EXHIBIT X

Specification for Substation Equipment Installation, Testing and Commissioning

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1 Substation Testing and Commissioning

1.1 Scope of specification

Capitalized terms shall have the same meaning as defined in the Contract unless the context requires otherwise. This specification covers the testing of substation Equipment, auxiliary Equipment, relays, circuits and controls associated with the installation of new Equipment at Owner substations.

In general, all Equipment, switches, wiring, relays, controls, grounding systems, batteries, generators, buildings and associated systems, and all other devices shall be tested and verified by Contractor to meet the manufacturer's recommendations and Industry Standards and to be fully functional. In addition, the specific testing and commissioning criteria as stated in this document must be completed by Contractor. Testing is to be complete and as extensive as necessary to ensure the proper operation and functionality of the entire Project. If there is a conflict between the manufacturer testing requirements and Owner installation and/or testing procedures, Owner procedures shall prevail, unless specifically agreed to in writing by both parties. Any such conflicts or potential conflicts of procedures shall be highlighted and included in Contractor's pre-commissioning and test plan that must be submitted at least sixty (60) days before the Work starts, as described in Section 1.5. The primary purpose of these procedures is to: (a) ensure that the Equipment has been properly installed in accordance with the Equipment manufacturer and Owner procedures, and (b) to describe or provide the proper format for the documentation of all commissioning Work and test results obtained by Contractor so that Owner can review Contractor's Work.

1.2 Testing and commissioning responsibilities

Contractor shall be responsible for all aspects of installation, testing, pre-commissioning and commissioning, post-energization failures and corrections, except as noted below. The definitions of installation, testing, pre-commissioning and commissioning as used in this document are defined in Section 1.5. Contractor shall not install final protective relay settings or perform in-service verifications. However, Contractor shall dispatch personnel familiar with the Work to be on-site within twenty-four (24) hours after notification by Owner to correct any deficiencies due to Contractor performance of the Work. Review and acceptance by Owner of Contractor's test results and data shall not release Contractor of responsibility for any workmanship or Equipment deficiencies. Contractor shall be responsible to correct deficiencies due to Contractor performance of the Work in the manner described above until the Equipment has been placed in service, after which normal warranty procedures shall apply. Specific breakdown of Work responsibilities between Contractor and Owner can be found in PacifiCorp Testing and Commissioning Responsibility Matrix, Attachment X.1.2.

Contractor is responsible for confirming that all Equipment meets voltage, current, and other applicable ratings for the engineered design and application of the device.

Examples of typical Equipment and systems to be tested and verified for proper operation are listed below. This list is not all-inclusive and may include items not applicable:

- Circuit breakers
- Switches
- Transrupters
- Capacitor banks
- Power transformers and reactors

- Instrument transformers
- Bushings
- Arresters
- Protective relays and devices
- Monitoring devices
- Fault recording devices
- Meters and instruments
- Cables, wiring terminations and auxiliary controls
- AC and DC control systems
- Batteries and chargers
- Grounding systems and grids
- Lighting and AC service systems
- Building systems
- HVAC

1.3 Applicable standards

Contractor shall complete the testing and commissioning Work set out in this specification in full compliance of the following standards:

1.3.1 International Electrical Testing Association, Inc.

1.3.2 Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems

1.3.3 American National Standards Institute (ANSI):

- C12.1 - Code for Electricity Metering
- C12.10 - Physical Aspects of Watt-hour Meters - Safety Standard
- C12.11 - Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL
- C12.20 - Electricity Meters 0.2 and 0.5 Accuracy Classes
- C63.2 - Electromagnetic Noise and Field-Strength Instrumentation, 10 kHz to 40GHz
- C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz - Revision of ANSI C63.4-2001

1.3.4 American Society for Testing and Materials (ASTM):

- D 117 - Standard Guide for Sampling, Test Methods, Specifications, and Guide for Electrical Insulating Oils of Petroleum Origin
- D877 - Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- D1816 - Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes

1.3.5 Institute of Electrical and Electronics Engineers (IEEE):

- C37.20.1 - Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
- C37.20.2 - Metalclad and Station-Type Cubicle Switchgear
- C37.20.3 - Metal-Enclosed Interrupter Switchgear
- C57.13 - Requirements for Instrument Transformers
- C57.13.1 - Guide for Field Testing of Relaying Current Transformers
- C57.13.2 - Conformance Test Procedures for Instrument Transformers
- C57.13.3 - Guide for Grounding of Instrument Transformer Secondary Circuits and Cases
- C57.106 - Guide for Acceptance and Maintenance of Insulating Oil in Equipment
- IEEE 450 - Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations

1.3.6 National Electrical Manufacturers Association (NEMA) and Insulated Cable Engineers Association (ICEA):

- NEMA WC 57/ICEA S-73-532 - Standard for Control, Thermocouple Extension, and Instrumentation Cables
- NEMA WC 70/ICEA S-95-658 - Non-shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- NEMA WC 71/ICEA S-96-659 - Non-shielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy
- NEMA WC 74/ICEA S-93-639 - 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

1.3.7 National Fire Protection Association (NFPA):

- 70 - National Electrical Code

1.4 Safety

Test procedures, Equipment, temporary circuits, etc., shall be designed and used in a safe manner to minimize danger to testing technicians and other personnel. For example, current transformer temporary test circuits utilizing alligator clips shall not be permitted. Contractor shall furnish and utilize safety devices such as personal protective Equipment, personal grounds, rubber gloves and blankets, protective screens and barriers, yellow tape, danger signs, warning tags, and other items as appropriate to adequately protect and warn all personnel in the vicinity of the tests. Contractor shall keep Owner personnel informed of potential hazards associated with their Work when and as it could impact Owner's employees. Contractor shall participate in joint safety meetings with Owner personnel when they are on-site together. Contractor shall take all precautions necessary to ensure that Owner personnel are not exposed to safety hazards that may exist due to Contractor Work.

