block connection diagrams for the protective relays.
 - 2. Manufacturer's recommended wiring and interconnection diagrams for the specific project to be used to compare with the electrical equipment manufacturer's detailed Submittal.
- D. Calculations:
 - 1. Direct current power and current requirements needed to operate the protective relays and associated equipment.

2. Current transformer sizing calculations to substantiate that the current transformers will not saturate under a maximum fault current event.
 3. Burden, cable sizing, CT class, for differential CTs located remote from the switchgear or relay.
- E. Resumes:
1. Provide the following resumes for review and acceptance by the Engineer:
 - a. Protective relay manufacturer qualifications: A minimum of 15 years of documented experience in the Work of this Section.
 - b. Documented list of a minimum of 15 electric utilities using the protective relays used on the project along with complete contact information.
 - c. Protective relay programmer:
 - 1) Must have a minimum of 5 years' experience in programming, setting, and testing of protective relays used on the project.
 - 2) Certified by the protective relay manufacturer:
 - a) Employee of the protective relay manufacturer.
 - b) Employee of the switchgear manufacturer.
 - d. Must fully document and substantiate experience with programming and setting the actual protective relays provided for this Project.
- F. Owner Training Submittals:
1. As specified in Section 01_75_17 - Commissioning.
- G. Operation and maintenance manuals:
1. Submit operating and installation instructions and a maintenance manual presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this Contract.
 2. Maintenance manual:
 - a. Furnish with instructions covering details pertaining to care and maintenance of the equipment as well as data identifying the parts.
 - b. Shall include, but are not limited to, the following:
 - 1) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
 - 2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
- H. Test reports:
1. Provide .csv file, or similar format, for Engineer review of relay settings and programming.
 2. Information such as 1-line diagrams, time-current curves, calculations, etc., used to determine the settings shall be submitted with the exported relay file for review.

1.06 QUALITY ASSURANCE

- A. Relays, instrument transformers, and associated equipment shall be UL listed and labeled.

- B. Specific protective relay manufacturer requirements:
 - 1. Minimum of 15 years documented experience in providing electric utility grade protective relays to electrical utilities.
 - 2. Protective relay programmer, must have a minimum of 5 years' experience in programming, setting, and testing of protective relays used on the project.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.10 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Protective relays, current transformers, and voltage transformers with the protective functions as indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Specifications and Drawings show the desired functionality:
 - 1. It is understood that the named manufacturers' protective relays do not have the same functionality on a device-by-device comparison.
 - 2. It is the protective relay manufacturer's responsibility to configure the system with their products in order to provide the functionality as indicated on the Drawings and specified in this Section, using their standard products.

2.03 MANUFACTURERS

- A. Refer to the individual relay specifications for additional listings of acceptable manufacturers and model numbers.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

- A. Protective relays:
 - 1. General:
 - a. Furnish relays complete with devices and associated circuitry necessary to perform the required functions as specified or indicated on the Drawings.

- b. Manufacturers of relays and controls are listed to describe system operating requirements.
 - c. Furnish material not specifically listed or shown but necessary to perform required functions.
 - d. Mounting:
 - 1) As indicated on the Drawings.
 - e. Provide nameplates as specified in Section 26_05_53 - Identification for Electrical Systems.
2. Lockout relay:
- a. Where indicated on the Drawings, provide an ANSI function 86 lockout relay.
 - b. Operating voltage: 125 VDC.
 - c. Functions:
 - 1) Trip control.
 - 2) Block close control.
 - 3) Green LED for ready indication.
 - 4) Red LED for tripped indication.
 - 5) Black RESET target.
 - 6) Orange TRIP target.
 - 7) Manual reset.
 - d. Manufacturers: One of the following or equal:
 - 1) Electroswitch, Series 24.
 - 2) General Electric, Type SB.
3. Solid state digital relays:
- a. General:
 - 1) Multifunction, microprocessor based with monitoring and communications capabilities, with native IEC 61850 support.
 - 2) Continuous self-diagnostics.
 - 3) Fault recording:
 - a) Monitor and record fault data.
 - b) Fault events stored in event reports.
 - c) Event reports saved to non-volatile memory.
 - 4) Front keypad and display for programming and configuration:
 - a) 1 control pushbutton programmed to set relay protective functions to the minimum values.
 - b) Password protection for security.
 - 5) A minimum of 2 programmable digital inputs and 4 Form C programmable outputs.
 - 6) Installation and control connections, one of the following:
 - a) Draw-out case that allows removal of the relay without having to disconnect wiring. CT circuits shall be self-shorting with make before-break operation on removal of the relay.
 - b) Connectorized terminals with shorting for each current input.
 - 7) Selection for coordination with common IEC, WH-CO, and GE-IAC curves as specified in Section 26_05_74 - Electrical System Studies. For each individual protective relay:
 - a) Definite time.
 - b) Moderately inverse.
 - c) Inverse.
 - d) Very inverse.
 - e) Extremely inverse.

- 8) Power supply:125 VDC.
- 9) Provide common communications media for protective relays as follows, or as indicated on the Drawings:
 - a) Copper Ethernet.
- 10) Provide common communications protocols for protective relays as follows, or as indicated on the Drawings:
 - a) Modbus TCP.
- 4. Feeder protection system (FPS):
 - a. Description:
 - 1) Provide protective, metering, and control functionality, with setup, control, and monitoring programmable logic, front panel LOI, and remote communications.
 - b. Specific requirements:
 - 1) Directional inverse time overcurrent elements monitoring current on all 3 phases, 2 sets of neutral current calculated by the relay from phase current summation or an independent ground CT and calculated negative sequence current:
 - a) Each element may be set as forward, reverse, or non-directional.
 - b) User shall have the option of phase element being voltage controlled, voltage restrained, or neither (e.g., normal voltage independent overcurrent relays).
 - c) Functions: 51P,51N,51G,51Q or 46.
 - 2) 2 sets of directional instantaneous time overcurrent elements with a user-settable time delay monitoring all 3 phases, the neutral calculated by the relay from phase current summation, the independent ground CT, and the calculated negative sequence current:
 - a) Each element may be set as forward, reverse, or non-directional.
 - b) Functions: 50P,50N,50G,50Q or 46 Instantaneous.
 - c) Targeting shall show 67 if element is set as forward or reverse.
 - 3) Selection for coordination with common protective device coordination curves:
 - a) As specified in Section 26_05_74 - Electrical System Studies.
 - b) User-selectable reset rate to either integrating reset, to mimic the slow return to zero of induction disks, or instantaneous reset.
 - 4) Suitable for monitoring either 3-wire or 4-wire PT configurations:
 - a) Monitor phase overvoltage, phase undervoltage, and calculate and monitor negative sequence (V2) voltage.
 - b) User-settable phase overvoltage element to trip only for 1, 2, or 3 phases out of range.
 - c) User-settable fixed time delay tripping for each element.
 - d) User-settable phase element monitoring for either phase-phase or phase-ground.
 - e) Maximum phase setting shall be 300 VPP.
 - f) Function: 27,59,47N or 59Q.
 - 5) Monitor line currents and voltages and provide the following information:
 - a) Present values: Phase, neutral and negative sequence currents, volts; forward and reverse watts, VARs, watt-hours, VAR-hours.
 - b) Demand values: Phase, neutral, and negative sequence current, 3-phase watts and VARs, and peak since last demand reset.

