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1.0 GENERAL

1.1 Definitions

A. “AC” or “ac” shall mean alternating current.

B. “AC Rated Plant Capacity at the POI” shall equal the total net export capability at the Point of Interconnection as defined by the Interconnection Agreement.

C. “AC System Losses” shall mean the resistance losses (I^2R) through the AC cabling and magnetization and winding losses associated with the inverter step-up transformers and is exclusive of Auxiliary Loads.

D. “Agreement” shall mean the Term Sheet between Owner and Contractor to which this Attachment D is attached.

E. “Array” shall mean a collection of solar modules connected in series, all tying into one Inverter Skid Assembly (ISA).

F. “Auxiliary Loads” shall mean power consumption from activities not directly associated with power generation or transmission losses. These include, but are not limited to, inverter power and SCADA system power.

G. “Circuit” shall have the definition set forth in Exhibit 6.

H. “DC” or “dc” shall mean direct current.

I. “DC/AC ratio” shall mean the ratio of the ISA installed DC power to the Inverter power rating operated at maximum expected inverter-level power factor to meet power factor requirements at the POI. For example, a 2.75MVA inverter operated at a power factor of 0.92, with a total installed DC power of $3.5MW_{DC}$, would have a MW_{AC} rating of 2.53MW and a DC/AC of 1.38.

J. “Equipment and Materials” as defined in section 3.0.

K. “HZ” shall mean hertz.

L. “ISA” shall mean the Inverter Skid Assembly consisting of the static power inverter(s), inverter step-up transformer, associated controls, monitoring, cabling and grounding systems.

M. “kV” shall mean kilovolts.

N. “kW” shall mean a measure of instantaneous power as measured in kilowatts. If not specified, it shall be assumed to be in Alternating Current (AC).

O. “kWh” shall mean kilo-Watt-hours. If not specified, it shall be assumed to be in Alternating Current (AC).

P. “MET Station” shall mean the meteorological station/(s) installed within the solar field to measure critical weather data such as wind speed and direction, ambient temperature, solar irradiance, etc.

Q. “Operation and Maintenance Building” shall mean the building that houses the Project Control Room and offices. Refer to this section 6.0 for O&M Building scope.

R. “POI” shall mean the Point of Interconnection which defines the location of the physical electrical interconnection to the Transmission Provider as defined in the Interconnection Agreement.

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S. “PV” shall mean photovoltaic.

T. “Solar Substation” shall mean the interconnection facility which collects the feeds from the ISA and transforms the voltage (as required) for electrical interconnection to the Transmission Provider. Refer to Exhibit 1 for Solar Substation Statement of Work.

U. “Project” shall mean the solar Project as defined in the Agreement. The Project shall include all equipment and systems producing solar energy, from the solar modules up to the POI, including the collector system, substation and Generation Tie-line between the project substation and the POI, as applicable.

V. “SCADA” shall mean the Supervisory Control and Data Acquisition system, including all monitoring/control hardware and software, field instrumentation and communication devices.

W. “STC” shall mean standards test conditions, which is 1000 watts per square meter insolation, 25ºC module temperature, 1.5 AM (air mass).

X. “Transmission Provider” shall mean the public utility (or its designated agent) that owns, controls, or operates transmission or distribution facilities used for the transmission of electricity in interstate commerce and provides transmission service under the Tariff.

Y. “PPC” shall mean Power Plant Controller, including all necessary equipment to house and power up the device and allow it to communicate with the SCADA System

Capitalized terms not otherwise defined above shall have the meaning given such terms in the Agreement.

1.2 Contractor Scope of Work Overview

A. Contractor shall furnish a ground-mounted single-axis solar-tracking utility-scale Project for Owner at the specified capacity and energy production.

B. The Project shall be capable of operating in accordance with the terms and conditions of the Agreement, this “Statement of Work” and associated attachments.

C. Contractor shall design and construct the Project in accordance with the Agreement and this Specification. Scope of Work shall consist of:

1. Specify and furnish the Equipment and Materials which shall include, but not be limited to perimeter fences, structural support and tracking systems, module string DC wiring harnesses and CAB system (as applicable), DC combiner boxes or load break disconnects (LBDs), ISAs, SCADA system, MET Stations, AC collection, and ancillary hardware required to connect and operate listed equipment. Scope shall also include that defined in Exhibit 1 for the Solar Substation and section 6.0 for O&M Building.

2. Project design engineering, software models, and drawing packages for construction permitting, installation and “as-built” documentation.

3. Project construction including all site/civil work, structural, electrical, mechanical and monitoring/control systems.

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4. Third party verifications shall include piles, concrete reinforcement, soils, concrete and shall also be performed where required to comply with Applicable Permits and codes.

5. Project and construction management, including quality assurance/quality control, site safety, site material control and management of all subcontractors.

6. Design Review meetings in accordance with Exhibit 2. All design review meetings will be held at agreed upon meeting place and may be broken up into several meetings as required to meet schedule.

7. Project commissioning and testing in accordance with Exhibits 5 and 6.

8. Project turnover including Owner training and Project operations and maintenance documentation.

D. Contractor shall provide all temporary electrical and internet services for use during construction and commissioning.

E. Contractor shall provide all temporary lighting, including at trailers and parking lot.

F. Contractor shall provide all design documents required to support Owner in obtaining Owner-Acquired Permits and other regulatory agreements.

G. Temporary Facilities

1. Contractor shall provide Owner with one furnished office trailer complete with electrical, internet service. Minimum space shall include two (2) offices, conference room, hand washing stations and portable restrooms, and common areas.

2. Contractor shall be responsible for establishing and maintaining all portable restroom, lunchroom, and other office and meeting areas for the duration of the construction and commissioning portion of the Project.

3. Contractor shall provide hand washing stations and portable restrooms for the temporary office trailer complex. For in-field work areas Contractor shall provide temporary sanitary facilities consisting of above ground Porta-John type. Contractor shall be responsible for decommissioning the temporary sanitary facilities at the termination of construction.

4. Contractor shall maintain on-site dumpsters and personnel to maintain a clean and rubbish free work site.

5. Contractor shall be responsible for designing and implementing temporary traffic control measures as required by applicable County or local agencies throughout construction duration.

6. Contractor shall be responsible for permitting, installation, and removal of a temporary water storage facility to satisfy water requirements for dust control purposes.

7. Contractor shall be responsible for establishing and maintaining temporary parking areas for construction and office personnel. Temporary parking areas shall be returned to design grades and surfacing at the termination of construction.

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G. Contractor shall be responsible for design, permitting and implementation of dust suppression and erosion control measures.

H. Contractor shall be responsible for permitting, and installation of a temporary water storage facility to satisfy water requirements for dust control purposes and other uses during construction as required by local authorities. Sizing of temporary water storage facility shall be of adequate volume for dust suppression. Temporary water storage facilities shall be removed and the area returned to design grades and surfacing. All costs for water during construction shall be paid for by Contractor.

H. Contractor shall be responsible for site security throughout construction duration until turn over.

I. Contractor shall provide temporary barriers (snow fence or agreed upon barrier) to physically separate Circuits turned over to Owner prior to Substantial Completion.

J. Contractor shall provide traffic management as necessary to ensure safe site access from nearby public roads for all vehicles and equipment.

K. Contractor is responsible for meeting all construction and post-construction storm water requirements as dictated by Applicable Law.

L. Contractor shall provide all relevant electrical engineering studies for a comprehensive and complete design. This will include, but not be limited to, grounding study, arc flash study, short circuit study, ampacity study, temporary over voltage study, load flow (reactive power) study, harmonics analysis, and relay settings and coordination study,

M. Contractor shall provide a Geotechnical Study suitable for the project level design work including bearing capacities, soil characteristics (including electrical and mechanical) and infiltration requirements.

1.3 Site and Environmental Criteria

A. Project design shall be based upon the design conditions listed below (to be completed by Developer):

Table 1-1
Site Design Conditions

Project Location	Approximately XX miles XXX of XXXX, XX.
Minimum/Maximum Dry Bulb Temperature (for inverter design)	X°F/X°F (ASHRAE extreme annual)
Extreme low temperature (for module string design)	X°F (ASHRAE extreme low annual) (OR Contractor may use SAM simulation but to be reviewed and approved by Owner)
Design Wet Bulb Temperature or relative humidity (HVAC design)	X°F (ASHRAE 0.4% design)
Maximum Elevation	X feet above mean sea level
Site Road Access	TBD

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Seismic Criteria	SDS = XX, SD1 = XX, Seismic Design Category (SDC) = XXX, Site Class = D (assumed), Importance Factor = 1.0 unless otherwise approved by the local authority having jurisdiction (AHJ)
Wind Design	For Risk Category I structures (trackers), V = X MPH (X sec gust), Exposure = C (assumed), in accordance with the most recent edition of ASCE 7, unless otherwise approved by the local authority having jurisdiction For Risk Category II structures (ISAs and MET stations), V = X MPH (X sec gust), Exposure = C (assumed), in accordance with the most recent edition of ASCE 7, unless otherwise approved by the local authority having jurisdiction Wind on Ice shall be considered
Snow Load	XXXX psf For Risk Category I, Importance Factor = 0.8, in accordance with the most recent edition of ASCE 7, unless otherwise approved by the local authority having jurisdiction For Risk Category II, Importance Factor = 1.0, in accordance with the most recent edition of ASCE 7, unless otherwise approved by the local authority having jurisdiction
Risk Category	Unless indicated otherwise by the AHJ: For racking structures and racking foundations, Risk Category I For all other structures, Risk Category II
Maximum storm water velocity and depth	To be determined as part of design
Average Annual Rainfall	X inches
100 yr /Maximum 24 hr Rainfall	X – X inches
Design Maximum Rainfall Rate	100yr – Shall comply with applicable county requirements
Environmental	xxxx (based on environmental studies)
Floodplains	Projects cannot be built in a mapped floodplain. (Based on FEMA defined floodplains)
Subsurface Soil Conditions	Per final Geotechnical Report

1.4 Design Criteria

A. Project and individual components shall have a minimum design life of 30 years.

B. Project shall be designed for automatic operation.

C. Project electrical design will be in compliance with applicable codes and standards listed under section 1.4 unless otherwise noted.

D. Dissimilar metals in contact anywhere in system shall be avoided where possible to eliminate the possibility of galvanic corrosion. Lugs shall be rated for dissimilar metals where applicable.

E. During engineering design, Contractor shall work with the Owner when determining all signage, labeling and nomenclature.

1.5 Systems and Equipment

A. Provisions shall be included in the design of all systems to allow the performance of all routine maintenance without requiring a plant shutdown. Maintenance completed on each inverter should allow for the rest of the plant to remain in service.

B. Contractor shall:

1. Receive, inspect, store, unload, maintain, erect, clean, align, and prepare all equipment in strict accordance with equipment manufacturer’s instructions prior to Substantial Completion.
2. Provide lifting lugs on all equipment components or system components requiring removal for maintenance and weighing over 25 lbs.
3. Design the facility for a life of 30 years consistent with good engineering practice for solar generation facilities. However, it is understood that some of the equipment will require routine maintenance and possible replacement during the life of the facility.

1.6 Operating Criteria

A. DC grid voltage: equal to or less than 1500 volts DC, negatively grounded.

B. AC Medium voltage: below 100 kV, 60 Hz

C. DC & AC electrical systems under 1000V shall be radially configured. Medium voltage AC transformers shall be configured with loop feed features. No redundancy is required.

D. Convenience Power: 120VAC

E. Instrumentation voltage: 24VDC or 125VDC

F. Communications network: Ethernet via fiber optic within the arrays to the Communications Interface. Fiber optic to all field equipment shall be designed in a ‘collapsed loop’ configuration, at a minimum, to provide redundant path back to SCADA system. The network shall be 1 Gigabit and shall include adequate spare capacity to run parallel networks.

G. The DC/AC ratio of each inverter array shall be within 5% of the overall project DC/AC ratio.

1.7 Codes, Regulations and Standards

A. In the event that any Applicable Law or Industry Standard does not govern specific features of any item of Equipment and Materials, Temporary Work or system, Contractor or Original Equipment Manufacturer (OEM) standards shall be applied, with Owner’s approval. Where local codes or ordinances will have an impact on the design, Owner and Contractor shall jointly address these with the local authorities having jurisdiction.

B. Listed herein are the principal codes and standards applicable in the design, fabrication and installation of the Project; these are not intended to be all inclusive. Where local codes or

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ordinances will have an impact on the design, Contractor shall be responsible for meeting the codes or obtaining variances from local authorities having jurisdiction.

C. Contractor shall design and construct the Project in accordance with the most recent versions of the following standards, as applicable:

D. ACI - American Concrete Institute

E. AISC - American Institute of Steel Construction

F. ANSI - American National Standards Institute

G. AISI – American Iron and Steel Institute

H. ASCE – American Society of Civil Engineers

I. ASME – American Society of Mechanical Engineers

J. ASTM - American Society for Testing and Materials

K. AWS – American Welding Society

L. IBC - International Building Code

M. ICEA - Insulated Cable Engineers Association

N. IEC - International Electrotechnical Commission

O. IEEE - Institute of Electrical and Electronics Engineers

P. ISA – Instrumentation Society of America

Q. NEC - National Electrical Code

R. NEMA - National Electrical Manufacturers Association

S. NESC - National Electrical Safety Code

T. NETA - National Electrical Testing Association

U. NFPA – National Fire Protection Association

V. OSHA - Occupational Safety and Health Act

W. TUV SUD America

X. UL – Underwriters' Laboratories

In the case where standards have conflicting requirements, Owner and Contractor will develop a mutual agreement of the prevailing standards.

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2.0 SPECIAL CONDITIONS

2.1 Construction Water

A. Contractor shall size and provide all construction-water related infrastructure necessary to support Contractor's construction and schedule.

2.2 Flood Protection

A. Associated flood hazard requirements shall be incorporated into the design and construction of the Project. Contractor shall elevate and/or provide flood protection for structures subject to the approval of the AHJ.

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3.0 EQUIPMENT AND MATERIALS

3.1 Overview

A. Contractor shall furnish all Equipment and Materials as required to construct a fully functioning Project. Minimum requirements for major equipment are described herein

3.2 PV Modules

A. Contractor to provide standard wattage, tier 1 modules from one of the approved suppliers specified in Exhibit 9. Preference will be given to domestically produced panels, if available.

3.3 Tracker and Support Structure

A. The module support structures shall be designed and constructed to provide a stable support system for the PV modules that will remain effective throughout the design life of the Project.

B. Foundation shall be driven galvanized or equivalent corrosion-resistant steel members, mini-cast augured piles or equivalent. Corrosion resistance shall be as required by the findings of the Geotechnical Study and Corrosion Study. Corrosion Study shall be performed by an Owner-approved Corrosion Engineer.

C. Module support sub-structure frame may be corrosion-resistant steel or extruded aluminum.

D. Mounting hardware shall include corrosion resistant clips and fasteners.

E. Corrosion protection to be evaluated by Contractor to verify soil conditions are compatible with the module support structures.

F. The maximum support structure deflections shall prevent PV module and electrical system damage and shall not exceed allowable limits provided by the manufacturer and the most recent edition of IBC and ASCE 7 codes.

G. The module support system shall be designed and constructed to withstand environmental conditions and applied loads for the design life of the Project.

H. Dynamic force conditions from wind shall be considered and included in design.

I. Horizontal single-axis with backtracking.

J. Tracker drives electric motors or hydraulic. If hydraulic, oil must be bio-degradable type oil, not considered an environmental hazard.

K. Galvanized steel structural components.

L. Accurate stowing required for wind events based on design tolerance. Capable of quick stow or stowing based on accurate wind predictions or measurements.

M. Designed and manufactured per applicable AISC, AISI, ASTM, ANSI & AWS codes and standards.

N. The tracking system shall be designed and constructed to withstand environmental conditions and applied loads for the design life of the Project.

O. Bearings and gears shall have Basic Rating Life (L_{10}) of 100,000 hours.

P. Tracker supplier must have robust proven QA/QC program installed at shops supplying torque tubes, torque arms, drive struts, and other main components of tracker.

Q. DC cable management system - open cable trays if routed under arrays to minimize snow and ice buildup or CAB systems may be used.

R. Racking system and module mounting shall meet the requirements of UL 3703 and 2703, respectively.

S. All modules shall have a minimum ground clearance of thirty-three (33) inches at all points in their operating range and a maximum height of eight (8) feet above the ground. Combiner boxes, disconnect switches, inverter/transformers, and any other electrical equipment shall be a minimum 12” above the 100-year flood level. Module height at stow position shall be above the 100-year flood level unless otherwise required by AHJ.

3.4 DC Fused Combiner Boxes (as applicable)

A. Enclosure shall be rated NEMA 3R or 4.

B. Combiner boxes shall be installed above ground.

C. Factory assembled back panel complete with finger safe fuse holders rated for maximum VDC, reinforced, plated bus bars and power distribution blocks.

D. Combiners shall have a load-break DC disconnect switch with the capability of being pad-locked in the off position.

E. Enclosures doors shall have provisions for pad locking.

F. Completed assemblies shall be listed to UL 1741.

G. Combiner shall be labeled to meet NEC code requirements and labeled with an arc flash warning.

H. All feeders and cables into combiner boxes shall have preprinted labels with unique tags/identifiers.

I. Safety covers shall be provided for live components.

J. Surge suppression devices shall be mounted internal to combiner box.

K. All terminals shall be 90°C rated.

3.5 DC Load Break Disconnects (as applicable)

A. Enclosure shall be rated NEMA 3R or 4.

B. Load Break Disconnects (LBDs) shall be installed above ground.

C. Provisions for pad locking in the off position.

D. Completed assemblies shall be UL listed.

E. LBD shall be labeled to meet NEC code requirements and arc flash warnings.

F. All feeders and cables into LBDs shall have preprinted labels with unique tags/identifiers.

G. Surge suppression devices shall be mounted internal to LBD.

H. All terminals shall be 90°C rated.

3.6 Inverter Skid Assembly (ISA)

A. Each ISA shall consist of inverters with step up transformer, DC cabling/bus, AC cabling/bus, auxiliary equipment, and grounding system.

B. Inverters

1. Inverter shall be on Approved Supplier List and approved by Owner.
2. Inverter shall be UL 1741 Supplement A listed.
3. Inverter shall be rated for use in 1500 Vdc applications.
4. Inverter shall have California Energy Commission (CEC) weighted efficiency greater than or equal to 98% (without medium voltage inverter step-up transformer).
5. Environmental ratings:
    a. Inverter shall be capable of operation at full nameplate rating ambient air temperatures between -20 ºC to 50ºC. Depending on Site Design Temperature a 45 ºC upper limit may be acceptable.
    b. Inverter electronic compartments (IGBTs, communications, etc.) shall be NEMA 4 or better (or European equivalent) and the overall enclosure rating shall be NEMA 3R or better (or European equivalent).
    c. Inverter enclosure should be designed with ingress protection to limit dirt/dust/insects/rodents from entering the enclosed space over the full temperature range.
6. Nameplate: Inverter shall be sized to deliver rated power at ±0.95 power factor up to 50°C.
7. Quantity: Adequate inverters shall be provided, considering losses and reactive power, in order to deliver the required power at the POI at the design temperature.
8. Inverters shall have the capability of dynamic power factor adjustment from 0.95 lag to 0.95 lead, unless more stringently defined by Interconnect Agreement.
9. Inverters shall not de-rate while operating within their rated DC voltage range for an ambient temperature of 50˚C and below. A gradual de-rate may be experienced in the case that the operating conditions are outside the rated DC voltage or ambient temperature range(s).
10. Current and voltage harmonics: <3% THD and IEEE-519-2014 requirements at the POI.

11. Inverter shall be designed to the requirements of IEEE C57.159 to be compatible with its step-up transformer in terms of harmonics and resonance.

12. Inverter cooling system shall not be susceptible to particle contamination and require minimal maintenance.

13. Inverters shall be provided with surge suppression devices on both the DC Input and AC Output.

14. Inverter shall have protective measures to prevent single IGBT failures from causing cascading failures.

15. Inverter AC breaker shall be externally operated, with visual open indication such as an indication light, and capable of remote operation to minimize arc flash hazards.

16. Inverter shall be provided with ground isolation detection devices where used with systems having ungrounded PV arrays.

17. Inverter shall be operated in accordance with manufacturer's recommendations. Any deviation shall be authorized in writing from the manufacturer and not before notification and acceptance by Owner.

18. Inverter shall have built-in protection against undervoltage, overcurrent, overvoltage, and transients.

19. Inverter shall have capabilities for voltage and frequency ride-through and the features shall be compliant with IEEE 1547 and NERC PRC-024. Where system are directly connected to distribution systems, Contractor shall provide equipment and functionality to meet voltage and frequency ride-through requirements.

20. Inverter shall integrate Inverter Step-up Transformer signals (low oil, high pressure, high-temp warning, and high-temp trip) into SCADA system and trip/warn/de-rate signals appropriately.

21. Inverters shall have adequate and easily accessible grounding points to add ground clusters during maintenance activities.

3.7 Inverter Step-up Transformers

A. Transformers shall be of the compartmental pad-mount design with dead front and loop feed features.

B. Ratings: Transformer kVA rating shall match ISA combined inverter rating. Impedance shall match inverter manufacturer requirements. Cooling class = KNAN

C. Primary voltage: Below 100 kV Delta with elbow surge arrestors located on transformers that do not contain a loop feed out.

D. Secondary Voltage: Matched to selected inverter.

E. High efficiency: 99.2% or greater at nameplate output.

F. No-Load losses shall be limited to 0.15% of full KVA rating.

G. BIL ratings: To be stated in data sheet for Owner review.

H. Winding insulation: 65ºC rise over 45ºC ambient.

I. Number of windings: Maximum of three.

J. De-energized tap changer with high voltage taps: (2) 2.5% above and below nominal position – fully rated.

K. Hook stick disconnect switch with visual open shall be located such that Arc Flash protection is not required for operation.

L. Over-current protection via bayonet fuse (with holder) in series with partial range current limiting fuse, or internal expulsion fuse in series with oil immersed with current limiting fuse shall be provided.

M. Top powder coat of ANSI 70 light grey or other color as approved by Owner.

N. Oil level, pressure/vacuum and oil temperature gauges: All instrumentation shall be read into SCADA. Oil temperature gauge to be furnished with two alarm contacts (warning and trip). Oil temperature and pressure transmitters shall provide binary outputs. Oil level gauge to be furnished with alarm contacts. Instrument gauges shall be located such that gauges can be read without requiring Arc Flash protection. Access to the equipment shall be provided in accordance with NEC and OSHA standards.

O. Drain valve with oil and dissolved gas analysis (DGA) sampling provisions, readily accessible in normal operation.

P. Transformer mounting pad design may be required to incorporate features for secondary containment of oil. Contractor shall conform to requirements of local authorities having jurisdiction and design shall be reviewed and accepted by Owner.

Q. In addition to all routine factory testing per most recent standard of ANSI/IEEE standard C57.12.90 and C57.12.00, the following tests shall be conducted:

   1. Full ANSI impulse test on one (1) unit, preselected during production by Owner.

   2. Heat run test on one (1) unit, preselected during production by Owner.

I. Shall comply with the following latest ANSI/IEEE standards:

   1. C57.12.00 - IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

   2. C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers

   3. C57.12.28 – Switchgear and Transformers, Pad-Mounted Equipment – Enclosure Integrity.

   4. C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers

   5. C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

   6. C57.91 – Oil-immersed transformer temperature monitoring

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R. Baseline DGA, conducted at factory or on Site, shall be provided with each transformer.

3.8 PROJECT SCADA

A. SCADA system shall be composed of hardware and software, field instrumentation, meteorological stations, and communications devices designed for remote monitoring, control, and historical trending of the Project.

B. Shall be NERC CIP compliant and meet cyber security requirements (password protected with permission levels).

C. Site SCADA and telecom shall be fully protected and behind a firewall.

D. Shall allow for multiple external connections and be able to accommodate private networks (MPLS, etc.).

E. Shall be able to communicate with external parties in their protocols (DNP3, Modbus TCPIP etc.).

F. All power plant controller setpoints, etc. must be logged (set point, user, etc.).

G. The SCADA system shall include 10% spare hardware I/O points for Owner's future use.

H. The SCADA system shall meet all data frequency and duration requirements specified in Exhibit 6.

I. Contractor shall supply, install, and commission the SCADA System hardware at the Site in connection with the performance of its services pursuant to the terms of the Agreements.

J. SCADA system shall display data in real time and record and log performance data at regular intervals from the Project.

K. All SCADA data shall be made available for an OSI PI interface and other third parties as required for remote access, monitoring and data collection.

L. Communications infrastructure shall be fiber optic based and incorporate a collapsed-loop ring fiber network or equivalent.

M. Fiber Optic Installation Specification: All fiber optic cable is to be installed per the specifications below.

1. Placed within HDPE innerduct, 1.25" minimum diameter
2. Placing depth 42-48" or as specified by permits
3. Cable marking ribbon 12-18" above fiber in any plowed sections
4. Underground cable marker posts placed at every hand hole, on either side of every road crossing, at directional changes, on each side of any water crossings, within 50' of driveways and every 500' along route
5. Locate wire direct buried with fiber duct and terminated to fiber marker test stations at every hand hole
6. Hand holes, minimum size 24" W x 36" L x 24" D, placed at every location as marked on map and a minimum of every 5000'
7. 100' Fiber cable slack loops in every hand hole

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8. Pea rock placed in bottom of every hand hole

N. SCADA System

1. Contractor shall program the control software for the Project on an industry-standard SCADA platform for easy integration into Owner's operation. Software shall employ both remote monitoring and control and an Antivirus server.

2. Contractor shall provide a historian capable of capturing all data points, at one second intervals (or fastest available or permitted by each device) and log data for at least 1 year or minimum required to meet local ISO, NERC, or other requirements.

3. IP addressing to be coordinated with Owner.

4. All SCADA and network equipment must be of utility grade substation quality equipment by standard industry grade suppliers.

5. Field Area Network (FAN) shall maintain a dedicated redundant fiber gigabit Ethernet backbone from the central control room to each ISA. Inverter structures switch sub connections to Ethernet based inverter devices may be 10/100 megabit minimum connectivity.

6. Field network connectivity shall be established using Owner approved protocol and a physical ring topology. Each ring will be comprised of less than 34 switches. Loop connectivity for field network may be achieved through the use of 2 parallel fibers within the same cable (closed-loop).

7. All fiber shall be terminated on bulkheads/enclosures.

8. All fiber networks shall support 1 Gigabit network architecture.

9. Contractor shall install minimum one operator station for access to the SCADA system and historian server and provide all SCADA/historian licensing for the Project. Such hardware/software shall be located at the Site, and title to such hardware/software shall be transferred to Owner.

10. SCADA shall employ Remote I/O to be deployed at major data collections points in the Project. Typical locations for the Remote I/O include the ISAs.

11. The Remote I/O shall function as the input/output point for the command-and-control signals.

12. The SCADA system shall be either connected to its own UPS or connected to the substation backup energy system. 8hr run-time required.

13. The SCADA shall be designed with redundancy in mind, i.e., power supplies, network paths, etc. UPS system is required at Control Room.

14. The SCADA System should display interconnect status for breaker Trip/Close or any transformer alarms in the substation. This can be done over a network connection.

15. The SCADA System should display the internal building temperature and entry door open/close.

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O. Power Plant Controller: The Power Plant Controller shall be able to accept commands from the following locations and distribute these commands to all equipment on Site as necessary:

16. Local operator station
17. Owner’s centralized remote command center
18. Utility or ISO dispatch commands (such as Automated Dispatch System in CAISO) .
19. At a minimum, the following controls capabilities shall be available at the plant level:
    a. Power factor control
    b. Reactive power (VAR) control
    c. Output power curtailment
    d. Power and VAR ramp rate adjustment
    e. Frequency droop control (freq vs. kW)
    f. Automatic voltage regulation (AVR) at the point of interconnection (POI) utilizing reactive power (VAR) control

P. Power Plant controller shall utilize a Computer Server, PLC, SEL-3530 RTAC or similar quality controller.

Q. Control Room (Shall be located in either O&M Building or Control House of the Solar Substation)

1. The Project shall have a Control Room that will act as the central point for the SCADA System. The Control Room will also function as the SCADA room. SCADA network and all associated hardware will be located here.
2. The Control Room shall also function as the communications center for the site.
3. The Control Room shall also contain the Contractor supplied SCADA communications equipment which will transport all SCADA to the Solar Substation control house via fiber optic cable. The Contractor will be allowed access to this data via the remote system for an agreed upon time period (if applicable). The access method must be agreed upon by the Owner.

R. Meteorological Station (“Met Station”). The Met Station shall consist of instruments to measure the meteorological parameters listed in Exhibit 6. Accuracy and quantity requirements of Met Stations and associated measuring devices are specified in Exhibit 6. Met Station must have a backup power supply to allow normal data collection for a period of 48 hours without external power. Additional MET Station equipment required by the Utility shall be provided by the Contractor. Proposed locations shall be reviewed and accepted by the Owner.

S. Typical SCADA points monitored include the following:

1. Meteorological Parameters shall conform to all Participating Intermittent Resource Program (PIRP) requirements including but not limited to the following unless otherwise specified in these Contract documents (accuracy requirements specified in Exhibit 6):
    a. Outside Air Temperature and Relative Humidity

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b. Secondary Standard Horizontal Thermopile Pyranometer (Direct & Indirect Irradiance)

c. Secondary Standard Plane-of-Array Thermopile Pyranometer (Direct & Indirect Irradiance)

d. Rainfall Amount

e. Barometric Pressure

f. Back of module Temperature (see PV Module Points below)

g. Anemometer and Wind Vane (Wind Speed and Direction. Wind speed should be ranged for the full design spec of the site.)

2. ISA Points (per ISA)

h. Inverter Performance Points

i. To include real time AC and DC electrical characteristics, including but not limited to power, energy generated, inverter status and diagnostics, alarms, cooling system and component temperatures, and all data available from inverter system.

3. PV Module Points

i. PV Module Back Surface Temperature (minimum two (2) per MET Station). Temperature sensors shall be placed so as to accurately represent the average module temperature in the inverter array.

2. PV Sub-Array DC Current Points

a. PV Sub-Array DC Current Transmitters (one for each Inverter DC Sub-Array or inverter feeder input)

3. Inverter step-up Transformer at ISA Points

a. Transformer Oil Temperature Warning (Digital)

b. Transformer Oil Temperature Trip (Digital)

c. Transformer Pressure (Digital)

d. Transformer Low Oil Level (Digital)

4. Tracker

a. Tracker angles (setpoint and actual position)

b. Tracker status and operating state (including stow)

c. Tracker alarm states

d. All other applicable and industry standard data points

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5. Soiling Station (as required for Capacity Test, see Exhibit 6)
    a. Soiling Ratio
    b. Voltage of clean and dirty panels
    c. Current of clean and dirty panels
6. Solar Substation Points
    a. SCADA system shall be open architecture using standard programming language and support bidirectional data exchange between the Owner supplied equipment and the Contractor supplied equipment. See Exhibit 1.
7. AC Revenue Meter Points
    a. Shall include real time AC electrical characteristics, including but not limited to power, energy generated, meter status and diagnostics.
    b. All points required by utility and ISO.

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4.0 ELECTRICAL INSTALLATION

4.1 General

A. Cable runs shall only be made parallel and perpendicular to array mounting system.

B. Grounding lugs installed outdoors within 18” of grade shall be UL-listed for direct burial. Other grounding lugs installed outdoors shall be copper or brass with brass or stainless-steel hardware, or tin-plated aluminum with stainless steel hardware. All grounding lugs shall be UL listed.

C. Backfill and compaction of trenches shall meet geotechnical recommendations and shall be performed with compaction equipment specifically designed for such duty. Lifts shall not exceed 12”.

D. All cables and cable ties shall be UV resistant. This means their exterior materials shall be rated to withstand sunlight and extreme heat as defined per table 1-1 and NEC requirements. Materials shall contain UV inhibitors and a minimum of 2% carbon black, with a particle size no larger than 35 nm.

E. Direct-buried wiring shall meet NEC requirements for burial depth and warning ribbon. Warning ribbon width shall be 4” minimum. Cables shall be surrounded by a minimum of 4” of clean fill free of stones larger than 1-inch in diameter.

F. Electrical equipment shall be located a minimum of 12” above the 100-year floodplain elevation unless otherwise noted.

G. Conduit openings shall be sealed to protect against intrusion of pests and other wildlife.

H. Above ground bare copper ground cables shall be painted gray.

4.2 DC System Wiring

A. Contractor may combine strings in combiner boxes or with factory-supplied in-line fused connections and load break disconnects (LBD).

B. System shall be designed such that the maximum DC voltage drop for any one inverter array (from module string to inverter DC input) at full load and STC do not exceed 1.5%.

C. Series string connections between modules will be via locking multi-contact connectors and jumpers factory-supplied with modules.

D. All wiring shall be supported per NEC and manufacturer’s requirements.

E. DC cabling may run above grade, where allowed by code. Method to be reviewed and accepted by Owner.

F. Contractor shall submit cable data sheets and project cable schedule to Owner for approval for each application prior to procuring the cable.

G. DC cable for the wiring from the combiner box or trunk cable to the inverters shall be 1.5kV minimum, 90ºC (wet or dry), power cable type RHW-2 or XLPE with UL 1581, VW-1 rating, and suitable for direct burial. Conductors may be stranded copper or aluminum.

H. DC cable for the wiring from the modules to the combiner boxes or trunk cables shall be 1.5kV minimum, 90ºC (wet or dry), power cable type XHHW-2 or PV wire (as applicable), with UL 1581, VW-1 rating, and suitable for application. Conductors shall be stranded copper or aluminum.

I. Harnesses or cabling shall be rated to withstand sunlight and extreme heat as defined per table 1-1 and NEC requirements. For ultraviolet protection materials shall contain a minimum of 2% carbon black with a particle size of 35 nm or less.

J. Fuses shall be accessible and replaceable.

K. Factory cable assemblies may be pre-cut to length.

L. Locking multi-contact connectors shall mate with module terminations.

M. Wiring harnesses and cabling shall be UL listed.

N. Metal wire loom clamps or approved equivalent shall be used for cable fastening.

4.3 Low Voltage AC System Wiring

A. All conductors, lugs and cable accessories shall be UL listed.

B. No splicing shall be allowed.

C. System wiring installed in raceways shall be type THHN/THWN-2, or XHHW-2. Conductors may be stranded copper or aluminum.

D. System wiring installed in direct burial applications shall be type USE-2 with XLP insulation. Conductors may be stranded copper or aluminum.

E. When terminating aluminum conductors, coat conductor with oxide inhibitor and install per terminator manufacturer’s instructions.

4.4 Medium Voltage AC System Wiring

A. Phase conductors shall be jacketed MV105 or MV90 (if temperatures are low enough), (dry or wet) single compact or compressed concentric conductor, aluminum, 100% or 133% EPR insulation, concentric neutral.

B. Equipment grounding conductor shall meet NEC requirements.

C. Conductor size to not exceed temperature rating of conductor insulation at full generation and to allow for no more than 2% voltage drop at full generation at Solar Substation connection.

D. System shall be designed such that MV conductor kW losses (from high-side of MV ISA transformer to Solar Substation) at full load do not exceed 1.25% in total across the entire facility at Project nameplate rated capacity.

E. Medium voltage terminations shall be 600 A-rated dead break elbows that meet the requirements of ANSI/IEEE 386. Allow 18” of slack to facilitate re-termination.

F. Provide fault indicators at MV terminations, except for those at the end of a circuit.

G. No splices shall be allowed unless long AC collection cabling runs required due to site geometry. In such cases, only above ground splice boxes, approved by Owner, shall be acceptable.

4.5 Overhead Medium Voltage AC Wiring

A. Overhead wiring shall be used where economically efficient in routing power to Solar Substation with minimal losses.

B. Overhead wiring and poles shall be routed so as to minimize shading on the solar arrays.

C. All overhead lines shall be designed to maintain all applicable code and regulatory clearance requirements.

4.6 Grounding

A. Grounding system shall meet the requirements of NEC, IEEE 80, and ANSI C2 at a minimum. Grounding design shall be verified in grounding study.

B. All grounding hardware shall be listed and approved for the application.

C. Where applicable, ground equipment per the manufacturer's requirements.

D. A ground test well shall be furnished at each ISA. A flush cover over the test well shall expose one ground rod and cable with mechanical cable to rod connectors to allow disconnection for testing purposes.

E. Contractor shall install supplemental fence grounding or isolation sections where deemed necessary by the grounding study.

4.7 Labeling and Identification

A. For diagnostic and troubleshooting purposes, all string harnesses and combiner boxes, or load break disconnects (LBD), shall be uniquely tagged and identified with such tagging on the record construction drawings. These cables shall have a label affixed to the outer jacket with a cable marker tape at each termination. The marker tapes shall be vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process. Marker tapes to be approved by Owner before installation.

B. As part of the Contractor Deliverables that must be delivered prior to Final Completion, Contractor shall provide to Owner a Microsoft Access database including all module serial numbers which can be sorted by array, combiner box or LBD, and harness. Contractor shall also submit an "As-Built" drawing depicting the physical location of each array, combiner box or LBD, and harness indicating the unique tag number for each combiner box or LBD and harness. Electrical equipment shall be labeled to meet applicable safety codes and requirements.