1.5 Definition of Equipment installation, testing and the commissioning process

The Contractor shall perform all typical industry accepted installation practices, manufacturer recommended installation and commissioning tests and Owner's required tests.

The overall commissioning process typically includes all activities from when the equipment is installed until it is placed in operational service. In order to facilitate work assignments and responsibilities, and for purposes of clarification the commissioning process will typically follow the sequence of events listed below:

1.5.1 Commissioning consists of:

1.5.1.1 Pre-commissioning

1.5.1.1.1 Installation of equipment

1.5.1.1.2 Acceptance testing of equipment.

1.5.1.2 Final commissioning

1.5.1.2.1 Functional testing of equipment.

1.5.1.2.2 Energization of equipment.

1.5.2 Definitions:

The different terms as used in this process are intended to have the following meanings:

1.5.2.1 Installation (of Equipment):

To place, position, or fit into a position or location and then to assemble sub-components and connect control and power cables, conductors, and other accessories and fittings to the Equipment as required to make it ready to be operational.

1.5.2.2 Testing:

To perform appropriate electrical, mechanical, thermal, pressure, operational and functional testing and verification of Equipment such as transformers, circuit breakers, switches, bus Work and ground mats. Testing of equipment takes place during pre-commissioning and final commissioning and can be sub-divided as follows:

1.5.2.2.1 Acceptance testing: Are those testing activities performed to verify that the equipment has been properly assembled and installed. For control cables and relay panels it means to perform insulation resistance (Megger), continuity, and point to point wiring verification tests. These activities will typically be performed by the Contractor.

1.5.2.2.2 Functional testing: Are those testing activities that are performed immediately prior and during initial energization of the equipment to verify correct operation under energized conditions. For protection and control systems, it implies applying final settings and performing functional tests to verify correct operation of the Equipment. These activities will typically be performed by the Owner.

1.5.3 Pre-commissioning:

To perform all installation (as defined in Section 16.5.2.1), acceptance testing (as defined in Section 16.5.2.2.1) and verification activities of substation Equipment, cables and relay panels in order to prepare it for placing it in service. For Equipment such as batteries, circuit breakers, switches, reactors and transformers, it includes all installation activities such as assembly, oil or gas processing, functional testing of accessories and sub-components, timing tests, and any electrical and mechanical acceptance tests needed to verify that the Equipment has been installed and connected according to the manufacturer and Owner's specifications. The purpose of these activities is to ensure that the Equipment is able to perform its intended function. These activities will be performed by Contractor with the exception of Equipment, cables and relay panels that are installed in existing and energized control buildings. Installation and testing activities on these items will be performed by Owner.

1.5.4 Final Commissioning:

The process of energizing the Equipment with control power followed by all final functional testing (as defined in Section 16.5.2.2.2) and verification required to verify that the equipment can be energized at rated voltage and power. Functional testing of the Equipment will be followed by energizing the Equipment at rated voltage and power to perform all post energization testing and verification of proper power flows through the Equipment before it can be placed in operational service. Final commissioning requires that pre-commissioning (as defined in Section 16.5.3) of the Equipment has been completed. This activity includes doing. These activities will be performed by Owner unless expressly delegated to Contractor.

1.6 Documentation

1.6.1 General

No installation and testing forms with failed test results should be submitted to PacifiCorp. The technician shall contact PacifiCorp to determine an appropriate course of action when acceptable test results cannot be achieved.

1.6.2 Pre-commissioning schedule and test plan

Contractor shall provide a written pre-commissioning schedule and test plan for all pre-commissioning activities to be completed for this Project no later than sixty (60) calendar days prior to the start of those activities. An individual plan is required for each substation in the Project. This plan and schedule shall include Equipment to be tested, testing Equipment to be used, test forms used for each Equipment type, and schemes used to test. The test plan shall include a detailed description of the test procedures that will be followed and the sequence in which they will be followed for each type of Equipment. The overall sequence in which the Equipment will be installed and tested shall be described. Owner shall approve this plan in writing before any test or pre-commissioning Work may commence.

1.6.3 Installation and Testing documentation required – field copies

Contractor shall supply Owner with field copies of all test results no later than two (2) days after completion of the tests for each piece of Equipment as it is installed and tested. These test results shall be dated and signed by the lead on-site tester.

1.6.4 Installation and Test documentation required – final copies

Contractor shall supply Owner with the final completed test data and reports within ten (10) days after completion of the tests for each piece of Equipment as it is installed and no later than five (5) days prior to energization of that Equipment. These test results shall be dated and signed by the lead on-site tester and the lead Project test engineer, when applicable.

1.6.5 Use of Owner-provided installation procedures and forms

Equipment-specific procedures and forms are provided by Owner and shall be utilized during the installation and testing of substation Equipment. Each required installation and testing form must be completed in full before it is submitted.

Equipment-specific procedures and forms are listed under each Equipment type in section 2. These documents are also listed in the attachment index at the end of this document; however, this list does not include all of the required procedures and forms. See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of Owner-provided required documentation.

Where Owner procedures and forms are not available for a specific type of Equipment, Contractor shall submit his own procedures and suitable forms for documenting the test data for Owner review and approval. All Contractor procedures and forms that are to be used shall be included with the pre-commissioning and test plan for Owner review and approval.

1.6.6 Electronic test set-generated data

Test set-generated electronic data results shall be submitted in two formats: This will typically apply for any power factor; transformer turns ratio; battery; and transformer sweep frequency analysis test results.