- 6) User-definable programmable logic:
 - a) Logic able to inter-tie relay control inputs, output contacts, LOI and HMI addressable switches, protective element logical I/O, reclosing element I/O, timer element I/O, settings group control, and relay internal alarms.
- 7) 4 independent setting groups selectable by user logic:
 - a) Logic may utilize relay hardwire inputs, LOI or remote communications commands, relay internal logic, reclose status, or an automatic dynamic selection based on recent load levels.
- 8) Self-testing and alarming:
 - a) Capable of monitoring breaker systems, including the trip circuit, breaker trip time, breaker duty statistics, as well as power system conditions, including overloads and unbalances and alarming for such conditions.
 - b) User-defined logic points programmable as major or minor alarms.
- 9) Detailed sequence of events logger showing internal logic change of state for an event:
 - a) With multiple oscillographic reports for currents showing pre-fault, faulted, and post-fault currents.
- 10) LOI that allows reading of measured values and performing basic setting changes.
 - a) Capable of being programmed to automatically display and scroll user-specified information.
- 11) Controllable via virtual switches which are HMI or LOI addressable:
 - a) Switches may be usable for on/off/pulse of any user-selected function or logic point (e.g., instantaneous element block or reclose enable).
- 12) 1 virtual breaker control switch, accessible locally from the LOI or remotely from the communications ports, to provide trip and close control of a selected breaker:
 - a) Function: 101.
 - b) 4 virtual switches with 3 modes of operation, accessible locally from the LOI or remotely from the communications ports, can be used (e.g., to trip and close additional switches or breakers, or to enable and disable certain functions).
- 13) Minimum of 4 hardwired control inputs:
 - a) Each input programmable to represent system status, e.g., breaker position, or control any user-defined function or logic point.
 - b) Minimum of 5 normally open output contacts plus 1 normally closed major/relay alarm contact.
 - c) Contacts programmable to follow custom user-defined logic schemes.
 - d) Minimum make and carry 30 A, 0.2 s, 6 A continuous.
 - e) Break 0.3 ADC at L/R=0.04.
- 14) With a breaker or lockout relay trip circuit monitor to monitor for loss of voltage, fuse blown, or loss of continuity, trip coil open.

- 15) Meeting the isolation, surge withstand, fast transient, impulse, and radio interference standards in accordance with IEEE C37.90.1 and IEEE C37.90.2.
- 16) Future firmware enhancements made through flash memory.
- c. Manufacturers: One of the following:
 - 1) ABB, REF615.
 - 2) Basler. Model BE1-11f.
 - 3) Schweitzer, SEL-751A.
5. High-impedance bus differential relay (87B):
 - a. Description:
 - 1) High-speed, high-impedance, solid state bus differential relay, providing high speed fault protection.
 - b. Specific requirements:
 - 1) 3-phase current sensing zone between line-side of the switchgear's main breaker and associated feeder breakers.
 - 2) Operation time:
 - a) Maximum operating time for any fault: 1.25 cycles (21 msec).
 - 3) Sensing range input: 0.25 to 2.50 A.
 - 4) Timing: Instantaneous or 20 msec delay.
 - 5) CT overvoltage:
 - a) Alarm voltage selectable range: 10 to 80 percent in 10 percent increments.
 - b) Detect unbalance voltages.
 - c) CT overvoltage LED alarm lights.
 - 6) Pickup voltage control:
 - a) Pickup voltage setting range from 50 to 400 volts in 50-volt increments.
 - 7) Pickup current control:
 - a) Current setting of 0.25 to 2.50 A RMS in 0.25 A increments.
 - b) Setting determines the level of current sensing input resulting in the trip output contact closure.
 - c) With trip LED lights.
 - d) Operation based on the instantaneous peak value of the sinusoidal current detected.
 - 8) Pickup current trip LED:
 - a) Indicates when the level of current through the relay exceeds the setting of the pickup current control.
 - b) Latches on until reset button is pressed.
 - 9) Trip test pushbutton:
 - a) Used to simulate a trip condition to verify operation of output trip contacts, verify operation of trip LED lights.
 - 10) CT test pushbutton:
 - a) Used to verify the health of the CT input circuit.
 - b) Provide 1 CT Diagnostic Test Source.
 - c. Function: 87B.
 - d. Manufacturers: One of the following:
 - 1) ABB, REF615-N + 3 ph voltage dependent resistors.
 - 2) Basler, BE1-87B:
 - a) Basler P/N 9282300014 - CT Diagnostic.
 - 3) Schweitzer, SEL-587Z.

6. Current differential relay (87M, 87T):
 - a. Description:
 - 1) Provide current differential protection with programmable single- or dual-slope percentage restraint for 2-winding transformers, reactors, generator, large motors, and other 2-terminal apparatus.
 - 2) Use second- and fourth-harmonic blocking or restraint along with DC blocking to supervise differential elements during transformer energization conditions.
 - 3) Calculate fifth harmonic to supervise differential element operations during transformer over excitation events.
 - 4) Solid-state relay that compare 3-phase current entering and leaving the generator.
 - b. Specific requirements:
 - 1) Sensing input: As indicated on the Drawings.
 - 2) Restraint factor that is proportional to input current when the restraining current is greater than nominal by comparing the sensed input and output current and the lesser of the 2 sensed current level becomes the restraining current.
 - a) Difference between the 2 sensed currents is compared to a reference established by the sensitivity setting, adjusted by an amount proportional to the restraining current, increasing the sensitivity to low current internal faults and less sensitive to external faults with high level of through current.
 - 3) Function: 87M.
 - c. Manufacturers: One of the following:
 - 1) ABB:
 - a) Generator: REG615-D.
 - b) Transformer: RET615-B.
 - 2) Basler:
 - a) BE1-FLEX.
 - 3) Schweitzer:
 - a) SEL-587.
 - b) SEL-710.
 - c) SEL-787.
7. Instantaneous/Time overcurrent relay (50/51):
 - a. Description:
 - 1) Microprocessor based, multifunction protective that provides instantaneous (50) and time (51) overcurrent protection for the monitoring and control of power systems equipment.
 - 2) 3 current inputs to measure phase current:
 - a) Fundamental algorithm that responds to the fundamental component of the current and rejects the harmonic components.
 - b) Measures magnitude of the negative-sequence component of the fundamental phase current.
 - b. Specific requirements:
 - 1) Instantaneous overcurrent functions each with settable time delays: 50P, 50G, 50Q.
 - 2) Time overcurrent: 51P, 51G, 51Q.
 - 3) General purpose logic timers: 62.

- 4) AC current inputs:
 - a) 5A nominal:
 - (1) 15 A continuous; 500 A for 1 second linear to 100 A symmetrical.
 - (2) Limiting dynamic value: 625 A for 1 cycle.
 - (3) Burden: 0.16 VA at 5 A, 1.15 VA at 15 A.
 - b) 1A nominal:
 - (1) 3 A continuous; 100 A for 1 second linear to 20 A symmetrical.
 - (2) Limiting dynamic value: 250 A for 1 cycle.
- 5) Burden: 0.06 VA at 1A, 0.18 VA at 3 A.
- 6) Control switches:
 - a) 1 breaker control switch.
 - b) 4 virtual control switches.
 - c) Trip and close control of a selected breaker either locally or from HMI.
- 7) Metering:
 - a) Measured current and derived neutral and negative-sequence currents.
 - b) Demand reporting for all phases, neutral, and negative-sequence currents with user settable demand intervals.
 - c) Measurement accuracy: Within 2 percent.
- 8) Sequence of events recorder:
 - a) User-programmable.
 - b) Time stamped.
- 9) Sensing input:
 - a) 3-phase.
- c. Function: 50, 51, 50/51.
- d. Manufacturers: One of the following:
 - 1) ABB, REF615.
 - 2) Basler, Model BE1-851.
 - 3) Schweitzer, Model SEL-501.
- 8. Motor protection relay MPR Type 2:
 - a. Description:
 - 1) Provides protection of medium-voltage 3-phase induction and synchronous motors using a slip-dependent thermal model.
 - 2) Provides locked rotor, overload, over temperature, differential protection.
 - 3) Provide voltage transformers, current transformers, and a digital motor protection and management relay as indicated on the Drawings.
 - b. Specific requirements:
 - 1) Protection:
 - a) Primary protective function shall be a thermal model consisting of:
 - (1) Overload curves.
 - (2) Negative sequence unbalance/single phase biasing.
 - (3) RTD biasing (hot/cold motor compensation).
 - (4) Motor cooling time constants.
 - (5) Start inhibit and emergency restart.
 - (6) RTD biasing.
 - (7) Combine inputs from positive and negative sequence currents and RTD winding feedback.