4.8 Electrical Studies

A. Contractor shall prove the design meets Contract requirements and all relevant standards by performing the following studies:

1. Short Circuit Study: fault analysis of collection system. Contractor shall show that all equipment is rated for the relevant fault current.

2. Ampacity Study: Contractor shall prove equipment will not exceed its temperature rating at full load. Ambient temperatures shall be per ASHRAE. Contractor shall use no less than a 60% load factor for cable design. Greater values for AC cables shall be used if the interconnect agreement requires VAR-at-night support or energy storage is included.

3. Load Flow and Reactive Power Compensation Study: Contractor shall prove Project performance will meet all GIA and IEEE 399 requirements.

4. Harmonics Study: Contractor shall prove Project meets all IEEE 399 harmonics requirements.

5. Grounding Study: Contractor shall prove Project meets all IEEE 80 requirements, taking into account considerations in IEEE 2778. Show that step and touch potentials on all exposed conductors, including tracker tubes and fence, do not pose a hazard to site personnel or the public. Perform the analysis using a soil model based on the Geotechnical survey, taking freezing and thawing conditions into account. Assume a 50 kg body and no PPE. Fault duration shall be per Protection Coordination Study, or 0.5s if it has not yet been performed.

6. Arc Flash Study: Contractor shall perform an arc flash hazard analysis in accordance with NFPA 70E and IEEE 1584, taking the relevant switching and generation scenarios into account,

4.9 Electrical Equipment Enclosures

A. Control Cabinets, pull boxes and junction boxes shall be in accordance with NEMA Standards and type number and shall be suitable for the location conditions. Base design shall be:

1. Indoor: NEMA 1

2. Outdoor: NEMA 3R

B. All enclosures shall be provided with pad locking provisions.

4.10 Lightning Protection for Field Enclosures

A. Lightning protection, (where required) shall be limited to air terminals, down conductors and a connection to the ISA grounding electrode loop as well as surge arrestors at the inverter step-up transformer and inverter. Lightning protection (where required) shall comply with the requirements of NFPA 780 Standard for the Installation of Lightning Protection Systems. Master label certification is not required.

B. All components shall be un-insulated, copper, and exposed for inspection purposes.

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5.0 FIRE PROTECTION

5.1 Fire Protection System

A. As necessary, the Contractor shall provide a complete fire protection system in accordance with the recommendations and requirements of NFPA, UL, FM, and the local Fire Marshal. The systems shall receive the approval of the Owner's insurance carrier.

B. The engineer responsible for the fire protection system shall be a practicing fire protection engineer registered as a Professional Engineer in the applicable State. All drawings and specifications shall be signed and sealed by the Professional Engineer.

C. The fire protection and detection systems requirements for specific plant locations are summarized in Table 5-1.

D. Portable CO_2 fire extinguishers of sufficient size shall be provided in all areas requiring handheld fire protection.

E. Fire walls for oil-filled transformers shall be provided between transformers and adjacent structures in accordance with Section 5.0 of NFPA 850.

F. Adequate access roads and spacing to PV arrays and equipment shall be provided as required by local Fire Marshal.

G. General

1. Fire protection during plant construction shall meet requirements and recommendations of NFPA 241.

2. All fire protection systems are subject to the review and approval of the local fire department authorities.

TABLE 5-1

Plant Fire Protection and Detection Systems

Plant Location	Type of Fire Protection	Fire Detection
ISA	handheld CO2 fire extinguishers*	N/A
O&M Building Offices, conference room/multi-purpose room, restrooms, storage room, and kitchen area Control room	Handheld extinguishers* Handheld extinguishers*	Smoke and heat detectors and relays which report status to applicable alarm panel and interlocked to disable HVAC system(s) and exhaust fan(s) per EEE specification.

(*) or as required by local Fire Marshal

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6.0 O&M BUILDING (IF APPLICABLE)

6.1 General Requirements

A. Contractor shall design and construct the O&M Building in accordance with this Specification and the referenced applicable standards.

B. O&M Building and associated parking areas shall be enclosed within fenced area of same design as solar arrays.

C. At a minimum, the O&M Building shall have the general dimensions as indicated in Table 6-1 below for the size. The floorplan, site plan, and adjustments to the size of the building shall be reviewed and approved by Owner.

TABLE 6-1

O&M Building Schedule

Project Rating (MWac)	Approximate Building Size and Type
<10	Two 40- foot converted shipping containers and Communications Shelter
10 - 30	Three 40-foot converted shipping containers and Communications Shelter
>30-50	Four 40-foot converted shipping containers and Communications Shelter
>50	Minimum 3,000 square feet building and one (1) 40-foot converted shipping container and an additional 40-foot converted shipping container for each 20 MWac increment over 50MWac. Shipping containers shall be installed on 6-inch high pads.

D. The O&M Building shall be designed and constructed per AHJ requirements.

E. O&M Building foundation and shop apron shall be reinforced concrete designed and constructed for HS44-20 loading based on the recommendations of a final Geotechnical investigation and report performed by a licensed professional Engineer in applicable state. Additionally, foundation shall meet requirements of all applicable building codes.

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F. Roof design should include the proper handling of melting snow and ice buildup from falling onto personnel.

G. Building shall be designed and constructed for an occupancy of up to 10 persons.

H. Building and surrounding site shall be sloped and graded appropriately for site specific drainage considerations.

I. Shop area shall be smooth and hardened concrete. Shop walls and ceiling shall be finished with metal.

J. The O&M Building shall be constructed of standardized metal panel with steel support and framing using metal studs.

K. The roof covering and fascia shall be a 24-gauge coated steel with a snow retention system to prevent shedding of snow.

L. Gutters and downspouts shall be furnished and installed.

M. Lighting, flooring, ceiling/wall coverings, and other finishes shall be as approved by Owner.

N. Ceiling height outside of the shop area shall be 9-feet finished with removable ceiling tile.

O. O&M Building shall have suitable paved parking areas for specified occupancy rating and accessibility.

P. Provide all necessary utilities including electric, internet, potable water, and wastewater disposal.

Q. O&M Building shall include HVAC system suitable for the area environmental conditions. In the winter maintain a temperature of 65 degrees. Heating and cooling elements shall be electric. Interior cooling loads for the SCADA room shall be based upon actual equipment to be installed. Provide all necessary components for complete installation including programmable thermostats, filters, etc.

R. At least two (2) insulated exterior hose bibs shall be installed.

S. Floor drains shall be installed in the shop area and bathroom(s) in accordance with applicable codes and AHJ.

T. All exterior doors and SCADA room shall be equipped with lockable locksets and card readers. Exterior doors shall be commercial-grade insulated steel with closers and glass light kit. Interior doors shall be commercial-grade solid-core wood doors. Except for bathroom, SCADA room, and mechanical room, interior doors shall have light glass.

U. A telephone and data network system shall be provided including all distribution jacks, cable, and wireless systems. Communication circuits shall be ran in cable tray above the ceiling and within conduit in walls.

V. Internet service shall include a high speed internet service (WiFi) throughout the building and broadband internet service up the wall jacks (minimum T1 service).

W. Provide single phase electric service to the building sized to accommodate all electrical loads. All building wiring shall be in conduit.

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X. O&M Building shall include a backup diesel generator suitable for providing electric service for all anticipated building electric loads.

Y. Intrusion alarm: Each door shall have a magnetic contact entry alarm that provides two (2) closed contacts for an open door condition. See EEE specification section for further details on system requirements.

6.2 Scope of Work shall consist of:

A. Prepare design documents, size equipment, generate drawings and specifications, and other supporting activities to the degree of detail required to fully and clearly define design and construction work requirements.

B. Prepare calculations as required for design decisions, equipment and material selection and preparation of construction drawings.

C. Prepare system descriptions indicating equipment data, operating characteristics, sizing basis, functions, flow rates and other process information for all building systems.

D. Prepare mechanical, electrical and instrument equipment lists with summary descriptions, vendors and pertinent data.

E. Prepare arrangement drawings for Owner's Review and finalize arrangement drawings for construction. O&M Building shall have perimeter fence of same design and specification as solar substation (chain link). At a minimum, O&M Building shall have conditioned space for:

1. Control room with HMI screens interconnected SCADA system. Room to be secured from entry (no ceiling tiles).
2. Conference room suitable for seating for 10 individuals. Room shall be equipped with infrastructure for Owner specified A/V equipment (wall monitor, outlets, and A/V cable jacks in conference table source form floor to eliminate tripping hazards.
3. Technician locker room with cabinetry, seating for four (4) technicians and hookups for a clothes washer and clothes dryer.
4. Office with two (2) desks and space for printer/copier. Workstations shall be equipped with outlets and Ethernet jacks included on all wall sections.
5. Entryway with vestibule.
6. Break room for up to eight (8) individuals with sink, counter space, cabinetry, microwave, table, and refrigerator.
7. Bathroom(s) in accordance with AHJ based on occupancy. Furnish and install exhaust fan for bathroom as required by code.
8. Two-stall garage with motor operated insulated steel overhead doors. Overhead doors shall be minimum 10-feet wide by 10-feet tall with bollards installed on each side. Overhead door shall have reinforced concrete apron. Shop shall be a minimum of 40 feet wide and 36 feet deep with entry doors for direct access from exterior and interior.

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9. Mechanical room.

F. Provide all architectural, civil, electrical, mechanical and structural construction drawings for the building and supporting systems including but not limited to the following:

1. Site Arrangement
2. Architectural Plans, Elevations and Details
3. Control Room and Electrical Room Arrangements
4. Access Roads, Curbs, Walkways and Parking
5. All Grading
6. All Drainage
7. Foundations
8. Structural Steel
9. All above grade and below grade piping
10. Conduit, Cable, and Raceways
11. Fire Protection Systems
12. One-Line Electrical Diagram
13. Lighting

G. Prepare technical specifications and other documentation to support all equipment procurement, materials, and construction requirements.

H. Obtain necessary plan approvals and building permits from appropriate state, county and local building authorities. These permits may include but are not limited to the following:

1. Storm Water Pollution Prevention Plan
2. Dust Control Permit
3. Building Permit
4. Grading Permit
5. Septic Tank Permit
6. Construction Trailer Permit

M. All Architectural, Civil, Structural, Mechanical, Electrical, and Instrument and Control design documents that are issued for construction or procurement shall be prepared by or under the direct supervision of a Registered Professional Engineer or Architect according to the requirements in the applicable state. Each engineer or architect responsible for the design shall stamp or certify that the design documents have been prepared by him/her or under his/her direction.

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7.0 COMMUNICATIONS SHELTER

This section defines the requirements for the fabrication and delivery of at least one (1) prefabricated, transportable, non-inhabited, fire-resistant communications equipment shelter. The shelters shall be suitable for outdoor placement in the climate found in Northern Minnesota. The shelters will be used to house and protect control panels, metering, relay protection and fiber optic communications equipment utilized by the Owner as part of their existing control and communications network.

Contractor shall submit a proposed floor plan for approval by the Owner.

7.1 Description of Required Shelters

A. Each communications shelter shall be prefabricated with an equipment compartment with cable ladder and communication and electrical line entry ports. The table below shows the shelter configuration and construction options required:

Building Size	Minimum 10'-0" X 14'-0" (8'-0" Ceiling Height) Min)	
Building Type	Precast Concrete	Metal or Wood Frame
HVAC	Electric	Electric
Electrical Panel	200A 120/240	200A 120/240

The building shall have a single door opening outward to the outside of the shelter.

7.2 Workmanship

A. The shelters shall be crafted with first-class workmanship in every respect. Walls, ceilings, floor and parts shall be aligned, plumb, level and straight. Force shall not be required to mount equipment or appurtenances on mounting studs, fasteners, bolts or screws. Holes shall be aligned so field drilling is not required. The exterior finish of the building shall be in unblemished condition when received on site. There shall be no patches, cracks, voids, or repairs indicating a less than new appearance. Wall penetrations for doors, louvers, HVAC units, conduits, cable entrance panel, doors and other equipment shall be properly caulked, sealed and made completely weather-tight and dust resistant. The communications shelter shall be fully functioning and tested such that it is ready for service upon connection to suitable electrical power sources.

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7.3 Occupancy Classification

A. All buildings are intended for use as unoccupied operations facilities.

7.4 Applicable Codes

A. The proposed shelters and all associated equipment shall meet or exceed requirements of the following –

1. Uniform Building Code (UBC),
2. International Building Code (IBC),
3. Building Officials and Code Administrators (BOCA),
4. Interstate Industrialized Buildings Commission (Minnesota Certification),

The proposed shelters and associated equipment shall also meet or exceed all other relevant standards or approval authorities including but not limited to ACI, ANSI, ASTM, NFPA (NEC), and NEMA.

7.5 Exterior Finish and Color

A. Exterior finish of the shelters shall be natural stone exposed aggregate material or suitable metal siding. Color selections for painted exterior trim fixtures of shelters shall be coordinated at time of shop drawing approval. Contractor shall submit available wall color chips for Owner approval. Except for electrical fixtures, exterior finish of all metallic and other accessories and parts (doors, louvers, awnings, trim, etc.) shall be painted in a complementary tone subject to the painting specifications provided at time of shop drawing approval.

7.6 Shelter Construction

A. The shelter foundation and apron shall be reinforced concrete designed and constructed based on the recommendations of a final Geotechnical investigation and report performed by a licensed professional Engineer in applicable state. Additionally, foundation shall meet requirements of all applicable building codes.

B. The shelter shall be precast preassembled steel reinforced solid concrete, or metal, or wood frame. The shelter shall be designed and fabricated so that the interior floor is smooth and perfectly level, the walls are plumb, and the roof is symmetrical with an appropriate exterior sloped roof design to shed water and melting snow.

C. The structure shall be fabricated upon a steel, rust resistant skid assembly of either beam and/or pipe-beam construction. The skid assembly shall be designed and sized for the loads presented by each building type. The structure shall be uniform in appearance and finish and shall be

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weather tight and free of holes or other irregularities which would allow the penetration of water, insects, vermin, or dust.

D. Each shelter shall have a floor system comprised of a reinforced construction suitable for supporting the floor loads stipulated within this specification. All surfaces shall be smooth. The interior surface shall be covered with 1/8 inch light colored commercial grade vinyl floor covering, bonded with a waterproof contact adhesive.

E. The roof panel shall be minimum 4” thick gable design with minimum 1/8” per foot drainage slope. The roof shall provide at least a 1” overhang on all sides. It shall cap and fit over the walls, leaving no exposed roof to wall joint. Plastic joint or corner trim shall be installed at all panel joints.

F. The wall panel shall be minimum 4” thick with an exterior exposed aggregate finish. Interior walls shall be finished with a smooth surface and light in color to permit maximum utilization of available light, and shall be designed to support loads as specified. Plastic joint or corner trim shall be installed at all panel joints. Floor to wall intersection shall be finished with 4” vinyl baseboard. There shall be no exposed wall to floor joint.

G. Insulation (or other thermal composition of the building fabrication design) shall be provided in roof, walls, and floor to achieve the following minimum performance objectives:

1. Floor: R-19
2. Roof: R-30
3. Walls: R-19

H. Door frames shall be 16 gauge galvanized steel, primed, painted and fastened to the wall panel. Doors shall be 18 gauge galvanized steel, insulated, rust resistant, and painted and shall have the following minimum dimensions:

1. 3’- 0” wide for equipment compartment;
2. 7’- 0” tall
3. 1¾” thick

Door position and hinge swing side shall be as defined on project shop drawings. The door threshold shall be not less than 3.5" or more than 6" above the concrete pad (or platform) upon which the shelter shall rest. The door jams shall sit perfectly flush with the interior of the shelter wall. The door threshold shall be of full width aluminum construction. The door shall be sealed and have weather strips on all sides.

I. The entry door and any exterior wall-mounted equipment shall have a drip cap/rain hood installed on the outside of the shelter. Doors shall be hung on 4" x 4" stainless steel hinges with non-removable pins. The hinges shall be bolted through the door jam with stainless steel fasteners. For tamper resistance, the hinges shall be oriented in the full-mortised position with no fasteners exposed when the door is closed. Each door shall include a heavy duty stainless steel door holder/closer. The device shall allow the door to be set in the open position. Once set in the open position, the holder/closer shall resist moderate wind and allow for shock absorption. The door stop mechanism shall prevent the door from contacting the outside wall of the shelter or any exterior fixtures. Doors shall be trimmed with weather-tight neoprene gaskets on all sides. The standard door hardware latching device shall be a single sided deadbolt lock with interior turn/release knob. An exterior anti-pick plate shall cover the bolt assembly. The

Owner shall provide the successful bidder with the designated door lockset and manufacturer for Contractor to procure and install.

7.7 Drawings

A. Sufficient drawings shall be furnished to uniquely identify the proposed shelters including proposed foundation, unique site preparation needs, and overall shelter weights. Within five (5) calendar days after notice of intent to award a contract, the successful Contractor shall furnish preliminary shelter shop drawings in AutoCAD format to the Owner. The shop drawings shall show layout, proposed construction details, and bill of material. Not later than ten (10) calendar days after return of annotated shop drawings, Contractor shall furnish one (1) AutoCAD file and one (1) PDF copy of fabrication/approval drawings to the Owner for each new shelter showing details suitable for the intended purpose. The PDF copy shall be certified by a Minnesota registered professional engineer or architect who is competent and experienced in building design. Written evidence of all necessary building code approvals shall be furnished to the Owner by the Contractor, before construction of the shelters begins.

7.8 Environmental Performance

A. Temperature performance of the completed building shall provide for floor, roof, and wall systems that allow for thermal movements resulting from an ambient outdoor air temperature ranging from -40 F to +110 F. The design shall prevent separating or buckling, opening of joints, over-stressing of components, failure of joint sealants, failure of connections, and other detrimental effects which will shorten the life of the structure or the contents. Shelters shall be completely weather-tight and every seam or joint shall be sealed with an industrial grade polyurethane caulk during and after assembly. All exterior corner joints shall be capped with a one-piece aggregate corner cover as required to complete the exterior finish detail. The supplier shall be responsible for making field corrections, at the delivery site, of any joint separation or construction anomaly which may develop during the course of shipping, offloading, or setting of the shelter as part of the contracted work.

7.9 Fire Suppression

A. Built-in shelter fire suppression systems shall be as required per relevant codes. Shipped shelters shall include one (1), exposed, wall mounted fire extinguisher mounted inside each entry door as depicted below:

B. Communications Room: 10 lb. ‘Halotron’ Portable (1A,10B;C Rating)

7.10 Delivery & Installation

A. All shelters shall be delivered, offloaded, and set upon the foundation constructed and prepared by Contractor. All delivery costs shall be listed separate from actual shelter fabrication cost. Contractor shall list any special resources (lifting equipment, crew size, etc.) required to offload and set various shelter options.

B. Special handling equipment, local permits or other requirements not related to shelter transportation costs shall not be included in delivery cost. Such additional costs shall be separately identified as a narrative attachment to the proposal. Owner shall have the option of coming to manufacturer's facility to complete pre-shipment inspections with travel and accommodations being paid by Owner. If Owner is unable to complete a pre-shipment inspection onsite, the manufacturer shall be required to provide detailed photographic evidence of the construction and final product to Owner prior to shipment.

7.11 Permits & Inspections

A. Not less than ten (10) working days before the completed shelter(s) are scheduled for shipment; Contractor shall notify the Owner that the shelter(s) are being scheduled for release from the factory. At the option of the Owner, the shelter(s) may be inspected by the Owner at the manufacturing facility for assurance that construction and fabrication practices reflect the requirements of the shop drawings and will meet the needs of the project.

Any defects or corrections identified during the pre-shipment inspection or through the photographs sent to the Owner shall be corrected at no cost prior to release of the shelter(s) from the factory. Any modifications which vary from approved shop drawings as requested by the Owner during the pre-shipment inspection or photographs shall be subject to approval via the change order process.

7.12 Structural Loading

A. The shelter shall meet the following loading requirements.

1. Roof Live: The design shall allow for live loads of 125 pounds per square foot as defined in ANSI A58.1. The roof shall resist impact of a falling object weighing 220 lbs without damage or deflection to either the interior or exterior of the shelter.
2. Roof Snow: The design shall allow for roof snow load of 115 pounds per square foot as defined in ANSI A58.1.
3. Walls: Minimum wall depth shall be 4". In locations shown by applicable notes on the shop drawings, interior walls shall provide adequate strength to support hanging of equipment with minimum dead weight loads of 175 lbs.
4. Floor: Uniformly placed floor loads of 350 pounds per square foot are contemplated in the communications equipment areas.
5. Wind: The design shall allow for a maximum wind speed of 150 miles per hour per ANSI A58.1.

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7.13 Rodent Resistance

A. Unless an applicable substitute is approved, the underside of the floor assembly, and any exposed wood surfaces, shall be covered with a 16-mesh (.011 wire) rodent shield before the floor assembly is attached to the skid assembly.

7.14 Handling & Offloading

A. All components provided inside buildings shall be installed at manufacturing location to verify fit, finish and alignment. All shelters shall be provided with lifting rings so that the shelter can be hoisted up using overhead equipment such as cranes or boom trucks. Shelter handling instructions shall be provided with each delivery to help the receiving party properly determine how to handle the shelter once it is set in place at the site.

7.15 Shelter Warranty

A. The shelter shall carry a ten (10) year limited warranty, which covers the materials and workmanship of the enclosure. The shelter manufacturer’s liability on an item purchased from others, by manufacturer, and installed in a shelter shall be stipulated with the bid for each respective item

7.16 Factory Installed and Packaged Shelter Subsystems

A. Alarm System

1. Alarm Control Point (ACP)

a. The ACP (Marshalling Point) shall be located within the communications equipment room. All door intrusion sensors, smoke/fire detection sensors and high/low temperature sensors shall be wired to the ACP for inclusion in the customer owned equipment. Owner will specify the exact location of the ACP on the shop drawings. The general location shall be near the electrical panels. The ACP shall receive inputs via normally open (NO) sensor or detector. Each connection on the ACP shall present on a set of isolated contacts on a Type ‘66’ communications block that is to be furnished with the shelter and interfaced to other external annunciation equipment by others. Upon alarm, these external contacts remain active for the duration of the alarm condition.

b. Door Intrusion Sensors

i. Each shelter entry door shall be outfitted with one (1) set of NO magnetic switch contacts. Each set of contacts shall separately deliver NO circuit continuity to the ACP. Upon opening the shelter entry door, the associated contact for that door shall change to a closed contact status and remain in that state until the door is re-secured. Wiring from door intrusion sensors shall be via conduit or armored flexible cable to the ACP.

c. Smoke/Fire Detection Sensors

i. Each shelter shall have at least one (1) independently functioning smoke/fire detector with NO contacts. The detectors shall be mounted to the ceiling and spaced appropriately to provide uniform room coverage. The detectors shall be combination devices incorporating both rate-of- rise (temperature) and ionizing detection technology. Wiring from fire detection sensors shall be via conduit or armored flexible cable to the ACP.

d. Independent High/Low Temperature Sensors

i. Each shelter compartment shall contain one (1) each, Normally Open high and low temperature alarm sensors wired to the ACP. The high/low temperature alarm sensors shall be independent of alarm sensors furnished as part of the HVAC package. Set points for the high and low temperature limits shall be field adjustable with the selected set point clearly visible on a dial or indicator as part of the assembly.

7.17 Electrical Package

A. All furnished electrical packages are to be installed and wired in conformity to the latest edition of the National Electric Code. A suitable penetration will be provided to allow for a 2/0 ground wire to be routed from the ground bar in the building to the grounding grid inside the fence of the solar site. This penetration will be located and sized on the approval drawings.

B. All shelters shall include an electrical package which shall consist of:

1. Load Center and Transient Voltage Surge Suppression (TVSS)
2. 2” through wall electrical entrance penetration into the Load Center and rated service disconnect on the outside of the building
3. Feeder and Branch circuit conduit, boxes, wire, fixtures, outlets, and interior grounding and bonding materials

C. Basic Shelter Electrical Requirements

1. All wiring shall be carried through the structure via UL listed thin wall conduit. Where interior grounding conductors penetrate walls, floor or ceiling, the ground should pass through the partition via PVC conduit sleeve. Use of “seal tight” or other flexible conduit shall be allowed as permitted on shop drawings and applicable codes; use of “SO” cord connections shall be as permitted on shop drawings and applicable codes. Conduit fill capacity shall strictly observe the limits imposed by the NEC; any conduit which has reached its fill limit at time of production shall be upsized to the next largest conduit dimension. All wiring, conduit, and equipment mounted inside and outside the building shall be aligned, plumb, level, straight and square to the building and equipment. Flexible conduits shall be cut to length without excessive slack or bends.

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2. General Material Summary

ITEM	DESCRIPTION	MFR	UNITS
1	Lighting Panel w/ 200A Main Disconnect	Square - D	1
2	2 Ton Wall Mounted HVAC Unit, 5kW heat strip, Tan, RH, Econ		1
3	Thermostat Controller, MC4001, Solid State Unit Lead/Lag Controller		1
4	Master Ground Bars		2
5	12" Cable Ladder Tray		lot
6	Smoke Detector		1
7	4’, 2 Bulb LED Light Fixture		4
8	19” Rack Mount enclosures		2
9	Convenience outlets, duplex		4
10	Security light, dusk to dawn		1

3. Additional Notes:

a. All furnished electrical packages are to be installed and wired in conformity to the latest edition of the National Electric Code. Shop drawings shall include a conduit fill table.

b. Furnish and install cable ladder 8’- 0” above finished floor (AFF)

c. Ground door frame, cable tray, service boxes to the grounding system. Do not ground baseboard heaters, disconnects, wireway or distribution panel enclosures to the grounding system.

d. Interior green 2/0 ground to connect to each end of the interior master ground bar and flow through the cable ladder on the bottom of double J-hooks. This 2/0 open ring is two separate runs and is spaced 1’ apart where they would meet. Interior grounding system is to be kept away from any metal conduit a minimum of 1 ½”.

e. Penetrations located in the floor will be identified on the Approval Drawings and allow for a conduit raceway. There will be a rectangular floor penetration for the Metering equipment, Solar Field low voltage, Solar Field Communications, Re-closer low voltage and fiber optic cable. The penetration will provide a barrier against insects and vermin and have a suitable interior cover to seal the hole.

f. Every electrical circuit device (outlet, switch, HVAC device, etc.) shall be properly labeled with a permanent, securely affixed, non-fading label which identifies the panel board number and circuit ID.

g. Furnish and install Qty. one (1) exterior, high efficiency, security down light with dusk to dawn sensor; single circuit, switched

h. Furnish and install wall outlets as specified on shop drawings and per relevant codes.

i. Furnish and install Qty. one (1) 120 VAC, 20 AMP GFCI, weather proof, exterior receptacle

j. Unless otherwise specified herein, install interior grounding system as per Motorola ‘R56’ and Owner specifications.

k. Furnish and install Qty. one (1) 3/4” flexible conduit drop with two (2) 30A, 240 VAC circuits for battery charging equipment as specified on shop drawings and per relevant codes

l. Install a single 20A, 120 VAC drop to be inserted into cable management on its own circuit. Exact location to be determined by the owner.

m. Install awnings over exterior doors. Awnings shall extend two feet from the building with a total width to be a minimum of the door frame exterior dimension plus one foot on either side. Awnings shall direct rain and snow away from the side above the door handle.

7.18 SHELTER MECHANICAL & HVAC SYSTEMS

A. The building shall be equipped with an HVAC system as described below. Pre-approved manufacturer of HVAC equipment shall be Bard, but bidder may propose a suitable substitute. The HVAC units shall be designed for wall mounting and shall consume no interior space within the shelter. HVAC units shall be equipped with dual blowers having multi-speed capability. Internal, make-up heat strips shall be provided. The HVAC systems shall be outfitted to automatically operate in an “Economizer” mode permitting reduction of energy costs when environmental conditions permit its use. HVAC unit shall be configured for single sided service access. The HVAC unit shall be adequately sized to meet the requirements of the shelter and maintain an interior ambient temperature between 68 and 70 Degrees F.

B. The following minimum mechanical/HVAC systems are required:

1. Qty. One (1)
2. Input voltage 240 VAC, Single Phase
3. Compressor Type: Scroll
4. SEER efficiency: Minimum 10
5. 2 Ton Cooling Capacity (Based on building size and design)

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6. 5 kW Heat Strip (Based on building size and design)
7. Filter: 2” Pleated 35% dust spot efficiency
8. Alarm relay kit
9. Painted Housing
10. Awnings
11. Solid State Lead/Lag Controller, Thermostat Equipment Room Ventilation

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8.0 SITE WORK

8.1 General Requirements

A. This section covers the minimum scope and quality for the plant civil design and construction.

B. Contractor shall develop a Worker Environmental Training Program. All site personnel shall undergo the Worker Environmental Training Program prior to being allowed to work on the site.

C. Contractor is responsible to inspect the Site, obtain all necessary Site data, obtain all required geotechnical and drainage investigations, and determine all Site data for the design and construction of the PV power plant. This shall include determination of local code requirements for seismic and wind design loads. It is Contractor's sole responsibility to ensure that the Site work complies with all federal, state, and local code requirements and all applicable industry codes and standards, including standards of applicable authority having jurisdiction.

D. The scope shall include, but not be limited to the following:

1. Design and prepare the construction plans, final design reports, and project specifications for the civil site work, including the storm water drainage, grading, roads, temporary construction facilities, etc. All must meet the approvals of the Owner and jurisdictional government agencies.
2. Coordinate design with other engineering firms and utilities responsible for scope outside of its own scope.
3. Obtain all necessary permitting associated with civil site work construction such as wetland permits, grading permits, haul permits, dust permits, storm water pollution prevention plans, etc., in compliance with City or County requirements and other jurisdictional government agencies as may pertain.
4. Construction of all civil site work, including the storm water drainage infrastructure, earth grading, roads, security fencing, etc. Construction of any temporary civil site work such as temporary security fencing, temporary construction roads, etc.
5. Perform flood damage management and storm water pollution management during construction in compliance with state and local sediment and erosion control rules, regulations, ordinances and approved Storm Water Pollution Prevention Plan (SWPPP).
6. Perform dust control measures during construction in compliance with state and local rules, plans, regulations, permits and ordinances for fugitive dust emissions.
7. Perform the geotechnical evaluations as necessary for the civil site work.
8. Prepare the drainage report(s) to meet applicable agency's permit requirements.
9. Perform all construction surveys (construction staking).

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10. Prepare record drawings that depict any deviation from original design drawings.

E. The Project design shall take into account existing site conditions with respect to soil characteristics, site clearing, grading, and drainage. The Contractor shall be responsible for all site preparation including any demolition, soil stabilization, grading, drainage, roadways, and temporary parking areas.

8.2 Units

A. All design dimensions and design calculations shall be in British (United States Customary) units (Feet/Inches).

8.3 Geotechnical

A. The Contractor's final design shall be based on the recommendations of a final Geotechnical investigation and report performed by a licensed professional Engineer in the applicable state.

8.4 Construction Surveys

A. Contractor is responsible for the construction surveying and staking. All construction surveying and staking shall be performed under the supervision of a surveyor licensed in the applicable state. Environmentally sensitive areas shall be flagged in a different color than other flagging.

B. Contractor is responsible for all surveys required for environmental and cultural permitting; and shall meet all such permit requirements during the execution of the Project.

8.5 Site Preparation and Maintenance

A. Site Clearing and Grubbing

1. Immediately prior to Substantial Completion, Contractor shall remove all weeds and trim all native vegetation from areas surrounding PV Modules, other electrical equipment and site infrastructure, in compliance with the Revegetation Plan. The Contractor shall be responsible for all applicable permitting with jurisdictional agencies for use of herbicides should the decision be made to use them during construction.

2. Owner will provide specific clearing and grubbing restrictions, if any.

B. Debris

1. All construction-related debris and unsuitable material including material from site clearing and grubbing shall become the immediate property of Contractor and shall be removed from the premises and lawfully disposed of off-Site by Contractor at Contractor's cost.

C. Stormwater Management and Erosion Control

1. Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) for its construction activities. The Contractor shall be responsible for installing and maintaining the storm water controls and best management

practices in compliance with the SWPPP. The Contractor shall provide for sediment and erosion control during and after construction in accordance with project permits and local and state laws and regulations. Best management practices such as check dams and sedimentation basins shall be used during construction to minimize erosion. Long-term operational best management practices shall be installed prior to substantial completion and be designed to minimize erosion on site and sedimentation of waterways.

2. Drainage facilities shall be designed and constructed in a manner to minimize erosion and prevent excessive erosion within the Array areas. Excessive erosion shall be considered as anticipated erosion exposing the pile such that the design embedment depth is no longer met. Drainage facilities should also be designed to limit off-site sedimentation of waterways per applicable regulations or permits and may include retention basins as appropriate to achieve these objectives.

3. Drainage design shall be approved by AHJ, as applicable.

4. Contractor shall design and construct site grading/drainage to minimize potential for site flooding and ponding. The working area of the site shall be well drained during and after construction. The civil drainage infrastructure design shall conform with the standard of the jurisdictional government agencies.

5. Contractor shall prepare drainage report(s) to support obtaining construction permits for the project, as applicable. The report(s) shall meet the standards and requirements of the applicable agency and shall describe the final design of the storm water drainage infrastructure and provide the hydrologic and hydraulic calculations applied.

6. The Contractor shall prepare a design meeting the acceptance of Owner, such acceptance shall not be unreasonably withheld, which incorporates permanent, long-term measures which mitigate the flood potential associated with on-site generated storm water runoff.

7. Waters of the United States shall not be impacted, filled, or used in connection with the site drainage plan unless proper permits are obtained.

D. Road Maintenance

1. All temporary access roadways used by Contractor, as well as the new site permanent roads shall be maintained in serviceable condition. Contractor shall keep the surfaces of those roadways free from spills, mounds, depressions, and obstructions, which might present a safety hazard or annoyance to traffic.

2. Contractor shall be responsible for securing authorization and permits to transport oversized/overweight loads on local, County and State roads for the supply of materials under Contractor’s scope.

3. Contractor shall supply and install any temporary or permanent facilities required to facilitate delivery of Contractor and Owner equipment/materials. Contractor shall also be responsible for removing all such temporary facilities.

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E. Signs and Barricades

1. Signs and barricades shall be provided and maintained by Contractor and shall be in accordance with jurisdictional regulations for accident prevention and Contractor's safety plan. Signs shall further comply with any County-specific design standards.

F. Dust Control

1. Dust Control for Construction Activities

a. Contractor shall be responsible for obtaining dust control permits, if required, and complying with requirements of said permit. Contractor shall be responsible for compliance with State and local requirements for fugitive dust emissions and shall obtain local authority approvals and conform to the dust control regulations and reporting requirements.

b. Contractor is responsible for locating source of construction water to support dust control and construction activities.

G. Open Burning

1. Onsite open burning is not permitted.

H. Earth Grading

1. Contractor shall balance the earth grading and leave no stockpiles or pits remaining at the completion of the full build-out of the project. (Stock piling in accordance with applicable regulations may be permitted in support of phased construction.) The grading design shall balance the earth work such that no major volumes of soils will be imported or exported from the Site for grading purposes. Any permitting, or costs for import or disposal will be the responsibility of the Contractor.

2. The Contractor is responsible to meet the grades and slopes as necessary to support the solar installation. The Contractor is responsible for any re-grading or repair costs associated with not providing ground surfaces which adequately support the solar installation.

3. Contractor shall identify site specific grading restrictions, if any.

I. Excavation, Filling, and Backfilling

1. Excavated native material may be used on the site for embankment and backfill, if suitable. All unsuitable materials such as; rock, concrete, wood, metal, and other materials from the excavation shall be considered debris and disposed of as described herein.

2. Structural fill, bedding material, topsoil, and other materials not readily available on site shall be procured, tested, and delivered to the site by the Contractor.

3. Contractor shall be solely responsible for maintaining the stability of all excavated faces and shall provide adequate sheeting, shoring, and bracing to support any lateral earth pressure.

4. Contractor shall be solely responsible for protecting personnel and adjacent structures against any damage from cave-ins, heaving or other earth

movements. Sheeting, shoring and bracing shall be removed as backfilling proceeds or it may, with the approval of Owner, be left fully or partially in place.

5. Fill characteristics and compaction requirements shall be determined by Contractor’s geotechnical investigation and report recommendations.

6. All equipment used to meet compaction requirements shall be specifically designed for such duty.

8.6 Roads

A. Site Access:

1. Site Access road improvement shall be the responsibility of the Contractor.

2. Access to the Site will be constructed in accordance with applicable agency requirements, including, but not limited to the local fire department.

3. Contractor shall be responsible to obtain and comply with all encroachment permits required to construct driveway aprons or otherwise connect access roads to county-maintained roads, as applicable.

B. Roads on-site shall consist of the following:

1. The perimeter roads shall be routed around the exterior of the solar arrays, connecting the Solar Substation, O&M Building (if applicable), inverter access driveways, and any areas designated for flood management. Roads shall be stabilized in accordance with the recommendations of the geotechnical evaluations.

2. Array access driveways shall be constructed to provide access to the interior array inverters. Array access driveways shall consist of a compacted aggregate roadway. Widths will vary depending on design, but design should consider access requirements for operations and maintenance.