1.6.6.1 Adobe Acrobat copies or print-outs of all test set generated reports.

1.6.6.2 Test set generated data files shall be submitted as attachments in the OEM test equipment software format.

1.6.7 Installation reports and test data format and file naming convention

All test reports and documentation packages shall be e-mailed to the following e-mail address: Commissioning@PacifiCorp.com.

All equipment that is listed and tracked in the Commissioning Notebook shall have equipment memorandum forms submitted in addition to all test reports. These forms are listed Substation Apparatus and Line Equipment Memorandum, Form 001F, Attachment A-X1.6.7A, and Relay and Interchange Meter Equipment Memorandum, Form 006F, Attachment X1.6.7B

Test data and forms pertaining to any one piece of Equipment shall be submitted together in one e-mail. If the e-mail message size will exceed ten megabytes, the data shall be divided into separate e-mails and clearly labeled with subpart numbers, for example: Part 1 of 3; Part 2 of 3; etc.

- Type of test report (e.g. Field copy or Final Test Report)
- The subject line of the e-mail shall list the following information:
- Installed location of Equipment (e.g. substation name)
- Equipment description (e.g. 345kV circuit breaker CB123)
- Company identification number if the Equipment has one (e.g. SAP#: 123456)
- Subpart number of e-mail. Single e-mail submittals will be listed as Part 1 of 1.
    - e.g. Ashley_CB123_SAP123456_part 1 of 1

When several different forms are submitted for a particular piece of Equipment, these forms may not be combined or scanned into one electronic Adobe Acrobat file. Each form or data set shall be included as a separate attachment contained in the one e-mail submittal. The body of the e-mail shall list all the attachments contained in the e-mail by form or document name.

All test forms shall be delivered to Owner electronically in the original Adobe Acrobat format as provided and using marked up design or installation drawings (when required). Testing and verification data not specifically addressed in this specification shall be formally documented and submitted in Adobe Acrobat format, unless otherwise agreed to by Owner.

All information fields on all Owner-provided forms shall be completed in full by Contractor. Where more than one subcontractor performs parts of the Work for any particular type of Equipment, their respective Work shall be combined on one form for Owner review. Partially

completed forms from each subcontractor are unacceptable. Each documentation package submitted shall be arranged as described below.

In addition to the electronic submittals, an official copy of the field and final test reports shall be submitted in duplicate on CD-ROM. Paper copies of the reports are optional.

All test reports on paper or CD-ROM shall include the minimum subsections and subparts in the format as listed below:

a. A title page listing:

- **i.** Report title/purpose: Field Installation/Test Report for "Equipment Type";
- **ii.** The installed location of the equipment;
- **iii.** The Owner project title or description;
- **iv.** The date the test reports were submitted to the Owner;

b. If test reports are submitted for more than one piece of equipment in one report, an index page shall follow the title page with the information as listed below for each separate piece or unit of equipment (i.e. circuit breaker, transformer, instrument transformer, switch, etc.) included in the report:

- **i.** The type of equipment – circuit breaker, transformer, etc.;
- **ii.** The Owner equipment number;
- **iii.** The equipment serial number provided by the manufacturer; and
- **iv.** Equipment location (substation) and Owner-provided position number.

c. For each separate unit or piece of equipment included in the report, a separate cover page shall be included preceding the test data for that equipment, listing the following information as it pertains to that piece of equipment:

- **i.** Type of equipment - circuit breaker, transformer, etc.;
- **ii.** The Owner equipment number (if applicable);
- **iii.** The equipment serial number;
- **iv.** The name and contact details of the manufacturer / factory representatives on site during the installation;
- **v.** The names and contact details of all subcontractors that performed the field installation and testing (if more than one subcontractor was used, please specify each and their responsibility);
- **vi.** The start and end dates of field installation and testing work;
- **vii.** All test reports and forms included in the report, in chronological order as they appear in the report; and
- **viii.** Miscellaneous test results as described in Section 1.6.8.

d. If test reports are submitted for more than one piece of equipment in one report, an index page shall follow the title page with the information as listed below for each separate piece or unit of equipment (i.e. circuit breaker, transformer, instrument transformer, switch, etc.) included in the report:

- **i.** The type of equipment – circuit breaker, transformer, etc.;

ii. The Owner equipment number;

iii. The equipment serial number provided by the manufacturer; and

iv. Equipment location (substation) and Owner-provided position number.

e. For each separate unit or piece of equipment included in the report, a separate cover page shall be included preceding the test data for that equipment, listing the following information as it pertains to that piece of equipment:

i. Type of equipment - circuit breaker, transformer, etc.;

ii. The Owner equipment number (if applicable);

iii. The equipment serial number;

iv. The name and contact details of the manufacturer / factory representatives on site during the installation;

v. The names and contact details of all subcontractors that performed the field installation and testing (if more than one subcontractor was used, please specify each and their responsibility);

vi. The start and end dates of field installation and testing work;

vii. All test reports and forms included in the report, in chronological order as they appear in the report; and

viii. Miscellaneous test results as described in Section 1.6.8.

1.6.8 Miscellaneous Equipment and Equipment without company identification numbers

Control cable tests, wiring verifications, alarm verifications and all other required testing that does not have a specific associated check sheet or computer generated test result shall be highlighted (yellow for wire verification and pink for devices), initialed by the tester, and dated on the appropriate clean construction drawing or print. The highlight will confirm that all verification and testing has been completed by Contractor.

Additions of Equipment, wiring, or any other modifications to the drawings shall be fully and professionally documented. Removals of Equipment or wiring shall be drawn in green and permanent corrections and additions shall be marked in red. All changes shall be reviewed and approved by Contractor design engineer.

Testing technician comments or notes pertaining to the marked changes that are not intended for permanent retention on the drawings shall be marked in standard pencil. Corrected drawings ("as-constructed") shall be continually updated and completed prior to energization for Owner's engineering review and technician's use during energization commissioning.