- (8) Dynamic in nature in order to follow the loading and temperature of the motor.
- (9) Provide protection of the rotor during stall and acceleration:
 - (a) Stall/acceleration curve shall be voltage compensated.
 - (b) A speed switch input shall be available.
- (10) INOM = 5 A secondary as indicated on the Drawings.
- b) Thermal overload 49:
 - (1) Full-load current (FLA) Limits: 0.2 to 5,000.0 A primary (limited to 20 to 160 percent of CT rating).
 - (2) Locked rotor current: 2.5 to 12.0*FLA.
 - (3) Hot locked rotor time: 1.0 to 600.0 seconds.
 - (4) Service factor: 1.01 to 1.5.
 - (5) Accuracy: 5 percent within 25 ms at multiples of FLA greater than 2 (cold curve method).
- c) Short circuit 50P:
 - (1) Setting range: Off, 0.10 to 20.00*FLA in 0.01*FLA increments.
 - (2) Accuracy: Within 5 percent of setting within 0.02* INOM RMS secondary.
 - (3) Maximum pickup/dropout time: 1.5 cycles.
 - (4) Time delay: 0.0 to 5.0 seconds in 0.01 second increments.
 - (5) Accuracy: Within 0.5 percent of setting within 0.25 cycle.
- d) Ground fault 50G:
 - (1) Setting range: Off, 0.10 to 20.00*FLA in 0.01*FLA increments.
 - (2) Accuracy: Within 5 percent of setting within 0.02* INOM RMS secondary.
 - (3) Maximum pickup/dropout time: 1.5 cycles.
 - (4) Time delay: 0.0 to 5.0 seconds in 0.01 second increments.
 - (5) Accuracy: Within 0.5 percent of setting within 0.25 cycle.
- e) Ground fault 50N:
 - (1) Setting range:
 - (a) 1A, 5A: Off, 0.01 to 650.00 A primary in 0.01 A RMS increments.
 - (b) 2.5 mA: Off, 0.01 to 25.00 A primary in 0.01 A RMS increments.
 - (2) Accuracy: Within 5 percent of setting within 0.05 mA secondary.
 - (3) Maximum pickup/dropout time:
 - (a) 1A, 5A: 1.5 cycles/1.5 cycles.
 - (b) 2.5 mA: 100 msec plus 1.5 cycles/1.5 cycles.
 - (4) Time delay: 0.0 to 5.0 seconds in 0.01 second increments.
 - (5) Accuracy: Within 0.5 percent of setting within 0.25 cycles.
- f) Negative-sequence overcurrent 50Q:
 - (1) Setting range: Off, 0.10 to 20.00*FLA in 0.01*FLA increments.
 - (2) Accuracy: Within 5 percent of setting within 0.02* INOM secondary.
 - (3) Maximum pickup/dropout time: 1.5cycles.
 - (4) Time delay: 0.0 to 120.0 seconds in 0.01 second increments.
 - (5) Within 0.5 percent of setting within 0.25 cycle.

- g) Inverse-time overcurrent phase 51P:
 - (1) Pickup setting range secondary:
 - (a) 5A: Off, 0.50 to 10.00 A in 0.01 A steps.
 - (b) 1A: Off, 0.10 to 2.00 A in 0.01 A steps.
 - (2) Accuracy: Within 5 percent of setting within 0.02-INOM secondary.
 - (3) Time dial: 0.50 to 15.00 in 0.01 steps.
 - (4) Accuracy: Within 1.5 cycles within 4 percent between 2 and 30 multiples of pickup.
- h) Inverse-time overcurrent ground 51G:
 - (1) Pickup setting range secondary:
 - (a) 5A: Off, 0.50 to 10.00 A in 0.01 A steps.
 - (b) 1A: Off, 0.10 to 2.00 A in 0.01 A steps.
 - (2) Accuracy: Within 5 percent of setting within 0.02-INOM secondary.
 - (3) Time dial: 0.50 to 15.00 in 0.01 steps.
 - (4) Accuracy: Within 1.5 cycles within 4 percent between 2 and 30 multiples of pickup.
- i) Inverse-time overcurrent negative-sequence 51Q:
 - (1) Pickup setting range secondary:
 - (a) 5A: Off, 0.50 to 10.00 A in 0.01 A steps.
 - (b) 1A: Off, 0.10 to 2.00 A in 0.01 A steps.
 - (2) Accuracy: Within 5 percent of setting within 0.02-INOM secondary.
 - (3) Time dial: 0.50 to 15.00 in 0.01 steps.
 - (4) Accuracy: Within 1.5 cycles within 4 percent between 2 and 30 multiples of pickup.
- j) Differential protection 87M:
 - (1) Setting range: Off, 0.05 to 8.00 A secondary.
 - (2) Accuracy: Within 5 percent of setting within 0.10 A secondary.
 - (3) Maximum pickup/dropout time: 1.5 cycles.
 - (4) Accuracy: Within 0.5 percent of setting within 0.25 cycle.
- c. Manufacturers: One of the following:
 - 1) ABB,
 - REX640B10NN+AIM2+AIM2+ADD1+APP7+ARC1+BIO2+CMP2+COM4+LNG1+MCT2+PCL1+PSM2+RTD1+SCT1:
 - a) Additional 2 RTD inputs, 2 mA inputs, 4 mA outputs with RIO600 (PSMH+LECMIR+RTD4+AOM4) modules.
 - b) RIO600 communication with REX640 via RJ45 Ethernet port.
 - 2) Schweitzer, SEL-710-5.
- d. Transformer differential relays:
 - 1) Provide the following functions as a minimum:
 - a) Phase time overcurrent: 51P.
 - b) Phase instantaneous overcurrent: 50P.
 - c) Ground time overcurrent: 51G.
 - d) Ground instantaneous overcurrent: 50G.
 - e) Differential current: 87.
 - 2) Provide multiple relays where necessary to meet the required protective functions and the zone interlocking capability.

- 3) Manufacturers: One of the following:
 - a) ABB, RET615.
 - b) Basler, BE1-CDS-220/BE1-1051.
 - c) Schweitzer, SEL-587-1/SEL-351S.

2.08 ACCESSORIES

A. Current transformers:

1. Ring type:
 - a. Suitable for service within low or medium voltage switchgear as indicated on the Drawings.
 - b. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the circuit breaker of the application.
2. Current ratio: As indicated on the Drawings, for use as a guideline:
 - a. It is the switchgear manufacturer's responsibility to size the current transformers to ensure that they will not saturate under the maximum available fault current at the installed location based upon the short-circuit fault analysis study as performed as specified in Section 26_05_74 - Electrical System Studies.
3. Rated in accordance with IEEE C57.13 with accuracy of the current transformers suitable for relay accuracy class and rated for 200 percent burden for the required connected devices.
4. Identify polarity with standard marking or symbols.
5. Capable of carrying rated primary current continuously without damage.
6. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

B. Voltage transformers:

1. Indoor dry type, single-phase, 60 hertz, with a minimum thermal capacity of not less than 400 volt-amperes at 131 degrees Fahrenheit rise above 104 degrees Fahrenheit ambient.
2. Accuracy classification in accordance with IEEE C57.13, suitable for relay accuracy class, and 200 percent burden, for the required connected devices, with the secondary voltage 120 volts.
3. Insulation levels as required for the switchgear system voltage but not less than:
 - a. 600 VAC, 10 kV BIL for 480 VAC systems.
 - b. 5.6 kV, 60 kV BIL for 2300 and 4160 VAC systems.
 - c. 15.5 kV, 110 kV BIL for 12.47 kV and 13.2 kV systems.
4. Identify polarity with standard markings or symbols.
5. Connect secondaries to voltage buses as required.
6. Provide primary and secondary current-limiting fuses.