C. Access Design Characteristics

1. The following plant design characteristics shall be adhered to:

a. At a minimum, roads for accessing inverters, MET, O&M Building, and substation shall be designed to accommodate Owner specified design vehicles. A design vehicle is to be defined for this project to be a typical crane used in placement and servicing of site equipment, such as inverters. Contractor shall model vehicle swept paths with AutoTURN software or equivalent to verify design vehicle accommodations in road designs. Modeling reports shall be provided to Owner for review.

b. Inverter access road width shall be at minimum 12-feet wide within a 20-foot corridor to allow access by design vehicles.

c. Substation/O&M access road width shall be at minimum 20-feet wide to allow access by design vehicles.

d. Site design shall include a 20-foot width from module edge to fence line to allow for operations and maintenance access after plant is in operation.

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e. The perimeter road width shall be at minimum 16 feet with an additional 6 feet of cleared ground on either side to allow sufficient space to get a tractor trailer and or crane down a row to replace transformers or inverters in the event one fails.

f. All roads shall have sufficient turning radii (30’ minimum) for expected use of design vehicles.

g. All roads shall meet minimum requirements of local fire department or AHJ, if required.

h. The minimum distance between an inverter and the nearest module shall allow for maintenance and repair of any and all components of the ISA with locally available equipment.

i. Design to provide for adequate snow storage and clearing locations to allow access to the O&M Building and inverters.

j. All roads to be designed for HS-20 loading.

8.7 Security

A. A game fence shall be installed around the perimeter of the site.

1. Alternative fencing is not allowed unless authorized by Owner.

B. Permanent perimeter fence shall consist of 6’-3” minimum of Stay-Tuff Deer Fence Wire 1775-6 Class 3 or approved equal with a single barbed wire 9 inches above top of game fence fabric. See Exhibit 14 for additional fence details. End, corner, and gate posts shall be set in concrete. Fence fabric shall be no more than 2 inches above finish grade. Contractor shall provide a temporary physical barrier between completed Circuits in the custody of the Owner and Circuits under construction by the Contractor. The physical barrier shall allow for controlled access to the completed Circuits in the custody of the Owner. Contractor shall move all such fencing, as necessary, as Circuits are turned over to Owner, and shall remove all temporary fencing prior to Project Substantial Completion. Materials for site game fencing shall meet the requirements of Game Fence Details in Exhibit 14. Security site specific design requirement as set forth in this Attachment D.

C. Gates:

1. Main Entrance Contractor shall install a minimum 20-foot wide swing gate.

2. Maintenance Gates: Contractor shall install swing gates as required to allow access to all areas of the site.

a. Gates shall be swing type, hinged to swing 180 degrees from closed to open, complete with frames, latches, stops, keepers, hinges, fabric, and braces.

b. Latches shall be plunger-bar type with locking device and padlock eyes integral to the latch. Keeper to automatically engage gate leaf and secure free end of gate in open position.

D. Contractor shall repair and/or replace fencing damaged by construction activities.

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E. Cameras and Lighting: At a minimum, one camera and lighting shall be installed at the main gate of the site and of the Solar Substation with a view to the entire substation. See section 9 of Exhibit 1 for additional requirements.

8.8 Site Revegetation

A. Prior to substantial completion, Contractor shall prepare the site in compliance with a Revegetation Plan developed by Contractor that meets Owner and permitting requirements. Owner requires re-seeding with an approved ground cover that will prevent erosion and be easily controlled and managed. See Exhibit 14 for Pollinator Seed Mix. If there are requirements beyond this, from permitting, those must be adhered to as well.

8.9 As-Built Drawings

A. Contractor shall prepare as-built drawings as may be necessary to meet the standards of the jurisdictional government agencies. At minimum, Contractor shall prepare as-built drawings for the Owner's record which contain as-built elevations, dimensions, etc. and any variation from the design drawings, sealed by an engineer or surveyor licensed in the applicable state.

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9.0 STRUCTURAL

9.1 Materials

A. Steel

1. Design of hot-rolled structural and miscellaneous steel shall be in accordance with the American Institute of Steel Construction (AISC) “Manual of Steel Construction”. Design of structural and miscellaneous steel shall also be in accordance with National Electrical Manufacturers Association (NEMA) “SG6” and “TT1”, American Society of Civil Engineers (ACSE) “Guide for the Design of Steel Transmission Towers, Manual No. 52” and the International Code Council “International Building Code”. Design of cold-formed steel shall be in accordance with the American Iron and Steel Institute (ANSI) “North American Specifications for the Design of Cold-Formed Steel Structural Members”.
2. Materials for structural steel and miscellaneous steel shall conform to the following requirements of the American Society for Testing and Materials:
    a. Wide Flange (WF) Shapes and Tees cut from WF: ASTM A992, Grade 50 or multi-certification A36/A572, Grade 50.
    b. M shapes, S shapes, HP (Bearing Piles), Channels, and Angles: ASTM A36
    c. Structural Plates and Bars: ASTM A36
    d. Square/Rectangular Hollow Structural Sections (HHS): ASTM A500 Grade B
    e. Pipe: A53, Grade B
3. High strength bolts, nuts, and washers shall conform to ASTM A325, ASTM A563, and ASTM F436 respectively and shall be galvanized in accordance with ASTM A2329.
4. Bolts, nuts and washers under one-half inch in diameter shall conform to ASTM A307, Grade B, ASTM 563 and ASTM F844 respectively and shall be galvanized in accordance with ASTM F2329.
5. Anchor bolts, anchor bolt assemblies and concrete embedments shall be galvanized.
6. Anchor bolts shall conform to ASTM A449, ASTM F1554, Grade 36, or A307. Anchor bolt sleeves shall conform to ASTM A501.
7. All structural welding shall conform to the requirements of AWS D1.1.
8. Galvanizing, as specified herein, shall conform to the requirements of ASTM A123, ASTM A153 or ASTM A2329, as applicable.
9. Stainless steel shall conform to ASTM A167.

B. Aluminum

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1. Design of structural and miscellaneous aluminum shall be in accordance with the latest version of the Aluminum Association – “Aluminum Design Manual” and “Aluminum Standards and Data”.
2. Materials for structural and miscellaneous aluminum, including structural shapes and plate, shall conform to ASTM B209 and ASTM B308 and shall be aluminum alloy 6061-T6.
3. Bolts and nuts shall conform to ASTM F468 and ASTM 467, respectively and shall be aluminum alloy 6061-T6. Washers shall be aluminum-clad steel Alclad 2024-T4 or approved equal.

C. Concrete

1. Design of structural concrete shall be in accordance with the latest version of the American Concrete Institute (ACI) - "Building Code Requirements for Structural Concrete," ACI 318. All concrete formwork shall conform to ACI 347.
2. Hot and cold weather concreting shall be in accordance with the latest version of ACI 305 and 306.
3. Concrete intended for use on native soil shall be specified consistent with the properties of the soil. Concrete mix proportions, including documentation of materials, admixture product information, and compressive strength of mix, shall be submitted and approved by the Owner prior to placing concrete.
4. Minimum concrete strength classes for various structures shall be as follows:

Item	Minimum Ultimate Compressive Strength (psi) (at 28 Days)
Electrical Duct banks	3,000
Major equipment/structures where required and all other construction	4,500

5. Reinforcing bars shall be deformed bars conforming to ASTM A615, Grade 60. Welded wire fabric shall conform to ASTM A185. Plain wire shall conform to ASTM A82. Placement shall be in accordance with Chapters 7 and 12 of ACI 318 and the Manual of Standard Practice of The Concrete Reinforcing Steel Institute.
6. Cement shall be Portland cement conforming to ASTM C150, Type I or Type II or as suggested by the Contractor’s Geotechnical report.
7. Aggregates for normal weight concrete shall conform to ASTM C33.
8. All foundations shall extend a minimum of 6 inches above the adjacent finish grade.
9. All concrete trucks may be rinsed out at one designated location on-site in accordance with applicable permits. Rinse material shall be properly disposed of off-site.

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9.2 Concrete Testing

A. Field testing and sampling shall be performed by an independent testing laboratory at Contractor's expense. The testing technician shall be an ACI Concrete Field Testing Technician Grade 1.

B. Compressive strength determinations shall be made from 6-inch diameter by twelve-inch long concrete cylinders or 4-inch diameter by eight-inch long concrete cylinders tested in accordance with ASTM C39. Cylinders shall be prepared for compressive strength tests on concrete with a designed compressive strength of 2,500 psi or higher for the following conditions:

1. Each one hundred (100) cubic yards or fraction thereof of concrete poured;
2. At least once per day
3. For each 5,000 square feet of surface area for slabs or walls.
4. A minimum of four concrete cylinders shall be prepared from each composite sample.

C. Field slump tests shall be performed in accordance with ASTM C143 and shall be performed for the following conditions:

1. The first batch produced each day,
2. For every 50 cubic yards or fraction thereafter, and
3. With every set of test cylinders.

D. Air content, concrete temperature, and air temperature tests shall be performed for the first batch of each day and with each set of test cylinders. All testing shall be done in accordance with the requirements of the American Society of Testing Materials (ASTM). Test results shall be provided to Owner for records within 30 days of test completion. In the event of failure of any aforementioned test, the Owner shall be notified.

9.3 Structural Loading

A. Contractor shall determine all Site data for the design and construction of the plant. This shall include determination of local code requirements for seismic and wind design loads. It is the Contractor's sole responsibility to ensure that the plant structural and architectural facilities comply with all federal, state, and local code requirements and all industry codes and standards.

B. Structural loads shall be applied with post embedment depth accounting for maximum scour associated with 100-year storm event.

C. Dead Loads

1. Dead loads shall include all vertical loads due to weight of permanent structural and nonstructural components, including permanent hung loads.

D. Live Loads

1. Live loads shall be in accordance with the IBC and ASCE 7 as modified by the applicable agency Local Additions and Addenda.

E. Snow Loads

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1. Snow loads shall be in accordance with the IBC and ASCE 7 as modified by the applicable agency Local Additions and Addenda

F. Wind Loads

1. Wind loads shall be in accordance with the adopted versions of the IBC and ASCE 7, as modified by the applicable agency Local Additions and Addenda. Wind tunnel testing method is permitted upon explicit Owner consent. Irrespective of any wind tunnel testing results, the minimum design wind pressure shall be no less than 10 pounds per square foot (psf) applied normal to the face of each PV module. The PV module rack shall be designed in such a way that deflections due to wind will not damage the PV modules. Contractor shall ensure that the PV modules support foundations can withstand the uplift due to wind loading.

G. Seismic Loads

1. Seismic loads shall be in accordance with the adopted versions of the IBC and ASCE 7, as modified by the applicable agency Local Additions and Addenda. The soil profile type shall be determined by the Contractor based on the results of a subsurface investigation, which shall be obtained by the Contractor.

H. Thermal Loads

1. Buildings and structures shall be designed for forces and/or movements resulting from changes in temperature. Induced thermal loads (i.e., thermal loads induced by equipment operating temperatures) shall be considered in design of applicable structural elements.

I. Adfreeze Loads

1. Adfreeze (frost heave) shall be designed in accordance with recommendations of Contractor's Geotechnical Engineer. Provisions for mitigating adfreeze shall be included in the design.

J. Vehicle Loads

1. Design loading, for areas accessible to trucks, shall be (AASHTO) HS20.

K. Soil and Hydrostatic Pressure Loads

1. Earth pressure and hydrostatic pressure loads shall be based on the geotechnical conditions and groundwater levels at the project site.

L. Transmission Line Loads

1. In addition to the aforementioned loading criteria, overhead transmission loads shall also conform to ASCE Manuals and Reports on Engineering Practice No. 74 "Guidelines for Electrical Transmission Line Structural Loading" and to NESC requirements.

M. Load Combinations

1. Load combinations shall be in accordance with the IBC and ASCE 7. If the state or county that the project is located in has any Additions or Addenda to this code, it is the Contractor's responsibility to determine this and adhere to it.

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9.4 Structural Foundations

A. Type of foundations required and allowable bearing values for soil and rock shall be as recommended by Contractor's Geotechnical Engineer based on the subsurface conditions found in the Contractor's Geotechnical report. All loose materials shall be removed from excavation bottoms. Unsatisfactory foundation subgrade material shall be removed and replaced with compacted structural fill material or with 2000 psi (minimum) concrete. Total foundation settlements will be limited to 1 inch or as required by applicable building or industry codes, and equipment supplier's recommendations.

B. A minimum of 18 inches of the native soil to be removed and compacted to 95% of relative compaction as a subgrade for various concrete housekeeping pads.

   1. All equipment used to meet compaction requirements shall be specifically designed for such duty.

C. Building and Equipment Foundations

   1. Building and equipment foundations shall be of reinforced concrete and shall include all formwork, rebar, waterstop, etc.

D. Transformer Foundation and Containment

   1. Transformers shall be provided with secondary oil containment equal to 110% of the volume of oil present in the transformer.

9.5 Corrosion Protection

A. In general, all exposed carbon steel surfaces shall be treated for corrosion protection. Contractor shall design and specify corrosion protection systems, which shall include surface preparation measures, for the following conditions:

   1. Carbon steel exposed to ambient environmental conditions (i.e., PV module support structure, if applicable)

   2. Carbon steel exposed to soil conditions below grade (i.e., driven or augured piles, if applicable). This coating shall be designed such that it is not damaged during installation. The Contractor shall consult a corrosion engineer to recommend corrosion protection measures based on the soil conditions. Submit the corrosion engineer's recommendations to the Owner for information and acceptance of the recommendations. In no case, however, shall a galvanized coating be assumed to last the life of the project.

B. Stainless steel and galvanized steel shall not be painted.

9.6 Buildings/Structures (if applicable)

A. The Contractor shall obtain Owner's approval of building arrangements prior to detailed design.

ATTACHMENT D
SOLAR TECHNICAL SPECIFICATIONS

10.0 COMMISSIONING AND PROJECT ACCEPTANCE TESTING

10.1 Commissioning, Functional Testing & Capacity Testing

See Exhibits 5 and 6 for requirements of Commissioning, Functional Testing, and Capacity Testing.

11.0 PROJECT AND CONSTRUCTION MANAGEMENT

11.1 Staffing

A. Contractor shall provide the appropriate personnel to manage all aspects of the Work.

B. Contractor shall ensure an OSHA "competent" person be present during all work hours.

C. Contractor may work on Site at any time subject to Applicable Laws. In project areas with residents within ½ mile from the site, pile driving activities shall be limited to 8:00 AM – 5:00 PM or as otherwise agreed upon.

11.2 Reporting/Meetings

A. Contractor shall provide progress and schedule reporting on a weekly basis. A two-week look ahead of activities shall be provided at weekly reoccurring meetings with the Owner, Contractor and Contractor's subcontractors.

B. Progress meetings shall be held at the Site on a weekly basis on dates mutually agreeable to Owner and Contractor.

11.3 Safety Plan

A. Contractor shall maintain a safety plan and observe all safety practices required for performing construction work of this type including OSHA standards.

B. Contractor shall submit final Safety Plan, per the requirements of Exhibit 4, a minimum of 30 days before the start of construction for review and approval.

11.4 Work Schedule

A. Contractor shall submit a detailed schedule in native file using Primavera P6 or similar mutually agreed upon project management software which also meets the requirements of Exhibit 7.

B. The Project Schedule shall be updated monthly against the baseline schedule and submitted to the Owner.

ATTACHMENT D
SOLAR TECHNICAL SPECIFICATIONS

12.0 DESIGN ENGINEERING

12.1 Engineering Design Package

A. Contractor shall develop a comprehensive design package consisting of drawings generated in a format in accordance with Exhibit 2. Design packages and submittals shall be provided for Owner review in native or PDF format.

EXHIBIT 1 – SOLAR SUBSTATION AND GEN-TIE

EXHIBIT 1
SOLAR SUBSTATION AND GEN-TIE

1.0 GENERAL

12.2 Definitions

A. Capitalized terms not otherwise defined in this Exhibit 1 shall have the meaning set forth in Article 1 of the Agreement or as defined in Attachment D.

B. ” Agreement” shall mean the Term Sheet executed between Owner and Contractor to which this Exhibit 1 is attached.

C. “AC” or “ac” shall mean alternating current.

D. “Contractor” shall mean the successful bidder which designs, procures, constructs, and commissions the proposed Project.

E. “DC” or “dc” shall mean direct current.

F. “HV” shall mean high voltage. For purposes of this document, HV shall mean greater than 100 kV.

G. “HZ” or “Hz” shall mean hertz.

H. “kV” shall mean kilovolts.

I. “kW” shall mean a measure of instantaneous power as measured in kilowatts. If not specified in particular it shall be assumed to be in Alternating Current (AC).

J. "MV" shall mean medium voltage, commonly 34.5 kV. For purposes of this document, MV shall mean sub-100 kV.

K. “POI” shall mean the Point of Interconnection which defines the location of the physical electrical interconnection to the Transmission Provider.

L. “Project” shall mean the solar Project as defined in the Agreement. The Project shall include all equipment and systems producing solar energy, from the solar modules up to the POI, including the collector system, substation and Generation Tie-line between the project substation and the POI.

M. “PV” shall mean photovoltaic.

N. “Solar Substation” shall mean the facility which collects the feeds from the PV Field and transforms the voltage (as required) for electrical interconnection to the Transmission Provider.

O. “SCADA” shall mean the Supervisory Control and Data Acquisition system, and shall include all monitoring/control hardware and software, field instrumentation and communication devices.

P. “Transmission Provider” shall mean the public utility (or its designated agent) that owns, controls, or operates transmission or distribution facilities used for the transmission of electricity in interstate commerce and provides transmission service under the Tariff.

12.3 General Specifications

A. The purpose of the technical specifications is to define the minimum scope, substation, gen-tie line features, and quality standards for the design, procurement,

EXHIBIT 1
SOLAR SUBSTATION AND GEN-TIE

construction, testing, and commissioning of the electrical interconnection systems supporting the new solar plant.

B. Contractor shall provide final design and detailed specifications and drawings for the system in conformance with this Exhibit 1.

12.4 Contractor Scope of Work Overview

A. Contractor shall design, fabricate, furnish, install, test, and commission a complete functional, operating, interconnection system as specified herein with a high degree of reliability, integrity, maintainability, efficiency, and environmental compatibility which conforms to normally accepted standards of HV substation and gen-tie facilities. Contractor shall provide all components necessary for a fully functional substation.

B. Contractor shall furnish a new HV single circuit Gen-Tie line from the POI to the new HV/MV Solar Substation as proposed in Interconnection Agreement.

C. Contractor shall furnish a new HV/MV Solar Substation as proposed in Interconnection Agreement. The substation will consist of one (1) HV line position to the POI, one (1) or more HV/MV transformer(s), Contractor to specify number of MV collection circuit positions, and one (1) MV capacitor bank of sufficient capacity when coupled with inverters to deliver a power factor between 0.95 lead and 0.95 lag (over entire plant operational temperature, power and voltage range) to the POI. Transformer shall be provided with an “ON-Load Tap Changer” to guarantee full power throughout the power factor range (+/-0.95PF) and assume steady state voltage range (0.95pu to 1.05pu).

D. The Project shall be capable of operating in accordance with Attachment D, “Statement of Work – PV”, and this Exhibit 1.

E. Contractor shall design and construct the Project in accordance with this Specification and the Agreement. Scope of Work shall consist of:

1. Specify and furnish the equipment and materials which shall include, but not be limited to, disconnect switches, circuit breakers, instrument transformers, main and auxiliary voltage transformers, capacitor banks, substation structures, relay equipment, control enclosures, gen-tie line structures, all foundations, and associated ancillary hardware.

2. Project design engineering and drawing packages for construction permitting, installation and “as-built” documentation.

3. Project construction including all final grading site/civil work, structural, electrical, mechanical and monitoring/control systems.

4. Project and construction management, including quality assurance/quality control, site safety, site material control and management of all subcontractors.

5. Project commissioning and testing in accordance with Exhibit 5 of the Agreement.

6. Project turnover including Owner training and Project operations and maintenance documentation.

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F. Except as specified otherwise, provide all equipment, materials, transportation services, labor, labor supervision, technical field assistance, scheduling, consumables, construction equipment, construction tools, special tools, construction utilities, permanent utilities, testing services, instruments, spare parts, and other services and items required for, or incidental to the engineering, design, procurement, installation, construction, startup, testing, commissioning, and training for the Project. The supply of construction equipment shall include fuel, lubricants, spare parts, and any other elements required for operation and maintenance.

G. Contractor shall procure and obtain all permits required for the construction of the project with the exception of permits acquired by Owner.

H. Design, fabricate, install, inspect, examine, and test each system in accordance with the specified industry standards, Applicable Permits and Applicable Laws.

I. Perform specified, code required, and Contractor’s standard quality assurance testing, inspection, examination, and documentation.

J. Submit design, fabrication, and quality assurance documentation, and operating and maintenance manuals in accordance with the submittal requirements Exhibit 2..

K. Contractor shall provide all design documents required to support Owner in obtaining permitting and other regulatory agreements.

L. Receive, inspect, store, unload, maintain, erect, clean, lubricate, align, and prepare all equipment in strict accordance with equipment manufacturer’s instructions. Contractor shall arrange for and provide properly conditioned storage in strict accordance with manufacturer’s requirements for all equipment and material to be incorporated into the Project.

M. Except as specified otherwise, provide all technical assistance, equipment, and supplies required, specialized and non-specialized, for erection, testing, commissioning, and start-up of equipment furnished and installed by Contractor.

N. Contractor shall procure, deliver, unload, install, commission and test main step-up transformer(s). If main power transformer is procured by Owner, Contractor shall be responsible for securing transformer to foundation and connecting it to electrical and SCADA, and testing any protection or monitoring devices it installs for operation of the transformer.

O. Coordinate start-up and commissioning operations with Owner’s operating and maintenance personnel, and involve Owner’s personnel in start-up and commissioning activities to the extent desired by Owner.

P. Train Owner’s operators and maintenance personnel on all operating and maintenance aspects of the Project prior to system start-up in accordance with the Agreement. Contractor shall complete all formal training efforts prior to start-up of associated system, including training for Owner supplied equipment. Contractor shall provide all facilities necessary for all required training.

Q. Fire protection during construction shall meet the requirements of NFPA 241. All fire protection systems shall be subject to the review and approval of the local fire department authorities.

R. Provide all special tools and lifting devices for equipment supplied by Contractor as required for maintenance and operations of Contractor furnished Equipment and Materials.

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SOLAR SUBSTATION AND GEN-TIE

S. Contractor shall furnish and maintain temporary construction facilities and provide construction services including, but not limited to, the following aspects applicable to the Solar Substation Site:

1. Temporary Storage Facilities at the Site for the proper unloading and storage of all Contractor furnished substation equipment and material delivered to the Site. If adequate facilities are not available, such material shall be stored at suitable off-site facilities (e.g., warehouses, storage yards, etc.) provided by Contractor.
2. Construction Power and Distribution.
3. Contractor shall be responsible for all transmission and distribution electric power tie-ins at the Site.
4. Temporary communication system
5. Temporary lighting system
6. Site drainage, erosion and sedimentation control, and dewatering systems
7. Temporary roads
8. Fire protection
9. Temporary water supply and distribution (potable and non-potable). Potable water shall be high quality bottled water.
10. Parking Facilities
11. Site Security
12. Construction testing services (e.g., welding, megger testing, concrete strength and placement, fill and backfill compaction testing, etc.)
13. Safety and first aid services
14. Contractor shall provide temporary sanitary facilities consisting of above ground Porta-John type. Contractor shall provide separate male and female facilities. Quantity shall be per OSHA requirements.
15. Contractor shall maintain on-site dumpsters and personnel to maintain a clean and rubbish free work site.

T. Contractor shall be responsible for design, permitting and implementation of dust suppression and erosion control measures.

U. Contractor is responsible for storm water quality requirements or retention basin requirements during construction as required. Permanent storm water quality requirements shall be installed in accordance with the drainage requirements of the associated Authority Having Jurisdiction.

V. Contractor shall provide:

1. Protective Device Coordination Study including time coordination curves and a narrative document explaining relay settings philosophy and calculations.
2. Electronic settings files for insertion to applicable relays.
3. Harmonics Study.

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4. Load Flow Study.

5. Short Circuit Analysis.

6. Facility Rating Report in accordance with FERC and NERC regulations.

7. Grounding System Study (including step and touch potential).

8. Any other studies required by the Interconnection Agreement, Power Purchase Agreement, or by local utility/ISO.

9. All engineering studies and documents shall be prepared by a licensed Professional Engineer in the corresponding state. Contractor shall furnish completed study to Owner for review.

W. Contractor shall provide all necessary information and steady state and dynamic models in PSCAD and PSS/E formats as required by NERC, FERC, MP, and MISO. Dynamic models must be listed on NERC Acceptable Models List at time of submission. The expected response of the positive sequence dynamic models shall reasonably match the EMT models provided so as to meet the requirements of NERC standards MOD-026 and MOD-027.

X. Contractor will furnish and install a communication link between the Solar Substation and the operations building (if applicable).

Y. Contractor shall furnish and install primary Optical Ground Wire (OPGW) and secondary fiber optic communication link from POI to the Solar Substation. The secondary path must be physically separate and diverse from the primary communication path.

Z. Contractor shall upgrade the access road(s), as required, to allow delivery of HV/MV step-up transformer.

AA. Contractor shall coordinate with applicable Transmission Provider for the Solar Substation regarding the control and integration of the Solar Substation including but not limited to the control and monitoring MV Capacitor Bank, MV breakers, HV breakers, HV disconnects, monitoring of the HV/MV transformer and all revenue meters located in the Solar Substation. Contractor shall comply with all requirements of the Transmission Provider.

BB. Contractor shall coordinate with Transmission Provider regarding the SCADA and protection relaying (including testing).

CC. Contractor shall provide all water for dust suppression.

DD. If local utility power is available, Contractor shall supply main power for Substation through local distribution system and back-up from the Solar Substation aux transformer. If local utility power is not available, Contractor shall supply a stand-by emergency generator (12-hr capacity) as the back-up source.

EE. Contractor shall be responsible for geotechnical information which is required by Contractor in performance of the Work, and Contractor shall conduct geotechnical studies required for detailed design.

12.5 Owner Provided Facilities and Services

A. Owner will provide permits in accordance with Exhibit 3.

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12.6 Construction Facilities and Services

A. Coordination

1. Contractor shall attend pre-construction meetings as may be requested by Owner. At the initial meeting, Contractor shall present a construction plan including, but not limited to, the following: safety, procurement plan, major equipment receipt, inventory and storage plan, construction sequence, methods and equipment to be used in all phases, proposed access and right-of-way roads, locations of staging areas, and a construction schedule showing all activities for the entire construction phase of the project. Pre-construction coordination meetings and design review meetings shall be held in Owner’s or Contractor’s office.

2. Contractor shall be responsible for contacting all involved utility companies prior to starting any work to coordinate schedule of work (including outage windows) and location of all temporary and permanent utilities in the Project area.

3. Contractor shall prepare an outage plan for all scheduled interruptions of electrical power or other utilities that would affect the Solar Plant, or third parties. This plan shall be submitted by Contractor to Owner and the affected parties at least six (6) weeks prior to outage.

4. Representatives of Contractor shall attend weekly coordination meetings to discuss matters relative to the progress and execution of the construction and startup of the project. Current week progress and three-week look-ahead schedules shall be presented by Contractor and reviewed at these meetings in addition to other site coordination items. Past and current safety statistics shall also be provided.

5. Owner shall be given the opportunity to attend any and all factory acceptance tests and perform shop visits for equipment procured by Contractor. Contractor shall notify owner at least two weeks in advance of factory acceptance test dates and shall coordinate all such events with Owner.

B. Safety and Security.

1. Contractor shall develop Safety Plan and submit to Owner for review and approval. Contractor shall ensure all personnel adhere to Safety Plan provisions and wear proper personal protection equipment (PPE) at all times. Contractor shall conduct a safety briefing each day before work, and before each construction activity. Refer to section 11.3 of this Attachment, and Attachment D, for further information.

2. Sufficient access space shall be provided for maintenance of all equipment.

3. Substation shall meet requirements of Critical Infrastructure Protection (CIP) and NERC for security.

C. Fire Protection

1. Only work procedures which minimize fire hazards to the extent practicable shall be used. Combustion debris and waste materials shall be collected and removed from the site each day. Fuels, solvents, and other volatile or

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flammable materials shall be stored away from the construction and storage areas in well-marked, safe containers. Good housekeeping is essential to fire prevention and shall be practiced by Contractor throughout the construction period. Contractor shall follow the recommendations of the Associated General Contractors "Manual of Accident Prevention in Construction" regarding fire hazards and prevention.

2. Formwork, scaffolding, planking, cabling, and similar materials which are combustible, but which are essential to execution of the work shall be protected against combustion resulting from welding sparks, cutting flames, and similar fire sources.

3. Contractor shall provide qualified personnel for fire control as appropriate. Contractor shall provide adequate fire protection equipment in each warehouse, office and other temporary structures, and in each work area that he is occupying. Suitable fire extinguishers shall be provided in enclosed areas, in areas that are not accessible to fire protection water, or in areas that may be exposed to fire that cannot be safely extinguished with water. Each fire extinguisher shall be of a type suitable for extinguishing fires that might occur in the area in which it is located. In areas where more than one type of fire might occur, the type of fire extinguisher required in each case shall be provided. Each extinguisher shall be placed in a convenient, clearly identified location that will most likely be accessible in the event of fire.

4. Contractor shall be responsible for providing adequate fire protection for the construction areas.

D. Cleanliness

1. Contractor shall keep the Site and surrounding grounds clean and free from trash and debris. Contractor shall require all disciplines to thoroughly clean their work areas each working day. Contractor's Construction Manager shall be responsible for Site maintenance and cleanliness. This shall include sweeping the floor, collecting and disposing of trash, and all other functions required to keep the site clean. All hoses, cables, extension cords, and similar materials shall be located, arranged, and grouped so they will not block any access way and will permit easy cleaning and maintenance.

2. A roll-up of all hoses, welding leads and electrical cords will be executed once a month as a minimum or as determined by site management. Material and equipment not required for immediate use or installation will be stored in designated laydown and warehouse areas.

3. All trash, debris, and waste materials shall be collected, sorted, and deposited in waste collection receptacles near the work. These receptacles shall be emptied by Contractor regularly and the waste disposed of properly and off-site.

4. Promptly upon the completion of a construction task, Contractor shall thoroughly clean the equipment or structure affected by the task activity by removing all accumulations of dirt, scraps, waste, oil, grease, weld splatter, insulation, paint, and other foreign substances. Contractor, without additional cost or burden to Owner, shall properly and adequately restore

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surfaces affected by deposits of insulation, concrete, paint, weld metal, or other adhering materials.

E. Energized Facilities

1. Contractor shall be completely responsible for the safety and protection of its personnel, the Owner's personnel, any and all other personnel of 3rd parties and other contractors, and the public, and shall employ all methods necessary to achieve such safety and also assure continuity of all service systems encountered. These methods shall include, but not be limited to, providing barriers, guard structures, insulating guards and sleeves, warning signs, and prevention of unauthorized access to service system areas. Refer to section B above for further information on safety and security.

F. Reference Points

1. Contractor shall establish baselines, monuments, and reference points for construction as necessary to proceed with layout of the work. Contractor shall be responsible for laying out the work to such lines and grades indicated on the drawings and shall protect and preserve the established reference points.

G. Dangerous Materials

1. Contractor shall not use explosives, radioactive, or other dangerous material without prior notification to the Owner. Contractor shall be responsible for the proper handling, transporting, storage, and use of such materials. When the use of such materials or methods is necessary, Contractor shall exercise the utmost care and carry on such activities under supervision of its properly qualified personnel. Contractor, at its expense, shall repair any damage caused by its handling, transporting, storage, and use, and shall be responsible for obtaining permits as applicable.

H. Waste Disposal

1. Contractor shall be responsible for removal and lawful disposal of all discarded material, debris, rubbish, unusable excavated material, and waste, including hazardous substances, if any, generated by Contractor and its subcontractors and suppliers during construction of the plant.

I. Hazardous Material Management

1. Contractor shall be responsible for managing hazardous materials and hazardous wastes as described in the Agreement. Contractor shall obtain an EPA I.D. Number for its work.

J. Adjoining Utilities

1. Contractor shall make necessary efforts to protect the existing power gen-tie facilities, any and all parallel, converging, and intersecting electric lines and poles, telephone lines and poles, highways, waterways, railroads, and any and all property from damage as a result of its performance of the Work. Contractor shall bear all liability for and shall at its expense repair, rebuild or replace in kind any property damaged or destroyed caused by the Contractor in the course of its performance of the Work.

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12.7 Site and Environmental Criteria

A. Project design shall be based upon the design conditions listed in Attachment D, Table 1-1.

12.8 Design Criteria

A. Project and individual components shall have a minimum design life of 25 years.

B. Project shall be designed for automatic, unmanned operation.

C. Project electrical design will be in compliance with applicable codes and standards listed under section 1.9 unless otherwise noted.

12.9 Operating Criteria

A. Convenience Power: 120VAC

B. Instrumentation voltage: 125VDC

C. Communications network: Ethernet via direct buried fiber optic.

D. Solar Substation Voltage.

1. Primary Voltage (phase-to-phase, maximum): XXX kV
2. Secondary Voltage (phase-to-phase, maximum): XXX kV

E. Supply voltage wave form: per IEEE 519-2014 requirements.

F. System phase rotation: [to be determined by Contractor]

G. Volts per hertz ratio: 1.05

H. Electrical system ambient temperature range: -50°C to 40°C

I. 24-hour average ambient temperature: XX°C plus adjustment factors for the Site

J. Relative humidity range: 10-95% without condensation

K. Required XXXkV station and equipment BIL: [by Contractor]

L. Required station and equipment BIL: BIL per MP Substation Clearance Chart, Exhibit 14.

M. Steady State HV substation maximum current: [to be determined by Contractor] (per phase)

N. Steady State MV substation maximum current: [to be determined by Contractor] (per phase)

O. Maximum 500kV & 230kV fault current – sym.: [to be determined by Contractor].

P. Isokeraunic activity: In accordance with standard nationally published maps for thunderstorm activity.

Q. Soil resistivity: According to results of Geotechnical Study.

12.10 Codes, Regulations and Standards

A. In the event that any Applicable Law or Industry Standard does not govern specific features of any item of equipment and materials, Temporary Work or system,

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Contractor or Original Equipment Manufacturer (OEM) standards shall be applied, with Owner's approval.

B. Listed herein are the principal codes and standards applicable in the design, fabrication and installation of the Project; these are not intended to be all inclusive. Other recognized standards may be utilized when required in Contractor's opinion and when not in conflict with the standards listed below. Contractor shall notify and obtain Owner approval prior to us of any such other standards.

C. Contractor shall design and construct the Project in accordance with the latest accepted edition of the following standards:

1. AA – Aluminum Association
2. AASHTO – American Association of State Highway and Transportation Officials
3. ACI – American Concrete Institute
4. AISC – American Institute of Steel Construction
5. AISE – Association of Iron and Steel Engineers
6. ANSI – American National Standards Institute,
7. AREMA – American Railway Engineering and maintenance Association
8. ASCE – American Society of Civil Engineers
9. ASME – American Society of Mechanical Engineers
10. ASNT – American Society of Nondestructive Testing
11. ASTM – American Society for Testing and Materials
12. AWS – American Welding Society
13. CMAA – Crane Manufacturer Association of America
14. CRSI – Concrete Reinforce Steel Institute
15. EPA – United States Environmental Protection Agency
16. FAA – Federal Aviation Agency, Department of Transportation
17. IBC – International Building Code
18. ICEA – Insulated Cable Engineers Association
19. IEC – International Electrotechnical Commission
20. IEEE – Institute of Electrical and Electronics Engineers
21. ISA – Instrumentation Society of America
22. ISO – The International Organization for Standardization
23. NEC – National Electrical Code
24. NEMA – National Electrical Manufacturers Association
25. NERC – North American Electric Reliability Council

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26. NESC – National Electrical Safety Code
27. NETA – National Electrical Testing Association
28. NFPA – National Fire Protection Association
29. OSHA – Occupational Safety and Health Act
30. UL – Underwriters' Laboratories

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2.0 SPECIAL CONDITIONS

12.11 Refer to Attachment D for Special Conditions.

3.0 EQUIPMENT AND MATERIALS

12.12 Contractor Requirement

A. Contractor shall furnish all equipment and materials as required to construct a fully functioning Project. Minimum requirements for major equipment are described herein:

12.13 MV Capacitors, Shunt

A. Nominal system voltage: XX kV

B. Reactive power: To be determined by Load Flow Study, minimum of [by Contractor] kVAR.

C. Stepped Capacitor [by Contractor] MVAR

D. Frequency: 60 Hz

E. Capacitors shall be single phase.

F. Capacitors shall be equipped with an internal discharge device which will reduce the residual voltage to 50 volts or less within 5 minutes.