1.6.9 Review and acceptance of test results

All test results, forms and data shall be approved by Owner before the Equipment may be energized or placed in service. Acceptance of test results by Owner does not relieve Contractor of his responsibility to perform the Work in accordance with the various procedures and forms or the terms of the contract.

1.7 Personnel qualifications

1.7.1 General

All technicians shall be pre-qualified by PacifiCorp for each project prior to any installation or testing work commencing. All technicians shall be experienced in installation and testing

of substation equipment with similar voltage class and type as this project entails. All installation and testing of substation equipment must be carried out by qualified technicians.

1.7.2 Lead testing technician

The lead testing technician shall have a minimum of ten (10) years of relevant experience in electric utility high voltage substation testing, including being in charge of testing programs for substations of a similar size and nature to this project. The lead testing technician shall be present on-site during all testing activities. All testing of equipment shall be performed under the direct on-site supervision of the lead testing technician.

1.7.3 Testing Technician

The testing technician shall have a minimum of five (5) years of relevant experience in electric utility high voltage substation testing.

1.7.4 Installation technician

The installation technician shall have a minimum of five (5) years of relevant experience in electric utility high voltage substation equipment installation.

1.7.5 Proof of experience

Each technician shall submit detailed written documentation that describes the specific equipment type, models and manufacturers of relevant equipment previously installed and tested to support the technician's claims of relevant experience. The evidentiary documentation shall explain the specific responsibility and role that the person had for each type of equipment. Documentation shall include the company name for each project where work was performed. Owner may require all technicians to perform a practical skills and subject matter knowledge demonstration before being approved. The purpose of this process is to corroborate the technician's claims of specific and relevant experience. A general purpose resume style document is unacceptable.

All technicians may be interviewed by PacifiCorp representatives to determine if the technician is approved for installation and/or testing activities. All documentation for the technician shall be submitted one month before any installation or testing is to commence. Approvals may be limited to certain equipment types or by voltage class. Approvals will apply to both Rocky Mountain Power and Pacific Power.

1.8 Required test Equipment

Contractor shall furnish all required testing Equipment. All test Equipment shall have been tested, calibrated and certified to be in fully functional condition by the Equipment manufacturer (or other certified facility); in accordance with the Equipment manufacturer's recommended calibration intervals, prior to performing any testing. Copies of all certificates shall be provided to Owner prior to testing. Owner will field verify that only pre-qualified test Equipment is used during actual testing. Test technicians must be familiar with the use of this Equipment and have a thorough understanding of the devices that are being tested.

The following is a list of approved test Equipment. Deviations from this list shall require Owner approval. Complete details of Equipment that deviates from the approved list of Equipment, as well as any other Equipment that will be used and is not listed here shall be submitted with the pre-commissioning and test plan prior to the start of the Work as described in Section 1.5.

1.8.1 Power factor/exciting current (e.g. Doble M4000)

1.8.2 Relay test set for use as a power supply for functional testing, as required (e.g. Doble 6150 series or 3 each of the 2350 series)

NOTE: Contractor is not responsible for installation or verification of relay settings or in-services tests.

1.8.3 Voltmeter and ammeter

- Multi-meters may be used during the calibration of meters, transducers and relays. Any meter used must be high-accuracy digital and meet the following specifications:
- 4.5 digit or better resolution
- True RMS AC measurement
- Basic DC accuracy: 0.05 percent of scale used
- Basic AC accuracy: 0.2 percent of scale used

1.8.4 Current transformer test Equipment

1.8.5 A device specifically designed to test current transformers shall be used. Approved devices include:

- Model CTER-91 Vanguard EZ Current Transformer Tester (preferred)
- AVO Current Transformer Excitation Test Set
- Appropriate Vanguard current transformer excitation test set device

1.8.6 Test jack devices

- ABB FT-1 and FT-19R test switches shall be used extensively throughout the protective relay and control and metering systems to facilitate testing.
- Disconnection of internal wiring is discouraged and is to be performed only when absolutely necessary and with prior approval from the Owner.
- It shall be necessary to have sufficient quantities of ABB Test Plugs (duckbills) to enable the use of the test switches.

1.8.7 Computer and printer

- A computer and associated communications cables for communicating with the various types of testing Equipment is required and shall include special software to communicate with test Equipment, substation integration devices, and/or intelligent Equipment devices (i.e., relays, panel meters, transformer tap controllers, etc.). Contractor is responsible for providing the computer, printer, cables and any other associated hardware and software that may be needed.

1.8.8 Ohmmeters

- 5000-volt megohm meter with a minimum accuracy of 5 percent
- Digital Low Resistance Ohmmeter (DLRO)
- Direct current (DC) Micro ohmmeter, 100 ampere (A) true continuous DC current

1.8.9 Infrared (IR) scanning Equipment

- IR Equipment must be capable of recording thermal images and temperatures in full sunlight. Proper magnification lens must be used for distances of 75 feet or more.

1.8.10 Battery-powered wire identification test set

1.8.11 Standard insulating liquid test set

- The test set should include a test cell with one-inch disc electrodes and adjustable gap per ASTM D877 and a test cell with electrodes and spacing per ASTM D1816, Hipotronics Type OC or approved equivalent.

1.8.12 DC resistance load box, 100 A or greater

1.8.13 Alternate current (AC) high current test set, Multi-Amp MS-2, or approved equivalent

1.8.14 AC high-potential test set, adjustable up to 60 kV and 60 hertz

1.8.15 DC high-potential test set, adjustable up to 90 kV

1.8.16 Oscilloscope, capable of six traces, including three current traces

1.8.17 Contact resistance test set, 100 A or greater

1.8.18 Sweep frequency response analyzer (e.g. Doble M5000 series)

1.8.19 Circuit breaker timing test set (e.g. Vanguard CT7500)

2 Specific Equipment testing

2.1 Switches

2.1.1 Documentation:

2.1.1.1 Contractor shall complete and submit a separate PacifiCorp Substation Form SF-ABDISC-INST, Attachment X.2.1, for each switch that is installed.