C. Test blocks and plugs:

1. Make-before-break connections for CT circuits.
2. Provide cover for each test block.
3. Manufacturers: One of the following or equal:
 - a. ABB, FT-1:
 - 1) 10-pole test switch.

- b. Multilin, PK-2:
 - 1) Current circuits: 6-pole test blocks.
 - 2) Voltage circuits: 4-pole test blocks.
- D. Satellite-synchronized clock:
1. Provide a master clock to synchronize the clock functions of the protective relays:
 - a. IEEE 1588 PTP clock for IEC 61850-9-2LE.
 2. Surge standards:
 - a. IEEE C37.90.
 - b. IEC 60255.
 3. Power supply: 125 VDC:
 - a. Burden: Less than 15 W, less than 35 VA.
 4. Output: 6 unmodulated IRIG-B time-code outputs:
 - a. User-selectable for 1 PPS, 1 kPPS, IRIG-B.
 - b. IRIG Standard 200-02, Format B006.
 - c. Fiber-optic port:
 - 1) ST connections.
 - 2) Multiplexes an unmodulated IRIG-B signal on the data communications signal.
 - 3) 9,600 bps.
 5. Operating temperature: -40 degrees Fahrenheit to 176 degrees Fahrenheit.
 6. Altitude: 2,000 m (6,500 ft) AMSL.
 7. Clock accuracy to UTC time:
 - a. 1 PPS: Within 100 ns average, within 500 ns peak.
 - b. Unmodulated IRIG-B: Within 100 ns average, within 500 ns peak.
 - c. Modulated IRIG-B: Within 1 μ s peak.
 - d. Serial Port BX command: Within 500 μ s peak.
 - e. Holdover stability: Within 0.08 ppm for 20 minutes (from -40 degrees Fahrenheit to 176 degrees Fahrenheit).
 8. Antenna:
 - a. GPS GNSS:
 - 1) 5 V, less than 80 mA.
 - 2) 35 dB preamp.
 - b. Mounting:
 - 1) Unobstructed 360-degree view of sky.
 - 2) Low and close to the control house roof, above the maximum snow accumulation level.
 - c. Surge protector:
 - 1) Equalize the difference in voltage that can occur between the center conductor and the shield of the coaxial cable between the antenna and the clock.
 - 2) Located at building enclosure entrance.
 - 3) Ground the surge protector and clock to the same point.
 - 4) TNC female antenna connected.
 - d. Display:
 - 1) Front-panel LEDs show clock progress from start to satellite lock.
 - 2) Display: Ordinal day of the year: HH:MM:SS.
 - 3) Indicators:
 - a) Enabled.

- b) Satellite Lock.
 - c) Holdover.
 - 9. Manufacturers: The following:
 - a. Basler.
 - b. Schweitzer:
 - 1) Clock: SEL-2407.
 - 2) Antenna: SEL-9524A GPC GNSS.
 - 3) Surge protector: SEL Surge Protector Kit 915900139.
 - 4) Cable: SEL-C961.
- E. Real time process controller:
 - 1. General:
 - a. Information processor operating both serial and Ethernet communications network:
 - 1) Providing the following functions:
 - a) Deterministic logic processing.
 - b) Automatic transmission of outgoing messages.
 - c) Processing of responses.
 - d) Data scaling.
 - e) Data aggregation.
 - f) Simultaneous collection of data from multiple server devices for various manufacturers.
 - g) Simultaneous data access for multiple client (master) devices.
 - b. Suitable for use in utility substations or industrial control and automation systems.
 - c. Provides control with integrated security, seamless configuration, unified logic, and reliability.
 - d. Converts data between multiple protocols, communicates with any configured and connected device with an embedded IEC 61131 logic engine.
 - e. 32-bit microcontroller for protective relay-speed I/O, logic, and communications.
 - f. Precision time protocol (PTP) and demodulated IRIG-B input that synchronizes connected intelligent electronic devices (IEDs) to absolute time and drives the demodulated IRIG-B output, enabling synchronized control and management.
 - 2. Protocols:
 - a. Provide the following:
 - 1) FTP.
 - 2) SFTP.
 - 3) DNP3 serial.
 - 4) DNP3 LAN/WAN.
 - 5) IEC 61850 MMS.
 - 6) Modbus RTU.
 - 7) Modbus TCP.
 - 8) LG 8979.
 - 9) IEEE C37.118.
 - 10) IEC 60870-5-101/104.
 - 11) SES-92.
 - b. Client:
 - 1) CP2179.

- 2) Flex Parse.
- 3) SEL ASCII and Binary.
- 4) SNMP.
- 5) DNP3 serial.
- 6) DNP3 LAN/WAN.
- 7) IEC 61850 MMS.
- 8) Modbus RTU.
- 9) Modbus TCP.
- 10) LG 8979.
- 11) IEEE C37.118.
- 12) IEC 60870-5-101/104.
- 13) SES-92.
- 14) EtherCAT.
- c. Peer-to-peer:
 - 1) IEC 61850 GOOSE transmit and receive messages.
 - 2) Parallel Redundancy Protocol.
3. CPU:
 - a. Error correcting code (ECC) RAM information processor.
4. Intelligent and secure components:
 - a. Electronic equipment continuously self-testing and reports internal errors, including a hardwire contact indicating device health.
5. Programming:
 - a. Integrated IEC 61131-3 programming environment for the information processor, with the ability to continuously monitor and control every protective relay and Ethernet-distributed I/O module in the electrical system.
 - b. IEC 61131-3 programming environment integrated in 1 software package with the communications protocol mapping environment.
6. Role-based security:
 - a. Independent user-based security with strong passwords, role-based accounts, and settable account expiration dates.
 - b. Provide a mechanism to map security-related system tags into HMI reports.
7. Integrated HMI:
 - a. Integrated web-based human-machine interface (HMI) that provides visualization and control of data tags.
8. Central authentication:
 - a. Lightweight directory access protocol (LDAP) to provide central user account authentication.
9. Selectable processing interval and solve order:
 - a. Provide a method to configure the deterministic processing interval for protocol communications and custom logic, including a method to configure the processing sequence of software tasks.
 - b. Processing interval settable to as fast as 1 ms.
10. High-speed peer-to-peer communication:
 - a. Utilizing MIRRORRED BITS® communications protocol to transmit and receive high-speed digital data to/from intelligent electronic devices (IEDs) to create custom protection and control schemes.
11. Communications:
 - a. Serial ports:
 - 1) Each port software configurable for RS-232 or RS-485 communications modes.

- b. Ethernet ports:
 - 1) 2 or more Ethernet ports that can operate simultaneously on different networks through independent MAC addresses.
 - 2) Ports configurable as fiber-optic or copper Ethernet ports.
- 12. Alarm output:
 - a. Programmable dry contact output to signal internal errors and malfunctions, as well as additional conditions.
- 13. Environmental testing:
 - a. Information processor tested to IEEE 1613-2003 for communications and networking equipment in electric power substations, and to the same standards as protective relays, including the following:
 - 1) Cold:
 - a) IEC 60068-2-1:2007.
 - b) IEC 61850-3:2013.
 - c) IEEE 1613-2003.
 - d) Severity level: 16 hours at -40 degrees Celsius.
 - 2) Damp heat, cyclic:
 - a) IEC 60068-2-30:2005.
 - b) IEC 61850-3:2013.
 - c) IEEE 1613-2003.
 - d) Severity level: 12 + 12-hour cycle, 25 degrees Celsius to 55 degrees Celsius, 6 cycles, 95 percent relative humidity.
 - 3) Dry heat:
 - a) IEC 60068-2-2:2007.
 - b) IEC 61850-3:2013.
 - c) IEEE 1613-2003.
 - 4) Vibration:
 - a) IEC 60255-21-1:1988.
 - b) IEC 61850-3:2013:
 - (1) Severity level: Endurance Class 2, Response Class 2.
 - c) IEC 60255-21-2:1988:
 - (1) Severity level: Shock Withstand, Bump Class 1, Shock Response Class 2.
 - d) IEC 60255-21-3:1993:
 - (1) Severity level: Quake Response Class 2.
 - e) IEEE 1613-2003:
 - (1) Severity level: V.S.4.
- 14. Synchrophasors:
 - a. Capable of receiving synchronized phasor measurement data via the IEEE C37.118 protocol on serial and Ethernet ports to as fast as 5 messages per second.
- 15. Retained memory:
 - a. Nonvolatile memory available for user-programmable retained variables.
- 16. Engineering access:
 - a. Transparent connections between any serial or Ethernet communications ports for engineering access.
- 17. Conformal coating:
 - a. Of the circuit boards.
- 18. Reliability:
 - a. Submit actual measured mean time between failures (MTBF) for the device.