12.14 MV Circuit Breakers (Feeders)

A. Model/Type: Vacuum

B. Rated Voltage; Nominal: XX kV

C. Rated Voltage; Maximum: Per MP Substation Clearance Chart

D. BIL: Per MP Substation Clearance Chart

E. Rated Current-RMS: Continuous: [by Contractor] A

F. Rated Current-RMS: 3 seconds: [by Contractor] kA

G. Rated Current-RMS: Interrupting: [by Contractor] kA

H. Current Transformer:

X	Y	Z	Bushing		Z	Y	X
B	B		5	6		A	A
B	B		3	4		A	A
B	B		1	2		A	A

Ratio

A: [Ratio by Contractor]

B: [Ratio by Contractor]

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Relay accuracy classification: C800

C57.13 metering accuracy current transformers: 0.15 or .15S. VTs accuracy to be 0.3 accuracy class.Control Voltage: 120/240 VAC

I. Control Voltage: 125 VDC

J. Voltage for Space Heater: 120V Single Phase

12.15 HV Circuit Breaker(s)

A. Model/Type: SF6

B. Rated Voltage; Nominal: XXX kV

C. Rated Voltage; Maximum: Per MP Substation Clearance Chart

D. Minimum nameplate temperature of -50C.

E. BIL: XXX kV

F. Rated Current-RMS: Continuous: XXXX A

G. Rated Current-RMS: 3 seconds: [by Contractor] kA

H. Rated Current-RMS: Interrupting: [by Contractor] kA

I. Current Transformer:

X	Y	Z	Bushing		Z	Y	X
B	B		5	6		A	A
B	B		3	4		A	A
B	B		1	2		A	A

Ratio

A: [Ratio by Contractor]

B: [Ratio by Contractor]

Relay accuracy classification: C800

C57.13 metering accuracy current transformers: 0.3

J. Control Voltage: 120/240 VAC

K. Control Voltage: 125 VDC

L. Voltage for Space Heater: 120V Single Phase

12.16 HV Disconnect Switches

A. Nominal System voltage: XXX kV

B. Basic Impulse Level: XXX kV, Per MP Substation Clearance Chart, Exhibit 14.

C. Continuous current:

1. [by Contractor]

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D. Momentary current: XX-kA minimum [by Contractor]

E. Three-pole, single throw load break with visual open circuit inspection.

F. Switches rated XXX kV shall be vertical break or center side break horizontally mounted.

G. Switchblades and related current-carrying parts shall be of aluminum alloy construction and contact-making components shall be of silvered inlay copper or other approved metals.

H. Provide 4-hole or 6-hole NEMA terminal pads at each high-voltage connection.

I. Design to provide smooth, completely controlled simultaneous movement of switchblades throughout the entire cycle of operation with mechanism continually loaded to prevent switch from alternately leading or lagging the control.

J. Furnish group operated mechanism with necessary rods, bell cranks, interphase operating connections, bearings, supports, linkages, and vertical operating pipe. All operating pipe connections shall have set screws. All operating pipes shall be furnished precut to the specific lengths required for the phase spacing and bus height indicated.

K. Provide with permanently double sealed maintenance free automotive steel ball bearing assemblies.

L. Provide for individual adjustment of the operating mechanism of each pole; all hardware shall be fabricated with non-corrodible metal.

M. Provide a semaphore to be located at or near each operating mechanism to give positive indication of the open or closed position of the switch.

N. Operating handles or cranks shall have provision for locking in both the open and closed position.

O. Provide bolted ground connector and flexible grounding jumper for operating handle.

P. Switch bases shall be heavy-duty galvanized steel.

Q. Switches shall be of an essentially maintenance-free design.

R. HV switches shall be provided with worm gear operating mechanisms operated with a non-detachable crank having a clockwise operation of crank to close switch, with all gears and worms completely sealed, and requiring a torque of no more than 40-pound feet to operate the switch.

S. Furnish mechanically operated auxiliary switches with operating points individually adjustable over the entire travel of the operating mechanism.

12.17 MV Disconnect Switches

A. Nominal System voltage: XX kV

B. Basic Impulse Level: XX kV, Per MP Substation Clearance Chart, Exhibit 14.

C. Continuous current:

1. [by Contractor] A – QTY [by Contractor] (Transformer)
2. [by Contractor] A – QTY [by Contractor] (Feeders and Cap Bank)

D. Momentary current: 40-kA minimum

E. Three-pole, single throw load break with visual open circuit inspection.

F. Switches rated appropriately for the MV breaker shall be vertical break horizontally or vertical mounted.

G. Switchblades and related current-carrying parts shall be of aluminum alloy construction and contact-making components shall be of silvered inlay copper or other approved metals.

H. Provide 4-hole or 6-hole NEMA terminal pads at each high-voltage connection.

I. Design to provide smooth, completely controlled simultaneous movement of switchblades throughout the entire cycle of operation with mechanism continually loaded to prevent switch from alternately leading or lagging the control.

J. Furnish group-operated mechanism with necessary rods, bell cranks, interphase operating connections, bearings, supports, linkages, and vertical operating pipe. All operating pipe connections shall have set screws. All operating pipes shall be furnished precut to the specific lengths required for the phase spacing and bus height indicated.

K. Provide with permanently double sealed maintenance free automotive steel ball bearing assemblies.

L. Provide for individual adjustment of the operating mechanism of each pole; all hardware shall be fabricated with non-corrodible metal.

M. Provide a semaphore to be located at or near each operating mechanism to give positive indication of the open or closed position of the switch.

N. Operating handles or cranks shall have provision for locking in both the open and closed position.

O. Provide bolted ground connector and flexible grounding jumper for operating handle.

P. Switch bases shall be heavy-duty galvanized steel.

Q. Switches shall be of an essentially maintenance-free design.

R. MV switches shall be provided with worm gear operating mechanisms operated with a non-detachable crank having a clockwise operation of crank to close switch, with all gears and worms completely sealed, and requiring a torque of no more than 40 pound-feet to operate the switch.

S. Furnish mechanically operated auxiliary switches with operating points individually adjustable over the entire travel of the operating mechanism.

12.18 HV Surge Arrester

A. Nominal System Voltage: XXX kV

B. Arrester rating: [by Contractor] kV MCOV

C. Outdoor Station Class

D. Polymer

E. Mounting: Vertical

12.19 HV CCVTs

A. Nominal System Voltage: XXX kV

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B. Basic impulse level: XXX kV BIL

C. Frequency: 60 HZ

D. Secondary Windings: 2

E. Base mounted with potential adjusting unit mounted in the capacitor base or in separate weatherproof housing.

12.20 Station Service Transformer

A. Size to be determined by Contractor for review and approval by Owner.

12.21 Tubular and Strain Bus

A. Provide schedule 40, 6063-T6 seamless aluminum bus. Provide corona-free and watertight welded end covers on all exposed ends. Bus diameter shall be determined in accordance with the methods given in IEEE 605. Provide corona rings as required for High Voltage fittings. Provide internal damping cable to reduce Aeolian vibration. Damping cable dimensions and weight shall be determined in accordance with the methods given in IEEE 605. Bus shall withstand the stresses from short circuit forces stated in design criteria.

12.22 Bus and Switch Insulators

A. Provide station post bus insulators rated as indicated in design criteria. The minimum cantilever strength shall be determined in accordance with the methods given in IEEE 605, including wind and short circuit overload factors.

12.23 Bus Connector and Fittings

A. Provide connectors and fittings as required. Connectors shall be welded type for aluminum tubing connections and compression or puddle welded type for aluminum cable connections. Use expansion type connectors with internal ball-type alignment guides where tubing connections are made to switches. Fittings shall develop the full strength of the conductor and shall be capable of carrying the full current capacity of the conductor.

B. Bus support clamps for rigid bus shall be fixed or slip type as required to firmly support the bus while allowing for temperature expansion and contraction. Provide bolted ground connector and flexible type grounding jumper for operating handles of disconnect switches. Provide bus grounding stud weldments on main bus in at least three locations. Provide wire guides and bundled conductor spacers as required and indicated to maintain adequate clearance and support on cable jumpers, connections, and overhead lines. Provide corona shields for all 230-kV and above connections.

12.24 Relaying

A. Solar Substation

1. Relays shall be SEL or approved equal and of the model and type as approved by Transmission Provider for substation relays:

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a. Line Differential,

b. Line Distance

c. Breaker Failure

2. High Side Bus

a. Bus Differential Primary

b. Bus Differential Secondary

3. High Side Transformer Breaker

a. Breaker Failure

4. Transformer

a. Transformer Differential Primary

b. Transformer Differential Secondary

5. MV Feeders

a. Feeder Protection

6. MV Capacitor Bank

a. Overcurrent

b. Voltage

12.25 Main Power Transformer

A. Contractor will furnish one (1) or more HV/MV step-up transformer(s) for the PV Plant. This main power transformer will be high efficiency type configured with its primary (low side) winding as solidly grounded WYE to allow ground fault sensing and protection of the MV kV distribution system. Transformer will be sized to at least 10% above MVA rating of plant. See Minnesota Power Specification TR09PA and TR23PA Substation Transformer Specification, Exhibit 14.

B. Submittals:

1. Contractor shall submit complete specification for review and approval by Owner per timeline defined in Exhibit 2.

2. Contractor shall submit transformer design drawings for review and approval by Owner per timeline defined in Exhibit 2.

C. On Load Tap Changer (OLTC) required for voltage regulation at POI.

D. Performance Requirements:

1. No load losses shall not exceed 0.10% of rated power.

2. Load losses shall not exceed 0.70% of rated power at full load.

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4.0 ELECTRICAL

12.26 General

A. This section covers the minimum scope and quality standards for the systems. Contractor shall provide all material and labor for the engineering, design, procurement, installation, construction, startup, inspection, and testing of all electrical systems specified herein and necessary for a complete substation in conformance with generally accepted practices.

B. Contractor shall develop a detailed design based on Owner’s conceptual layout. Alternative designs may be acceptable if they meet the functional requirements of this specification. Any changes must be approved by the Owner.

C. The design and specification of all work shall be in accordance with all applicable industry codes and standards, and accepted standards of good engineering practice.

12.27 Substation System Studies

A. Contractor shall perform a set of studies and analyses to demonstrate the adequacy of the proposed electrical system design, by performing the following studies as a minimum. The design and construction of the electrical systems shall reflect the findings and conclusions of these studies. These system studies shall be subject to review and comment by Owner.

1. AC System Studies:
    a. The capacity of the Solar Substation low voltage AC system to determine size of station service.
2. DC System Studies:
    a. A load profile shall be developed for all DC loads to determine the capacity of the batteries and chargers with the DC service required for the equipment at the Solar Substation. The studies shall determine if the minimum voltages are maintained as specified and required by equipment vendors.
3. Short Circuit and Grounding Studies:
    a. Ensure equipment is rated to handle expected fault currents.
    b. The study shall assure that the ground grid modifications maintain touch and step voltages within tolerable limits. The study shall determine the ground potential rise (GPR) with respect to remote earth.
    c. The analysis of the ground grid shall have the following basis:
        i. Fault current per project characteristics plus 20% growth margin.
        ii. 50 kg body weight
        iii. A fault split factor may not be applied.
        iv. Ground resistivity determined from the Geotechnical Report, per the Wenner 4 point method.
        v. Fault duration of 0.25 seconds.

d. Ground grid design, including tolerable step and touch voltage and conductor fusing temperature, shall be in accordance with the procedures, data, and recommendations given in IEEE 80.

4. Relay coordination Study: To ensure designed protection devices will function properly to protect plant and its systems, as well as high side components.

5. Bus Design Analysis:

   a. Analyze the performance of the substation buses, disconnect switches, and separately mounted current transformers to determine the ampacity, structural integrity, vibration, and required mechanical and electrical ratings are in accordance with the methods and recommendations of IEEE 605. Bus design, including gust factor, exposure height factor, importance factor, and corona considerations, shall be in accordance with the procedures and data given in IEEE 605.

6. Bus Ampacity:

   a. Continuous current rating as given on the one-line diagram.

   b. Fault current as appropriate for the Project.

   c. Facility ratings shall be calculated using Minnesota Power's Facility Ratings Methodology. See Exhibit 14 for assumptions.

7. Bus Structural Design (bus, insulators, bus structures and foundations):

   a. Use wind speeds and ice loads as appropriate for the Project.

12.28 Mast for Direct Stroke Protection

A. Steel masts for direct stroke protection shall be round tapered seamless extruded or spun aluminum tubes.

B. The overall height of the masts above grade shall be determined from the Direct Stroke Protection Study. Mast design shall be for the site design.

C. Masts shall have a single uniform taper from top to bottom. Each mast shall be capped with a suitable finial. Each mast shall be equipped with an internal vibration dampening device. The design of masts shall have a safety factor of 2 based on the allowable yield stress for the mast material in accordance with the latest ASCE specifications governing design of structures. The horizontal deflection at the top of each free-standing mast shall be limited to L/20 of its height above foundation.

D. Each mast shall be provided with two grounding pads located 12 inches above the foundation.

12.29 Lighting

A. A lighting system shall be furnished for the Solar Substation. The lighting system shall provide personnel with illumination for substation operation and maintenance under normal conditions and means of egress under emergency conditions.

B. The lighting system shall be designed in accordance with the Illuminating Engineering Society (IES) to provide acceptable illumination levels.

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C. Lighting sources and fixture selections shall be based on the applicability of the luminaries for the area under consideration and shall comply with all local codes and standards.

D. Lighting levels shall meet the requirements of ANSI C2, the NESC.

12.30 HV/MV Solar Substation

A. Contractor shall design and install the substation and associated equipment and materials for the HV/MV substation. Coordinated design between the substation, gen-tie, and Solar Plant will determine the final placement of the structures and equipment; feedback of equipment status to the RTU; and associated details. Contractor shall provide all interface points. Contractor shall provide for status to the RTU of all substation equipment including open/close indication, voltage, currents, and alarms (including battery/battery charger related alarms), and revenue meter information (power, energy, accumulators).

B. Contractor is responsible for all site preparation, foundations, fencing, control building, grounding, crushed rock, structures, switches, instrument transformers, surge arresters, station service, instrument metering, relaying, conduit, cable, bus, conductor, connectors, insulators, and other associated equipment.

C. Contractor to furnish main power transformer (MPT) and deliver the transformer(s) to Site meeting all necessary transportation requirements to maintain manufacturer warranty. Contractor will unload, install, dress-up, and fill transformer, and have initial commissioning of transformer performed as required for warranty. Contractor shall provide foundations, oil containment, high voltage bus work, and low voltage power and control cables for the MPT.

D. The substation shall conform to the requirements of IEEE 605, the IEEE C37 and C57 family of standards, and, in general, conform to the preliminary arrangements provided by Owner. Minimum conductor clearance criteria shall be per ANSI C2 (NESC). Clearances shall be increased at locations where additional clearances are required for access to site equipment.

E. Design of the interconnect voltage and MV systems shall be based on short circuit study.

12.31 Installation of Major Solar Substation Equipment

A. Contractor shall provide all equipment required for the installation of substation equipment and materials.

B. Contractor shall receive, inventory, and store substation equipment. Equipment to be installed at substation shall be stored and protected. Installation and assembly of equipment and materials shall be according to manufacturer's recommendations complete as specified and as required for operation and continuous service at the locations in accordance with Contractor's detailed design.

C. Contractor shall erect structures in strict compliance with the manufacturer's drawings, code markings and instructions, after foundations have completely cured. Contractor shall repair all cuts, welds, and damaged areas.

D. Contractor shall assemble, install, lubricate, and adjust all switches and operating mechanisms in accordance with the manufacturer's instructions. Erect and install all buses, bus supports, bus support insulators, strain insulators, conductors, shielding wires and masts, and interconnections as required by manufacturer's drawings.

E. Welded aluminum bus erection shall include fabricating all buses and interconnections to the correct length and shape. Bends shall be made with a hydraulic bender without kinks or surface damage. Field weld all pipe-to-pipe and pipe-to-fitting connections using inert gas arc welding. Submit to Owner complete details of the proposed welding procedure, experience record, and certification data on the person(s) proposed to do the welding, as well as samples of welds made at the jobsite in all four standard positions.

12.32 Battery System

A. Codes and Standards

1. All equipment furnished under these specifications shall conform to applicable standards of IEEE, ANSI, and NEMA. All materials and devices shall be in accordance with the applicable requirements of the Federal "Occupational Safety and Health Standards." The latest edition of each code and standard shall apply.

B. Design and Construction

1. Batteries shall be provided with racks, connection devices, tools, instruction books, and other standard items.

2. Solar Substation battery chargers shall be 125VDC output, sized as required for 8-hour recharge while serving continuous load. Chargers shall include an AC circuit breaker in the charger input circuit to provide a disconnect point and overcurrent protection. Chargers also shall include DC ammeters, DC voltmeters, AC power failure alarm relays, high/low DC voltage alarm relays, ground detection alarm relays, and battery temperature compensation systems which reduce the charge rate if necessary. The chargers shall maintain output voltage (in a settable range between 125- and 140-volts DC) within 1/2 percent from no load to full load even with input voltage variation of 10 percent, maintain output voltage automatically without requirement for voltage readjustment, and automatically vary the charging rate in accordance with the requirements of the substation battery.

3. For the Solar Substation, provide DC systems including batteries, chargers, and panelboards. Batteries shall be lead antimony. Battery size shall be determined using the battery load profile. Nominal voltage shall be 125VDC with 60 cells. Battery shall be capable of being recharged to rated capacity from a discharge down to zero volts per cell, following an equalization charge. The battery shall be capable of being recharged within 8 hours following a complete discharge. Design shall be based on an 8-hour discharge time to 1.75 volts per cell and the voltage is to be maintained for the minimum 20-year life of the battery. The battery shall be sized accordingly to accommodate ultimate design loads but shall be no less than 240 Ah capacity.

4. Each battery cell shall be wet cell, lead-acid pasted plate-type with lead-calcium alloy plate grids or sealed type with 20-year expected life. Cell containers shall be sealed, clear, shock absorbing, heat resistant plastic, with electrolyte high and low-level markers and spray-proof vents. Batteries shall be manufactured for full float service with a high discharge rate, low deterioration rate, and low

maintenance. Batteries shall be supplied complete with all accessories (e.g., battery rack, inter-cell connectors). Racks shall be a 2-step configuration.

5. The DC switchboard and panel shall have a main bus current rating as required to supply the connected load. The continuous current ratings and interrupting ratings of the feeder breakers shall be based on the available fault current and the characteristics of the connected loads or the battery chargers. Each panelboard shall include the feeder breakers required to supply the connected loads. Switchboard shall include bus voltmeter, battery ammeter with shunt, ground detection and alarm, and low voltage alarm.

C. Rating

1. Contractor shall determine the capacity of each battery in accordance with the methods of IEEE 485 and these Specifications. With the battery initially fully charged at the floating voltage specified, and with the battery chargers disconnected, the battery shall be capable of supplying the duty cycle specified. The ambient temperature during the duty cycle shall be 25 degree C. An aging factor of 25% and design margin of 20% shall be used. Contractor shall submit battery calculations for approval.

D. Duty Cycle – The duty cycle for battery sizing shall include:

1. One minute at the level of current required to operate Solar Substation circuit breakers plus the continuous load.

2. Duration of continuous load to be reviewed and approved by Owner.

3. One minute at the level of current required to operate all Solar Substation circuit breakers plus the continuous load.

E. Battery Charger Requirements

1. Each battery charger-eliminator furnished shall be self-regulating, natural cooled, solid-state silicon controlled full wave rectifier type designed for single and parallel operation with the batteries specified under these Specifications. Charger shall be able to provide the DC load requirements in the event that battery is disconnected.

2. The chargers will be served from the substation AC system.

3. The battery charger shall maintain output voltage within plus or minus ½% from no load to full load, with an input power supply deviation in voltage level of plus or minus 10% and an input power supply deviation in frequency of plus or minus 5%.

4. Solid-state electronic circuits shall have AC and DC transient voltage protection and shall be designed to recharge a totally discharged battery without overloading and without causing an interrupting operation of AC or DC circuit breakers.

5. Charger shall be a full capacity charger and shall have the capacity to recharge the battery in 8 hours following complete discharge. Battery charger shall also have an equalizing charge mode. Battery charger will be self-regulating after charging levels are manually selected. Battery charger shall be manufactured in NEMA 1 enclosures suitable for placement in an indoor, environmentally

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controlled atmosphere. The battery charger shall require only front access and will allow either top or bottom conduit/cable entry.

12.33 Raceway

A. This section covers furnishing and field installation of a complete raceway system in accordance with these specifications.

B. Raceway shall conform to the recommendations included in IEEE 525.

C. The raceway system is defined to include conduit, flexible conduit, underground duct, wireway, cabinets and boxes, and all materials and devices required to install, support, secure, and provide a complete system for support and protection of electrical conductors.

D. Raceway that contains multiple cable circuits shall have all cables with identical insulation ratings.

E. Individual raceway systems shall be established for the following services:

1. 600-volt control cable, AC power and control cables.
2. Special electrical noise-sensitive circuits.

F. Routing of Above Grade Raceway and Conduit

1. Contractor shall route raceway and conduit and shall coordinate conduit locations with other equipment and structures.
2. All raceway and conduit shall be installed in a neat, rectangular form. Special attention shall be given to securing a neat appearance. All raceway and conduit shall be installed perpendicular or parallel to the major equipment, and bus structures.

G. Material:

1. Underground duct system materials furnished under these Specifications shall be new and undamaged and shall conform to the following requirements:

   a. Duct - Polyvinyl chloride, Schedule 40 PVC in accordance with NEMA TC-2.
   b. Couplings - Plastic, for use with duct previously specified and "Duct-to-steel" adapters as required, including joint cement.
   c. Spacers - Plastic high impact, interlocking, base and intermediate type
   d. Factory bends and sweeps - Schedule 40 PVC, 36-inch minimum radius.
   e. End bells – Plastic
   f. Plugs – Plastic, high impact, tapered to fit end bell provided.
   g. Duct binder – Hemp or sisal twine coupling
   h. Riser termination – Rigid hot-dip galvanized mild steel coupling.
   i. Riser bends - Rigid steel conduit elbows, factory or field made, 36-inch minimum radius, 90 degree, entirely concrete encased below grade; hot-dip galvanized rigid mild steel in accordance with ANSI C80.1 and UL 6;

the conduit interior and exterior surfaces having a continuous zinc coating with an overcoat of transparent enamel or transparent lacquer.

12.34 Conductors

A. Power conductor size and ampacity shall be coordinated with circuit protection devices. Conductor size shall be determined for 125% of connected load, or the short circuit duty, at the design basis maximum outdoor ambient temperature. Below grade power cable conductor size shall be determined in accordance with the methods in IEEE 835.

B. Insulated cable, conductors, and conductor accessories shall be furnished and installed in accordance with the requirements of these Specifications and the recommendations given in IEEE 525. Insulated cable, conductors, and conductor accessories shall be furnished in quantities sufficient for a complete installation as indicated in these Specifications.

C. Installation shall be defined to include placement, splicing, terminating conductors; coiling and taping of spare conductors; identification, testing, and verification of each circuit, cable, and conductor. Manufacturer’s pulling or side wall tension shall never be exceeded. Contractor shall submit recorded cable tension reports.

D. All Solar Substation control and instrument cables shall be shielded. Connectors, sizes 12 - 2 AWG, shall be vinyl or nylon pre-insulated ring-tongue type and power connectors, sizes 1 AWG – 750 MCM, shall be uninsulated two-hole rectangular tongue.

E. Cable Specifications

1. The cable furnished shall be flame retardant construction in accordance with the applicable ICEA standards and suitable for wet or dry locations. All cable shall have surface printing showing manufacturer’s name, insulation type, jacket type, conductor size, conductor type, voltage rating, and numbered footage markers. Control and instrument cables shall be terminated with ring tongue connectors, compression connections, or. as required to meet equipment supplier requirements:

2. The cable furnished shall conform to the cable descriptions included below:

CABLE TYPE	DESCRIPTION
Low Voltage Power	600 volts, single-conductor, Class B stranded copper; EPR or XLP insulated; CPS, PVC, or CPE jacketed.
Low Voltage Power	600 volts, three-conductor; concentric lay, stranded copper with a ground wire in the interstices; FRXLPE or FREPR insulation; CSP, PVC, or CPE jacketed overall.
Control	Control cable, 600 volt, multiple-conductor, as required, stranded copper, 10 AWG, 12 AWG, 14 AWG; multiple-conductor, XLP insulation; CSP, PVC, or CPE jacketed overall.
Instrumentation	Instrumentation cable, 600 V, flame retardant single-and multiple-twisted pairs and triads, shielded instrument cable with individually shielded pairs, overall shield, and overall jacket; FRXLPE or FREPR insulation; CSP, PVC, or CPE

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	jacketed overall. (Single pair or triad 16AWG, multi-pair or triad 18AWG).
Lighting & Receptacles	Lighting circuit runs totally enclosed in conduit, NEC Type RHH-RHW-USE with XLPE insulation for use in outdoor or unheated areas.
Shielded Control	Control cable, shielded, 600-volt, multiple conductor, as required, stranded copper, 10 AWG, 12 AWG, 14 AWG; multiple conductor, XLP insulation; CSP, FRPVC or CPE jacketed overall

12.35 Grounding

A. The section covers the furnishing and installation of grounding materials completed as specified herein.

B. The Solar Substation grounding system shall be an interconnected network of bare copper conductor and copper-clad ground rods (ground wells maybe used instead of ground rods if dictated by the soil analysis). The system shall be designed such that substation personnel are protected from the hazards that can occur as the substation grounding system provides the earth return electrode during power system phase to ground faults.

C. Contractor may perform ground resistivity testing prior to final design to determine ground analysis parameters. The ground resistivity shall be measured with the methods given in IEEE 81.

D. The station grounding grid shall be designed in accordance with the methods and recommendations of IEEE 80. The grounding system shall have adequate capacity to dissipate heat from ground current under the most severe conditions in areas of high ground fault current concentrations, with grid spacing such that safe voltage gradients are maintained. Ground conductors shall be sized for fault duration of 0.25 seconds. The ground system shall be designed to comply with IEEE 80 requirements.

E. Bare conductors to be installed below grade shall be spaced in a regular pattern that is consistent with the grounding analyses. Each junction of the grid will be bonded together by an exothermal welding process.

F. Grounding connections shall be made to fences, and equipment. Equipment grounds shall conform to the following general guidelines:

   1. Grounds shall conform to the NESC.

   2. All equipment grounding connections shall be connected to the ground grid.

G. All substation bus and equipment support structures shall be connected to the station ground grid. Metal support structures in direct metallic contact with other metal structures do not require a separate grounding connection to the station ground grid. Fences shall be grounded in accordance with the requirements of the NESC. The Solar Substation ground grid shall be extended 1 meter outside of the substation fence. The Solar Substation fence shall be connected to the substation ground grid.

H. Ground Grid Design.

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1. The final conductor sizing, grid configuration, grid depth, grid spacing, and quantities of conductor for the grid is to be determined during detailed design.

I. Materials

1. All grounding materials required shall be furnished new and undamaged in accordance with the following requirements.

   a. Rods - ¾ inch 10-foot copper-clad standard type. The copper cladding shall be electrolytically bonded to the steel rod or bonded by a molten welding process. Cold rolled copper cladding is not acceptable. Ground rods shall be as manufactured by Blackburn, Weaver, or Owner-approved equal.

   b. Cable

      i. Bare – Soft drawn copper, Class B stranding, ASTM BB.

      ii. Insulated – Soft drawn copper, Class B stranding with green colored polyvinyl chloride insulation, UL 83, Type TW, THW or THHN.

   c. Wire Mesh – Copper-clad, 6 AWG, 6 inch by 6 inch mesh spacing, copper weld or Owner-approved equal.

   d. Bus and Bars – Soft copper, cross section not less than 1/8 inch thick by 1 inch wide, ASTM 8187.

   e. Exothermal Welds - Molds, cartridges, materials, and accessories as recommended by the manufacturer of the molds for the items to be welded. Cadweld heavy duty or Owner-approved equal. Molds and powder shall be furnished by the same manufacturer.

   f. Flush ground plates - Cadweld B-162 Series, B-164 Series, or Owner-approved equal ground plates with NEMA hole spacing.

2. All clamps, connectors, bolts, washers, nuts, and other hardware used with the grounding system shall be made of copper.

12.36 Control, Protection, and Metering

A. Contractor shall design and fully manufacture, test and deliver the control and protection system at the Solar Substation. The system shall include instruments, devices, panels, racks, protective relays, meters, switches, accessories, and wiring. Relay panels are to be installed in a Contractor furnished Solar Substation control building.

B. For the control design Contractor shall provide drawings sets for all relaying drawings including one-line drawings, three-line drawings, control panel arrangements, fabrication details, Bill of Materials, nameplate lists, DC control schematics, AC schematics, circuit schedules, auxiliary equipment schematics, wiring diagrams, index sheets, and legends. Drawings shall be provided in electronic format.

C. Each PV circuit feeder shall have its own revenue grade meter (SEL-735 or similar) and revenue grade voltage and current sensing required to meet requirements for Capacity Test (Exhibit 6).

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12.37 Labeling and Identification

A. Electrical equipment shall be labeled to meet applicable safety codes and requirements.

12.38 Electrical Equipment Enclosures

A. Control Cabinets, pull boxes and junction boxes shall be in accordance with NEMA Standards and type number and shall be suitable for the location conditions. Base design shall be:

1. Indoor: NEMA 1
2. Outdoor: NEMA 3R or 4

B. All enclosures shall be provided with pad locking provisions.

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5.0 MECHANICAL

12.39 General Requirements

A. This section provides requirements for major mechanical equipment, mechanical systems, and mechanical interfaces with other plant systems and off-Site facilities.

12.40 General Arrangements

A. The location of equipment shall be based on safety, economics, ease of maintenance, and operation. Sufficient space shall be provided for maintenance of all equipment including equipment removal without excessive rigging or removal of surrounding equipment.

12.41 Mechanical Systems and Equipment

A. Provisions shall be included in the design of all mechanical systems to allow the performance of all routine maintenance without requiring a plant shutdown.

B. Contractor shall:

1. Receive, inspect, store, unload, maintain, erect, clean, align, and prepare all equipment in accordance with equipment manufacturer's instructions before initial operation.
2. Provide lifting lugs on all equipment components or system components requiring removal for maintenance and weighing over 25 lbs.
3. Select materials of construction and design equipment and systems to provide a minimum of a 25-year operating life at all operating conditions specified.
4. Design the facility for a life of 25 years consistent with good engineering practice for solar generation facilities. However, it is understood that some of the equipment will require routine maintenance and possible replacement during the life of the facility.
5. Provide grounding lugs and ground all equipment.

12.42 Fire Protection System

A. Contractor shall provide a complete fire protection system in accordance with the recommendations and requirements of NFPA, UL, FM, and the local Fire Marshal. The systems shall receive the approval of the Owner's insurance carrier.

B. The engineer responsible for the fire protection system shall be a practicing fire protection engineer registered as a Professional Engineer in the state of the Project location. All drawings and specifications shall be signed and sealed by the Professional Engineer.

C. The fire protection and detection systems requirements for specific plant locations are summarized in Table 5-1.

D. Portable fire extinguishers shall be provided in all areas requiring handheld fire protection.

E. All local alarms shall report status to the SCADA System.

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F. Fire walls for oil-filled transformers shall be provided between transformers and adjacent structures as required in accordance with Section 5.0 of NFPA 850.

G. General

1. Fire protection during plant construction shall meet requirements and recommendations of NFPA 241.

2. All fire protection systems are subject to the review and approval of the local fire department authorities.

TABLE 5-1

Plant Fire Protection and Detection Systems

Plant Location	Type of Fire Protection	Fire Detection
Control House(s)	handheld extinguishers*	Smoke/heat detectors (see EEE specification section for additional requirements)
Transformer(s)	Fire walls if required by NFPA	Fire walls

(*) or as required by local Fire Marshal

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6.0 SITE WORK

12.43 General Requirements

A. This section covers the minimum scope and quality for the plant civil design and construction.

B. Contractor is responsible to inspect the Site, obtain all necessary Site data, and determine all Site data for the design and construction of the Project. This shall include determination of local code requirements for seismic and wind design loads.

C. The scope shall include, but not be limited to the following:

1. Clearing and grubbing.
2. All subgrade preparation.
3. Dust control, including furnishing construction water.
4. Drainage during construction.
5. Permanent drainage system.
6. Construction wastewater and storm water disposal.
7. Final Site grading.
8. Construction of all foundations and structures.
9. Roads (permanent and temporary construction).
10. Temporary parking and laydown areas.
11. Site Security (permanent and temporary fencing including gates, card readers, and cameras as required).
12. Off-site Road Improvements and repair (if required to transport or receive equipment or if required as a result of construction work).

D. The Project design shall take into account existing site conditions with respect to soil characteristics, site clearing, grading, and drainage.

E. Contractor shall be responsible for all site preparation including any demolition, soil stabilization, grading, drainage, roadways, and temporary parking areas.

12.44 Units

A. All design dimensions and design calculations shall be in United States Customary units.

12.45 Geotechnical

A. Contractor’s final design shall be based on the recommendations of Contractor’s geotechnical investigation and report.

B. If subsurface conditions are encountered at the site are inconsistent with the data found in the Contractor’s geotechnical report, additional subsurface data shall be gathered and evaluated at Contractor’s expense. Any subsurface anomalies discovered by Contractor shall be reported immediately to the Owner.

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12.46 Site Preparation and Maintenance

A. Contractor shall be responsible for all Site preparation, backfill, and excavation. Cut and fill for the entire site, including storm water treatment/management (if necessary), shall be managed by Contractor.

B. Contractor shall clean permanent site drainage system components immediately prior to Substantial Completion.

C. Site Preparation:

1. Contractor shall design and specify site grading to include all trench excavation for underground utilities which includes electrical duct banks. The Site shall be properly leveled with no construction debris or dirt piles.

2. Contractor may store native material on Site that is suitable for use as backfill or topsoil.

3. Installation of all Site construction utilities shall be planned and constructed by Contractor. Location shall be approved by Owner.

D. Site Clearing and Grubbing:

1. Completely clear the Site of all trees, debris, rubbish, shrubs and vegetation as required for construction of new facilities. All debris from clearing and grubbing shall be removed from the Site. All root mats and stumps shall be completely removed, and holes refilled with engineered fill material and compacted adequately for the ultimate expected loading for the material used.

E. Debris:

1. All construction-related debris and unsuitable material shall become the immediate property of

2. Contractor and shall be removed from the premises and lawfully disposed of off-Site by Contractor at Contractor’s cost.

F. Erosion:

1. Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) for their construction activities.

2. Contractor shall be responsible for maintaining the storm water controls and best management practices.

3. Contractor shall provide for sediment and erosion control during and after construction in accordance with project permits and local and state laws and regulations. Best management practices such as check dams and sedimentation basins shall be used during construction to minimize erosion. Drainage facilities shall be designed and constructed in a manner to minimize erosion.

G. Road Maintenance:

1. All access roadways used by Contractor shall be maintained in serviceable condition.

2. Contractor shall keep the surfaces of those roadways free from spills, mounds, depressions, and obstructions, which might present a hazard or annoyance to traffic.

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3. Contractor shall be responsible for securing authorization and permits to transport oversized/overweight loads on local, County, and State roads for the supply of materials under Contractor's scope.

4. Contractor shall supply and install any temporary or permanent facilities required to facilitate delivery of these equipment/materials.

5. Contractor shall also be responsible for removing all such temporary facilities.

H. Signs and Barricades

1. Signs and barricades shall be provided and maintained by Contractor and shall be in accordance with jurisdictional regulations for accident prevention and Contractor's Safety Plan.

I. Dust Control

1. Dust Control for Construction Activities

   a. Contractor shall be responsible for dust control for the Work. Contractor shall prevent the spread of dust during its operations. Contractor shall moisten all surfaces with water to reduce the risk of dust becoming a nuisance to the public and neighbors. Contractor shall furnish labor and equipment necessary for dust control including tank trucks and hoses to apply the water. Contractor shall be responsible for compliance with State and local requirements for fugitive dust emissions and shall obtain local authority approvals and conform to the dust control regulations. Contractor shall conform to all requirements of the applicable permits.

J. Open Burning

1. Onsite open burning is not permitted.

K. Excavation, Filling, and Backfilling

1. Excavated native material may be used on the construction Site for embankment and backfill, if suitable. All unsuitable materials such as; rock, concrete, wood, metal, and other materials from the excavation shall be considered debris and disposed of as described herein.

2. Structural fill, bedding material, topsoil, and other materials not readily available on Site shall be procured, tested, and delivered to the Site by Contractor.

3. Contractor shall be solely responsible for maintaining the stability of all excavated faces and shall provide adequate sheeting, shoring, and bracing to support any lateral earth pressure.

4. Contactor shall be solely responsible for protecting personnel and adjacent structures against any damage from cave-ins, heaving or other earth movements. Sheeting, shoring and bracing shall be removed as backfilling proceeds or it may, with the approval of Owner, be left fully or partially in place.

5. Fill characteristics and compaction requirements shall be determined by the geotechnical investigation and report recommendations.

6. Site dewatering during construction is the responsibility of Contractor.

L. Site Grading and Drainage

1. Design and prepare the construction plans, final design reports, and project specifications for the civil site work, including the storm water drainage, grading,

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roads, temporary construction facilities, etc. All must meet the approvals of the Owner and jurisdictional government agencies.

12.47 Site Improvements

A. Paving and fencing improvements shall be in accordance with the Site plan.

B. Storm Water Drainage System

1. Design and prepare the construction plans, final design reports, and project specifications for the civil site work, including the storm water drainage, grading, roads, temporary construction facilities, etc. All must meet the approvals of the Owner and jurisdictional government agencies.

C. Duct Banks

1. Underground banks of power and instrument conduit shall be encased in concrete, if Contractor is unable to meet the 24” depth requirement and there is a possibility of heavy equipment will be driving over it. Encasements shall be reinforced to withstand AASHTO HS20 loading at roadway crossings and non-paved equipment access areas susceptible to damage by cranes, trucks, etc. Refer to Section 7.1.C of this document for required compressive strength of concrete encasement. The concrete at the top of the duct bank shall be colored red.