2.1.1.2 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

2.1.2 Description:

2.1.2.1 All high-voltage switches shall be verified to meet manufacturer's standards for functionality, toggle accuracy, timing accuracy, open- and closed-position accuracy, proper operating torque, and required torque of bolted connections. Owner shall verify switch operation prior to setting of piercing bolts by Contractor.

2.2 Grounding grid

2.2.1 Documentation:

2.2.1.1 This testing and inspection shall be highlighted or marked off on the grounding plan drawing for Owner's review. All test results shall be documented on the appropriate forms and will include tabulated and graphed results as required in the prescribed industry type tests or test methods described in PacifiCorp Substation Procedure SP-GRND-CONTINUITY, Attachment X.2.2A. Submit PacifiCorp Substation Form SF-GRND-CONTINUITY, Attachment X.2.2B, and soil resistivity report, if required.

2.2.1.2 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

2.2.2 Description:

2.2.2.1 If required, a soil resistivity test shall be performed along at least two (2) sides of the site, as well as diagonally from one corner to another, using the four point

"Wenner" measurement method. Test results shall be used as part of the ground grid design.

2.2.2.2 All ground grids, grounding connections, Equipment and fence grounding shall be tested and inspected for proper torque value and/or Cad-Weld integrity.

2.2.2.3 For new ground grids or additions to existing ground grids, a ground grid resistance to earth test shall be performed. Contractor shall ensure that the new grid under test is disconnected from all external utility neutral or grounding connections, including static lines on overhead power lines entering the substation. The test shall be performed using the "Fall of Potential" or three-point measurement method. Contractor shall verify the ground resistance test results meets or exceeds the design requirements. If test results do not meet or exceed design requirements, Contractor shall submit a mitigation plan for approval to Owner.

2.2.2.4 The ground grid shall be tested for continuity between all connected parts of the grid using the current injection method described in procedure SP-GRND-CONTINUITY, Attachment X.2.2A. All exposed ground grid connections must be verified using a high-current injection test set rated at one hundred (100) amperes (A) or greater. Each Equipment and structure connection point must be injected (forced to flow) with minimum one hundred (100) A to verify proper continuity of the below-ground level grounding grid conductors and connections. Voltage and current flows at each exposed conductor shall be recorded on form SF-GRND-CONTINUITY, Attachment X.2.2B, and on the grounding plan drawing. The location of the power supply connections for the specific test area shall be recorded and marked on the forms and drawings as described.

2.3 Phasing

2.3.1 Documentation:

2.3.1.1 Protective circuitry phasing verification shall be highlighted on applicable potential schematic drawings.

2.3.1.2 High-voltage bus phasing verification shall be highlighted on applicable potential schematic drawings.

2.3.1.3 Phasing nomenclature will be provided by Owner for each substation.

2.3.1.4 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

2.3.2 Description:

2.3.2.1 Physically, electrically, and mechanically verify high-voltage bus Work and lines, low-voltage station service, transfer switches, generator, and all motors have proper rotation and phasing and meet engineering design and application. Owner will ensure phasing is performed during commissioning.

2.4 Control wiring

2.4.1 Documentation:

2.4.1.1 All final substation as-constructed drawings, including manufacturer drawings, must be clearly marked-up and modified to reflect the exact substation Equipment installed details.

2.4.1.2 Complete and submit PacifiCorp Substation Form SF-CABLE-INST, Attachment X.2.4A for all control cables that are installed to connect equipment to each other.

2.4.1.3 Wiring termination drawings shall be highlighted to indicate wiring and device testing and verification.

2.4.1.4 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5 for a complete list of required procedures and forms.

2.4.2 Description:

2.4.2.1 Visual inspection: Visually inspect all relays, meters, electrical Equipment control cabinets, and any modified or new relay control panels for damage that may have occurred during shipping and installation.

2.4.2.2 Panel Equipment installation: Verify relays, Equipment, and nameplates are installed on the panel as documented on the panel layout and connection diagram.

2.4.2.3 Panel point-to-point wiring: Perform point-to-point wire checks on all new and modified relay control panels. Verify wiring matches the connection diagram and control schematics.

2.4.2.4 Panel wire lugs: Verify all new and modified panel wiring lugs are adequately crimped. See Construction Specifications, Attachment X.2.4B, for cable lug installation specifications.

2.4.2.5 Panel terminal blocks: Verify all new and modified panel wiring terminal block connections are checked for tightness.

2.4.2.6 Panel current transformer (CT) circuits: For each new or modified relay control panel, measure the direct current (DC) resistance of each CT circuit from the panel input terminal blocks with no shorting screws installed. This test is to ensure that the CT circuits are not open-circuited. The measured DC resistance of each circuit should be less than five (5) ohms.

2.4.2.7 Panel voltage transformer (VT) circuits: For each new or modified relay control panel, measure the DC resistance of each VT circuit from the panel input terminal blocks. This test is to ensure that the VT circuits are not short-circuited. The measured DC resistance of this circuit should be greater than one thousand (1,000) ohms.

2.4.2.8 Panel DC circuits: Measure the DC resistance of the DC control power circuit from the panel input (DC positive and DC negative) terminal blocks. This test is to ensure that the DC circuit is not short-circuited. The measured DC resistance of this circuit should be greater than ten (10) ohms.

2.4.2.9 Cable insulation testing: Test the insulation on all new and modified control wires before the leads are laid down. Test each wire to shield insulation resistance with all the other wires bonded to the shield, using a fine hundred (500) volt DC insulation tester. Measured insulation levels should exceed one megohm at five hundred (500) volts DC.