19. Service:
 - a. Manufacturer provided no-cost technical support for the life of the product.
 - b. Manufacturer to support a 72-hour turn-around on warranty repairs.
20. SEL-2240 Axion®:
 - a. Deterministic ethernet fieldbus:
 - 1) Utilizing EtherCAT protocol to operate a deterministic, Ethernet-based fieldbus network for connected I/O modules.
 - b. Digital inputs sequential events:
 - 1) Maintain a user-configurable record of digital input operations on the EtherCAT network that is accurate to 1 ms.
 - c. DC analog inputs:
 - 1) Include up to 16 DC analog input modules.
 - 2) Input ranges: Within 20 mA.
 - d. DC analog outputs:
 - 1) Include up to 16 DC analog output modules.
 - 2) Output ranges: Within 20 mA.
 - e. AC metering inputs:
 - 1) Include up to 16 CT/PT analog input modules.
 - 2) Input ranges:
 - a) CT: 0 to 22 A.
 - b) PT: 5 to 400 V.
 - f. AC protection inputs:
 - 1) Include up to 16 CT/PT protection modules.
 - 2) Input ranges:
 - a) CT: 0 to 20 A.
 - b) PT: 6 to 300 V.
 - g. Redundant power supply:
 - 1) Provide 2 power supply modules that continuously share load.
 - 2) If the incoming power for 1 module becomes unavailable, the remaining power supply shall have sufficient capacity to accommodate an entire node.
21. Manufacturers: The following:
 - a. Schweitzer:
 - 1) SEL-3530.

F. Control wiring:

1. As specified in the electrical equipment specifications.

G. Miscellaneous:

1. Provide terminal blocks, wireways, wiring, device mounting brackets, and other miscellaneous items.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 FIELD QUALITY CONTROL

A. Manufacturer's services:

1. Provide the services of a qualified relay manufacturer's representative to test:
 - a. Differential protection schemes.
 - b. Utility paralleling schemes.
 - c. Complete testing of the power management system confirming the calibration, accuracy, and communications.

3.05 OWNER TRAINING

- #### **A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.**

3.06 ADJUSTING (NOT USED)

END OF SECTION

SECTION 26_24_15

INDIVIDUALLY MOUNTED CIRCUIT BREAKER SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Free standing, dead-front type metal-enclosed, low voltage switchboards with individually mounted circuit protective devices.

1.02 REFERENCES

- A. International Organization for Standardization (ISO):
 - 1. 9001 - Quality Management Systems - Requirements.
- B. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
 - 2. PB 2 - Deadfront Distribution Switchboards.
- C. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code.
 - 2. 70E® - Standard for Electrical Safety in the Workplace®.
- D. Underwriters Laboratories, Inc. (UL):
 - 1. 891 - Switchboards.

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Manufacturer of switchboard.
 - 2. Manufacturer of component parts of switchboard.
 - 3. Dimensions:
 - a. Width.
 - b. Length.
 - c. Height.
 - d. Weight.
 - 4. Nameplate schedule.
 - 5. Bill of material.
 - 6. Ratings:
 - a. Voltage.
 - b. Phase.
 - c. Current.
 - d. Interrupting rating (circuit breakers and fuses).

7. List of recommended spare parts.
 8. Name of dealer's repair facility and parts stocking agreement with the factory:
 - a. Agreement shall outline in detail the manufacturer's parts stocking requirements and the method by which the manufacturer's representative verifies that the stock is at an acceptable level.
 - b. Agreement should also outline the method by which the manufacturer's representative determines that the service personnel meet factory standards.
 - c. A toll-free or local phone number with 24/7 emergency monitoring/call back is required.
 9. Furnish circuit breaker Submittals as specified in:
 - a. Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
 10. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01_81_50 - Design Criteria:
 - a. Manufacturer's statement of seismic qualification with substantiating test data.
 - b. Manufacturer's special seismic certification with substantiating test data.
- C. Shop Drawings:
1. Complete, detailed, and scaled switchboard layout:
 - a. Front panel.
 - b. Sub-panels.
 - c. Interior panels.
 - d. Top and bottom conduit windows.
 2. Complete electrical wiring diagrams:
 - a. Point-to-point connections.
 - b. Internal compartment-to-compartment interconnection wiring diagrams.
 - c. Wiring identification and terminal numbers.
 3. Complete 3-line diagrams for each switchboard lineup.
 - a. These Drawings shall indicate devices comprising the switchboard assembly, including, but not limited to, circuit breakers, control power and instrument transformers, meters, and control devices.
 - b. Clearly indicate electrical ratings of devices on Drawings.
 4. Complete interface and connection diagrams for metering system.
 5. Complete bill of material list and equipment datasheets identifying appropriate information specific to the switchboard being supplied.
 6. Nameplate schedule.
 7. Interfaces to other equipment.
- D. Installation instructions:
1. Provide manufacturer's installation instructions.
- E. Quality Control Submittals:
1. Manufacturer's representative qualifications.
 2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
 3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
 4. Test reports.

- F. Owner Training Submittals:
 - 1. As specified in Section 01_75_17 - Commissioning.

- G. Operation and maintenance manuals:
 - 1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
 - 2. Operating instructions:
 - a. Printed and framed instruction chart suitable for wall hanging.
 - b. Detail the operational functions custom controls which have been placed on the front of the switchboard.
 - 3. Maintenance manual:
 - a. Furnish maintenance manuals with instructions for maintenance of equipment and data identifying all parts.
 - b. Include information needed to maintain the switchboard, including, but not limited to, the following:
 - 1) Instructions for testing, adjustment, and start-up.
 - 2) Detailed control instructions which outline the purpose and operation of every control device used in normal operation.
 - 3) Schematic and wiring diagrams:
 - a) Showing internal and external connections.
 - b) Furnished in a reduced 11-inch by 17-inch fully legible format.

1.05 QUALITY ASSURANCE

- A. Switchboard and components shall be UL listed and labeled.

- B. Equipment shall be designed and constructed in accordance with the following standards and requirements:
 - 1. NEMA PB 2.
 - 2. UL 891.

- C. Manufacturer shall be ISO 9001 certified.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship switchboards to the Site in dedicated air ride vans that will allow the Contractor to utilize on-site off-loading equipment.

- B. Furnish temporary equipment heaters within the switchboard to prevent condensation from forming.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Conduct the initial fault current study as specified in Section 26_05_74 - Electrical System Studies and submit results for the Engineer's review.
 - 2. After successful review of the initial fault current study, submit complete equipment Submittal.

3. Conduct factory acceptance test and submit certified test results for the Engineer's review.
4. Ship equipment to the Project Site after successful completion of the factory acceptance test.
5. Submit manufacturer's certification that the equipment has been properly installed and is fully functional for the Engineer's review.
6. Conduct Owner Training sessions.
7. Commissioning as specified in Section 01_75_17 - Commissioning.