D. Crushed Stone Surfacing

1. Provide non-metallic, non-magnetic crushed rock, with 100% fractured 1 or more faces, and 75% (minimum) fractured 2 or more faces in accordance with ASTM D5821. Provide material meeting the specified gradation in accordance with ASTM C136, free from lumps of clay and other soft and objectionable material. Provide material having a minimum wet resistivity of 3,000 ohm-meters when tested in accordance with the WERTA requirements. Material shall also meet the durability testing requirements of ASTM C131 or C535 and ASTM C88 (MnDOT 1209.0, 1210.0, and 1219.0). The Contractor shall have the proposed rock tested to determine acceptability, and the test results shall be reviewed and approved by the Owner. Provide with the submittal a physical sample of representative material (5 to 10 pounds).

Table 6-1 Stone Surfacing Gradation

Coarse Aggregate meeting Mn/DOT 3137 CA-15 (or ASTM D448 #467).		
	Mn/DOT 3137 CA-15	ASTM D448 #467
US Standard Sieve Size (square):	% Passing:	% Passing:
50mm (2inch)	100	100
37.5mm (1 ½ inch)	90-100	95-100
19.0mm (3/4 inch)	35-65	35-70
9.5mm (3/8 inch)	5-25	10-30
4.75mm (#4)	0-7	0-5

E. Roads and Parking

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1. Subgrade preparation and compaction shall be in accordance with sound geotechnical engineering practice and as recommended by the geotechnical investigation and report.
2. Roadways and driveways areas shall be designed for AASHTO HS20 loading as a minimum. The laydown areas shall also be designed with consideration for concentrated loading due to handling of heavy loads.
3. Except as noted herein, no off-site road improvements are included unless required by Contractor for access or damaged by Contractor during construction.

12.48 Roads

A. Two access points to the Solar Substation shall be provided.

12.49 Fence

A. A security fence shall be installed around the perimeter of the substation. The Solar Substation Control Building shall be accessible without entering the Solar Substation.

B. Security fence shall consist of 8 feet of chain link fence fabric topped with three strands of barbed wire, with an overall height of 9 feet from the bottom of the fabric to the top barbed wire. The fence shall have top rail, bottom tension wire, and three strands of barbed wire mounted on 45-degree extension arms. The upper strand shall be approximately 12 inches out from the fence and 12 inches above the top of the fabric. Posts shall be set in concrete. Fence fabric shall be no more than 2 inches above finish grade.

C. Minimum material requirements (or as required by governing agency) for security fencing shall be as follows:

1. Materials
   a. Fence Fabric
      i. Furnish 9 gage, 2 inch diamond mesh, 8 foot (96 inch) all aluminum coated woven steel fabric per ASTM A491.
      ii. Fabric twisted and barbed at the top and bottom selvage. Furnish 6 gage aluminum coated wire clips at 14 inches on center for fabric to line posts, 9 gage aluminum coated wire clips at 24 inches on center for fabric to top rail, 9 gage aluminum coated hog rings at 24 inches on center for fabric to the bottom tension wire, and integrally woven tension bars with steel bands for attachment to corner, terminal, and gate posts.
   b. Privacy Screening (Where Specified) – UPSIZE POSTS IF FENCE HAS SLATS
      i. Provide PrivacyLink fence screening (or approved equivalent) with the following additional requirements:
      ii. Use 3 ½”x5” 9 gage hot-dip galvanized mesh.
      iii. Color: dark brown.
      iv. Furnish and install mid-height rail at all privacy screening.

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v. Continuous, uniform pattern with 90 percent minimum effective screening.

vi. Material to be secured to fabric to prevent easy removal by general public.

vii. UV resistant and warranted against fading and deterioration for a period of not less than 10 years.

viii. Submit Manufacturer's standard color samples along with product data for review.

c. Barbed Wire

i. Furnish 3 rows of double stranded 12 1/2 gage steel wire with 14 gage barbs in a 4 point pattern on 5 inch centers with Class 11 aluminum coating per ASTM A585.

ii. Furnish galvanized barbed wire standoff arms extending at 45 degrees to the fabric with the top strand 12" above and 12" out from the fence line with corner connections and terminal connections as shown.

d. Line Posts

i. Furnish 3 inch (2 7/8 inch) O.D. x 0.203 inch steel line posts. Cut posts to lengths to provide 6 foot driven embedment. Approved roll-formed C-sections, 3 ¼ inch x 2 ½ inch with a minimum wall thickness of 0.150 inch and minimum yield strength of 50 ksi may be used for typical line posts, but shall not be used at braced bays such as at corners, terminal bays or adjacent to gates.

e. Corner and Gate Posts

i. Furnish 4 inch O.D. x .226 inch steel corner posts and 4 inch O.D. x 0.226 inch or 6 5/8 inch O.D. x 0.280 inch steel gate posts as indicated.

f. Top Rails

i. Furnish 1 5/8 inch O.D. x 0.140 inch galvanized top rail passing through intermediate post tops and forming a continuous brace for the stretch of fence.

g. Bracing

i. Furnish all corner, end and gate post bracing trusses consisting of 3/8 inch diameter truss rods (with turnbuckles or approved tensioning devices) and 1 5/8 inch O.D. x 0.140 inch steel pipe brace rail as shown.

h. Bottom Tension Wire

i. Furnish 7 gage aluminum coated spring coil tension wire.

i. Gates

i. Furnish fabricated trussed 2 inch (1 7/8 inch) O.D. x 0.090 inch steel pipe gate frames, welded or with approved corner fittings. Matching 8 foot fence fabric shall be fastened in frames by means of tension bars and hook bolts. Provide additional horizontal, vertical and brace members as required for a rigid panel.

ii. Furnish single leaf gates with heavy-duty positive fork type latching device with provision for padlocking. Provide center plunger rod and catch with padlock eye for double swing gates.

iii. Furnish heavy-duty pressed steel or malleable iron hinges with 180 degree swing capability, 1 pair per leaf.

iv. Furnish pivoting drop down holdback (Option 1 on the Substation Fence Details), Wepco brand or similar, unless otherwise directed by the Owner. Provide Option 2 (duckbill style with post) or Option 3 (overhead gatepost mounted style) if so directed.

j. Foundation Work

i. Furnish concrete as indicated on the Substation Fence Details. Install foundations for all posts as a part of this Work. See Exhibit 14.

k. Coatings

i. Provide posts, bracing, gate frames, fittings, road gates, guardrail and appurtenances, all hot-dip galvanized per ASTM A 120, A 123 or A 153.

ii. Contractor shall repair and/or replace fencing damaged by construction activities.

12.50 Bollards

A. Buildings, electrical enclosures and equipment adjacent to traffic areas shall be protected with minimum 6" diameter steel pipe guard post painted yellow. Guard post shall be minimum height of 42" above finished grade, and 72” below finished grade. Post shall be set in 18” minimum diameter hole filled with concrete. Post shall be filled with concrete.

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7.0 STRUCTURAL

12.51 Materials

A. Steel

1. Design of structural and miscellaneous steel shall be in accordance with the American Institute of Steel Construction (AISC) “Manual of Steel Construction”. Design of structural and miscellaneous steel shall also be in accordance with the American Society of Civil Engineers (ASCE) “Substation Structure Design Guide, Manual of Practice 113”; NEMA TT1 – Design of Tapered Tubular Steel Structures; “Design of Steel Transmission Pole Structures”, ASCE/SEI 48; Minimum Design Loads for Buildings and Other Structures”, ASCE/SEI 7; and the International Code Council “International Building Code”. Seismic design shall be in accordance with the Institute of Electrical and Electronics Engineers (IEEE) “IEEE Recommended Practice for Seismic Design of Substations”, IEEE 693.

2. Materials for structural steel and miscellaneous steel shall conform to the following requirements of the American Society for Testing and Materials:

B. Wide Flange (WF) Shapes and Tees cut from WF: ASTM A992, Grade 50 or multi-certification A36/A572, Grade 50.

C. M shapes, S shapes, HP (Bearing Piles), Channels, and Angles: ASTM A36

D. Structural Plates and Bars: ASTM A36

E. Square/Rectangular Hollow Structural Sections (HHS): ASTM A500 Grade B

F. Tubular – a structure composed of closed sections (tubes) of circular, multi-sided, or elliptical cross section and tapered or untapered: NEAM TT1

G. Pipe: A53, Grade B

H. High strength bolts, nuts, and washers shall conform to ASTM A325, ASTM A563, and ASTM F436 respectively and shall be galvanized in accordance with ASTM A153.

I. Bolts, nuts and washers under one-half inch in diameter shall conform to ASTM A307, Grade B, ASTM A563 and ASTM F844 respectively and shall be galvanized in accordance with ASTM A153.

J. Anchor bolts, anchor bolt assemblies and concrete embedments shall be galvanized in accordance with ASTM A153.

K. Anchor bolts shall conform to ASTM A449, ASTM F1554, Grade 36, or A307.

L. All structural welding shall conform to the requirements of AWS D1.1.

M. Galvanizing, as specified herein, shall conform to the requirements of ASTM A123, ASTM A143 and ASTM A153 as applicable.

N. Stainless steel shall conform to ASTM A167.

O. Aluminum

1. Design of structural and miscellaneous aluminum shall be in accordance with the latest version of the Aluminum Association – “Aluminum Design Manual” and “Aluminum Standards and Data”.

2. Materials for structural and miscellaneous aluminum, including structural shapes and plate, shall conform to ASTM B209 and ASTM B308 and shall be aluminum alloy 6061-T6.

3. Bolts and nuts shall conform to ASTM F468 and ASTM F467, respectively and shall be aluminum alloy 6061-T6. Washers shall be aluminum-clad steel Alclad 2024-T4 or approved equal.

P. Concrete

1. Design of structural concrete shall be in accordance with the latest version of the American Concrete Institute (ACI) - "Building Code Requirements for Structural Concrete," ACI 318. All concrete formwork shall conform to ACI 347.

2. Hot and cold weather concreting shall be in accordance with the latest version of ACI 305 and 306.

3. Concrete mix proportions, including documentation of materials, admixture product information, and compressive strength of mix, shall be submitted and approved by the Owner prior to placing concrete.

4. Minimum concrete strength classes for various structures shall be as follows:

Item	Minimum Ultimate Compressive Strength (psi) (at 28 Days)
Electrical Ductbanks	3,000
Major equipment/structures where required and all other construction	4,500

5. Reinforcing bars shall be deformed bars conforming to ASTM A615, Grade 60. Welded wire fabric shall conform to ASTM A185. Plain wire shall conform to ASTM A82. Placement shall be in accordance with Chapters 7 and 12 of ACI 318 and the Manual of Standard Practice of The Concrete Reinforcing Steel Institute.

6. Cement shall be Portland cement conforming to ASTM C150, Type I or Type II or as recommended by the geotechnical report.

7. Aggregates for normal weight concrete shall conform to ASTM C33.

8. Slump of concrete used for substation foundations shall be 3 inches plus or minus 1 inch, unless otherwise noted.

9. All foundations shall extend a minimum of 6 inches above the adjacent finish grade.

10. All concrete trucks may be rinsed out on-site. Rinse material shall be properly disposed of off-site.

12.52 Structural Loading

A. Contractor shall determine all Site data for the design and construction of the plant. This shall include determination of local code requirements for seismic and wind design loads. It is the Contractor’s sole responsibility to ensure that the plant structural and architectural facilities comply with all federal, state, and local code requirements and all industry codes and standards. Occupancy Category III shall be used for all structural loading in the design of this plant.

B. Dead Loads

1. Dead loads shall include all vertical loads due to weight of permanent structural and nonstructural components, including permanent hung loads.

C. Live Loads

1. Live loads shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency.

D. Snow Loads

1. Snow loads shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency.

E. Wind Loads

1. Wind loads shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency.

F. Seismic Loads

1. Seismic loads shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency. The soil profile type shall be determined by Contractor based on the results of Contractor's subsurface investigation.

G. Thermal Loads

1. Buildings and structures shall be designed for forces and/or movements resulting from changes in temperature. Induced thermal loads (i.e., thermal loads induced by equipment operating temperatures) shall be considered in design of applicable structural elements.

H. Adfreeze Loads

1. Adfreeze (frost heave) shall be designed in accordance with recommendations of Contractor's Geotechnical Engineer. Provisions for mitigating adfreeze shall be included in the design.

I. Vehicle Loads

1. Design loading, for areas accessible to trucks, shall be (AASHTO) HS20.

J. Soil and Hydrostatic Pressure Loads

1. Earth pressure and hydrostatic pressure loads shall be based on the geotechnical conditions and groundwater levels at the project site.

K. Gen-tie Line Loads

1. In addition to the aforementioned loading criteria, overhead gen-tie line loads shall also conform to ASCE Manuals and Reports on Engineering Practice No. 74 "Guidelines for Electrical Transmission Line Structural Loading" and to NESC requirements.

L. Load Combinations

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1. Load combinations shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency.

12.53 Structural Foundations

A. Type of foundations required and allowable bearing values for soil and rock shall be as recommended by the geotechnical engineer based on the subsurface conditions found in Contractor's geotechnical report. All loose materials shall be removed from excavation bottoms. Unsatisfactory foundation subgrade material shall be removed and replaced with compacted structural fill material or with 2000 psi concrete. Total foundation settlements will be limited to 1 inch or as required by applicable building or industry codes, and equipment supplier's recommendations.

B. Building and Equipment Foundations

1. Building and equipment foundations shall be of reinforced concrete and their construction shall incorporate formwork, appropriately sized and configured rebar, waterstops, expansion joints, etc.

C. Transformer Foundation and Containment

1. Transformers shall be provided with secondary oil containment according to IEEE 980 with a capacity equal to 110% of the volume of oil present in the transformer. Owner may decide to require an additional capacity to include a 25-year storm rain volume but for initial planning the former shall be assumed.
2. Containment design shall be reinforced concrete "moat-style" containment with skimmer and non-conductive grating to allow access to equipment.

12.54 Corrosion Protection

A. Stainless steel and galvanized steel shall not be painted.

12.55 Solar Substation Control Building

A. The Solar Substation control building shall contain relay and communications panels, telecommunication panel, an RTU, station service equipment, and other items associated with the Project including any required utility/ISO equipment.

B. Scope

1. This section sets forth the minimum technical requirements for an electric equipment enclosure, herein referred to as Electrical Equipment Enclosure (EEE).

   a. Standards
   b. The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:
   c. Minnesota State Building Code (MSBC)
   d. Minnesota Energy Code (MEC)
   e. International Building Code (IBC) as amended and adopted by the state in which the EEE will be installed.

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f. American Society of Civil Engineers ASCE/SEI 7-10

g. National Electric Safety Code (NESC) (IEEE C2)

h. National Electric Code (NEC) as amended and adopted by the state in which the EEE will be installed.

i. American Welding Society (AWS)

j. All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, IEC 60529, NEMA, NEMA 250, ASTM, ICEA, IEEE, NFPA, UL, etc.)

C. Environmental Data

1. The EEE shall be designed to meet all rating and performance requirements specified in this document while operating in the site and environmental conditions listed in this document.

D. Voltage

1. The EEE will be used in an outdoor electrical substation.

2. The equipment shall be designed to withstand electrical and magnetic fields and transients that are present in an electrical substation.

E. Elevation

1. The structures and apparatus designed herein shall be rated for use at an altitude of less than 3000 feet.

F. Temperature

1. Contractor shall provide the following design parameters for review and approval by Owner:

a. Maximum ambient temperature recorded is XX°F

b. Maximum daily average ambient temperature is XX°F

c. Minimum ambient temperature recorded is -XX°F

d. Minimum daily average ambient temperature is -XX°F.

G. Loadings

1. The required Ultimate Design Wind Speed (3 second gust) is 120 mph, using Risk Category III and Exposure Category C.

a. Ground Snow Load of 60 lbs/ft2, using an Exposure Factor of 1.0.

b. Floor Live Load of 350 lbs/ft2 throughout, unless noted otherwise.

c. Walls and wall framing shall be capable of supporting a concentrated wall loading of up to 175 lbs. to support hanging of equipment at any location, with a minimum eccentricity of 3 inches measured from the interior face of the wall.

d. Seismic Design: Per MSBC.

H. General Description

a. Contractor shall be responsible for all required work including the furnishing, delivery, and installation/erection of one (1) pre-assembled, pre-engineered, complete steel EEE acceptable for the intended use as specified herein.

b. Contractor shall design, prepare plans and specifications, furnish all materials, provide supervision and construct the EEE including the auxiliary systems and lighting.

c. Contractor shall supply plans and calculations stamped and signed by a Licensed Professional Engineer for the state where EEE is to be installed, and is responsible for obtaining all Approvals, Third Party Inspections, and State Industrial Building Commission Approvals if required by the state or local jurisdiction in which the EEE is installed.

d. Contractor shall complete all internal control panel wiring and all interconnection wiring.

e. If interconnection wiring must be disconnected during shipment, Contractor is responsible for termination and retesting continuity of this wiring upon delivery.

f. Building materials, equipment and fittings shall be suitable for industrial use and require minimal maintenance. Materials, equipment and fittings which are available in the continental United States are preferred to facilitate future maintenance.

g. The materials used to construct the EEE shall be new, unused, and fabricated in a workmanlike manner in a factory environment.

h. The EEE structure shall contain all the equipment indicated in this specification and associated drawings making up part of this specification.

i. The EEE shall be fully assembled and suitable for human occupancy upon completion of installation.

I. Electrical Systems

a. ELECTRICAL WIRING METHODS AND MATERIALS

i. All grounding, workmanship and materials shall conform to the NEC and NESC as outlined in this specification.

ii. If conduit is used, it shall be electrical thin wall metallic tubing (EMT) except service runs which may be run in cable troughs and flexible metallic conduit used for motor and fixture connections.

iii. All cable and conductors shall meet Minnesota Power Standard Equipment Specification CA01PA, Flame Retardant Power & Control Cable, Exhibit 14.

iv. All interior conductors shall be low-halogen, flame-resistant, 600V rated EPR cables for all applications other than the electrical switchgear assembly wiring.

v. All interior junction boxes shall be NEMA Class 1.

vi. All wiring, cable troughs, and conduit shall be surface-mounted and run tight to walls and ceiling with adequate clamps and supports.

vii. All cable splices and terminations shall be on terminal blocks.

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b. AC STATION SERVICE

i. AC Station service shall be single phase 120/240V or as approved by Owner.

ii. The normal station service source shall be provided by a Station Service Voltage Transformer in the station yard from the high-side voltage.

iii. The alternate station service source shall be supplied from a pad mount step-down transformer located inside the substation fence.

iv. Each AC Station Service source shall either enter the EEE through wall penetrations via a 3" Rigid type LB conduit body into an Automatic Transfer Switch or via Service Disconnect Switches into an Automatic Transfer switch as shown on the Electrical Equipment Enclosure (EEE) Layout Plan drawing, as submitted by Contractor and approved by Minnesota Power.

v. Metering CT Cabinet(s) shall be provided on the outside of the EEE if shown on the Electrical Equipment Enclosure (EEE) Layout Plan drawing and wired as shown in the provided Purchaser schematics

vi. AC Distribution Panels shall be furnished in accordance with Minnesota Power Specification PN03PA, Distribution Panel – 120/240 Volt, 600 Volts or Less AC, Exhibit 14

c. DC STATION SERVICE

i. The EEE shall have 130VDC power for all control functions. The 130VDC Battery System shall include:

ii. 130VDC 58 Cell Battery String

iii. 130VDC Battery Charger meeting the requirements of Minnesota Power Standard Specification SB02PA (Exhibit 14), Battery Charger

iv. Midpoint fuse, holder, and fiberglass enclosure with viewing window

v. Grounded battery rack, spill containment, and neutralizing pillows

vi. Honeywell Fendell 1000 Eyewash Station, Cat. No. 32-001000-0000

vii. Honeywell Fendell Eyewash Cartridge, 3.5 gal., PK2, Cat. No. 32-001005-0000

viii. Contractor shall provide all other items related to the battery system including items as required by Minnesota Power Standard Specification SB01PA, Lead Storage Battery (Exhibit 14).

ix. The eyewash station shall be installed in close proximity to the 130VDC battery string.

x. The 130VDC Battery Charger float and equalize voltages shall be set per the Battery Manufacturer's recommendation for the cell type and quantity installed.

xi. A Wall Penetration for battery system test cables and temporary battery trailer connection cables to be provided

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xii. Wall Penetration to be 3” capped UV resistant PVC and located between the battery rack and safety switch

xiii. DC distribution panel(s) shall be furnished per the 125VDC Distribution Diagram drawings in accordance with Minnesota Power Specification PN02PA (Exhibit 14), Distribution Panel 125 Volt DC and located per the Electrical Equipment Enclosure (EEE) Layout Plan drawing, as approved by Owner.

d. LIGHTING

i. The EEE shall have normal and emergency lighting.

ii. Emergency lighting shall be designed and installed to deliver not less than 1fc at floor level in all areas of the EEE with a 90-minute back-up.

iii. Emergency lighting system shall be self-contained with a five (5) year life, containing no nuclear reactive substances or isotopes.

iv. No emergency lighting circuits shall emanate from the 130VDC Battery System.

v. The normal lighting shall be designed to deliver not less than 50fc at desk level in all areas of the EEE.

vi. Illuminated Exit Signs shall be provided

vii. Both normal and emergency light fixtures shall be LEDs and have diffuser covers.

viii. LED light color temperature shall be 5000k

ix. Light switches shall be 20A, three way, wall-mounted with standard cover plates, mounted at 44" above the floor, and placed conveniently near the entrances to the EEE.

x. The EEE shall have vandal-resistant, photo-eye-sensor-controlled exterior LED lighting to illuminate all entryways into the EEE, set to automatically be on from dusk until dawn.

e. GROUNDING

i. Any steel structure supplied as part of the EEE shall be permanently and solidly grounded to the ground bus or grounding conductor referenced in this specification.

ii. A ground bus or grounding conductor shall be provided in the EEE to ground all communication, control and SCADA panels, and all AC and DC distribution panels.

7.1.A.1.a.i.1 The grounding conductor or grounding bus shall be placed at the top of the walls near the ceiling.

iii. The ground lugs shall be an integral part of the steel and shall not be bolted to the frame.

iv. Ground lugs to be indicated on the submitted drawings.

v. The exterior of the EEE shall have grounding pads at each corner of the EEE.

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vi. The raceway system shall not be considered to be a ground conductor except for grounding of itself.

vii. All metal conduits containing power circuits shall be provided with grounding type bushings and shall be wired together inside enclosures and connected internally to the enclosure grounding pad or grounding bus with bar copper conductor.

7.1.A.1.a.i.2 The grounding bushing ground conductor shall be sized in accordance with NEC or other internationally recognized standards but shall not be less than #8 AWG bare copper conductor.

viii. Ground conductors shall be soft drawn, bare stranded copper strand class B as defined in NEMA WC 3 (formerly ICEA S-19-81) (or Class II in IEC 60228).

ix. All clamps, conductors, bolts, washers, nuts, and other hardware used with the grounding system shall be copper.

f. CONTROL, RTU, HMI/ALARM, COMMUNICATION, METERING & TERMINATION PANELS

i. Refer to the Owner approved Electrical Equipment Enclosure (EEE) Layout Plan drawing for the necessary panel line-up and placement.

ii. The panels shall meet Minnesota Power Standard Equipment Specification PN01PA, Control Panels, Exhibit 14.

iii. The panels shall be installed and delivered with the EEE by the Contractor.

iv. Panels will be individually grounded to the cable tray and connected as shown on the panel drawings provided by the Purchaser.

v. The Termination Panel(s) shall have the following features:

7.1.A.1.a.i.3 LED lighting switched ON/OFF via door contacts

7.1.A.1.a.i.4 Designed for bottom cable entry or as shown on the Owner approved termination cabinet drawing provided by the Purchaser.

7.1.A.1.a.i.5 A 10 gauge aluminum removable bottom cover plate for the termination panel floor opening

7.1.A.1.a.i.6 The location of the termination panel(s) may be subject to change due to foundation design.

g. EEE ALARM ENCLOSURE

i. The EEE Alarm Enclosure shall be wall-mounted 12" x 12" NEMA 1 enclosure, with terminal blocks mounted and alarms wired as outlined in this specification.

ii. The EEE Alarm Enclosure shall be mounted in close proximity to the telco plywood board.

iii. The following alarms shall be wired to the EEE Alarm Enclosure:

7.1.A.1.a.i.7 Fire Alarm: Ceiling-mounted, 120VAC smoke detector(s) and relay(s) shall be installed; contacts shall be interlocked to disable HVAC system(s) and exhaust fans(s).

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7.1.A.1.a.i.8 Intrusion Alarm: Each door shall have a magnetic contact entry alarm that provides two (2) closed contacts for an open door condition per this specification.

7.1.A.1.a.i.9 High Temperature Alarm: One (1) high temperature alarm shall be provided.

7.1.A.1.a.i.10 Low Temperature Alarm: One (1) low temperature alarm shall be provided

7.1.A.1.a.i.11 Hydrogen Detector Alarm: Alarm on Hydrogen concentrations 2% or greater per Section 12.56J.7.f.i.

h. RECEPTACLES

i. Interior convenience outlets shall be wall-mounted 20A, 120VAC duplex receptacles installed at 18" above floor level with cover plates.

ii. Contractor shall determine number and placement of receptacles and indicate on approval drawings.

iii. Exterior weatherproof, 20A, 120VAC, GFCI duplex convenience outlets shall be provided at each corner of the EEE.

iv. At least one exterior weatherproof, 20A, 120VAC, GFCI duplex convenience outlet shall be installed next to air conditioner(s) and at any other locations to be indicated by Contractor on the approval drawings.

v. The ground wire for the receptacles shall be insulated over its entire length.

i. GPS ANTENNA

i. A GPS Antenna shall be provided and mounted on a south facing gable end facing cell tower with 360 degree sky exposure and shall extend above the roofline a minimum of 2 feet.

ii. The GPS Antenna surge protector is to be mounted on the inside of the wall in close proximity to the wall penetration.

iii. The conduit on the outside of the EEE shall include a junction (conduit STYLE TB) to allow the exit of a cable for cellular phone repeater antenna at communication cable tray level. The conduit is to be 1” diameter.

j. EXTERNAL TELEPHONE RINGER

i. An external telephone ringer shall be provided on the wall facing the substation per the Owner approved Electrical Equipment Enclosure Layout Drawing and Communication Panel Bill of Material Drawing.

ii. A wall penetration for the cable to the external telephone ringer shall be provided via 1” conduit.

k. TELEPHONE CONNECTIONS

i. Conduits and CAT 5e cabling shall be provided from each door location to the Communication Panel.

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ii. Conduits and CAT 5e cabling shall be provided from the Communications Panel to the desk phone location

iii. Quad Junction Boxes shall be provided at each phone location.

12.56 MECHANICAL SYSTEMS

A. Heavy duty lifting plates or similar hardware shall be supplied and mounted to the base as needed for lifting the EEE.

B. FOUNDATION LOADING

1. The EEE foundation (drilled piers or slab-on-grade) shall be designed by Contractor.

C. ENERGY USE AND INSULATION

1. The EEE shall be designed and insulated to meet all requirements of the most current version of the code listed in this specification. Including thermal spacer blocks or similar thermal breaks as part of the building envelope requirements as required by the referenced code.

2. The following minimum insulation values are required:

    a. Walls: R-20 + R-13 Continuous Insulation

    b. Roof: R-30 + R-11 Liner System and R-5 Thermal Blocks

    c. Floor: R-38

    d. Doors: R-15

D. INGRESS AND EGRESS

1. The EEE shall have two (2) single-door entrances/exits.

2. One single-door entrance/exit shall be a nominal minimum opening size of 48"W x 96"H and the other single-door entrance/exit shall be a nominal minimum opening size of 36”W x 84”H taking into account the frame height.

3. Entrance/exit doors shall swing out and be equipped with panic bars, safety chain, pressure plates, or other devices that are normally latched but open under simple pressure.

4. All doors shall be completely weather-stripped.

E. DOORS AND FRAMES

1. Doors shall comply with Steel Door Institute directive SDI-100.

2. Doors shall have an insulated core and be constructed of no less than 18-gauge steel-faced leafs with stiffeners and 16-gauge door frames.

3. Doors and frames to be hot-dipped galvanized to ASTM-A924 and ASTM-A653, and then factory primed and painted with epoxy enamel to match the EEE or the trim.

4. The size and quantity of doors are indicated in this specification.

5. Door Hardware:

6. NRP stainless steel ball bearing hinges, minimum of three (3) per door.

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7. Von Duprin 99NL X US26D exit device
8. Von Duprin 990TP thumb latch exterior
9. Schlage large format removable core rim cylinder lock
10. GE Interlogix 1076D DPDT steel door contact
11. Door closer with hold open arm
12. Weather stripping and sweep
13. Removable threshold (for double wide doors only)
14. Watershed, at top of door
15. Drip cap, extending 3" past door edge
16. Safety chain to limit door swing
17. Door Lock Boxes
18. Manufacturer shall supply a wall-mounted lock box mounted on the external of the building near doors to store the door key. Refer to the Location per Owner approved Electrical Equipment Enclosure (EEE) Layout Plan drawing for locations.
19. The lock boxes shall be capable of being securely locked by Purchaser provided padlocks.
20. The door key shall be affixed to the inside of the lock box by a retaining chain long enough to unlock the entrance door to the EEE while the key is affixed to the retaining chain.
21. The lockbox shall be placed at a height in close proximity to the door lock.

F. EXPANSION

1. The EEE shall be required to be expandable in one direction for possible future substation expansion. Refer to the Owner approved Electrical Equipment Enclosure (EEE) Layout Plan drawing.

G. DESIGN REQUIREMENTS

1. The structure design and manufacture shall, at a minimum, conform to the Codes and Standards listed in this specification.
2. The entire structure including primary framing, secondary framing and cladding, shall be designed in accordance with the IBC as adopted and amended by the current applicable State Building Code. The structure shall be designed utilizing Occupancy Category III.
3. Structural Load Combinations shall be in accordance with the IBC (ASD or LRFD).

H. EXTERIOR TREATMENTS, WALLS, AND ROOF

1. The EEE shall have a complete, internal, self-supporting, structural steel frame that meets or exceeds the specified design load criteria without reliance on exterior sheeting, exterior panels, or roof cover panels for its structural strength or framing.

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2. Metal exteriors and roofing shall have a PVDF resin-based paint coating, over either a Galvalume or galvanized substrate, with a twenty (20) year warranty against rust perforation, a twenty (20) year warranty against fading and chalking, and a twenty-five (25) year warranty against flaking, peeling, and checking.
3. The roof shall be pitched 1 inch in 12 or greater and shall have a roof covering of mechanically-seamed, standing-seam roofing with a minimum seam height of 2". Standing seam roof panels shall be baked-on, resin-base pre-finished steel and shall have no visible fasteners on the main run. Roof to include a matching, die-formed ridge cap, and a fully supported 3" overhang. Properly sized attic space ventilation shall be provided. All attic openings shall be screened to prevent entrance of bees or larger insects or birds.
4. A steel canopy of sufficient size shall be provided over the entrance doors to prevent ice formation outside the EEE exits during the winter months and to channel rain water from the roof away from the doorway.
5. Snow guards shall be provided on the roof above positions where equipment is mounted on the exterior of the EEE.
6. The wall exteriors shall be galvanized steel panels with a PVDF resin-based finish in manufacturer's standard colors. Exterior siding panels to be overlapped and installed with appropriate self-tapping fasteners with integral gaskets, and shall be removable without any disturbance to interior panels.
7. Butted seams are not allowed.
8. Repair or replacement of panels must be able to be done entirely from outside the EEE structure.
9. Exterior trim package shall include stepped or boxed eave, rake, fascia, base, corner, jamb, and header trim in 26 gauge Galvalume material with Owner’s choice of standard KYNAR colors.
10. Hood covers shall be provided on the exterior wall above positions where equipment is installed on the sides of the EEE.

I. WALL PENETRATIONS

1. Contractor shall provide wall penetrations per the Owner approved Electrical Equipment Enclosure (EEE) Layout Plan drawing. Unless otherwise stated the following wall penetrations are required:
    a. Penetrations for AC Station Service per this specification.
    b. Penetration for battery system test cables per this specification.
    c. Penetration for GPS antenna and cellular phone repeater cable per this specification.
    d. Penetration for external telephone ringer per this specification.
2. All openings in walls are to be structurally framed, sleeved, trimmed, watertight, and provided with external drip caps with piping or formed metal of the same composition as the exterior panels.

J. INTERIOR TREATMENTS, WALL, CEILING, AND FLOOR

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1. The EEE's interior walls and ceiling shall be lined with flush-fit 24 gauge, roll-formed liner panels, fully reinforced, with concealed fasteners and a baked-on polyester finish over G-90 galvanized substrate.

2. The EEE interior shall feature a complete matching trim system including base, jamb, header, and ceiling trim. Contractor to provide color options for both the interior panels and trim.

3. The ceiling height of the EEE shall be designed to allow the vertically-stacked cable tray design per this specification, with a minimum ceiling height of 10'.

4. INSULATED STRUCTURAL STEEL FLOOR SYSTEM

   a. Floor system shall have a hot rolled, welded steel framework, with interior hot-rolled steel or steel tube supports to meet required loads, with maximum live load deflection of L/360 and total load deflection of L/240, and cold formed joists sized and spaced to meet design loads.

   b. Floor insulation system shall be comprised of fiberglass batt insulation or spray closed cell foam between joists, and 2" of continuous extruded rigid polystyrene insulation between joists and the fully hot-dipped galvanized steel rodent and insect barrier.

      i. Floor perimeter area and roof perimeter at the wall/roof juncture shall be either dense packed with fiberglass or similar batt or covered with spray closed cell foam.

   c. A fully hot-dipped galvanized steel rodent and insect barrier shall be provided below insulation.

   d. Floor insulation system to provide specified insulation value called out by all applicable codes with a minimum insulation value as listed in Section 7.6.C.2 of this Exhibit.

   e. Hot-rolled steel shall be ASTM A36, A572 or A992, and shall be galvanized in accordance with ASTM A653. Tube steel shall be hot-dip-galvanized ASTM A500, Grade B.

   f. Steel floor surface shall be welded plate steel of sufficient thickness (1/4" minimum) to support specified design loads and meet the deflection limitations stated above, with a painted, slip-resistant finish.

   g. Floor system shall be designed to be anchored to and supported by foundation.

   h. Floor framework and floor deck plates shall be fully chemically cleaned, primed and painted with a self-priming, catalyzed coating system designed to provide an extremely durable finish, suitable for heavy resistance to fading. Paint system shall have a minimum Dry Film Thickness, per coat of 3 - 5 mils. Color to be ANSI 61. Floor shall have a non-slip texture added to paint. Approved coating: Rustoleum High Performance Polyurethane 9800 Urethane Mastic System.

   i. Floor system weld standards shall meet all AWS recommended practices.

   j. Protective temporary floor covering shall be installed and delivered with the EEE made out of corrugated fiberboard with size "A" flute.

5. FASTENERS, ADHESIVES, AND SEALANTS

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a. The fasteners, adhesives, and sealants utilized shall be of types approved for use on this type of structure as required by the appropriate agency or governing body, as covered in this specification.

6. CLOSURES

a. Matching, pre-molded, closed cell elastomer closures provided by the siding and roof panel manufacturer shall be installed according to the manufacturer's recommendations at the eave line, beneath the roof panels, and where the trim meets the wall panels.

7. INTAKE AND EXHAUST FAN

a. Intake to have a filter rack, pleated high-efficiency filter, insect screens and painted steel weather hood.

b. Exhaust to have a back draft damper, insect screen, and painted steel weather hood.

c. Intake and exhaust units to be louvered aluminum with motorized dampers

d. Intake and exhaust to be sized by Contractor based on size of EEE and/or any specific requirements based on battery system being used.

e. Exhaust fans are not to be mounted directly above the battery bank.

f. Exhaust fan to be controlled by a manual on-off switch, hydrogen sensor, and a separate wall-mounted thermostat.

i. The Hydrogen Sensor shall be wired to turn on the exhaust fan at 1% Hydrogen concentration and to alarm to the RTU at 2% Hydrogen concentration via the EEE Alarm Enclosure as referenced in this specification. Hydrogen sensor to be mounted on ceiling in close proximity to the batteries, while still being accessible by ladder for testing and replacement. Hydrogen sensor shall not be mounted directly above the batteries.

ii. The wall-mounted thermostat shall turn on the fan when temperatures are above the thermostat setpoint.

8. DRIP LEDGE AND RAIN GUTTERS

a. The EEE shall have a drip ledge placed appropriately to encourage water draining off of the roof away from the side of the EEE.

b. Rain gutters are not acceptable.

9. FURNISHINGS

a. Contractor shall supply a desk, filing cabinet, storage cabinet, print rack, and two print clamps for placement in the building per the Owner approved Electrical Equipment Enclosure (EEE) Layout Plan drawing.

i. The provided desk shall be HON Company, Right Single Pedestal, Model Number HONP3251RCL or equivalent.

ii. The filing cabinet shall be Sandusky Company, 4 Drawer Vertical Letter, MODEL HS384PL or equivalent.

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iii. The storage cabinet shall be Sandusky Company, 2 door, Model Number VF31301572-07 or equivalent.

iv. The print rack and print clamps shall be capable of holding to 12” to 36” wide prints.