2.4.2.10 Cable lugs: Verify all new and modified cable lugs are adequately crimped.

2.4.2.11 Cable terminal blocks: Verify all new and modified outdoor cable terminal block connections are checked for tightness.

2.5 Circuit breakers

2.5.1 Documentation:

2.5.1.1 Complete and submit manufacturer-specific installation forms in conjunction with Owner provided Adobe Acrobat forms, SF_6 gas analysis results and electronic test Equipment generated data files with timing information.

2.5.1.2 Use PacifiCorp Substation Form SF-CKB-SF6PUFF-INST, Attachment X.2.5A, for all generic circuit breakers without model specific forms.

2.5.1.3 Use PacifiCorp Substation Form SF-CKB-HVB362-INST, Attachment X.2.5B, for HVB-362 model circuit breakers.

2.5.1.4 Use PacifiCorp Substation Form SF-CKB-BOTTLE-INST, Attachment X.2.5C for all outdoor type distribution vacuum or SF6 bottle type circuit breakers.

2.5.1.5 Use PacifiCorp Substation Form SF-CKB-SWG-INST, Attachment X.2.5D for all metal clad distribution vacuum circuit breakers.

2.5.1.6 Use PacifiCorp Substation Form SF-SF6-SMPL, Attachment X.2.5E, for submitting SF_6 gas samples. Refer to PacifiCorp Substation Procedure SP-CKB-SF6PUFF-INST, Attachment X.2.5F, and PacifiCorp Substation Procedure SP-SF6-SMPL, Attachment X.2.5G, for instructions.

2.5.1.7 Refer to PacifiCorp Procedure MATP-SF6CYL-PROCESS, Attachment X.2.5H, for SF_6 gas procurement instructions and PacifiCorp Substation Procedure SP-SF6-FILL, Attachment X.2.5I, regarding introduction of SF_6 gas into the breakers.

2.5.1.8 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

Description:

2.5.1.9 Refer to procedure SP-CKB-SF6PUFF-INST, Attachment X.2.5F, and follow the process outlined in that procedure for the installation and testing of SF6 circuit breakers.

2.5.1.10 Refer to procedure SP-CKB-BOTTLE-INST, Attachment X.2.5J for installation and testing of all outdoor type distribution vacuum or SF6 bottle type circuit breakers.

2.5.1.11 Refer to procedure SP-CKB-SWG-INST, Attachment X.2.5K and follow the process outlined in that procedure to install and test metal clad distribution vacuum circuit breakers.

2.5.1.12 Perform all assembly and installation tasks and internal checks and adjustments in accordance with manufacturer instructions.

2.5.1.13 Refer to procedure MATP-SF6CYL-PROCESS, Attachment X.2.5H, to obtain SF_6 gas from the PacifiCorp technical operations warehouse for breaker filling. DO NOT use SF_6 gas from any other source.

2.5.1.14 Install SF_6 gas using manufacturer procedures in conjunction with procedures SP-SF6-FILL, Attachment X.2.5I, and SP-SF6-SMPL, Attachment X.2.5G. SF_6

gas samples shall be taken from all circuit breakers no less than twenty-four (24) hours after filling, and submitted to an Owner-approved laboratory for analysis. Unless the circuit breaker has a common gas manifold between the poles, a separate sample shall be taken from each pole. The laboratory analysis should include moisture content, dielectric and gas purity. The analysis results shall be included with the test reports.

2.6 Current and voltage transformers

2.6.1 Documentation:

2.6.1.1 PacifiCorp Protection and Control Form PCF-CT-INST, Attachment X.2.6A, for current transformer installation and testing.

2.6.1.2 PacifiCorp Substation Form SF-VT-INST, Attachment X.2.6B for voltage transformer installation and testing.

2.6.2 Description:

2.6.2.1 Current transformer (CT) secondary wiring:

2.6.2.1.1 Verify all secondary CT wiring matches the substation connection diagrams and control schematics. Ensure correct CT ratio, polarity, and grounding.

2.6.2.2 CT Testing and inspection:

2.6.2.2.1 Visually inspect the CT wiring, lugs, and shorting-type terminal blocks for tight connections, and any damage that may have occurred during shipping. The physical installation should be consistent with the Equipment wiring diagrams and schematics.

2.6.2.2.2 Ratio test: Verify the ratio between the secondary and the primary windings. For multi-ratio CT's, verify the ratio for each ratio. Measured ratio values should be consistent with the manufacture's CT test data, and the Equipment wiring diagrams and schematics.

2.6.2.2.3 Saturation test: Perform a saturation test on the full winding (maximum ratio) of the CT. Graph the secondary exciting volts verses secondary exciting amps for the winding. In addition, determine the saturation value for the full winding. Saturation is defined as the point where the curve is tangent, or forty-five (45) degrees, to the secondary exciting amperes. Measured saturation curve characteristics and saturation value should be consistent with the CT excitation curves and data provided by the manufacturer.

2.6.2.2.4 Polarity test: Verify the polarity of the CT primary to the secondary windings. Correct polarity is when the current entering the positive primary terminal is in phase with the current leaving the positive secondary terminal. Verify that measured polarity is consistent with the Equipment, wiring diagrams, and schematics.

2.6.2.2.5 Insulation resistance test: Measure the CT insulation resistance to ground on each output terminal using a five hundred (500) volt DC insulation tester. Values greater than one (1) megohm are acceptable.

2.6.2.3 Voltage transformer (VT) testing and inspection:

2.6.2.3.1 Perform all installation activities and tests as listed on procedure SP-VT-INST, Attachment X.2.6C.

2.6.2.3.2 For capacitive coupled voltage transformers (CCVTs), verify that the capacitor stacks are assembled per manufacturer assembly diagrams and that the nameplate data for each capacitor stack matches the manufacturer data for location, serial number and capacitance.