1.09 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Factory assembled, wired, and tested switchboards, with major components being products of a single manufacturer, including circuit breakers, and other equipment specified in this Section and indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.
- B. Non-conditioned spaces:
 1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.
- C. Outdoor installations:
 1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.
- D. Provide complete and functional switchboards with required controls.
- E. Furnish and install devices or accessories not described in this Section but necessary for the proper installation and operation of the equipment.

2.03 MANUFACTURERS

- A. One of the following or equal:
 1. ABB.
 2. Eaton.
 3. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

- A. Voltage ratings:
 - 1. Voltage level and configuration: As indicated on the Drawings.
 - 2. Frequency: 60 hertz.
 - 3. Insulation level:
 - a. Twice the rated voltage plus 1,000 volts.

- B. Bus:
 - 1. General:
 - a. Tin-plated copper.
 - b. Bus cross-section in accordance with UL heat rise requirements.
 - c. Current density of 1,000 amps per square inch.
 - d. Mounted on supports of high-impact, non-tracking insulators.
 - e. Phase A-B-C bus arrangement:
 - 1) Top-to-bottom, left-to-right, front-to-back throughout the switchboard.
 - f. Symmetrical short circuit current bracing of as indicated on the Drawings.
 - g. Continuous current rating as indicated on the Drawings.
 - 2. Horizontal bus:
 - a. Provisions for future connections to additional switchboard sections.
 - 3. Ground bus:
 - a. Sized in accordance with UL 891.

- C. Space for future devices:
 - 1. Provide spaces as indicated on the Drawings.
 - 2. As specified in Section 26_05_00 - Common Work Requirements for Electrical.

- D. Enclosure:
 - 1. General:
 - a. Self-supporting structures bolted together to form the required lineup.
 - b. All sections rear aligned.
 - c. Dead-front.
 - d. Conduit entry:
 - 1) Open bottom.
 - 2) Removable top cover.
 - 2. Frame:
 - a. Die-formed 12-gauge steel.
 - 3. Covers:
 - a. Bolt-on.
 - b. Code gauge steel.
 - c. Removable front covers:
 - 1) Held in place by captive screws.
 - 4. Rating:
 - a. NEMA Type 1.

2.07 COMPONENTS

- A. Circuit breakers:
 - 1. As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
 - 2. Individually mounted with line and load bus connections.
 - 3. Main circuit breakers shall be 100 percent rated, fixed mounted molded case breaker with frame and trip ratings as indicated on the Drawings.
 - a. Breaker with rating of 1,000 amps or more shall be provided with ground fault shunt trip.
 - 4. Individually fixed mounted feeder devices shall be molded case breaker with ratings as indicated on the Drawings.
 - 5. Have a minimum interrupting rating equal to the bus rating or as indicated on the Drawings.
- B. Wiring:
 - 1. Provide necessary internal wiring, fuse blocks, and terminal blocks as required. Number wires at each end and indicate wire numbers on Shop Drawings.
 - 2. Type SIS switchboard wire with at least 26 strands.
 - 3. Minimum wire size:
 - a. No. 14 for control circuits.
 - b. No. 12 for voltage and current transformer circuits.
 - 4. Numbered and labeled as specified in Section 26_05_53 - Identification for Electrical Systems.
- C. The following electrical safety devices:
 - 1. Maintenance mode switch.

2.08 ACCESSORIES

- A. Metering system:
 - 1. Provide power meters as indicated on the Drawings.
 - 2. As specified in Section 26_09_13 - Electrical Power Monitoring.
- B. Surge protective devices:
 - 1. As specified in Section 26_43_14 - Surge Protective Devices.
- C. Nameplates:
 - 1. As specified in Section 26_05_53 - Identification for Electrical Systems.
 - 2. Furnish an individual nameplate for each breaker and/or switch identifying the load served.
 - 3. Furnish an individual nameplate for each vertical section identifying the vertical section:
 - a. Mounted and centered on the top horizontal wireway for each vertical section.
 - 4. Furnish an individual nameplate for each cubicle:
 - a. 1 nameplate to identify cubicle designation.
 - b. 1 nameplate to identify load served.
 - 5. Manufacturer's labels:
 - a. Each vertical section shall have a label identifying:
 - 1) Serial number.
 - 2) Shop order number.

- 3) Bus rating.
- 4) Vertical section reference number.
- 5) Date of manufacture.

D. Warning signs:

1. Voltage:
 - a. Provide a minimum of 2 warning signs on the front of the switchboard lineup and 2 on the back.
 - b. Red laminated plastic engraved with white letters approximately 1/2 inch high.
 - c. Signs shall read:
 - 1) "WARNING-HIGH VOLTAGE-KEEP OUT".
2. Arc flash:
 - a. Provide 1 warning sign for each switchboard compartment.
 - b. Signs shall have read a minimum of:
 - 1) "DANGER ELECTRIC ARC FLASH HAZARD."
 - 2) Signs shall meet the requirements of NFPA 70E and NEC Article 110.16.

E. Lugs:

1. For external connections of No. 6 AWG or larger, plated or otherwise suitable for copper or aluminum and UL listed for copper or aluminum.
2. Shall be of the compression type in design requiring a hydraulic press and die for installation as manufactured by:
 - a. Burndy.
 - b. T&B.

F. Key interlocks:

1. Provide key interlocks as indicated on the Drawings.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

- A. Chemically clean steel surfaces before painting.
- B. Exterior color: Manufacturer's standard gray over phosphate-type rust inhibitor.

2.11 SOURCE QUALITY CONTROL

A. Source Testing:

1. Witnessed, in-person:
 - a. Number of Owner and Engineer representatives in person: 2.
2. Test in accordance with the manufacturer's standard testing procedures.
3. Furnish test reports and the Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Furnish Manufacturer's Certificate of Installation Verification.

3.04 FIELD QUALITY CONTROL

- A. As specified in Section 26_05_00 - Common Work Results for Electrical.
- B. Provide the services of a qualified manufacturer's representative to:
 - 1. Inspect, verify, and certify that the mechanical installation meets the manufacturer's requirements.
 - 2. Make control connections across the shipping splits.
 - 3. Install and align circuit breakers.
 - 4. Make bus splice connections.
 - 5. Make control connections across shipping splits.
 - 6. Ensure that items furnished are in proper operating condition:
 - a. Technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.

3.05 OWNER TRAINING

- A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

3.06 ADJUSTING (NOT USED)

END OF SECTION

SECTION 26_24_16

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Panelboards serving feeder circuits and branch circuits.

1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
- B. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC).
- C. Underwriters Laboratories, Inc. (UL):
 - 1. 67 - Standard for Panelboards.

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Manufacturer of panelboard.
 - 2. Bill of material.
 - 3. Assembly ratings including:
 - a. Voltage.
 - b. Phase.
 - c. Continuous current.
 - d. Short circuit interrupting rating.
 - 4. NEMA enclosure type.
 - 5. Cable terminal sizes based upon actual feeder and sub-feeder conductors used.
 - 6. Furnish circuit breaker Submittals as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
 - 7. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01_81_50 - Design Criteria:
 - a. Manufacturer's statement of seismic qualification with substantiating test data.
 - b. Manufacturer's special seismic certification with substantiating test data.

- C. Shop Drawings:
 - 1. Overall panelboard dimensions, interior panel dimensions, and wiring gutter dimensions:
 - a. Height.
 - b. Length.
 - c. Width.
 - 2. Weight.
 - 3. Anchoring locations.
 - 4. Breaker layout drawing with dimensions:
 - a. Location of the main, branches, solid neutral, and ground.
 - 5. Conduit entry/exit locations:
 - a. Identify conduit entry/exit locations and restrictions.
 - 6. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for every panelboard.

- D. Calculations:
 - 1. Detailed calculations or details of the actual physical testing performed on the panelboard to prove the panelboard is suitable for the seismic requirements at the Project Site.