10. CABLE TRAY

a. The EEE shall have 24" wide and 18” wide ladder-type aluminum cable tray with 6" rung spacing and 4" loading depth for power and control cables

b. The EEE shall have 6" wide cable tray with 6” rung spacing and 4" loading depth section for communications cables.

c. The entire raceway system will be trapeze-supported from the ceiling.

d. The EEE ceiling shall be reinforced to support the cable tray system with an additional working load of 100lbs/lineal ft.

e. The cable tray spans shall not exceed manufacturer's recommended distances between support hangers.

f. Cable tray shall extend to allow cable runs to all panels, including the AC and DC distribution panels.

g. Contractor shall maintain sufficient vertical spacing between cable tray and the top of the panels.

h. The control and power cable tray and communications cable tray shall be vertically stacked.

i. The vertical spacing between cable trays shall be 6”

12.57 HEATING AND COOLING SYSTEMS

A. HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

1. Minimum Standards: Unit(s) to be sized by EEE Contractor to be readily available, wall-mounted, commercial-grade air conditioner with integral heater with a cold weather package if available.

2. Unit(s) supplied by Contractor shall have service representation within a 150-mile radius of installation site.

3. Size and Quantity: The minimum and maximum interior ambient temperatures shall be calculated using ambient site conditions and expected internal heat gains as outlined in this specification.

4. HVAC Unit quantity to be determined by the Contractor

5. Power feed is assumed to be 208/240VAC, single phase unless otherwise approved by Owner.

6. HVAC Unit(s) to have supply and return grilles, and a replaceable pleated high efficiency filter on the return side.

7. HVAC Unit(s) to be controlled by a separate wall-mounted, auto-change-over thermostat, or a lead-lag controller if two (2) units are used.

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8. Thermostat or controller shall be AC powered.

B. HEATING SIZING

1. The primary heating source is to be thermostatically controlled electric heating and shall be provided, sized, and preset at the factory, to maintain the EEE at a minimum average ambient temperature of 70°F throughout the EEE when subjected to the atmospheric temperature noted in this specification and Coldest Month 0.4% occurrence wind speed per ASHRAE.
2. The heat load calculations shall be calculated using the initial EEE design thermal gain, not taking into account the ultimate design heat loading.
3. The heating load calculations shall take into account the exhaust fan operation and building ACH (air changes per hour).
4. Secondary Electric Heater
5. A secondary electric unit heater with controlled by a wall mounted thermostat shall be provided, and preset at the factory, to maintain the EEE at a minimum average ambient temperature of 40°F throughout the EEE when subjected to the atmospheric temperature in Section 12.55F.1.c and coldest month 0.4% occurrence wind speed per ASHRAE.
6. A built in thermostat is not acceptable
7. The heating load calculations shall follow the requirements of this specification.
8. The electric unit heater is not to be included in the heating calculations for sizing the primary heat source. The electric unit heater is intended for partial redundancy in the event of a failure of the primary heating source.

C. AIR CONDITIONING SIZING

1. Air conditioning shall be provided, sized, and preset at the factory, to maintain the EEE at a maximum of 80°F with all heat producing sources on during the maximum ambient temperature found in this specification using the ultimate EEE design and following all other ASHRAE requirements.

12.58 TESTS

A. The EEE and all associated equipment, amenities, apparatus, spare equipment/parts/tools, and ancillary devices shall be acceptance-tested and function-tested in accordance with all required specific ANSI, NEMA, IEEE, UL, IEC, UBC, IBCO tests or special Purchaser tests that apply.

1. Test Reports: Contractor to provide two copies of all test reports in electronic format (i.e. CD-ROM or e-mail). These are required no later than two weeks prior to delivery of the EEE to avoid delays in critical path schedule.
2. Contractor to provide any certified test reports required by Owner or regulatory bodies.
3. Test for protection against ingress of water.
4. Contractor to provide option for Building Air Blower Test

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12.59 RECORD DOCUMENTS

A. One (1) electronic copy (i.e. CD-ROM, e-mail) of all record drawings are required by close of business no later than two weeks prior to EEE delivery date. Electronic documents shall be in PDF and AutoCAD format. One (1) paper copy is required to be shipped with the EEE.

B. The following are required record documents:

   1. Photos of the following before liners or flooring material are installed:
      a. Floor, wall, and ceiling assemblies while open
      b. Floor rim area
      c. Roof / wall juncture
   2. A copy of the production (routine) tests
   3. Instruction, installation and maintenance manuals
   4. Manufacturer’s drawings of equipment supplied
   5. EEE as built control and layout drawings
      a. Drawings shall be centered on 18” x 24” paper
   6. Completed price breakdown of assets that reflects completed EEE.
   7. Report of all OEM warranty periods per this specification
   8. Quality Control Program documentation per this specification

12.60 WARRANTY

A. Contractor shall guarantee that the complete EEE will have no defects in materials and workmanship as well as warranted against water leakage per IEEE requirements for a period of five (5) years from date of shipment, except as limited or extended by the Original Equipment Manufacturer (OEM).

B. Contractor to provide report of all OEM components and equipment with their respective warranty periods

C. Manufacturer warranties shall pass through to Owner for 3rd party equipment, software, etc. (ex. SEL Relays, GE RTU).

D. Contractor to also adhere to requirements noted earlier in this specification.

12.61 SHIPMENT

A. The EEE shall be able to be shipped via semi-tractor trailer method. The EEE may not be separated into two or more sections for shipment unless approved by Owner.

B. The Contractor shall prepare all equipment covered by this specification for shipment in such a manner as to protect it from damage in transit.

C. Any and all damage resulting from improper preparation or damage during transit shall be repaired or replaced at the Contractor’s expense.

D. The EEE shall be wrapped such to protect it from dirt and debris during shipment.

E. The Contractor shall be responsible for delivery of the EEE to the substation, including shipping, placement on foundation, and performing all finishing work to make the unit ready for service.

12.62 INSTALLATION

A. The Contractor is responsible for the delivery and installation of the EEE and installation cost thereof. This is to include, but not limited to, cranes, rigging, and all associated materials and labor required to install the EEE on its foundation to include marking and chalking correct placement on the foundation and install any equipment removed from the EEE for shipment. The Contractor is solely responsible for providing the correct equipment for the terrain and ground conditions encountered at the site.

1. Anchor Bolts and Clips shall be provided by Contractor and included with the EEE delivery.

B. The following shall be required five weeks before first date of shipment to avoid delays in critical path of assembly:

1. EEE facility lifting/crane/rigging plan shall be provided. The lift plan must include the following:

a. Location of truck/trailer

b. Location of crane

c. Final outrigger locations

d. Distance from center of crane to center of extended outrigger post

e. Dimensions from center of crane to centerline of outriggers, sides, front and back

f. Order of sections for final field assembly

12.63 QUALITY SYSTEM REQUIREMENTS

A. QUALITY ASSURANCE

1. Contractor shall have a Quality Control Program that follows the EEE from design through completion that shall be passed onto Owner with all instruction manuals and final record drawings.

B. VERIFICATION

1. The Owner shall have access to perform assessments, quality audits, or witness test activities during the manufacturing process and to review applicable records. Owner may designate an authorized agent to perform these activities. The authorized agent may be an employee of the Owner or an outside agency. When an outside agency is designated as an authorized agent for the Owner, such designation shall be in writing with a copy provided to the Contractor. Hereinafter, when the term “Owner’s representative” is used, it may also mean the Owner or the authorized agent.

2. The following requirements apply for Owner’s inspection at the Contractor’s mill, factory, yard, warehouse, or sub tier Contractor’s facilities:

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a. The Owner shall have the right to access the Contractor’s and sub tier Contractor’s work and related documents at any time during the manufacturing process without delaying the schedule. The Contractor shall provide, without cost, reasonable facilities including tools, personnel and instruments for demonstrating acceptability of the work.

b. If any items or articles are identified as not meeting the requirements of the specifications, the lot, or any faulty portion thereof, may be rejected. Before offering specified material or equipment for shipment, the Contractor shall inspect the material and equipment and eliminate any items that are defective or do not meet the requirements of the purchase order. The fact that equipment or materials have been previously inspected, tested, and accepted does not relieve the Supplier of responsibility in the case of later discovery of flaws or defects.

c. Materials or equipment purchased under this purchase order may be inspected at the specified receiving points and will either be accepted or rejected. Receipt inspection will include testing to determine compliance with the purchase specifications. Initial receipt inspection acceptance tests will be performed by the Owner at the Owner's expense. Items found to be defective may be returned to the Contractor for correction at the Contractor's expense, including shipping cost or the cost to correct and inspect the item will be charged to the Supplier.

d. Owner's review of drawings and other submittals will cover only general conformity of the data to the Specifications and Drawings, external connections, interfaces with equipment and materials furnished under separate specifications, and dimensions that affect plant arrangements. Owner's review does not include a thorough review of all dimensions, quantities, and details of the equipment, material, device, or item indicated or the accuracy of the information submitted. Review and comment by Owner of Contractor's Drawings or other submittals shall not relieve Contractor of its sole responsibility to meet the Completion Dates requirement of this Purchase Order and to supply Goods that conform to the requirements of this Purchase Order.

C. To reduce site congestion, building shall be delivered as a single, completely assembled unit to the greatest extent practical. Contractor will unload and place on foundation.

D. Roof and supporting structure shall be designed for minimum 30 psf uniformly distributed load plus a 200-pound concentrated load over a 1'x1' area located anywhere on the roof surface plus any interior loads imposed by suspended equipment or cable tray. For wind and uplift loads, structure and anchorage shall be designed for 100-mph winds. Floors shall be designed for a minimum of 150 psf loading. Design for loading of battery rack; batteries; charger; electrical equipment and raceways; heating, ventilating, and air conditioning equipment; relay switchboards; and transformers, lighting, and other miscellaneous items as required.

E. The enclosure base shall be all welded steel frame construction. The enclosure floor shall be a minimum of 3/16-inch steel plate welded to the base. Provide special anchoring and support members under the battery racks and relay control panels. The floor shall be finished with a non-skid coating. The floor and walls shall be insulated to a minimum R11 value. Provide a bottom plate to enclose and protect the insulation. The entire enclosure shall be framed with an equivalent of three (3) inch square tubular steel. All openings, such as doors, windows, etc., shall be similarly framed with three-inch square tubular steel or structural equivalent. The height from floor to ceiling shall be ten (10) feet minimum.

F. The exterior and interior walls shall be a minimum of 16-gauge paint quality galvanized steel. The walls shall be designed and assembled to allow for future lateral expansion of the enclosure. Interior walls and supporting panels shall be designed so that interior loads of 400 pounds per linear foot of wall length may be attached to the wall without compromising the design wind loads. If additional reinforcement is required to mount equipment, the manufacturer may use Unistrut or equivalent.

G. The exterior of the roof shall be 16-gauge paint quality galvanized steel panels. The roof shall be sloped away from door openings, at a 2-degree pitch, to allow for adequate drainage. The roof shall be designed to support interior loads of 100 pounds per linear foot of truss length without compromising the roof design load. Screened, louvered ventilation openings shall be provided, to prevent condensation in attic space. The ceiling shall consist of formed 16-gauge paint quality galvanized steel panels. It shall be designed to retain the insulation and to provide a smooth ceiling surface. Ceiling shall be insulated to a minimum value of R30. Interior ceiling and supporting structure shall be designed so that interior loads of 100 pounds per linear foot of truss length may be suspended from the ceiling without compromising the specified roof design load. Design for additional load, as required, to support cable tray, lighting, conduits, and other items provided by this Contract.

H. The enclosure shall have two (2) separate 16-gauge heavy-duty steel doors; one (1) 36 by 84 inch and one (1) 72 by 96 inch with removable transom. The doors shall be equipped with low profile panic-type door hardware and an automatic door closer. A drip shield shall be provided above all doors. Each set of door hinges shall include one entry alarm hinge comprised of an integral SPST electric switch rated 125VDC. Contractor shall provide and terminate a two-wire circuit from each alarm hinge to the RTU.

I. The room-type heat/cool air conditioners shall be sized and provided by the Contractor based on the heat loads. Consideration shall be given to the ambient site conditions, the dimensions and heat retention of the enclosure building, and the heat dissipated by the control/monitoring equipment inside the building. Equipment shall be capable of maintaining a building temperature of not more than 75-degree F for cooling and not less than 65 degree F for heating. HVAC heater shall be used only as backup heat to the baseboard heaters. Contractor shall provide calculations of heating and cooling capacity requirements. Contractor shall furnish and install baseboard heaters as required to maintain a building temperature of not less than 65 degrees F. Furnish and install one staging thermostat with two-stage heat and two-stage cooling that cycles equipment of both heating and cooling stages.

J. Interior lighting shall consist of fluorescent lights that provide 40-foot candles of light at a level three feet above the floor. Lighting shall be controlled by heavy-duty 3-way switches located near each door. Lighting locations indicated on Contract drawings shall be modified to meet illumination requirements. External lighting shall be provided above each personnel door with automatic operation provided by a photo-electrically controlled lighting contactor. Provide 100-watt, enclosed, weatherproof, heavy-duty high-pressure sodium fixtures. Emergency lighting shall consist of self-contained, battery powered units with two illuminating heads. The units shall switch-on automatically upon loss of AC power, shall provide 1.5 hours of continuous illumination, and shall recharge when AC power is resumed. Duplex receptacles, polarized, arc resistant, specification grade, shall be rated 120V AC, 20A. Lighting contactors and switches shall also be provided for all yard lighting.

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K. Provide cable risers to extend from yard cable trench and ductbank to cable entrance wall openings to access the building cable tray. A generation interface junction box containing terminal blocks shall be integral to one of the cable risers. Risers shall be designed and sealed to prevent infiltration of water, snow, dust, and animals into the cabinet or building. Cabinet shall be constructed of corrosion-resistant aluminum or stainless steel and meet or exceed NEMA standards. Risers shall be provided with removable, gasketed covers to accommodate easy access for cable installation and termination.

L. Provide wall mounted exhaust fans sized and located as required to provide proper ventilation for the selected battery arrangement. Provide a gravity intake damper with an exterior weatherhood associated with each exhaust fan. Provide exhaust fan on/off toggle switches to control the exhaust fans and intake dampers

M. Furnish and install AC panelboards sized as required and located generally as shown on the drawings. Furnish and install all cable tray as shown in the drawings. Furnish and install conduit and wireways as necessary to wire the control building. Provide an automatic transfer switch for the incoming station service sources to allow immediate restoration of AC service in the event of loss of the primary station service source. Provide safety switches for AC and DC systems. Provide station service transformers for 208V three-phase service.

N. Provide a battery system as described in Section 4 (Electrical) of this Exhibit.

O. Furnish and install one combination smoke and heat detector unit with one normally open and one normally closed alarm contact rated 5A at 125V DC. Provide LED or fluorescent illuminated exit signs above each door. Provide an appropriate eye wash station, a dry chemical fire extinguisher (ABC rated), and other items required or indicated for a complete building system.

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8.0 GEN-TIE LINE (AS APPLICABLE)

12.64 Introduction

A. Section 8 of this, Exhibit 1, shall form the technical basis for the design, material procurement, and construction of the Gen-Tie line between the Solar Substation to POI.

12.65 General

A. A new single circuit XXX kV Gen-Tie line, to be installed on self-supporting tubular steel poles (or Owner approved structures), shall begin at the Solar Substation and terminate at Point of Change of Ownership as defined in the Interconnection Agreement.

B. Contractor shall be responsible for the following:

1. Perform Gen-Tie line engineering, analysis, and design.
2. Prepare a complete construction package to include the following: final plan and profile drawings, sag charts, stringing tables, complete bills of material, structure list, structure foundation drawings, structure erection drawings, insulator and hardware assembly drawings, right-of-way constraints, phasing, outage constraints with complete schedule, and construction technical provisions.
3. Procure equipment and material.
4. Receive, inventory, store, and protect equipment and material.
5. Install the line.
6. Test and commission.
7. Prepare as-constructed documents, which shall include the gen-tie facilities, right-of-way widths, easement areas, fences and gates, and labeling of all major roads and points of interest in both AutoCAD and pdf formats. In addition, prepare as-built PLS-CADD model and all supporting documentation.

C. It shall be Contractor’s responsibility to complete all tasks necessary to provide Owner with a complete and fully functional Gen-Tie line facility that meets all Owner’s standards and specifications, including the Interconnection Agreement.

D. Contractor shall review and comply with all permit requirements and stipulations.

12.66 Gen-tie Line Engineering and Design

A. General Requirements.

1. The design specifications and drawing requirements provided or referenced in this document are to be considered as minimum requirements. Any criteria not specifically addressed in this specification shall as a minimum meet or exceed the requirement of the current edition of the National Electric Safety Code (NESC) C2.
2. The Facility Ratings shall be calculated using assumptions from MP’s Facility Rating Methodology. See Exhibit 14 for methodology.
3. Contractor shall use PLS-CADD software to spot and perform detailed analysis and design of the gen-tie line.

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B. Survey

1. The survey firm is responsible for establishing a ground control network and collecting controlled, color, digital, ortho-rectified photography and terrain data. Terrain data shall be collected using LiDAR. The survey firm is also responsible for processing the raw data and delivering a digital elevation model in a format readily imported into PLS-CADD.

2. Contractor shall be responsible for identifying and obtaining any additional survey data needed for design.

C. Right-of-Way

1. The Gen-tie shall fit within defined right-of-way while adhering to all NERC and NESC regulations.

2. Minimum horizontal clearance from the wires to the edge of the right-of-way shall be determines using the following criteria:

   a. Load Cases A and B are based on maintaining clearances to buildings. Clearances shall be at minimum 4.5 feet greater than NESC required clearances. See NESC 234 C.1.

   b. Load Case C is intended to keep the wires within the right-of-way or away from adjacent circuits during extreme wind conditions.

   c. When determining the location of the conductor at blowout conditions, the deflection of the structure must also be considered. For single shaft steel poles, the maximum structure pole top deflection shall be assumed at 8% of structure above grade height for the Extreme Wind case (Load Case C) and shall be prorated for the 6psf wind case.

Load Case A	a) 120 °F, Final sag b) Maximum operating temp, Final sag c) 32 °F with radial thickness of ice for the loading district, Final sag d) Minimum conductor temp, Initial sag
Load Case B	6 PSF Wind, No Ice, 60°F, Final
Load Case C	300 Year MRI Extreme Wind

D. Geotechnical.

1. Contractor shall be responsible for obtaining all geotechnical data needed for foundation design. Boring should be done at every engineered foundation location.

2. A project-specific geotechnical investigation shall be performed to obtain information from field and laboratory testing to provide soil strength properties to be used for foundation design.

3. Borings shall be taken at each dead-end structure, failure containment structure (if any), and PI location with a line angle of 2 degrees (2-deg) or greater. Additional borings shall be taken at convenient locations such that adjacent borings are no more than one (1) mile apart.

4. Borings should also be taken at any location where the terrain changes may indicate a significant change in the geotechnical properties of the soil.

E. Foundations

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1. All steel pole structure foundations shall be of an engineered foundation type such as drilled pier, vibratory caisson, micro pile, helical pile, etc.
2. All foundations shall have a minimum projection of one foot (1 ft) above ground level or 1 ft above 10-year flood levels. Anchor bolt/base plate type foundations shall utilize anchor bolts with a separate full length rebar cage.
3. Drilled pier foundation diameters shall include a clearance of the larger: three (3) times the vertical reinforcement bar diameter or six (6) inches between the face of the vertical reinforcement and the face of the anchor bolts.
4. No steps in casing are permitted in the top 8 feet of a drilled pier hole.
5. The following parameters shall be used to design the foundations:
    a. The foundation designs will utilize a Load and Resistance Factor Design (LRFD) design methodology.
    b. The FAD tools software suite will be utilized for geotechnical and structural design. Monopole structures will be analyzed with MFAD. Alternative software, such as LPile, will be considered on an as-needed basis to evaluate multi-pole structures to understand group effects.
    c. Overload and Strength Factors
        i. The below Table provides a summary of the overload and strength factors that will be used for design. It is assumed all foundation loading for design includes Owner and code required overload factors.

Overload and Strength Factors	
Overload Factor	1.1
Lateral SRF	0.63
Skin Friction SRF	Refer to FAD Tools Manual
End Bearing SRF	
Concrete Design SRF	Per ACI 318

    d. Drilled pier minimum diameter will be determined by adding the project required clear spacing, clear cover, assumed longitudinal bar size of #11 and shear tie bar size of #5 to the assumed anchor bolt template diameter. In the absence of vendor anchor bolt drawings, the anchor bolt template is assumed to be 6” greater in diameter than the anchor bolt circle.
        i. Side Shear Springs in FAD will be utilized as follows:
            - Springs On
                - Site specific borings
                - Competent rock
            - Springs Off
                - Assumed soil borings
                - Clay, soft soils, or shallow groundwater

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- Use of casing anticipated

e. 5ft of soil will be ignored to account for construction disturbances and frost unless otherwise noted in the geotechnical report.

f. Ground water will be placed at boring-specific depths as recommended by the project specific geotechnical report. If no design values are provided, water will be assumed to be a minimum of 3ft shallower than the observed boring depth to account for seasonal fluctuations. Additionally, any pier located in swamp, marsh, wetland etc. will be designed for water at grade.

g. Minimum Embedment

- Soil – 3x Pier Diameter
- Rock – Min 2x Pier Diameter overall with at least 1x Pier Diameter into competent rock.

h. Axial capacity may be spot checked in HFAD for monopoles at the Engineer's discretion.

i. Deflection criteria for drilled piers is summarized in the below table. Deflection requirements will be verified against fully factored loads. Max deflection limits shall be satisfied at the top of the pier.

Top of Drilled Pier Lateral Deflection Criteria	
Total Deflection	4% Pier Diameter
Total Rotation	1°
Non-Recoverable Deflection	2% Pier Diameter
Non-Recoverable Rotation	0.5°

*FAD will not flag criteria violations at top of pier, engineer must verify manually

j. Concrete design parameters will be as summarized in the table below:

Concrete Design Parameters	
Concrete Strength	3,500psi for design 4,500 psi for construction
Max Agg.	0.75"
Min Long Bar Spacing	4" (ACI 336 5.2.2)
Reinforcement	ASTM A615 Grade 60 (60ksi)
Clear Cover	6" (FHWA 12.4)
Clear Spacing	4" (ACI 336 5.2.2)
Long. Bar Design	ACI Column Method
Concrete Shear Strength	ACI Method**

**Shear tie spacing not to exceed 12" for reinforcing cage rigidity

F. Structures

1. Type and Finish

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a. Structures shall base plated tubular steel.

b. For multiple piece poles, deadend and angle structures shall use flange connections. Tangents may use slip joint connections.

c. Structures shall have a Corten finish.

2. Structure Marking

a. All structures shall be furnished with brackets for installing aerial markers. Aerial marker signs are required on:

b. The first and last structures of a line (terminal structure at every substation)

c. Structure numbers ending in either "0" or "5"

d. Structures on each side of major road or water crossings

e. Structures on each side of major line crossings

f. All structures shall be furnished with brackets for installing structure numbers at the pole base. The ground markers shall be located on the transverse faces of the structure to be seen by road patrols.

3. Distribution underbuild will not be allowed.

4. Structure Spotting

a. Structures shall be spotted so that all applicable clearances are maintained. The center of a structure should be located no closer than:

i. 5 ft to the edge of a railroad right-of-way, for dead-end structures 8 ft shall be used.

ii. 5 ft to the edge of a state/county rural road right-of-way, for dead-end structures 8 ft shall be used.

iii. 10 ft to the edge of a pipeline right-of-way.

5. Vertical clearances shall be maintained when the conductor is at its greatest sag resulting from either the maximum operating temperature or the maximum loaded condition.

6. Structures shall be spotted in such a way that suspension attachments for conductors and shield wires shall not be in uplift at a temperature of -40°F initial sag and no wind.

7. Failure Containment Structures

a. Structure spotting for 115 and 230kV transmission line shall incorporate failure containment structures at intervals not exceeding ten miles. 345kV and above shall incorporate failure containment structures at intervals not exceeding five miles. The full-tension dead-end criteria shall be met by any failure containment structure.

G. Grounding

1. Continuous bonding shall be provided for all pier foundations between the rebar cage to the anchor bolt cage and to the steel pole in order to reduce ground resistance.

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2. Grounding shall be connected to the steel pole utilizing a stainless steel grounding plate or 1/2" stainless steel nut welded to surface of the pole. Typical locations are the base of the steel pole close to base plate, the crossarms close to the insulator attachments, and the shield wire peak or crossarm close to the attachment points.

3. All transmission structures shall be individually grounded through a dedicated earth driven system composed of ground rods. The grounding resistance shall be measured on each structure prior to the installation of any overhead wire. The number of ground rods required to obtain the structure ground resistance is dependent on the soil resistivity. Additional rods shall be installed to reach acceptable structure grounding resistance of 25 ohms. The rebar cage and anchor bolt cage shall be bonded to the steel pole to reduce ground resistance for all pier foundations.

H. Loading Conditions and Load Cases:

1. The criteria established in this document shall meet or exceed the requirements of the latest edition of the National Electrical Safety Code (NESC) C2. Any criteria not specifically addressed in this specification shall, at a minimum, meet or exceed the requirements of the latest edition of the NESC C2.

2. NESC Load Cases (NESC Section 250)

   a. NESC 250B, C, & D shall apply to all structures at minimum.

   b. All structures with arms shall also include in the vertical load component of Load Case 250B the weight of a worker and equipment equal to 500 lbs multiplied by the vertical overload factor of 1.5. This load is to be applied to each wire attachment point to design the arms.

3. Reliability Load Cases (300 year Return Period)

   a. The minimum extreme radial ice with concurrent wind load required by the current edition of the NESC is a 50-year return period load. For increased reliability, 300 year return period extreme ice with concurrent wind and extreme wind load cases shall be used for the design of the Gen-Tie Line.

4. Deflection

   a. Deflection at the pole tip shall be limited to 1% of the total structure height. All structures with arms shall also include in the vertical load component the weight of a worker and equipment equal to 500 lbs multiplied by the corresponding vertical overload factor. This load is to be applied to only one wire attachment point at the controlling location to maximize deflection.

   b. Full DE structure deflection shall be analyzed under NESC 250B loading conditions.

   c. All other structure deflection shall be analyzed at an average everyday load condition.

5. Broken wire and Unbalanced Ice

   a. The longitudinal load shall be applied at any one shield wire or one conductor (phase) position, whichever produces the most severe loading condition. The wind span at the broken wire (phase) position shall be

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assumed as 60% of the intact wind span. For the remaining intact wire (phase) positions full (intact) wind and weight span loads shall be used.

b. For arms with a shield wire and conductor attachment (if applicable), the one load creating the most severe condition shall be applied, not both. Broken wire case shall be analyzed for one broken wire at a time. For bundled conductors, the broken wire case shall consider both wires of the bundle broken, one phase at a time.

c. The differential tensions for unbalanced ice shall be calculated for the 300-year MRI equivalent radial ice load on all conductors and shield wires on one side of the structure and no ice on the other side. All wires shall be intact on both sides.

d. For suspension type attachments, the conductor tension for the Broken Wire or Unbalanced Ice differential tension load shall be multiplied by 0.70. The Broken Wire or Unbalanced Ice load at the shield wire position shall not be reduced.

6. Construction

a. This load case shall be used on all structures at all voltages with arms. The vertical load shall consist of the wire tension with overload factor of 1.1 at a three horizontal to one vertical stringing slope plus the weight of all hardware, stringing equipment, and the weight of one worker (500 lbs minimum) times the overload factor of 1.5.

b. The transverse load shall be based on the structure’s actual wind span.

c. The longitudinal load shall be based on the assumption that the wire gets caught in the stringing block at a three horizontal to one vertical slope.

d. This Construction load is to be applied to one wire attachment location at a time with all other wire attachments intact at the stated Construction case weather conditions and overload factors.

7. Fall Protection

a. This load case shall be used on all structures at all voltages with arms. The vertical load shall consist of the vertical load in the load case plus an additional 5000 lbs. This Fall Protection load is to be applied to one wire attachment at a time with all other wire attachments intact under the stated Fall Protection case weather conditions and overload factors.

8. Load Case Application

a. Terminal dead-end structures shall consider all load cases defined for the project. Loading combinations for both “all wires intact” and “all wires removed from one side” or "partial wires on both sides" must be considered. These structures shall be designed for any combination of intact and/or dead-ended wires that create the highest stress in the pole under each of the load cases considered and their respective load factors.

b. All load cases must be analyzed for both single and double circuit installations. All shield wire and/or OPGW loading must be applied in all cases. Load case application by structure type is as follows:

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Str. Type	NESC 250B	NESC 250C	NESC 250D	300 Yr Ice & Wind	300 Yr Wind	DE Defl.	Susp. Defl.	Brkn Wire	Unblc Ice	Const.	Fall Prot.
Suspension	X	X	X	X	X		X	X	X	X	X
Terminal Dead-End	X	X	X	X	X	X				X	X
Failure Containment	X	X	X	X	X	X				X	X

I. Wire Tension Limits.

1. The following maximum tension limits shall be applied to the conductors and shield wires:

Weather Case				Tension Limit
Wind (psf)	**Radial Ice (inches)**	**Temp (°F)**	**Condition**	**Project Specific Limit**
4	0.5	0	Initial	60% RBS
0	0	0	Final	25% RBS
0	0	0	Initial	35% RBS
300 Yr Ext. Wind	300 Yr Ext. Wind	300 Yr Ext. Wind	Initial	80% RBS
300 Yr Ext. Ice & Wind	300 Yr Ext. Ice & Wind	300 Yr Ext. Ice & Wind	Initial	80% RBS

2. Tensions shall be limited to protect the conductor against damage due to vibration.
3. Tension limits assume the use of vibration protection devices but shall not exceed the limits specified by manufacturer recommendations.
4. A vibration analysis shall be performed by the damper manufacturer to determine the requirement and placement of spacers, spacer-dampers and/or dampers for single conductors, conductor bundles, shield wires and OPGWs.
5. The OPGW and shield wire’s final after creep sag shall not exceed 80% of the conductor’s final after creep sag at 60 °F, but shall not exceed the specified tension limits to protect the shield wire and OPGW against damage due to vibration.
6. Tension limits may consider the use of vibration protection devices but shall not exceed the limits specified.

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7. Stringing tensions for the OPGW shall not exceed 20% of the ultimate cable strength.

8. The bi-metallic conductor properties shall account for aluminum strands going into compression for ACSR conductors at temperatures greater than 167 °F. When aluminum strands can go into compression, a value of 1.5 ksi can be used for modeling maximum compressive stress in PLS-CADD.

9. ACSR with a steel content by area less than 7.5% shall be designed for a Maximum Operating Temperature of 167°F, all other ACSR shall be designed for a MOT of 212°F and ACSS/TW for 482°F.

10. Conductor stretch due to Creep shall be evaluated at 60 °F and no wind.

11. Conductor stretch due to Load shall be evaluated at the 300 year MRI Extreme Ice with Concurrent Wind load case.

12. Sagging charts produced for construction shall take into account conductor sagging tolerance while maintaining final installed tensions below the stated limits.

J. Electrical Clearances.

1. All systems are considered effectively grounded where ground faults are cleared by promptly de- energizing the faulted section, both initially and following subsequent breaker operations.

2. Basic ground clearances are designed to meet a minimum of NESC clearance plus a buffer not less than 4 feet. For clearance criteria not specified within this document, minimum clearances defined in the latest edition of the NESC C2 code shall be applied.

3. Working Clearances (MAD)

   a. Minimum Approach Distances (MAD) are provided in the following table:

Transmission Line Characteristics	Voltage Base (kV)	Minimum Approach Distance	
		Phase to Ground (ft-in)	Phase to Phase (ft-in)
MAD	115	3-9	4-8
MAD	230	6-8	10-2
MAD	345	11-3	18-2
MAD	500	16-8	27-1

*Values From Minnesota Power Safety Manual

4. Galloping Clearances Between Ellipses

   a. Single loop galloping shall be used for spans of 700 feet or less where galloping ellipses shall be calculated using the A.E. Davison method. Double loop galloping shall be used for spans of 700 feet or greater utilizing the Toye calculation method. The line shall be designed such that the galloping ellipses do not overlap on single conductor lines, lines with

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bundled conductor shall maintain a minimum distance of the bundle spacing between the ellipses. The following load cases shall be used for galloping calculations:

i. 32°F, 0.5" radial ice, 2 PSF wind for swing angle

ii. 32°F, 0.5" radial ice, 0 PSF wind for sag

K. Phasing.

1. Phasing shall be determined in the field by the Contractor.

2. Phasing shall be placed on the Plan & Profile Drawings as well as the phasing diagram.

12.67 Material

A. General Requirements.

1. Material shall be of new manufacture and unused and be free of defects and irregularities.

2. All assemblies, hardware, and components of assemblies shall be designed to meet the strength requirements of most recent edition of NESC C2.

3. Contractor shall verify that all material, assemblies, hardware, and components of assemblies meet the strength requirements for the application and intended use.

4. Any piece of hardware in an insulator assembly must at a minimum match the ultimate strength of the insulator.

5. Contractor shall be responsible for design of the jumper assemblies such that all electrical clearances are maintained.

6. North American Sourcing Requirement: Steel poles, Hardware, Conductor, and other materials manufactured in North America utilizing North American steel content is required when available. Non-North American components may be approved by Owner on a per project basis for reasons of lead time, suitability, or other project specific requirements.

7. Charpy V-Notch Test

a. All structural steel plate material furnished shall be mill-certified to meet an impact property of 15 ft. lbs. at -20°F in the longitudinal direction using the Charpy V-Notch Test. This will be on an average of three (3) tests with no one (1) test below 10 ft. lbs. The location of the sample in the test fixture will be as described in ASTM Standard A673. The criterion of 15 ft. lbs. at -20°F is based on full-size test specimens. For sub size specimens, the dimensions and values to be used shall be in accordance with ASTM Standard A673. The Contractor shall guarantee that the Charpy requirement will be met.

b. Insulators and hardware shall be tested for toughness by the Charpy V-Notch method in accordance with ASTM A370 and ASTM E23 and shall provide a minimum energy absorption of 20 Joules at -20°C (CSA C83-17 Charpy Level 1).

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8. All insulators shall be toughened glass for all structure types. Polymer post insulators may be used for jumper supports. The maximum allowable load shall not exceed 50% of the insulator's maximum strength rating under the NESC District Loading.

9. Do not apply overload factor to loads when evaluating insulator load cases with a strength reduction factor.

10. End Fittings: Unless otherwise specified, all insulators shall be standard ball and socket type meeting ANSI C 29.1 & C 29.2 (latest edition). Bolt, nut and cotter shall be used for any material with pinned connections.

11. Toughened glass suspension shall be manufactured and tested in accordance with ANSI C29.2B, except that for the Thermal Shock Test as defined in clause 8.2.5 of ANSI C29.2B shall have the low and high temperatures adjusted to -50°F and 122°F, respectively. Additionally, insulator pin material shall be tested for toughness by the Charpy V-Notch method in accordance with ASTM A370 and ASTM E23 and shall provide a minimum energy absorption of 20 Joules at -20°C (CSA C83-17 Charpy Level 1). Annealed glass is not acceptable. Pins shall include a sacrificial zinc sleeve. Austenitic stainless steel cotter keys meeting the requirements of ANSI C29.2B shall be provided with all ball and socket fittings. All toughened glass insulator units shall be clearly marked in accordance with ANSI C29.2B. Additionally, certain units will be further identified with a colored band applied to the cap.

12. Bolt, nut and cotter shall be used for any material with pinned connections. All material shall be of new manufacture, unused, clean and free of defects and irregularities. The designed corona protection should not exceed 0.45 kV/mm anywhere along the insulator string.

13. The type and manufacturer of the insulators shall be consistent (not mixed) across each specific project segment.

14. Insulation Levels

    a. The following table lists the insulation levels for each line voltage, in terms of the minimum number of toughened glass bell insulator for each structure type.

	Typical Number of Toughened Glass Bells per String		
Voltage	Tangent & Light Angle (0-10°)	Medium and Heavy Angle (10-60°)	Deadend
115kV	8	10	10
230kV	14	16	16
345kV	Perform Insulation Coordination Study		
500kV	Perform Insulation Coordination Study		

B. Conductor

1. Several conductors, overhead ground wires, and overhead optical ground wires are listed in the tables below. These cables are standard across the Minnesota Power System. Cables for the project shall be selected from the below tables depending on project requirements. Exceptions must be approved by the Owner.