2.7 Oil-filled transformers and shunt reactors

2.7.1 Documentation:

2.7.1.1 Refer to PacifiCorp Substation Procedure, SP-TRF-INST, Attachment X.2.7A, for all required forms and referenced procedures.

2.7.1.2 Follow and complete PacifiCorp Substation Form SF-TRF-INST, Attachment X.2.7B, beginning at receipt of transformers from the shipper. Complete and submit all required forms listed in procedure SP-TRF-INST, Attachment X.2.7A.

2.7.1.3 PacifiCorp Substation Procedure SPC-TRF-OILPROC, Attachment X.2.7C, and PacifiCorp Substation Form SF-TRF-OILPROC, Attachment X.2.7D.

2.7.1.4 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

2.7.2 Description:

2.7.2.1 The installation and testing of the transformer shall be performed in accordance with procedure SP-TRF-INST, Attachment X.2.7A, and all sub-procedures referenced therein.

2.7.2.2 If the transformer is to be oil-filled on site, the dry-out and oil filling process described in procedure SPC-TRF-OILPROC, Attachment X.2.7C shall be followed. Complete vacuum processing log SF-TRF-OILPROC, Attachment X.2.7D.

2.8 Shunt capacitor banks

2.8.1 Documentation:

2.8.1.1 Refer to PacifiCorp Substation Procedure SP-CAP-INST, Attachment X.2.8, and submit documented test results as described in that procedure.

2.8.1.2 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

2.8.2 Description:

2.8.2.1 Perform all manufacturer-recommended mechanical assembly tests and verifications.

2.8.2.2 The capacitor bank’s capacitance value for each individual phase shall be measured and verified to be balanced within engineering design criteria.

2.8.2.3 Individual capacitor cans shall be measured using a capacitance bridge to measure the capacitance. Measurements must be logged on a drawing clearly indicating each capacitor can’s physical location in the bank.

2.8.2.4 For factory assembled racks, the rack location and capacitor can serial numbers shall be verified against the manufacturer design drawings to ensure correct rack and capacitor can placement.

2.8.2.5 Bank electrical layout must be verified according to design.

2.9 Series capacitor banks

2.9.1 Documentation:

2.9.1.1 Completed test reports of capacitor checks and tests recommended by the manufacturer, also to include manufacturer specifications with Equipment measurements.

2.9.1.2 Series capacitor bank bypass circuit breakers require completion of PacifiCorp Substation Form SF-CKB-SF6-INST, Attachment X.2.5A. Refer to Section 2.5 of this document for instructions specific to SF_6 circuit breaker installation.

2.9.1.3 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

2.9.2 Description:

2.9.2.1 Perform all manufacturer-recommended mechanical assembly and electrical commissioning tests.

2.9.2.2 The capacitor bank capacitance value for each individual phase shall be measured and verified to be balanced within engineering design criteria.

2.9.2.3 Individual capacitor cans shall be measured using a capacitance bridge to measure the capacitance. Measurements must be logged on a drawing that clearly identifies the physical location of each capacitor can in the bank.

2.9.2.4 For factory-assembled racks, the rack location and capacitor can serial numbers shall be verified against the manufacturer design drawings to ensure correct rack and capacitor can placement.

2.9.2.5 Bank electrical layout must be verified according to design.

2.10 Batteries

2.10.1 Documentation:

2.10.1.1 Refer to PacifiCorp Substation Procedure SP-BAT-CHGR-INST, Attachment X.2.10A. Complete and submit PacifiCorp Substation Form SF-BAT-CHGR-INST, Attachment X.2.10B.

2.10.1.2 Submit any battery or charger manufacturer-specific installation and test forms.

2.10.1.3 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

2.10.2 Description:

2.10.2.1 Perform all manufacturer installation and setup actions and other tests as specified in procedure SP-BAT-CHGR-INST, Attachment X.2.10A.

2.10.2.2 Perform a DLRO low-resistance micro ohm test across all cell interconnections.

2.10.2.3 An IR scan and image of all connections and the bank shall be performed during load testing. If abnormal heating of any cells or connections between cells are connected these shall be corrected and brought to Owner's immediate attention if corrections can not readily be made.

2.10.2.4 The charger shall be configured and tested for the specific application, including verification of all DC output voltages and all alarm points, in accordance with manufacturer procedures and Owner settings.

2.11 Circuit Switchers and Transrupters

2.11.1 Documentation:

2.11.1.1 PacifiCorp Substation Form SF-TRUPTER-S2000-INST, Attachment X.2.11A

2.11.2 Description:

2.11.2.1 Perform all installation and testing activities as described in procedure SP-TRUPTER-S2000-INST, Attachment X.2.11B

2.12 Emergency Generators

2.12.1 Documentation:

2.12.1.1 PacifiCorp Substation Form SF-EPU-INST, Attachment X.2.12A

2.12.2 Description:

2.12.2.1 Perform all installation and testing activities as described in procedure SP-EPU-INST, Attachment X.2.12B

2.13 Metal Clad Switchgear

2.13.1 Documentation

2.13.1.1 PacifiCorp Substation Form SF-SWG-INST, Attachment X.2.13A

2.13.2 Description

2.13.2.1 Perform all manufacturer recommended installation and testing activities, in addition to those described in procedure SP-SWG-INST, Attachment X.2.13B

2.14 Air Core Reactor

2.14.1 Documentation

2.14.1.1 PacifiCorp Substation Form SF-XRT-AIR-INST, Attachment X.2.14

2.14.2 Description

2.14.2.1 Follow manufacturer recommended installation procedures and testing, in addition to completing form SF-XRT-AIR-INST, Attachment X.2.14

2.15 Control Buildings and other miscellaneous equipment

2.15.1 Documentation

2.15.1.1 PacifiCorp Substation Form SF-HVAC-INST, Attachment X.2.15A for HVAC systems.

2.15.1.2 PacifiCorp Substation Form SF-REG-INST, Attachment X.2.15B for single phase voltage regulator installation.

2.15.1.3 PacifiCorp Substation Form SF-SS-INST, Attachment X.2.15C for station service transformers and associated switches and panels.