- E. Installation instructions:
 - 1. Provide manufacturer's installation instructions.

- F. Quality Control Submittals:
 - 1. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
 - 2. Test reports.

- G. Operations and maintenance manual:
 - 1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
 - 2. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories:
 - a. Including, but not limited to:
 - 1) Instruction narratives and bulletins.
 - 2) Renewal parts lists.
 - 3) Time-current curves for all devices.

1.05 QUALITY ASSURANCE

- A. Where indicated as service entrance equipment, panelboards shall be UL listed and labeled "Suitable for Service Entrance."

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and where indicated on the Drawings:
 - 1. Service voltage and configuration as indicated on the panel schedules.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.
- B. Non-conditioned spaces:
 - 1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.
- C. Outdoor installations:
 - 1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.

2.03 MANUFACTURERS

- A. One of the following or equal:
 - 1. ABB.
 - 2. Eaton.
 - 3. Schneider Electric.
- B. Circuit breakers:
 - 1. Same manufacturer as the panelboard.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

- A. Provide panelboards with:
 - 1. Molded-case circuit breakers with trip ratings as shown on the panel schedules.
 - 2. Spares and spaces for future circuit breakers in panels as shown on the panel schedules.
 - a. Space for future devices as specified in Section 26_05_00 - Common Work Requirements for Electrical.

- B. Short circuit rating:
 - 1. Provide as indicated on the Drawings.
 - 2. Testing method in accordance with UL 67.
 - 3. Mark each panelboard with its maximum short circuit rating at the supply voltage.
 - 4. Panelboards shall be fully rated.

2.07 COMPONENTS

- A. Enclosure:
 - 1. NEMA enclosure type as indicated on the Drawings:
 - a. Where not indicated on the Drawings, as specified in Section 26_05_00 - Common Work Results for Electrical for the installed location.
 - 2. Minimum width: 20 inches.
 - 3. Gutter space in accordance with the NEC:
 - a. Minimum of 4 inches.
 - 4. Dead-front, no live parts when the panelboard is in service.
 - 5. Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.
 - 6. 4-piece front to provide ease of wiring access.
 - 7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull:
 - a. Minimum 2 keys per panelboard.
 - b. Key all panelboard locks alike.
 - 8. Circuit directory frame and card on the inside of the door.
 - 9. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.
 - 10. Outdoor locations: Provide NEMA Type 4X enclosures with a NEMA Type 4X stainless steel outer enclosure (with a hinged door) and a NEMA Type 1 interior panelboard, unless otherwise indicated.
- B. Bus:
 - 1. General:
 - a. Tin-plated copper.
 - 2. Phase bus:
 - a. Full size and height without reduction.
 - b. Dimensions and temperature rise in accordance with UL 67:
 - 1) Limit current density to less than 1,000 amps per square inch.
 - c. Insulate current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.
 - 3. Ground bus:
 - a. Copper, solidly bonded.
 - 4. Neutral bus:
 - a. Provide where indicated on the Drawings.
 - b. 100 percent rated.
 - c. Provide lugs for each outgoing feeder requiring a neutral connection.
 - 5. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

- C. Lugs:
 - 1. UL listed for copper and aluminum wire:
 - a. Rated for 75-degree Celsius terminations.
 - b. Provide bolted or compression main lug terminations as required for the incoming cable size.
- D. Circuit breakers: As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers and as indicated on the Drawings:
 - 1. Provide with bolt-on connections:
 - a. Plug-in circuit breakers are not allowed.

2.08 ACCESSORIES

- A. Surge protective devices:
 - 1. Furnish panelboards with surge protective devices as indicated on the Drawings.
 - 2. As specified in Section 26_43_14 - Surge Protective Devices.
- B. Nameplates:
 - 1. As specified in Section 26_05_53 - Identification for Electrical Systems.
 - 2. Install on outside of door.
 - 3. Indicating:
 - a. Panel designation.
 - b. Voltage.
 - c. Number of phases and configuration.
- C. Circuit identification labels:
 - 1. Provide index cards behind heavy clear plastic in cardholders on the inside of the doors.
 - 2. Type all information on the cards using designations in the panel schedules.
 - 3. Laminated on both sides.
- D. Pad locking mechanism:
 - 1. Provide a pad locking attachment to allow circuit breakers to be locked in the off position.
 - 2. At a minimum, provide 1 mechanism per panelboard:
 - a. Provide multiple mechanisms if required to accommodate all circuit breaker frame sizes in the panelboard.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

- A. Finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat, and 2 coats of oven-baked enamel with manufacturer's standard gray.
- B. Finish panelboards mounted in motor control centers to match the motor control center finish and color.

2.11 SOURCE QUALITY CONTROL

- A. Source Testing:
 - 1. Perform standard factory tests on the panelboards.
 - 2. Test in accordance with NEMA and UL standards.
 - 3. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 FIELD QUALITY CONTROL

- A. As specified in Section 26_05_00 - Common Work Results for Electrical.

END OF SECTION

SECTION 26_28_01

LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Low voltage molded case circuit breakers.

1.02 REFERENCES

- A. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC).
- B. Underwriters Laboratories (UL):
 - 1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.03 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 - 1. Catalog cutsheets.
 - 2. Manufacturer's time-current curves for molded case circuit breakers furnished.
- C. Operation and maintenance manuals:
 - 1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
- D. Owner Training Submittals:
 - 1. As specified in Section 01_75_17 - Commissioning.

1.04 QUALITY ASSURANCE

- A. Low voltage molded case circuit breakers shall be UL listed and labeled.

1.05 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.06 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.08 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Molded case thermal magnetic, solid-state, or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

2.03 MANUFACTURERS

- A. One of the following or equal:
 - 1. ABB.
 - 2. Eaton.
 - 3. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS

- A. General:
 - 1. In accordance with UL 489.
 - 2. Operating mechanism:
 - a. Quick-make, quick-break, non-welding silver alloy contacts.
 - b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
 - c. Mechanically trip free from the handle.
 - d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
 - e. Lockable in the OFF position.
 - 3. Arc extinction:
 - a. In arc chutes.
 - 4. Voltage and current ratings:
 - a. Minimum ratings as indicated on the Drawings.
 - b. Minimum frame size 100 A.
 - 5. Interrupting ratings:
 - a. Minimum ratings as indicated on the Drawings.
 - b. Modify as required to meet requirements of the short circuit fault analysis as specified in Section 26_05_74 - Electrical System Studies.
 - c. Not less than the rating of the assembly (panelboard, switchboard, motor control center, etc.).
- B. Motor circuit protectors:
 - 1. Instantaneous only circuit breaker as part of a listed combination motor controller.
 - 2. Each pole continuously adjustable in a linear scale with "LO" and "HI" settings factory calibrated.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

- A. Terminals:
 - 1. Line and load terminals suitable for the conductor type, size, and number of conductors indicated on the Drawings and in accordance with UL 489.
- B. Case:
 - 1. Molded polyester glass reinforced.
 - 2. Ratings clearly marked.
- C. Trip units:
 - 1. Provide thermal magnetic or solid-state trip units as indicated on the Drawings.
 - 2. Thermal magnetic:
 - a. Instantaneous short circuit protection.
 - b. Inverse time delay overload.
 - c. Ambient or enclosure compensated by means of a bimetallic element.
 - 3. Solid state:
 - a. With the following settings as indicated on the Drawings:
 - 1) Adjustable long time current setting.
 - 2) Adjustable long time delay.
 - 3) Adjustable short time pickup.
 - 4) Adjustable short time delay.
 - 5) Adjustable instantaneous pickup.
 - 6) Adjustable ground fault pickup as indicated on the Drawings.
 - 7) Adjustable ground fault delay as indicated on the Drawings.
 - b. Energy reducing maintenance switch on breakers 1,200 amps and above and on additional breakers as indicated on the Drawings.
 - 1) Indication on the breaker.
- D. Provide ground fault trip devices as indicated on the Drawings.
- E. Molded case circuit breakers for use in panelboards:
 - 1. Bolt-on type:
 - a. Plug-in type breakers are not acceptable.
 - 2. Ground fault trip devices as indicated on the Drawings.