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2. Wire, ACSR, Bare: When Aluminum Conductor Steel Reinforced (ACSR) bare conductor is required, the wire shall conform to the mechanical and electrical requirements of ASTM B230, ASTM B232, ASTM B498, ASTM B500, ASTM 606, and the specific properties summarized below:

Wire, ACSR						
Size (kcmil)	Core Type	Stranding (aluminum/ steel)	Code Word	Outside Diameter (inches)	Weight (lbs/ft)	Rated Tensile Strength (lbs)
336.4	GA2	26/7	Linnet	0.72	0.462	14100
636	GA2	24/7	Rook	0.977	0.8182	22600
795	GA2	26/7	Drake	1.108	1.093	31500
954	GA2	54/7	Cardinal	1.196	1.2271	33800
1192.5	GA2	45/7	Bunting	1.302	1.342	32000
1272	GA2	45/7	Bittern	1.345	1.432	34100
1590	GA2	45/7	Lapwing	1.504	1.79	42200

3. Wire, ACSS/TW, Bare: When Aluminum Conductor Steel Supported, Trapezoidal Shaped Aluminum Stands (ACSS/TW) bare conductor is required, the wire shall conform to the mechanical and electrical requirements of ASTM B500, ASTM B609, ASTM B803, ASTM B857, ASTM B958, and the specific properties summarized below:

Wire, ACSS/TW						
Size (kcmil)	Core Type	Stranding (aluminum/ steel)	Code Word	Outside Diameter (inches)	Weight (lbs/ft)	Rated Tensile Strength (lbs)
666.6	MA5	Type 13 20/7	Mystic	0.913	0.855	22900
1033.5	MA3	Type 13 21/7	Curlew	1.129	1.326	30300
1780	MA3	Type 8 37/19	Chukar	1.445	2.06	38200

4. Wire, Overhead Ground, Steel: When galvanized steel or steel OHGW is required, the OHGW shall conform to the mechanical and electrical requirements of ASTM A363, ASTM B6, ASTM A90, and the specific properties summarized below:

Galvanized Steel OHGW					
Type	Stranding	Coating	Outside Diameter (inches)	Weight (lbs/ft)	Rated Tensile Strength (lbs)
3/8”EHS	7 Strand	Class A	0.36	0.273	15400
7/16”EHS	7 Strand	Class B	0.435	0.399	20800
1/2"EHS	7 Strand	Class A	0.495	0.517	26900

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5. Wire, Optical Ground: When optical ground wire (OPGW), the OPGW shall conform to the mechanical, electrical, and communication requirements of IEEE 1138, IEC 60794-4, IEC 60793, ITU-T G.65x Series, ANSI/EIA 359-A, ANSI 598-A, IEC 60304, ASTM B483, ASTM B415, and the specific properties summarized below:

Optical Ground Wire					
Type	AFL Spec#	Fiber Count	Outside Diameter (inches)	Weight (lbs/ft)	Rated Tensile Strength (lbs)
AC-64/528	DNO-5651	24	0.528	0.359	18391
AC-77/557	DNO-11204	48	0.557	0.419	22002
AC-34/52/646	DNO-6651	48	0.646	0.417	18053

*Optical ground wire (OPGW) shall be 24-fiber OPGW or as specified in the Interconnection Agreement.

C. Vibration Dampers

1. Spiral vibration dampers shall be installed on all OPGW spans per the manufacturer’s recommended spacing.
2. Spiral vibration dampers shall be installed on the overhead ground wire per the manufacturer’s recommended spacing.
3. Stockbridge Type Vibration Dampers shall be installed per the manufacturer’s recommended spacing on all spans of conductor where the vibration analysis indicates dampers are required.

D. Spacer Dampers

1. If conductors are spaced horizontally, spacer-dampers shall be used on conductor bundles at intervals recommended by the manufacturer. Spacer-dampers shall have elastomer bushings, breakaway bolts, and must be rated for the maximum operating temperature.
2. Mid-span spacers are not required for vertically bundled conductors.

E. Conductor Attachment

1. AGS type units shall be used for suspension applications. A second suspension clamp shall be used for deflection angles over 30 degrees.
2. Compression-type terminals appropriately designed for high temperature and EHV application depending on cable type and voltage shall be used for dead-ends and jumpers.
3. All conductor attachment hardware shall meet the maximum conductor operating temperature for the project.

F. Shield Wire and OPGW Attachment

1. AGS type units shall be used for all suspension applications.
2. Bolted strain clamps shall be used for dead-end applications on the OPGW.

3. Compression type terminals shall be used for dead-end applications on the shield wire.

G. Design For Corona (EHV Fittings)

1. For 345 kV and above, corona-free hardware and corona rings shall be used to limit the audible noise to acceptable levels.

2. All armor rods and line guards included with the AGS assemblies on 345 kV and above applications shall have parrot-bill ends.

12.68 Construction

A. Contractor shall prepare, compile, issue, and update a construction specification for the work described in Section 8 of Exhibit 1.

B. Contractor shall procure material and construct the gen-tie line such that, when in operation, does not cause nuisance audible noise or radio or television interference.

C. Contractor shall make all reasonable efforts to minimize all damages due to construction activities.

D. Contractor shall be responsible for preparing and acquiring all crossing permits from the owners of the foreign overhead or underground facilities crossed.

E. Contractor shall be responsible for preparing and acquiring all construction access permits from the state and local agencies with jurisdiction.

F. Contractor shall be responsible for preparing and acquiring all stormwater construction permits.

G. All temporary openings in fences created by the Contractor shall be removed and the fence repaired when access is no longer required. Contractor shall be held responsible for damage to crops, livestock, or other property resulting from failure to keep fences, gates, or fence gaps in proper condition.

H. Contractor shall be responsible for grounding all fences and structures along the gen-tie route.

I. Contractor shall repair and restore the right-of-way and clean up each structure location to the satisfaction of the Owner and the landowner/tenant. All earthwork, culverts, bridges, and drainage structures constructed by the Contractor shall be removed when no longer required.

J. All parts of the structure shall be purchased and installed by the Contractor.

K. Conductor, shield wire, and/or OPGW shall be installed in accordance with “IEEE Guide to the Installation of Overhead Transmission Line Conductors”, Std. No. 524.

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9.0 SECURITY PERFORMANCE GUIDELINES

12.69 Security Lighting

A. Basic security lighting shall be provided to assist in maintaining acceptable levels of facility protection. This includes, but is not limited to, lighting at entrance gates, employee entrances, building entrances, employee parking areas, and areas around the building perimeter.

B. Boundary lighting must consist of a series of fixed lights to light the boundary or area from which an intruder could approach.

C. Area lighting shall supplement existing street lighting to provide a maximum level of illumination from a minimum number of fixtures. The system shall be designed to illuminate the entire area evenly, including doorways, structures and all opening into the structures.

D. Lighting shall be provided to cover the building faces evenly. Doorways and other openings in the building must be lighted to eliminate shadows.

E. Pedestrian and vehicle entrances that are actively used are to be provided with sufficient illumination to permit recognition of individuals and examination of credentials. All vehicle entrances must be lighted so that the entire vehicle, occupants, and contents can be viewed. Doorways and other recesses must be lighted to eliminate shadows.

F. Lighting Minimum Requirements:

Location	**Minimum Foot-Candles (fc) on a Horizontal Plane at Ground Level**
Vehicular entrances***	1.0**
Pedestrian entrances	2.0
Security-sensitive site areas	2.0
Employee parking and maneuvering areas	1.0**

* Lighting should be directed inward from the property line.
** Lighting must be increased to 2 fc if an exterior security CCTV system is provided. This is based on the worst-case or reflective light conditions (asphalt).
*** Lighting must be increased as necessary to allow proper identification of the individuals in the vehicle.

G. Contractor must document security lighting requirements by providing a point-by-point, computerized photometric plan or other method that demonstrates that appropriate lighting has been planned.

H. Alternate circuitry must be used in the power circuits so that the failure of any one lamp does not leave a large portion of either the site perimeter or critical or vulnerable area in darkness.

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12.70 Building Utilities

A. To the extent possible, all utilities associated with the security performance requirements are to be run underground. All circuits must be run in conduit.

12.71 Electronic Security System (Exterior Design)

A. The exterior security system encompasses the required exterior lighting and fencing with top guard as well as all exterior electronic security equipment (i.e., access control, intrusion detection, and CCTV).

B. When the electronic system is required there must be sufficient lighting throughout the site so that the cameras can operate effectively and record the required information. The electrical and the security systems architects or engineers shall coordinate their efforts. If there are areas of concern, e.g., lack of or limited coverage, alternatives or additional camera locations shall be approved by Owner.

12.72 Security CCTV System

A. The security CCTV system consists of CCTV cameras housings, video and power cable, control panel, switchers, multiplexers, monitors and recorders. The system must be designed so that it is capable of recording and being monitored 24 hours per day, 7 days per week.

B. The security cameras shall provide a color picture, have an automatic iris and pan-tilt-zoom (PTZ) control lens, and, if for exterior use, installed in environmentally controlled, domed housings. The domes must be designed to eliminate the ability to observe the camera operation and location from inside the dome.

C. The entire substation area shall be covered by the CCTV system without any areas being blocked or obscured by substation equipment and/or structures. The entire exterior of the Operations Building shall be covered without being blocked or screened by any equipment and/or structures.

D. The cameras shall be mounted on light poles when possible. The camera's lens configuration shall be able to provide identifiable personnel images as well as read license plates and numbers. A separate camera coverage drawing showing camera placement as well as the focal distance and arcs for each camera shall be submitted to the Owner at a design review meeting.

E. The CCTV System shall be provided with an operator interface in the control room.

EXHIBIT 1
SOLAR SUBSTATION AND GEN-TIE

10.0 TESTING, COMMISSIONING, AND PROJECT ACCEPTANCE

12.73 Overview

A. See Exhibit 5 and Exhibit 5-02 for requirements of Field Testing, Functional Testing, and Commissioning. All commissioning and testing shall be coordinated with the Utility.

11.0 PROJECT AND CONSTRUCTION MANAGEMENT

12.74 Staffing

A. Contractor shall provide the appropriate personnel to manage all aspects of the Work.

B. Contractor shall ensure an OSHA “competent” person be present during all work hours.

C. Contractor may work on Site at any time subject to Applicable Laws.

12.75 Reporting/Meetings

A. Contractor shall provide progress and schedule reporting on a weekly basis. A two-week look ahead of activities shall be provided at weekly reoccurring meetings with the Owner, Contractor and Contractor’s subcontractors.

B. Progress meetings shall be held at the Site on a monthly basis on dates mutually agreeable to Owner and Contractor.

12.76 Safety Plan

A. Contractor shall maintain a Safety Plan and observe all safety practices required for performing construction work of this type including OSHA standards and adherence to Owner standards.

12.77 Work Schedule

A. Contractor shall submit a detailed critical path schedule using Microsoft Project or similar mutually agreed upon project management software which also meets the requirements of the Agreement.

B. The Work Schedule shall be updated monthly against the baseline schedule and submitted to Owner in its native file.

EXHIBIT 2 – CONTRACTOR DELIVERABLES

EXHIBIT 2
CONTRACTOR DELIVERABLES

1.0 SCOPE

This specification outlines the review and approval requirements for the Contractor deliverables. Contractor scope includes all documents in this specification.

2.0 PURPOSE

This Attachment defines the Contractor and Contractor Supplier deliverables to be submitted with the following information:

- Schedule for the deliverables to be submitted to Owner.
- Review/Approval requirements.
- Format that the deliverables are to be submitted to Owner as addressed in Section 7 of this Attachment.
- Number of copies to be submitted to Owner as addressed in Section 7 of this Attachment.

3.0 RESPONSIBILITIES

- The Contractor is responsible for submitting documentation in accordance with this Matrix.
- Owner is responsible for defining date of the award of the contract from which the document submittal dates are timed.
- Upon receipt of the transmittal, Contractor shall allow ten (10) Business Days for Owner review and comment cycle for all documents and drawings unless otherwise indicated.
- Owner reserves the right to review all engineering documents and records produced by Contractor during each design phase and until Project Substantial Completion. Contractor shall respond in writing to all of Owner's comments.
- Contractor is responsible for the following regarding design of the Project:
  - 30%, 60%, 90%, and 100% (or Issued For Construction, IFC) packages. 30% is considered the design issued at bid with refinements and additions to completely define the project to potential financing partners. 90% is a package complete enough to issue for permitting. 60% is the intermediary package between 30% and 90%. Many of the Engineering Studies and calculations are due at 60%. 100%, or IFC, is a complete package with all details necessary to be able to construct the Project.
  - Contractor shall host a meeting to review the 30% design with Owner within 5 business days after its issue. The meeting shall be hosted either at an agreed upon location or virtually on-line with adequate time to cover major elements of the design.
  - Upon issue of the 60%, 90%, and IFC design packages, Contractor shall, upon Owner request, host design review meetings.
- Contractor shall provide as-built drawings for all Drawings used and issued for construction.

4.0 INSTRUCTIONS

The review/approval matrices shall be used as the basis for submitting documents to Owner. Following is a definition of the codes associated with each document:

Issued for Owner Review (IFR): Contractor shall submit documents to Owner for review and approval and shall incorporate comments from Owner.

Issued for Information (IFI): Contractor shall submit documents to Owner for information only. (Owner reserves the right to comment).

Owner will, by a notice to Contractor, review the submittal to issue comments or indicate the acceptance or rejection of the documents per the agreed upon Deliverables Matrix. Owner review of and/or

EXHIBIT 2
CONTRACTOR DELIVERABLES

comments, or lack of comments to Contractor documents does not relieve Contractor of any Contract requirements.

5.0 DOCUMENT REQUIREMENTS

Contractor shall provide copies of Submittals as indicated in Section 7 of this Attachment in incompliance with the guidelines established within the document to ensure proper document control capabilities and seamless transfer of information to Owner.

6.0 GENERAL REQUIREMENTS

This Section covers the scope of the engineering services to be provided by the Contractor. Contractor shall perform all design engineering work including but not limited to the following items:

- **Design Documents:** Prepare design documents, models, size equipment, generate drawings and specifications, and other supporting activities to the degree of detail required to fully and clearly define construction work requirements.
- **Calculations:** Prepare calculations and models as required for design decisions, equipment and material selection, construction drawings preparation, and regulatory review and approval.
- **System Descriptions:** Prepare system descriptions indicating equipment data, operating characteristics, design basis, functions, and other process information for:
  1. PV Modules and DC wiring systems
  2. Trackers
  3. ISAs
  4. AC Collection System
  5. SCADA System
  6. Substation
- **Equipment Lists:** Prepare electrical, instrument, and mechanical equipment lists with summary descriptions, vendors, and pertinent data.
- **Design Package:** Provide a comprehensive design package consisting of drawings including all civil, electrical, Instrumentation and Control, mechanical, and structural construction drawings for the plant and supporting systems. This will include, but not limited to, the following:

  1. Cover Sheet
  2. Site plan
  3. Symbols, abbreviations and notes

  Electrical
  1. Symbols, abbreviations and notes
  2. Layout plans for all equipment
  3. Cable routing plans
  4. One-line electrical diagrams for AC and DC systems
  5. Three-line diagram (Substation)
  6. Module string and combiner wiring diagrams (typical)
  7. Inverter skid assembly wiring diagrams
  8. Grounding and lighting protection plans and details
  9. Lighting plans and details (where applicable)
  10. Equipment specifications for all equipment, including inverters, transformers, switchgear, cables, metering and grounding
  11. Engineering Studies (refer to Electrical Matrix)

  Instrumentation and Control
  1. Instrumentation Layout and Location Plan

EXHIBIT 2
CONTRACTOR DELIVERABLES

2. Instrumentation Installation Details
3. Control Block Diagram
4. Control Logic Specifications
5. Instrument Data Sheets
6. Instrument Index
7. Control Room Layouts
8. SCADA Field Panel Drawings with Wiring Details
9. SCADA Network Architecture Drawing
10. Telecom Design

Civil/Structural
1. Grading plan
2. Offsite Drainage Plan
3. Onsite Drainage Plan
4. Soil erosion and sediment control plan
5. Hydrology report (as required for permitting and drainage design)
6. Geotech Report
7. Site fencing and roadway plans
8. Structural plans, details and elevations
9. Foundations and Equipment Pads
10. Structural Steel details
11. Array and Inverter Layout Plans

Operations Building (If Applicable)
1. HVAC plans
2. Plumbing plans
3. Electrical Plans
4. Architectural Plans, Elevations, and Details
5. Fire Protection Systems

- **Technical Specifications:** Prepare technical specifications and other documentation to support all equipment procurement, materials, and construction requirements.

- **Operation and Maintenance Manuals**: Prepare O&M manual of Photovoltaic power system and Solar Substation, to include system description, equipment list, equipment data sheets, calibration certificates, warranties, and as-built drawings.

- **Plan approvals and Building permits**: Obtain necessary plan approvals and building permits from appropriate state, county and local building authorities. Architectural, Civil, Structural, Mechanical, Electrical, and Instrument and Control design documents that are issued for construction or procurement shall be prepared by or under the direct supervision of a professional engineer or architect registered in the applicable state. Documents shall be prepared and sealed where required by the jurisdiction having authority.

- **System Startup & Commissioning Test Procedures and Reports:** Startup and commissioning test procedures and reports, and test protocol shall be prepared for all systems in accordance with Exhibit 5. Copies of the test procedures and of the test results shall be provided to Owner per requirements established in Section 7 of this Attachment.

- **Project Execution Plan:** Prepare and submit for review a Project Execution Plan indicating a responsibility matrix; key Project contacts; document distributions; Project scope; Project organization; execution plan; administrative procedures; quality control procedures; Project schedule;

equipment, piping, and instrument tagging procedures; design criteria; and other key Project execution functions.

- **Outage Plan:** Contractor shall prepare an outage plan for all scheduled interruptions of electrical power or other utilities-interference that would affect the Owner or third parties. This plan shall be submitted by Contractor to Owner and the affected parties at least thirty (30) days prior to outage.

- **Contractor Acquired Permits:** Contractor shall provide Owner copies of all Contractor Acquired Permit applications as they are being submitted to the responsible agency, per the requirements established in Section 7 of this Attachment. Contractor shall provide Owner copies of all issued Contractor Acquired Permits upon approval from the responsible agency, per the requirements established in Section 7 of this Attachment.

- **Module Fabrication Quality Assurance and Quality Control (If by Contractor):** Contractor shall provide a separate quality control & quality assurance plan specifically to manage these elements at the factory or factories where the photovoltaic modules are to be manufactured for the Work and at the Site.

- **Quality Assurance and Quality Control:** Contractor and its Subcontractors shall establish and maintain a documented QA Program conforming to applicable sections and elements of the International Standard on Quality Systems ISO-9001 1994 Edition Quality Systems-Model for Quality Assurance in Design/Development, Production, Installation and Servicing.

- **Quality Assurance (QA) Plans** Contractor shall prepare one or more QA Plans for Equipment or Services in Contractor's scope. These QA Plans shall be submitted to Owner for review as specified in this Attachment and shall be revised, if necessary, to reflect Owner's comments. Each QA Plan shall describe how Contractor's QA Program will be applied to Equipment or Services to be furnished and shall address requirements defined by the Contract Documents. QA plans shall also contain the Scope of Work and Schedule of Key Activities.
  The Design Quality Assurance Plans shall address the following key elements:

  Contract review
  Control of customer supplied product
  Control of non-conforming product
  Corrective and preventative action
  Design control
  Document and data control
  Handling storage packaging and delivery
  Internal quality audits
  Management responsibilities
  Process control
  Product identification and traceability
  Quality records
  Quality system definition
  Services
  Training

  The Construction Quality Assurance Plans shall address the following key elements:

  Audit/surveillance
  Backfill and compaction procedure
  Calibration
  Care and maintenance instruction procedure
  Change control

EXHIBIT 2
CONTRACTOR DELIVERABLES

Concrete placement procedure
Control of measurement and test equipment
Control of Nonconformance
Corrective Action
Document control
Drawing format and document identification
Electrical fabrication and installation
Equipment installation
Examination
Examination status
Handling storage and preservation
Identification and control of items
Inspection and test status
Inspection and testing
Personnel indoctrination training records
Personnel Qualification
Procedure development and approval
Procurement controls
Quality assurance records
Receiving Examinations
Structural Steel installation
Survey control
Vendor qualification and source surveillance
Warehouse and material control

- Contractor shall furnish all factory acceptance test procedures and reports (on equipment with FAT's) to Owner for information.
- At Owner's request, Contractor shall provide available manufacturers quality control documentation.
- Owner shall pay Owner's costs associated with any Witness Test.

- **Manuals and Instruction Books:** Contractor is responsible for providing Manuals that will cover all the details required in order to operate and maintain the PROJECT; including but not limited to Equipment Manufacturer Documentation, and Contractor generated Documents. Manufacturer's instruction books shall be properly referenced out of the plant manual with multiple volumes and provided per the requirements set forth in Section 7 of this Attachment. A preliminary plant manual shall be provided no later than the start of training. 3 hard copies and 1 electronic version of final manuals will be provided.
  The plant manuals shall contain site specific information on the plant operation, the latest as-built information for the facility. Contractor shall obtain as-built information for vendor's equipment. Manuals shall be updated with any modifications to equipment or systems made to the facility during the warranty period resulting from defects corrected under the warranty. Contractor shall provide markups to vendor as-fabricated drawings to reflect changes made in the field. The Manuals shall address the following table of contents:

  - **Installation, start-up and initial test** instructions.
  - **Operating instructions**, including safety precautions. Normal operating modes, parameters and sequences (including startup and shutdown) shall be described together with normal running inspections for all supplied equipment and systems Special notes and cautionary statements shall be included and highlighted throughout the manual to enable easy recognition of special procedures and techniques that must be followed to ensure correctness and safety for equipment and personnel.

EXHIBIT 2
CONTRACTOR DELIVERABLES

- **Maintenance** Procedures and routine adjustments. Troubleshooting and diagnostic recommendations shall also be included. Maintenance and replacement instructions, which shall include detailed assembly drawings with parts numbers, parts lists, instructions for ordering spare parts, and complete preventative maintenance instructions required to ensure satisfactory performance and longevity of the equipment involved.
- **Parts** illustrations, including parts lists adequate for the purpose of identifying and ordering replacement parts and lists of recommended spare parts for three (3) years of operation of any given component.
- **Wiring schematics** for electrical equipment.
- **Detailed descriptions of the functions** of each principal component of a system.
- **Performance and nameplate data**.
- **Safety precautions**.
- **Parts lists** shall be submitted in vendor's standard format.

- **Turn-Over Documents:** Contractor shall submit all Turn-Over documents for review and approval by Owner to fulfill requirements for Substantial Completion. These documents shall include all pre-commissioning and commissioning testing results and all of the above-mentioned documents and those mentioned in the Matrix at their respective milestone dates.

7.0 DELIVERABLES MATRIX

For sake of clarity, "days" in these tables refers to business days.

1) CERTIFICATES AND KEY NOTICES		
Submittal Description	**CODE**	**Timing/Frequency**
Mechanical Completion	IFR	10 days prior to planned Mechanical Completion issue
Functionality	IFR	5 days after Functional Test
Performance Guarantee (Capacity Test)	IFR	5 days after completion of Capacity Test
Substantial Completion	IFR	10 days prior to planned Substantial Completion
Final Completion	IFR	At Completion

2) SCHEDULES		
Submittal Description	**CODE**	**Timing/Frequency**
Notice of Long Lead Time Equipment	IFR	5 days after LNTP
Project Schedule (including Critical Path Schedule and proposed completed Key Date Schedule)	IFR	30 days after FNTP
Updates to Critical Path Schedule	IFR	Monthly after FNTP
Current Week Progress and Rolling look ahead Schedule	IFR	Weekly after FNTP

EXHIBIT 2
CONTRACTOR DELIVERABLES

– 2 Weeks		
Material Delivery Schedule	IFR	Weekly after FNTP

3) PROCEDURES		
Submittal Description	**CODE**	**Timing/Frequency**
Vendor Factory Witness Test Plan	IFR	20 weeks after FNTP or 8 weeks prior to test, whichever comes first
Lifting Plan	IFR	1 week prior to lift

4) PROJECT PLANS		
Submittal Description	**CODE**	**Timing/Frequency**
Site-Specific Environmental, Health & Safety and Plan	IFR	30 days after FNTP
Vendor Shop Test Inspection Plan	IFR	2 weeks prior to the start of procurement
Project Quality Assurance/ Quality Control Plan (Including Management of Change)	IFR	45 days after FNTP
Alternate Supplier Plan	IFR	45 days after FNTP
Commissioning Plan	IFR	90 days after FNTP
Document Control Plan	IFR	30 Days after FNTP
Project Execution Plan	IFR	45 days after FNTP

5) PURCHASE ORDERS/INVOICES		
Submittal Description	**CODE**	**Timing/Frequency**
Invoices Including Support documentation as required	IFR	As Issued
Materials and Equipment Procurement Specifications	IFI	Prior to ordering

6) SUBCONTRACTS		
Submittal Description	**CODE**	**Timing/Frequency**
Subcontracts (un-priced)	IFI	As Requested
SUBContractor List if added outside of list	IFR	5 days prior to add

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CONTRACTOR DELIVERABLES

7) INSTRUMENTATION AND CONTROL		
Submittal Description	**CODE**	**Timing/Frequency**
SCADA Narratives (Including Supplier Equipment)	IFR	With 90% Design
Instrumentation and Control Block Diagram	IFR	With 90% Design
Wiring Specification Drawings	IFR	With 90% Design
Wiring Drawings	IFR	With 90% Design
Control Panel Layout and Construction Drawing	IFR	With 90% Design
Instrument Specifications and Data Sheets	IFR	With 90% Design
Cable Routing Diagrams, including Junction Box Drawings	IFR	With 90% Design
Instrument Installation Details including MET Station and field POAs and temperature sensors, as applicable	IFR	With 90% Design
SCADA Architecture Diagram	IFR	With 60% Design
Point Configuration and System Configuration Details	IFI	With 90% Design
SCADA Vendor Drawings and Data	IFI	With 90% Design
Instrument List (Including Set-points, Engineering Units, Ranges, Type, signal type, etc.	IFR	With 90% Design

EXHIBIT 2
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8) ELECTRICAL		
Submittal Description	**CODE**	**Timing/Frequency**
Title Sheet, Legend, and Notes	IFR	With 30% Design
Array and Substation Layout w/Major Equipment Locations	IFR	With 60% Design
AC Single Line(s)	IFR	With 30% Design
DC Single Line(s)	IFR	With 30% Design
Inverter Skid Layout	IFR	With 60% Design
Monitored Points List	IFR	With 60% Design
Site Logistics Plan	IFR	With 60% Design
Specification List	IFR	With 60% Design
Conduit, cable block diagrams, and raceway drawings	IFR	With 90% Design
Cable Routing Layouts	IFR	With 60% Design
Grounding and Lightning Protection layouts	IFR	With 60% Design
Panel Layout	IFR	With 90% Design
Substation 3-Line Diagram	IFR	With 60% Design
Substation Layout	IFR	With 60% Design
Substation Elevations	IFR	With 100% Design
Underground electrical	IFR	With 60% Design
Lighting Drawings (as applicable)	IFR	With 100% Design
Supplier Internal Power and Control Wiring Diagrams (as applicable)	IFR	With 100% Design
Electrical Schematics and Connection Diagrams	IFR	With 60% Design
IEEE 80 Study	IFR	5 days prior to 100% issue
Short Circuit Study	IFR	With 60% Design
Grounding Study	IFR	With 90% Design
Ampacity and Loss Study	IFR	With 60% Design
Relay Coordination Study	IFR	With 100% Design
Load Flow and Voltage Compensation Study	IFR	With 60% Design
Arc Flash Study	IFR	With 100% Design

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Transient Over Voltage Study	IFR	With 100% Design
Harmonics Study	IFR	With 100% Design
Vendor Drawings (one-line and outline drawings as well as vendor manuals for review all other for information)	IFR	With 100% Design
Electrical Load List	IFI	With 90% Design
Cable Schedule	IFR	With 90% Design
Lighting and Small Power Distribution Board	IFR	With 90% Design
Cable trench details	IFR	With 60% Design
Construction details	IFR	With 90% Design
Protection & metering diagrams	IFR	With 100% Design
Equipment performance data sheets and Nameplate Data	IFI	With 100% Design
Equipment performance data sheets (vendor as applicable)	IFI	With 100% Design
Main Power Transformer (MPT, Substation) Specification (If by Contractor)	IFR	5 days after FNTP
MPT Loss Table (if by Contractor)	IFR	At 60% Design

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9) CIVIL		
Submittal Description	**CODE**	**Timing/Frequency**
Title Sheet, Legend, Notes	IFR	At 60% Design
Overall Site Plan	IFR	At 60% issue
Plant General Arrangement	IFR	At 60% issue
Access roads, and fencing	IFR	At 60% issue
Grading and Drainage Plans and Topography	IFR	At 60% issue
Stormwater Pollution Prevention Plan	IFR	At 100% issue
Site construction utilities	IFI	At 60% issue
All Site surveys	IFI	At 60% issue
Lay down and temporary facility Plans	IFR	At 60% issue
All construction specifications	IFR	At 60% issue
Paving Plan and Pavement Design	IFR	At 60% issue
All Geotechnical Reports	IFI	At start of design
Hydrology Report (If required by AHJ)	IFR	At start of design
Final Soil Stabilization Plan	IFR	At 60% issue

10) STRUCTURAL		
Submittal Description	**CODE**	**Timing/Frequency**
Title Sheet, Legend, Notes	IFR	At 60% Design
All Structural Steel Design Drawings	IFR	At 100% issue
Foundation Location Plans	IFR	At 60% issue
All Foundation Drawings	IFR	At 100% issue
All Structural Steel Fabrication Drawings	IFI	At 100% issue
All Rebar Engineering Drawings	IFI	At 100% issue
All Construction Specifications	IFR	At 100% issue
Structural and Foundation Design Calculations	IFI	At 60% issue
All Structural Material Specifications	IFI	At 100% issue
Pile Load Test Results	IFI	10 days after test
11) ELECTRICAL EQUIPMENT ENCLOSURE		

EXHIBIT 2
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EEE outline dimensions, physical requirements, floor plan, interior and exterior dimensions, elevations, suggested foundation elevations and dimensions, and the location of all primary accessories included with the EEE.	IFR	At 60% issue
Equipment and electrical performance data, including cut sheets and technical specifications adequate to determine quality of equipment being provided concerning the EEE and all components included as part of the EEE (i.e. HVAC equipment, lights, batteries, battery charger, AC & DC panels, etc.).	IFR	At 60% issue
Proof of being in the EEE design and manufacturing business for a minimum of 5 years, and be able to supply proof of supplying at least 25 EEE's of a similar type in that timeframe.	IFR	With proposal
Mechanical and mechanical performance data	IFR	At 60% issue
Shipped and installed weights.	IFI	At 60% issue
Mounting provisions and structural loading	IFR	At 60% issue
Exceptions to these specifications or any required standards	IFI	With proposal
Outline of all tests which will be performed	IFR	At 60% issue
Schedule of all submittals	IFR	10 business days after order
Complete Bill of Materials	IFR	At 60% issue
Contractor to provide one (1) electronic copy (PDF or AutoCAD) of design loads for foundation design, all static and dynamic loading calculations, foundation reactions, and all critical mounting features for the EEE	IFR	2 weeks ARO
Contractor to provide one (1) electronic copy (PDF or AutoCAD) of design loads for foundation design, all static and dynamic loading calculations, foundation reactions, and all critical mounting features for the EEE. One (1) electronic copy (PDF or AutoCAD) of all other approval documents. Approval documents shall include: A. Bill of Material B. Outline C. Mounting and Moving Provisions D. Schematics E. Nameplate F. Other rating data furnished with this specification. G. A standard color chart shall be provided to Owner for interior and exterior color selection prior to manufacturing. H. Door and door frame details. I. Roof and wall sections with proposed framing J. Design loads for Foundation Design . K. HVAC Calculations L. Secondary Heating Calculations M. Structural Submittals: The structure manufacturer shall submit a structural design criteria document stating the basis of structural design in the form of a drawing, letter or calculation package, certified by an Engineer licensed in the	IFR	2 weeks ARO

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state of the project. Fabrication of the structure shall not commence until this document has been reviewed and approved by the Owner. This document shall include, as a minimum, the following items: 1. Live Loads: Floor and roof live loads. 2. Snow Loads: Ground snow load, flat-roof snow load, exposure factor, importance factor and thermal factor. 3. Wind Loads: Ultimate and nominal design wind speeds (mph), risk category, exposure category, internal pressure coefficient and components and cladding wall and roof wind pressures (psf). 4. Seismic Loads (if applicable): Risk category, importance factor, mapped spectral response acceleration parameters, site class (assume D unless other information is provided), seismic design category, basic force resisting system(s), design base shears, seismic response coefficients, response modification coefficients and analysis procedure use. 5. Base support frame layout including dimensions, maximum foundation support spacing (assuming support by multiple drilled pier foundations). 6. Foundation reactions for both drilled pier and slab foundation options. Identify whether foundation reactions are service load or factored reactions, and provide breakdown of forces by load type. Include maximum vertical compressive and uplift forces, shear and moment (if applicable), including units. Include recommended or maximum support spacing for drilled pier foundation option. 7. Structural framing and floor plate deflection calculations or written statement outlining maximum live and total load deflections as a ratio of element length. 8. Anchor bolt and clip drawings		

12) ALL DISCIPLINES (Operations Building - If applicable)		
Submittal Description	**CODE**	**Timing/Frequency**
Title Sheet, Legend, Notes	IFR	At 60% Design
System Descriptions	IFR	At 100% issue
Equipment Arrangements and Locations	IFR	At 60% issue
Equipment List	IFR	At 100% issue
Reflected Ceiling Plan		At 60% issue
HVAC Layouts	IFR	At 60% issue
Layout Drawings	IFR	At 60% issue
Detail Drawings	IFR	At 60% issue
Construction Specifications	IFR	At 100% issue
Vendor drawings and submittals	IFI	At 100% issue

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13) PERFORMANCE AND TESTING		
Submittal Description	**CODE**	**Timing/Frequency**
PV Simulation Model (PVSyst)	IFR	At Contract Execution
Functional Test Plan/Procedure	IFR	90 days after FNTP
Capacity Test Plan/Procedure	IFR	90 days after FNTP
Functional Test Report	IFR	5 days after Functional Testing
Capacity Test Results	IFR	10 Business Days after the completion of the test
PSS/E Steady State Model	IFR	At Contract Execution
PSS/E Dynamic Model	IFR	At Contract Execution
PSCAD Model	IFR	At Contract Execution

14) REFERENCE DOCUMENTS/LISTS/INDICES		
Submittal Description	**CODE**	**Timing/Frequency**
Master Document List (transmittal log)	IFR	30 days after FNTP
Vendor Document List (manuals, cutsheets, dwgs)	IFR	30 Days After FNTP
Equipment List	IFI	30 days after FNTP
Drafting Standards/Symbols	IFI	30 days after FNTP
Non-proprietary Calculations, Including: -Electrical -Mechanical -Civil/Structural -Instrumentation	IFR	At 100% issue
Construction Specifications, Including: -Electrical -Civil/Structural -Instrumentation -Mechanical	IFR	30 days after FNTP

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Monthly Reports	IFI	No later than the 10th of each month
Engineering Drawing List	IFI	10 days after FNTP
Supplier Drawing List	IFI	60 Days after FNTP
Equipment Data Books	IFI	At Final Completion
System Turn-over Record Books	IFR	At Final Completion
Commissioning and Start-up Spare Parts List (Including Equipment Criticality Rating)	IFI	60 days prior to Mechanical Completion of first Circuit or 20 weeks after FNTP whichever comes first
Operating spare Parts List (1, 3, and 5 years)	IFR	60 days prior to Mechanical Completion of first Circuit or 20 weeks after FNTP whichever comes first
FAT Documentation	IFR	60 days prior to Mechanical Completion of first Circuit or 20 weeks after FNTP whichever comes first
Systems List (Per Turn-over definition)	IFR	60 days prior to Mechanical Completion of first Circuit or 20 weeks after FNTP whichever comes first
Project Design Data	IFR	30 days after FNTP
Project Punchlist (As generated from Construction to Commissioning Turn-over and Commissioning/Client Walkdown)	IFR	As Issued after Mechanical Completion of each Circuit, and at least 10 days prior to scheduled Substantial Completion

15) TRAINING		
Submittal Description	**CODE**	**Timing/Frequency**
Training Syllabus	IFR	20 days prior to training or 30 weeks after FNTP whichever comes first
System Training Manuals (including major equipment training)	IFR	20 days prior to training or 30 weeks

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		after FNTP whichever comes first
Training Schedule	IFR	20 days prior to training or 30 weeks after FNTP whichever comes first

16) MANUALS AND INSTRUCTION BOOK		
Submittal Description	**CODE**	**Timing/Frequency**
Operation and Maintenance Manuals List	IFI	30 days Prior to Circuit Substantial Completion of the first Circuit
Contractor Operation and Maintenance Manuals	IFR	At Circuit Substantial Completion of the first Circuit
Vendor Operation and Maintenance Manuals	IFI	At Circuit Substantial Completion of the first Circuit

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17) QA DOCUMENTATION		
Submittal Description	**CODE**	**Timing/Frequency**
Quality Plans (Including Design, Construction and Commissioning)	IFR	45 days after FNTP
Reports of Supplier Inspections	IFI	10 days after inspection
Quality Audit Plan	IFR	45 days after FNTP
Quality Dossiers	IFR	At Final Completion
Health, Safety and Environmental Review Reports	IFR	As Required By Permit Conditions
Personnel Qualifications and Certifications Requirements	IFI	45 days after FNTP
Personnel Qualifications and Certifications	IFI	45 days after FNTP
Field Inspection and Test Reports	IFR	As Issued
Non-Conformity Reports and Solutions	IFR	As Issued
Instrument Assurance Certificates	IFI	As Issued
Electrical Assurance Certificates	IFI	As Issued
Equipment Assurance Certificates (Including Vendor Equipment)	IFI	As Issued
Material Identification and Traceability Procedure/Records	IFI	As Issued
PV Modules Flash Test Data	IFI	At submittal of Turn-over documents
Soiling Station and all instrumentation Calibration Certificates	IFI	5 days prior to Capacity Test
Equipment Factory and Field Test Reports	IFI	10 days after test

EXHIBIT 3 – PERMIT REQUIREMENTS

Exhibit 3
PERMIT REQUIREMENTS

1.0 CONTRACTOR ACQUIRED PERMITS

Bidder to list all:

- Contractor is responsible for all siting, zoning, wetland and building/construction-related permits required for the construction of the Project.
- Contractor is responsible for all labor or health standard permits, and approvals reasonably related to construction of the Project.
- Contractor is responsible for all business permits reasonably related to the conduct of the operations of Contractor and all Subcontractors in the State of [Project Specific] and local government units where such permits may be required (including all contractors' licenses and related documents).
- Contractor is responsible for all permits, approvals, consents or agreements from or with any Person necessary for the performance by Contractor of the Work or its warranty obligations hereunder, for the transportation or importation of equipment, tools, machinery and other items used by Contractor in performance of the Work.
- Contractor is responsible for all permits, visas, approvals and certifications necessary for Contractor's employees to legally perform the Work in the State of [Project Specific] (including documentation of citizenship or legal residency in the United States). Without limiting the foregoing, Contractor Acquired Permits include permits for temporary construction utilities and temporary sanitary facilities, dump permits, road use permits, permits related to the use, storage and disposal of Hazardous Materials, and permits issued pursuant to any building, mechanical, electrical, plumbing or similar codes.