2.16 Infra-red Scans

2.16.1 Documentation

2.16.1.1 PacifiCorp Substation Form SF-INS, Attachment X.2.16

2.16.2 Description:

2.16.2.1 Follow the manufacturer recommended guidelines and perform in-service infra-red scans of all energized equipment including for which installation activities were performed, including bus bars and equipment connection jumpers.

2.17 Auxiliary settings and commissioning (other than protective relays)

2.17.1 Documentation:

2.17.1.1 Setting and verification of functional operation shall be noted on appropriate drawings or prints.

2.17.1.2 See PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents, Attachment X.1.6.5, for a complete list of required procedures and forms.

2.17.2 Required settings and testing:

2.17.2.1 All devices not specifically addressed in this document shall be tested in accordance with manufacturer specific procedures and requirements.

END OF SECTION

ATTACHMENTS

Exhibit X

Testing & Commissioning

X.1.2	PacifiCorp Testing and Commissioning Responsibility Matrix
X.1.6.5	PacifiCorp SubEquip-Comprehensive List of Installation and Testing Documents
X.1.6.7A	PacifiCorp Apparatus and Line Equipment Memorandum, Form 001F
X.1.6.7B	PacifiCorp Relay and Interchange Meter Equipment Memorandum, Form 006F
X.2.1	PacifiCorp Substation Form SF-ABDISC-INST Air Break Switch Installation
X.2.2A	PacifiCorp Substation Procedure SP-GRND-CONTINUITY Ground Grid Continuity Test
X.2.2B	PacifiCorp Substation Form SF-GRND-CONTINUITY Ground Grid Continuity Test
X2.4A	PacifiCorp Substation Form SF-CABLE-INST Cable Installation
X.2.4.B	PacifiCorp Construction Specification 16300
X.2.5A	PacifiCorp Substation Form SF-CKB-SF6PUFF-INST SF6 Circuit Breaker Installation
X.2.5B	PacifiCorp Substation Form SF-CKB-HVB362-INST HVB-362 Circuit Breaker Installation
X.2.5C	PacifiCorp Substation Form SF-CKB-BOTTLE-INST Outdoor Vacuum and SF6 Bottle Circuit Breaker Installation
X2.5D	PacifiCorp Substation Form CKB-SWG-INST Metal Clad Circuit Breaker Installation
X2.5E	PacifiCorp Substation Form SF-SF6-SMPL Gas Sampling
X.2.5F	PacifiCorp Substation Procedure SP-CKB-SF6PUFF-INST Puffer Style SF6 Circuit Breaker Installation
X.2.5G	PacifiCorp Substation Procedure SP-SF6-SMPL Gas Sampling
X.2.5H	PacifiCorp Procedure MATP-SF6-CYL-PROCESS Procedure to Obtain Sulfur Hexafluoride (SF_6) Gas Cylinders
X.2.5I	PacifiCorp Substation Procedure SP-SF6-FILL SF6 Filling
X2.5J	PacifiCorp Substation Procedure SP-CKB-SWG-INST Metal Clad Circuit Breaker Installation
X2.6A	PacifiCorp Protection and Control Form PCF-CT-INST Current Transformer Instalaltion
X.2.6B	PacifiCorp Substation Form SF-VT-INST Voltage Transformer Installation
X.2.6C	PacifiCorp Substation Procedure SP-VT-INST Voltage Transformer Installation
X.2.7A	PacifiCorp Substation Procedure SP-TRF-INST Transformer Installation
X.2.7B	PacifiCorp Substation Form SF-TRF-INST Transformer Installation

X.2.7C	PacifiCorp Contractor Procedure SPC-TRF-OILPROC Oil Processing of Transformers
X.2.7D	PacifiCorp Substation Form SF-TRF-OILPROC Vacuum Processing Log
X.2.8	PacifiCorp Substation Procedure SP-CAP-INST Capacitor Bank Installation
X.2.10A	PacifiCorp Substation Procedure SP-BAT-CHGR-INST Battery and Charger Installation
X.2.10B	PacifiCorp Substation Form SF-BAT-CHGR-INST Battery and Charger Installation
X2.11A	PacifiCorp Substation Form SF-TRUPTER-S2000 Transrupter and Series 2000 Circuit Switcher Installation
X2.11B	PacifiCorp Substation Procedure SP-TRUPTER-S2000 Transrupter and Series 2000 Circuit Switcher Installation
X2.12A	PacifiCorp Substation Form SF-EPU-INST Emergency Generator Installation
X2.12B	PacifiCorp Substation Procedure SP-EPU-INST Emergency Generator Installation
X2.13A	PacifiCorp Substation Form SF-SWG-INST Metal Clad Switchgear Installation
X2.13B	PacifiCorp Substation Procedure SP-SWG-INST Metal Clad Switchgear Installation
X2.14	PacifiCorp Substation Form SF-XRT-AIR-INST Air Core Reacto Installation
X2.15A	PacifiCorp Substation Form SF-HVAC-INST HVAC Installation
X2.15B	PacifiCorp Substation Form SF-REG-INST Single Phase Voltage Regulator Installation
X2.15C	PacifiCorp Substation Form SF-SS-INST Station Service Installation
X2.16	PacifiCorp Substation Form SF-INF Infra-red Scan