2.08 ACCESSORIES

- A. Lockable handle:
 - 1. Provide assembly to lock operating handle in "OPEN" position.
 - 2. Where a molded case circuit breaker is located in a dedicated enclosure, provide a lockable handle. Reference the Electrical Specifications for additional locking requirements associated with other mounting installations.
- B. Key interlocks:
 - 1. Provide key operated interlocks to ensure safe switching procedures as indicated on the Drawings.

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Test breakers in accordance with:
 - 1. UL 489.
 - 2. Manufacturer's standard testing procedures.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Install breakers to correspond with the accepted Shop Drawings.

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 OWNER TRAINING

- A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

3.06 ADJUSTING (NOT USED)

END OF SECTION

SECTION 26_43_14

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
1. High-energy surge protective devices.

1.02 REFERENCES

- A. Institute of Electrical and Electronics Engineers (IEEE):
1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
 2. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and Less) AC Power Circuits.
 3. C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
 4. C62.62- Standard Test Specifications for Surge Protective Devices (SPD) for Use on the Load Side of the Service Equipment in Low Voltage (1,000 V and less) AC Power Circuits.
- B. International Electrotechnical Commission (IEC):
1. 1000-4 - Electromagnetic Compatibility Standards for Industrial Process Measurement and Control Equipment.
- C. National Electrical Manufacturers Association (NEMA).
- D. National Fire Protection Agency (NFPA):
1. 20 - Standard for the Installation of Stationary Pumps for Fire Protection.
 2. 70 - National Electrical Code (NEC).
 3. 75 - Standard for the Fire Protection of Information Technology Equipment.
 4. 780 - Standard for the Installation of Lightning Protection Systems.
- E. Underwriters Laboratory (UL):
1. 96A - Standard for Installation Requirements for Lightning Protection Systems.
 2. 1283 - Standard for Electromagnetic Interference Filters.
 3. 1449 - Standard for Surge Protective Devices.

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. I_n : Nominal discharge current.
 2. MCOV: Maximum continuous operating voltage.
 3. MOV: Metal oxide varistor.
 4. SAD: Silicon avalanche diode.

5. SCCR: Short circuit current rating.
6. SPD: Surge protective device.
7. VPR: Voltage protection rating.

1.04 DELEGATED DESIGN (NOT USED)

1.05 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
 2. Manufacturer's catalog cutsheets indicating:
 - a. Manufacturer and model numbers.
 - b. Ratings of each SPD, including, but not limited to:
 - 1) Short circuit current rating.
 - 2) Nominal discharge current.
 - 3) Maximum continuous operating voltage.
 - 4) Voltage protection rating.
 - 5) System voltage.
 - 6) System frequency.
 - 7) Surge current capacity.
 3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
 - a. Overcurrent protection.
 - b. UL 1449.
- C. Shop Drawings:
 1. Provide electrical and mechanical drawings by the manufacturer that detail:
 - a. Unit dimensions.
 - b. Weights.
 - c. Components.
 - d. Field connection locations.
 - e. Mounting provisions.
 - f. Connection details.
 - g. Wiring diagram.
- D. Quality Control Submittals:
 1. Manufacturer's representative qualifications.
 2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
- E. Owner Training Submittals:
 1. As specified in Section 01_75_17 - Commissioning.
- F. Operation and maintenance manuals:
 1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
 2. Provide the manufacturer's manual with installation, start-up, and operating instructions for the specified system.

1.06 QUALITY ASSURANCE

- A. Provide SPD units that are designed, manufactured, tested and installed in accordance with the following codes and standards:
 - 1. IEEE C62.41.1, C62.41.2, C62.45, C62.62.
 - 2. Federal Information Processing Standards Publication 94 (FIBS PUB 94).
 - 3. NEMA.
 - 4. NFPA 20, 70, 75, and 780.
 - 5. UL 1449 current edition and UL 1283.
 - 6. IEC 1000-4.
- B. Provide surge protective devices that are suitable for application in IEEE C62.41.1, C62.41.2 Category A, B, and C3 environments, as tested to IEEE C62.45.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.10 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.
- B. Extended warranty:
 - 1. Furnish a manufacturer's standard parts and labor warranty from date of shipment against any part failure when installed in accordance with the manufacturer's instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
 - 2. Warranty shall include:
 - a. Direct, factory-trained employees must be available within 48 hours for assessment of the problem.
 - b. A 24-hour toll-free 800-number for warranty support.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide surge protection as indicated on the Drawings.

2.03 MANUFACTURERS

- A. One of the following or equal:
1. ABB.
 2. Eaton.
 3. Southern Tier Technologies.
 4. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

- A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.
- B. Electrical requirements:
1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
 2. MCOV:
 - a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
 3. Operating frequency:
 - a. 47 to 63 hertz.
 4. SCCR:
 - a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
 - b. Marked on the SPD in accordance with UL 1449 and the NEC.
 5. Nominal discharge current I_n :
 - a. 20 kA.
 6. Maximum VPR:

Modes	240/120 3W	208Y/120	480Y/277	480 V
L-N, L-G, N-G	700	700	1,200	1,800
L-L	1,200	1,200	2,000	1,800

7. Peak surge current:
 - a. Service entrance locations:
 - 1) 240 kA per phase minimum.
 - 2) 120 kA per mode minimum.
 - b. Branch locations:
 - 1) 120 kA per phase, minimum.
 - 2) 60 kA per mode minimum.
- C. Protection modes:
1. Provide SPD protection modes as follows:
 - a. Line to neutral (L-N) where applicable.
 - b. Line to ground (L-G).
 - c. Neutral to ground (N-G), where applicable.

- D. Environmental requirements:
 - 1. Storage temperature:
 - a. -40 to 122 degrees Fahrenheit.
 - 2. Operating temperature:
 - a. 32 to 140 degrees Fahrenheit.
 - 3. Relative humidity:
 - a. 5 to 95 percent.
 - 4. Audible noise:
 - a. Less than 45 dBA at 5 feet (1.5 m).
 - 5. Operating altitude:
 - a. Zero to 12,000 feet above sea level.

2.07 COMPONENTS

- A. Enclosure:
 - 1. Located in electrical equipment as indicated on the Drawings.
- B. Internal connections:
 - 1. Provide low impedance copper plates for intra-unit connections:
 - a. Attach surge modules using bolted connections to the plates for low impedance connections.
 - 2. Size connections, conductors, and terminals for the specified surge current capacity.
- C. Surge diversion modules:
 - 1. MOV:
 - a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.
- D. Overcurrent protection:
 - 1. Individually fuse components, including suppression, filtering, and monitoring components:
 - a. Rated to allow maximum specified nominal discharge current capacity.
 - b. Overcurrent protection that limits specified surge currents is not acceptable.
- E. Connections:
 - 1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.08 ACCESSORIES

- A. Unit status indicators:
 - 1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
 - a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
 - b. Indicates the status of protection on each mode or phase.

- B. Dry contacts for remote monitoring:
 - 1. Electrically isolated Form C dry contacts (1 A/125 VAC, or 2 A/24 VDC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.
- C. Provide an audible alarm which activates under any fault condition:
 - 1. Alarm On/Off switch to silence the alarm.
 - 2. A visible LED will confirm whether alarm is On or Disabled.
 - 3. Locate both switches and the audible alarm on the unit's front cover.

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Source Testing:
 - 1. Perform manufacturer's standard factory test:
 - a. Perform testing in accordance with UL 1449.
 - 2. Furnish test reports and Manufacturer's Certificate of Source Testing.
- B. Permanently affix surge rating to the SPD.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 OWNER TRAINING

- A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

END OF SECTION