Permit/Approval	**Agency**
Dust Permit	[Project Specific]
Grading Permit	[Project Specific]
Building Permit	[Project Specific]
Trailer Permit	[Project Specific]
Fence Permit	[Project Specific]
Storm Water Notice of Intent	[Project Specific]

EXHIBIT 4 – SAFETY AND SITE SECURITY REQUIREMENTS

EXHIBIT 4
SITE SAFETY AND SECURITY REQUIREMENTS

1.0 GENERAL SAFETY & SITE SECURITY

12.78 Overview

A. Contractor shall take all necessary precautions for the safety and security of its employees, Subcontractors, agents, owner representatives and visitors on the jobsite and prevent accidents or injury to individuals on, about, or adjacent to the Site. Contractor shall develop and provide, for the site specific work being performed, their Site Environmental, Health & Safety, and Security Plan no later than 6 weeks after Limited Notice to Proceed. Contractor shall ensure that the Plan complies with all federal, state and local regulations and any project specific requirements. Owner shall have 15 business days to review and comment on such Plan submitted by the Contractor; provided, however, that Contractor shall remain solely responsible for performing such Work in accordance with this Agreement. If Owner provides any comments with respect to the Plan to Contractor, then Contractor shall consider Owner's comments and incorporate changes into the Plan, or otherwise address, and resubmit the revised Plan to Owner. Such resubmission of the Plan shall not be considered a Change In Work. Contractor shall perform the Work in accordance with the accepted Plan. Contractor shall not perform any Work on the Site prior to final acceptance of the Plan. In addition, Contractor shall erect and properly maintain at all times, as required by the conditions and progress of the Work, all safeguards and warnings for the protection of its employees and the general public that are reasonably prudent or required by Applicable Law.

B. Contractor shall conduct regular inspections required to ensure that safe working conditions and equipment exist. Contractor accepts sole responsibility for: (a) providing a safe place to work for its employees and for employees of its Subcontractors working at the Site and agents, and (b) ensuring the adequacy of and required use of all safety practices, procedures and equipment.

C. Contractor shall orally notify the Owner of any serious accident or near miss occurring on the Site or in connection with the Work within 24 hours of occurrence. A fatality occurring on the Site or in connection with the Work must be communicated to the Owner within 8 hours of its occurrence. Contractor shall document any serious accident or near miss occurring on the Site or in connection with the Work and shall furnish Owner Representative with a copy of the written investigation report within 72 hours of any accident or injury to any of the employees or agents of Contractor or any and all Subcontractors utilized in the performance of the Work.

D. Contractor shall immediately notify Owner of any governmental agency (OSHA, Fire Dept., Health Dept., etc.) complaint and/or inspection of the Site.

E. Contractor shall provide to Owner at least monthly, project-related safety performance data to include at a minimum recordable injuries and illnesses, days away from work injuries and illnesses (lost time), recordable and days away from work rates, and performance to project health and safety goals.

F. Contractor shall be responsible for any and all security services (which shall consist of 24-HOUR services) required for the performance and completion of the Work prior to the occurrence of Project Substantial Completion. Prior to the occurrence of Project Substantial Completion, Owner shall have no responsibility for the security of Contractor's equipment, or any of its Subcontractor's equipment stored at the Site during the performance of the Work including construction of appropriate fencing. When designing, procuring and implementing any securities services, and during the performance of all security services pursuant to this paragraph, Contractor shall cooperate and cause its Subcontractors performing work at the Site to cooperate with Owner.

EXHIBIT 5 – COMMISSIONING

EXHIBIT 5
COMMISSIONING

1.0 OVERVIEW

The Commissioning process provides a quality-oriented methodology for verifying and documenting the design, construction, functionality, and performance of the Project. The commissioning process shall ensure that all system components perform interactively to meet the defined system objectives and criteria of the Owner, as established in the Agreement and its Exhibits.

The Commissioning representative to be used by the Contractor must be proposed to Owner as part of Commissioning Plan and agreed upon by Owner before start of work.

2.0 SCOPE

All commissioning activities shall be executed under a phased approach, as identified below. Activities of each phase shall be documented and submitted to the Owner for review, acceptance, and documentation:

12.79 Design Phase

2.1.1 Design Review: Design review is part of the Commissioning process. The Contractor shall provide regular design reviews with the Owner to ensure the Owner's project requirements are being met. There is to be a Conceptual Design Review at the launch of the project (LNTP) and at each of the design package milestones of the Construction Drawings (refer to Agreement). The Commissioning team will participate in later phases of the reviews.

2.1.2 Commissioning Plan: A project-specific Commissioning Plan shall be developed and issued by the Contractor. The Plan shall outline the proposed personnel and/or company, tasks, processes, procedures, and deliverables required to prove the function and performance of the Project and all of its systems. It will include a section on Deficiencies and Resolution Procedures for each phase and the Commissioning Schedule. The Plan shall also reference safety requirements for start-up and commissioning, including electrical safety and lock-out/tag-out procedures. The Plan shall be submitted to the Owner for review and approval. The plan shall include example forms for each commissioning activity that clearly state the pass/fail criteria, the individual(s) performing the test, the date and time of the test and the result of the test.

2.1.3 Commissioning Specifications: Commissioning specifications shall be provided by the Contractor to outline the requirements for the installing contractors.

2.1.3 Commissioning Review: A commissioning review of the design drawings shall be performed by the Contractor and shall address design fundamentals for reliability, maintainability, and commissionability (e.g., design, location, and quantity of primary and secondary measurement devices)

2.1.4 Commissioning Log: A detailed commissioning log will be developed and issued by the Contractor for the tracking of all commissioning issues, observations, and deficiencies. The commissioning log will enable current status and resolution tracking of any open items. The log will be circulated to the project team on a regular basis for review.

EXHIBIT 5
COMMISSIONING

12.80 Construction Phase

2.2.1 Meetings: Commissioning meetings will be held on-site on a periodic basis. A commissioning kick-off meeting will be held with the project team at the commencement of project construction, or at least 30 days before commissioning. The Commissioning Team consists of, at a minimum, the Contractor's Commissioning Agent, project manager, design team representative, construction team representative, the Owner's project manager and project engineer.

2.2.2 Submittal Reviews: Approved equipment submittals shall be reviewed by the Contractor for compliance with the project design, intent and specifications.

2.2.3 Factory Acceptance Tests:

The following PV equipment shall be tested for functionality, operability, and performance:

1. Solar Modules (IEC 61215 tests and Flash Tests)
    a. Contractor to provide Owner approved means for large file transfer in order to effectively share documentation.
2. Combiner Boxes (or Load Break Disconnects as applicable)
3. Inverter Skid Assemblies
4. Solar Substation GSU
5. SCADA
6. Trackers
7. MET Station

OWNER and ENGINEER shall be given opportunity to witness each test and shall be given 15-day advance notice prior to any planned test. The related expense will be paid by the Contractor. Owner and/or Engineer's travel expense for attending factory acceptance testing will be paid by the Owner

Refer to Exhibit 5-01 for the required factory tests on the inverter. Since inverter efficiency and other testing are impractical in the field, the Project requires more stringent testing in the factory. All testing results shall be fully documented and reported to Owner.

2.2.4 Prefunctional Checklists: Project and equipment-specific prefunctional checklists shall be developed and issued by Contractor to the installing contractors. The prefunctional checklists shall address proper installation methods, vendors' requirements, applicable codes and standards, and good engineering practice requirements. A master checklist, with acceptance criteria, shall be included in the Commissioning Plan which is issued to the Owner. Prefunctional check out of all systems shall be required as part of Mechanical Completion [refer to Agreement section for more definition]

2.2.5 Inspections: Equipment delivery inspections shall be carried out by Contractor during the course of construction. Reports shall be issued for inspections of inverter skids. This will include signatures of the responsible personnel and verification of proper installation of all equipment, devices, and wiring per manufacturer's recommendations. This will also include observations and punch-lists from Quality Control personnel verifying installation has occurred per their design drawings and specifications.

2.2.6 Functional Testing: There are two types of functional testing required:
1) Equipment-specific functional testing and 2) PV Plant Functional Testing – these

EXHIBIT 5
COMMISSIONING

protocols will be developed and executed by Contractor to address functionality and safe operation of components and systems. The functional testing protocols shall be detailed so as to address operation, failure modes, and recovery modes.

Equipment-specific functional testing: The Project will consist of PV generation equipment and sub-systems: PV modules, DC wiring, combiner boxes or Load Break Disconnects (LBD), Inverter Skid Assemblies, trackers, and all associated structural elements and interconnecting cables that will allow the PV Plant to generate and deliver the AC power to the Project Point of Interconnection. Prior to energization, all NETA-ATS tests shall be completed including the following checks and testing, at a minimum:

1. Proper mechanical and electrical installation of the PV modules.
2. Completion of the pre-functional tests of the PV Modules and DC collection system, including but not limited to string level Open Circuit Voltage Testing, Operating Current Testing, IV Curve Tracing (to be performed on 1% of the strings, and to re-test strings that are outside acceptable tolerances), cable Megger Tests, and Grounding Tests.
3. AC cabling Very Low Frequency (VLF) testing or Partial Discharge (PD) testing.
4. Proper installation and operation of the Inverter Skid Assemblies.
5. Completion of Inverter pre-functional checks and functional tests per Contractor's commissioning protocols (Including phase rotation and synch checks, emergency and safety features). Inverters shall be checked for proper firmware, installation and connection of all components and systems such as fuses, capacitors, CTs, IGBTs, grounding, and cooling. All pre-functional checks shall be followed strictly per manufacturer's instructions (Cold commissioning plans).
6. Inverters shall have no manual deratings and shall be set to default manufacturer nameplate ratings. Inverters shall have all settings at factory default settings unless approved in writing in advance.
7. Grounding tests shall be completed for each system. Grounding path from inverter skid to tracker piles shall also be checked in each inverter array and not exceed [TBD] ohms. Completion of the pre-functional checks and functional tests of the inverter medium voltage transformers, including but not limited to Megger Tests, HI-POT Tests, Oil sampling tests (Dissolved Gas Analysis required to be performed either in factory or field in order to establish a baseline), Grounding Tests, operation of alarm and indication sensors. Insulation resistance of windings and turns ratio test at all tap settings shall be performed in both the factory and the field.
    a. Liquid filled transformers shall have the following field testing requirements:
        i. Verify nameplate data.
        ii. Coordinate and perform instrument transformer tests on CTs with transformer assembly.
        iii. Winding Tests:
            1. TTR at all no-load taps.
            2. Megger winding to ground.
            3. Megger winding to winding.
        iv. Set high-side voltage taps at positions determined by Engineer.
        v. Check and measure equipment ground; neutral to grounding grid resistance shall not be more than one ohm.
        vi. DGA:
            1. Check insulating fluid for clear or pale amber color and report any variance to Owner. Other colors may indicate contamination from decomposition of insulation, foreign material, carbon, or other substances.
            2. Test oil samples from each transformer with standards in accordance with ASTM D1816.
        vii. Check liquid level in tanks.

EXHIBIT 5
COMMISSIONING

viii. If equipped with cooling fan, check operation of cooling equipment and cooling controls before energizing transformer.
ix. Check calibration of pressure relief device, top oil temperature gauge.
x. Test all gauges including level, temperature, and pressure gauges.

b. Dry type transformers shall have the following field testing requirements:
i. Verify nameplate data.
ii. Winding tests:
1. TTR at all taps.
2. Megger winding to winding.
3. Megger winding to ground.
iii. Check equipment ground to assure continuity of connections. Notify Owner if ground is more than one ohm.
iv. Check for proper operation of the winding temperature gauge and cooling fans.
v. Set high-side voltage taps at positions determined by Engineer.
vi. Check connections for tightness; clean out dust and other foreign material.

8. Trackers: Verify trackers are fully functional. Ensure they operate in unison and adjust angle accurately remaining normal to sun even with clouds and reset to proper angles after stow or night; back-tracking function works properly with no sustained interior shading. Proper tracker stow shall be checked and wind and hail stow shall be verified.
9. Completion of the functional test of cable terminations in all electrical cabinets including switchgear (if applicable) per Contractor's commissioning protocols, including but not limited to PID or VLF testing, and Disconnect devices integrity and operability, insulation test on each phase conductor with respect to phase to phase and phase to ground, verification of ratios of all VTs, and CTs, insulation resistance test of all VTs, CPTs, and CTs, polarity check of all CTs, verification of protective relay settings, secondary injection test.
10. Test plant controls to verify all control features are fully functional, including reactive power control (PF/VAR/voltage) and power curtailment.
11. All auxiliary systems and devices are installed and functionally tested.
12. Proper operation of the SCADA monitoring and control system. This includes all associated instrumentation, communications, and controls between SCADA and other System Devices (e.g., Inverters), alarms, data acquisition, and historian.
13. Fiber loop feed shall be tested to verify fully functioning fiber ring, including OTDR testing.

PV Plant Functional Testing: Plant Functional Testing is required on the entire electrical generation system prior to Substantial Completion [refer to Agreement section].

The Functional Test will ensure that a fully functioning PV Plant is commissioned and placed into automatic operation, including confirmation of the following systems: Inverters, trackers, auxiliary systems, transformers, SCADA, Power Plant Controller (PPC), MET stations, and other equipment. For substation testing refer to Attachment 2.

The Contractor shall develop a detailed plan to test the functionality of the PV Plant and submit to Owner for Owner's review and acceptance. Functional Testing shall be conducted by Contractor in accordance with the agreed upon Functional Test Plan.

The Functional Test Plan shall define and record the pre-test start condition of each Circuit, automatic start-up and shut-down of the inverters, trackers, auxiliary systems or devices, or any other automatic operation. Basic parameters that define such automatic operation shall be recorded as part of the test (e.g., Inverter Wake-up Voltage, shutdown, etc.)

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COMMISSIONING

Energization shall have been fully completed. There shall be no power curtailment or non-standard facility set points or settings, unless approved by Owner in writing in advance.

During the Test, as a minimum, the following operating parameters shall be captured of the Circuit of Project under test:

a. Irradiance
b. Ambient Temperature
c. Wind speed
d. Inverter Voltage, Amperage (both DC and AC)
e. Inverter IGBT (measured at heat sink) Temperature
f. Power, Voltage, Amperage
g. Module Temperatures
h. Transformer temperatures and pressures and alarm status
i. Tracker angle
j. All faults, alarms, errors, and warnings of all equipment

The Test shall be carried out for 120 hours without interruption or operator intervention under Normal Operating Conditions and emergency conditions shall be excluded. The Test shall maintain a 100% time-based availability of all equipment under test for the entire duration of the Test. An allowance of one inverter's downtime for one hour will be allowed during the Test (for the avoidance of doubt, no downtime is allowed for a 2nd inverter). The Test shall provide 100% data availability for all equipment under test for the entire duration of the Test. Owner will consider allowing some secondary data reporting to be temporarily non-functioning such as angle of one tracker.

12.81 Acceptance Phase

2.3.1 Capacity Testing: The performance of the PV Project and its components and systems shall be measured and documented pursuant to the procedures set forth in Exhibit 6.

2.3.2 Aerial Thermographic Survey: An aerial survey of the plant shall be completed prior to Final Completion. The survey shall use infrared imagery with adequate resolution to identify hot spots in the individual modules, strings, and ISAs. A report summarizing the findings shall be submitted to Owner for review.

2.3.3 Training: Contractor shall provide a training program to the Owner, including classroom and field training. The training program will cover operational aspects of the Project.

2.3.4 O&M Manuals: Contractor shall provide detailed and specific Operations and Maintenance (O&M) Manuals in mutually-agreed format. The O&M Manuals shall include, but not be limited to: System descriptions, method of plant operation, sequences of operation, troubleshooting procedures, maintenance procedures, as-built drawings, and all equipment vendor and subcontractor supplied manuals, warranties, and specification sheets.

2.3.5 Warranty Review: Contractor shall review all equipment warranties for compliance with contract documents. Extended warranty requirements and warranty activation dates shall be documented.

2.3.6 Commissioning Manual: Contractor shall create a Commissioning Manual, addressing the disposition of all system installation, functionality, and operation tests identified in the Commissioning Plan. The Commissioning Manual shall include all relevant start-up and commissioning documentation, test data, site reports, equipment start-up data, and checklists in a logical and sequential format. Upon completion of the project, the Commissioning Manual shall be submitted to Owner electronically.

3.0 INSTRUMENTATION

Contractor shall be responsible for all standard testing instrumentation. Testing instrumentation shall include, but is not limited to:

- Power meters
- Voltmeters
- Clamp-on meters (Amp meters)
- Irradiance meters
- Power quality test equipment
- Temperature sensors
- Met stations: Wind speed sensors, rain gauge, ambient temperature sensors, and all other sensors.

All instrumentation is to be NIST, or approved equivalent, calibrated; calibration certificates shall be current for all instrumentation used by Contractor during testing.

All irradiance meters shall be cleaned no less than once per week during testing.

4.0 SAFETY

During commissioning, Contractor shall be responsible for any requirements for specific safety procedures and equipment that are in addition to the standard site safety requirements. This shall include such items as:

- Fall protection
- Electrical Safety
- Lockout/Tagout

EXHIBIT 5
COMMISSIONING

EXHIBIT 5-01 – INVERTER TESTING REQUIREMENTS

EXHIBIT 5-01
INVERTER TESTING REQUIREMENTS

1.0 OVERVIEW

The Inverter factory testing shall ensure that all inverter components perform interactively to meet the inverter requirements and criteria of the Owner, as related to the site-specific requirements of the Project. This includes all safety, control, performance, and environmental aspects.

The Owner's objective is to verify that the inverter is fully functional and performing to meet all Project requirements. Test instrumentation accuracy shall be according to Table 1 of this Exhibit.

Owner shall have the opportunity to witness factory testing. Contractor shall give Owner fifteen business days advanced notice along with factory testing plan for review and response prior to testing.

2.0 SCOPE

The inverter manufacturer shall provide the following documentation from a certified NRTL:

1. UL 1741 Test Report
2. UL 1741 Certification
3. UL 1741 SA Test Report (if applicable)
4. UL 1741 SA Certification (if applicable)
5. IEEE 1547/519 Harmonics Test Report (including raw test data)
    a. Current THD < 3%
6. NERC PRC-024-2 Voltage and Frequency Ride-Through Test Report
7. CEC Efficiency Test Results

The inverter manufacturer shall provide the following documentation from type testing (or from a certified NRTL) to show the inverter meets the specifications outlined in the data sheet. The documentation shall include, at a minimum: active power, reactive power, frequency, DC voltage/current, AC voltage/current, and critical component temperatures (for ambient temperature testing).

1. Active Power
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the nameplate power rating (including any "overdrive" or 110% functionality).
2. Reactive Power
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the maximum reactive power capabilities.
    b. Minimum Requirement: 0.8 lead/lag in 0.01 intervals
3. Plant Controller Response
    a. Inverter manufacturer shall provide test documentation showing the inverter can receive active and reactive commands from a simulated plant controller interface.
    b. Inverter manufacturer shall provide test documentation showing the inverter can operate at the maximum and minimum ramp rates for both active and reactive power variation.
4. Edge-of-Cloud Effects
    a. Inverter manufacturer shall provide test documentation showing the inverter can track the PV array maximum power point (MPP) during high DC voltage and current transients.
5. DC Voltage
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated DC voltage operating range.
    b. Inverter manufacturer shall provide active power vs. DC voltage de-rating curves.
6. AC Voltage

EXHIBIT 5-01
INVERTER TESTING REQUIREMENTS

a. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated AC voltage operating range.
b. Inverter manufacturer shall provide active power vs. AC voltage de-rating curves from 0.9 to 1.1 p.u. terminal voltage and 0.9 lead/lag.

7. Ambient Temperature
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate over the entire ambient temperature range (minimum 4 hours at each test condition).
    b. At a minimum, the test documentation must include the following operating conditions:
        i. 25°C
        ii. 45°C
        iii. Maximum Operating Temperature
        iv. Minimum Operating Temperature
        v. Any “corner points” on ambient temperature de-rating curves
    c. Inverter manufacturer shall provide active power vs. ambient temperature de-rating curves.
8. DC/AC Ratio
    a. Inverter manufacturer shall provide design calculations and/or test data showing the inverter performance and reliability information at multiple DC/AC ratios including, but not limited to, the maximum and minimum DC/AC ratios specified for the project.
9. Reliability
    a. Inverter manufacturer shall provide test documentation summarizing the accelerated life testing (ALT) and highly accelerated life testing (HALT) testing that has been completed.
    b. Inverter manufacturer shall provide mean time between failures (MTBF) and mean time to failure (MTTF) rates for critical components such as:
        i. IGBTs
        ii. DC switches/contactors
        iii. AC contactors/breakers
        iv. DC link and AC filter capacitors
        v. Communications boards
        vi. Cooling system components (fans, pumps, etc.)

At a minimum, the following tests shall be performed on each inverter during production testing:

1. Calibration of all DC and AC voltage, current, and power circuitry/sensors.
2. UL 1741 production testing such as hi-pot and PE/ground testing
3. GFDI
4. Emergency stop (fast stop)
5. Remote start/stop
6. Burn-in (minimum 4 hours per inverter)
    a. Burn-in testing should be completed under elevated ambient temperature and high DC current conditions at maximum rated power.
7. Harmonic content verification (during burn-in tests)
8. Efficiency verification
    a. Verify inverter efficiency at multiple DC voltages and power levels which shall be consistent with the levels tested during CEC testing.
        i. The official CEC test procedure is not required.
9. Reactive power control (0.95 lead/lag) at rated apparent power
10. Voltage and frequency ride-through verification per IEEE 1547 and/or PRC-024-2

EXHIBIT 5-01
INVERTER TESTING REQUIREMENTS

Table 1 Basic Measurement Requirements

Parameter **True RMS (V, I, P)**	**Allowable Maximum** **Uncertainty**
DC Voltage	± 1% of reading
AC Voltage	± 1% of reading
DC Current	± 1% of reading
AC Current	± 1% of reading
DC Power	± 1% of reading
AC Power	± 1% of reading
Temperature	± 1°C
DC Current Ripple	± 5% of reading

Table 2 Power Conversion Efficiency Test Points

Test	**Vdc**	**Vac**	**Inverter DC Input Power Level**						
			100%	**75%**	**50%**	**30%**	**20%**	**10%**	**5%**
A	Vnom	Vnom							
B	Vmax	Vnom							
C	Vmin	Vnom							
D	Vmin	102% Vmin							
E	Vmax	98% Vmax							

EXHIBIT 5-02 – SOLAR SUBSTATION TESTING REQUIREMENTS

EXHIBIT 5-02
SOLAR SUBSTATION TESTING REQUIREMENTS

1.0 INTRODUCTION

The requirements of the Commissioning specification, Exhibit 5, are applicable to the Solar Substation power delivery system. The purpose of this attachment is to provide further detail on the requirements. This specification, however, is not meant to be all-inclusive or completely comprehensive but outlines the main tests that shall be performed on the Substation.

2.0 TESTING AND COMMISSIONING

The Contractor shall perform the Solar Substation testing listed below, though the list is not meant to be all-inclusive. This shall include all testing and recording required by the interconnection authority, and NETA-ATS. Equipment tests shall be in accordance with the manufacturer's recommendations. It is up to the Contractor's discretion whether or not to use an independent certified testing company in order to complete some or all of the tests. However, substation commissioning and testing will be observed by Owner's qualified personnel or representative for conformance to NETA-ATS and industry standards. Submit to the Owner for approval a proposed plan for testing 30 days prior to commencement of testing. In addition to schedule and personnel qualifications, the proposed testing plan shall also include pass criteria and a list of equipment to be used for the project testing.

- Electrical Testing
  - Types of test covered by this Contract shall include but not be limited to:
    - Megger tests
    - Instrument transformer tests
    - Insulating oil tests
    - Ground testing
    - Power panel tests, AC and DC
    - Low voltage automatic transfer switches
    - Battery chargers
    - Batteries
    - Molded-case circuit breaker trip test
    - High voltage testing
    - Radio interference tests
    - Lighting
    - Hot-spot tests on buses, connectors, and fittings
    - Miscellaneous tests on other equipment furnished and installed by the Contractor
    - Other tests as required by the Owner.
  - All relay functions, control, status, alarm, and interlock functions, and metering functions shall be tested by this Contract, and meet NETA ATS requirements.
  - Record any malfunctions noted in the operations and when repairs are completed, repeat the tests and record on the connection drawings the date that the scheme functioned satisfactorily and who conducted the tests.

EXHIBIT 5-02
SOLAR SUBSTATION TESTING REQUIREMENTS

- After completion of bench testing and after connection of all external wiring, conduct functional tests by forcing each relay contact to see the proper breaker is tripped and/or alarm picks up.
- Testing of relays shall include the tests wherein current and voltage are applied to the disconnected leads to relaying at current and potential transformers as well as phase angle and current checks after relays are actually in service and carrying load current.
- Instrument transformer tests including ratio tests and excitation current tests.
- High current tests shall simulate actual load current and fault current operation of the substation electrical equipment.
- Megger each high-voltage bus, PCB, transformer, switch, and CT, or other important item of equipment just before it is energized each time during construction.
- Maintain correct phasing on all circuits and buses. Solar Substation buses and connections shall conform to the phasing of the POI. Make phasing tests on all circuits that can be energized from two or more sources to prevent paralleling of sources out of phase.
- Immediately after initial energization, complete load tests and checks to include current checks on all applicable relays, meters, transducers, etc. Perform voltage checks on all applicable relays, meters, transducers, etc. Perform angle checks on all applicable relays, meters, transducers, etc.
- Capacitor Banks: Test capacitor banks for operability. Test in conjunction with the PPC to ensure proper power factor control is obtained.
- Due to the critical nature of the substation and the use of high-current equipment and connections, the Contractor shall provide equipment, supervision and labor as required to perform infrared temperature inspections. Obtain infrared scanning service including equipment and an operator from a qualified source if the Contractor does not own infrared equipment. Survey all substation bus, conductors, and connections installed by this Contract and all major equipment installed by this Contract.
- Infrared tests will include scanning all electrical connection points including terminal points. Tests will be performed with equipment in service or operating. A test report will be submitted on all tests including pictures of all equipment for baseline measurements. Any problem or questionable areas must be documented. A questionable area will be defined as an area where temperature is 10 degrees Celsius greater than its surrounding area. The Contractor shall correct any deficiencies in equipment or connections that resulted from improper installation.
- Functional Testing: Project and equipment-specific functional testing protocols will be developed by Contractor to address functionality and safe operation of components and systems. The functional testing protocols shall include all substation interfaces and shall be detailed so as to address all facets of operation, failure modes, and recovery modes.
- Interconnection authority testing: Documentation as required by interconnection authority (check lists and data forms) shall be submitted on time to meet project schedule for required testing of the substation at the completion of the project. There are three main tests required:
    - Primary Frequency Response (PFR)
    - Reactive Power
    - Automatic Voltage Regulation (AVR)

EXHIBIT 6 – PV CAPACITY TEST

EXHIBIT 6
CAPACITY TEST

1.0 OVERVIEW

Capitalized terms not otherwise defined in this Attachment shall have the meaning given such terms in the Agreement. The following is an overview of the procedures to be utilized in connection with the execution of performance tests of the PV Power Plant. The objective of the Capacity Test is to verify contract requirements and guarantees have been met. A PV Power Plant Capacity Test will be performed once the entire PV Power Plant is fully functional. The Contractor has the option of performing capacity tests on circuits prior to the contractual Capacity Test.

The tests are to be executed once Contractor has successfully completed all Functional Tests set forth in Exhibit 5, Commissioning, however, the Capacity Test may be run concurrently with the Functional Test if approved by Owner. Contractor shall remediate the shortcomings and re-test until the guarantees are achieved.

On or before Substantial Completion of the PV Power Plant, Contractor shall commence the Capacity Test which may be witnessed by Owner or Owner's representative. In such case that Contractor fails to satisfy all requirements of the PV Power Plant Capacity Test on or before the Substantial Completion of the PV Power Plant, Contractor shall remediate the shortcomings during the Cure Period before commencing re-tests.

This Capacity Test is based on ASTM E2848 but incorporates considerations for bifacial modules. PRC is the actual power measured at the Reporting Conditions (RC). PMIN is the guaranteed power at RC. Pass/fail: PRC/PMIN *100 greater than or equal to 97% (accounts for 3% test measurement error). PRC is determined from filtered on-site data (5 min or 1 min), running multiple regression and calculating from resulting equation with its coefficients, at RC. PMIN is determined by running Pvsyst with site weather data (1 hr, averaged from site data) or if not available from other source such as Solar Anywhere, filtering, running regression, calculating at RC. RC is determined from site data (can also use modeled but prefer site data), finding Irradiation Irro mean +/- 20%, 40%/60% distr., above 400 W/m2, and averaging T_0 and W_0.

2.0 DEFINITIONS

Agreement
The Term Sheet between Owner and Contractor to which Attachment D and this Exhibit 6 is attached.

Circuit
Group of ISAs that make up a portion of the full capacity of the PV Power Plant. This is the total AC power associated with one circuit breaker of the Solar Substation. If there are two feeders connected to one circuit breaker this will still be considered one Circuit.

Guaranteed Capacity
This is the guarantee by the Contractor for the total Power Rating of the PV Power Plant. It shall be verified by the Capacity Test (see section 5 below) in which the guaranteed Minimum Power Rating, $\mathbf{P_{MIN}}$, as calculated and predicted with the PV Simulation Model at the Reporting Conditions, is compared to the Power Rating, $\mathbf{P_{RC}}$, as measured by the Main Facility Meter at the Point of Interconnection. Guaranteed Capacity shall be calculated as 97% of the Facility Performance (allows for a percentage less than 100% accounting for some test measurement uncertainty). It shall be expressed as a percentage.

Minimum Facility Capacity
Shall be 95% with no correction for measurement uncertainty.

Minimum Power Rating ($\mathbf{P_{MIN}}$)
This shall mean the expected power output of the PV Power Plant at the Reporting Conditions, as computed by the procedure outlined in section 5 below.

Facility Performance
Shall mean the Power Rating divided by the Minimum Power Rating for the PV Power Plant at the time the

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Capacity Test is performed, expressed as a percentage.

PV Power Plant
The PV Power Plant (also referred to as the "Facility") will consist of XX MW_{AC} of PV generation equipment, including the PV Arrays, cable harnesses, combiner boxes, DC fuse boxes, inverters, transformers and switchgear (if required), as well as all associated structural elements and interconnecting cables that will allow the PV Power Plant to generate and output AC power to the Owner-supplied interconnection point.

Point Of Interconnect (POI)
This shall have the meaning set forth in the Agreement.

Power Rating (P_{RC})
This shall mean the actual power output of the PV Power Plant at the Reporting Conditions, per ASTM E2848-13. It shall be computed by the procedure outlined in section 5 below. Power measurements will be conducted within the range of power factor as required by the Project.

PV Simulation Model (Energy Model)
The PV Simulation Model shall be based on the most recent version of PVsyst at the time of limited notice to proceed. All of the program inputs shall be put forth by Contractor and Exhibit 8 and reviewed and approved by Owner and Contractor at the time of contract execution with a corresponding Guaranteed Capacity. In the event the PV Power Plant is modified by mutual agreement between the Contractor and Owner, the program inputs may be modified to match the constructed PV Power Plant if agreed upon by Owner and Contractor.

Primary Measurement Device
An instrument which provides a measurement or reading that is used in calculating the PV Power Plant Power Rating.

Reporting Conditions
This shall be as defined as the reference irradiance (Irr_0), the reference temperature (T_0), and the reference wind speed (WS_0) as determined by the procedures outlined below and referred to in ASTM E2848-13.

Secondary Measurement Device
An instrument which provides a measurement or reading that is not used in calculating the output power but is used as check on primary measurements or for further analysis.

Supervisory Control and Data Acquisition (SCADA)
The hardware and software installed at the Project Site, which is used to monitor and collect the weather and performance data from the PV Power Plant. This typically consists of programmable logic controllers, data loggers, software, and other network devices.

Test Measurement Uncertainty
Shall be calculated as described by ASTM E2848-13 (referred to as expanded uncertainty in ASTM E2848-13).

Test Period
Shall mean the "data collection period" referred to in ASTM Standard E2848 and Test Period contained in this document below.

3.0 TEST MEASUREMENTS

All test measurement devices shall be fully defined for their make/model, accuracy, calibration and location. The following tables summarize these measurements that will be required for all of the tests:

Test Measurements (Minimum)

Measurement	Quantity	Type	Instrument Type	Range	Minimum Accuracy
Global Horizontal Irradiance	1 per Met Station	Secondary	Secondary Standard Thermopile Pyranometer	0-1600 W/m2, 285 to 2800 nM	ISO 9060 Spectrally Flat Class A

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			mounted in the horizontal plane		
Plane of Array Irradiance	1 per Met Station	Primary	Secondary Standard Thermopile Pyranometer mounted within Array	0-1600 W/m2, 285 to 2800 nM	ISO 9060 Spectrally Flat Class A
Rear Plane of Array Irradiance – for estimating bifacial gain	1 per Met Station	Primary	Secondary Standard Thermopile Pyranometer mounted within Array	0-1600 W/m2, 285 to 2800 nM	ISO 9060 Spectrally Flat Class A
Net Power Output (kW)	1	Primary	Owner's power meter(s) installed at the POI with calibrated CTs and PTs		+/- 0.2%
Net Power Output (kW)	1 per Inverter	Secondary	Inverter internal power meter		+/- 2%
Ambient Temperature	At each Met Station	Primary	Part of weather station	-50 – 60°C	+/- 0.3°C
Module Temperature	2 per Met Station	Secondary	Platinum RTD (resistance temperature detector) (.00385 TCR DIN B), on back surface of module	-10 - 140°C	+/-0.3°C
AC/DC Power, Volts and Amperage	1 per Inverter	Secondary	From inverter CTs and PTs connected to plant SCADA		+/- 2%
Meteorological Stations: Ambient Temp, Wind Speed and Direction, GHI, Rainfall, and others as required	1 per 50 MW, minimum 2	Primary	On-Site weather station		Per manufacturer
Module Soiling	1 per 50 MW, minimum 2	Primary	On-Site soiling stations		Per manufacturer

3.1 Instrument Calibration

All instruments used for primary measurements shall have current NIST-based or equivalent calibration certificates. All calibrations certificates shall be submitted for Owner Review prior to commencement of the applicable test.

3.2 Data Collection

Data shall be recorded by the SCADA system. The use of alternative means for data acquisition shall be used only with the prior written consent of Owner, which consent shall not be unreasonably withheld or delayed. Contractor shall provide sufficient means for Owner to access the test data during the Test Period.

Should remote access to the SCADA system not be available Contractor shall provide daily test reports containing the 1-min interval data for the duration of the Test Period.

4.0 GENERAL TEST REQUIREMENTS

12.82 Scheduling

Contractor, in coordination with Owner's Engineer, shall notify Owner in writing of proposed PV Capacity Test date not less than ten (10) Business Days prior to the proposed date for the Performance Test.

12.83 Pre-test Conditions

The Performance Tests may be performed only when the following conditions are met:

- Weather conditions as required to complete the Performance Tests, as addressed in this Attachment and in the approved Performance Test Procedure.
- There is grid connectivity at each inverter such that the Performance Tests can be accomplished under load.
- Contractor has achieved Mechanical Completion.
- Contractor has completed energization, hot commissioning, and Functional Test.

12.84 Pre-Test Meeting

Prior to each test, a pre-test meeting shall be conducted and recorded. The meeting shall review the applicable approved test procedure, instrumentation locations, calibration sheets and other relevant topics including safety requirements. Minutes of this meeting shall be recorded by Contractor and approved by all parties.

12.85 Test Duration and Data Frequency for Capacity Test

Testing duration and frequency shall be as follows:

CAPACITY TEST DATA COLLECTION	
Test Period	The Test Period shall be a minimum of five (5) Days. The Test Period will continue until sufficient filtered measurement data has been obtained
Data Sampling Interval	1 minute
Data Averaging Interval	5 minute

12.86 Adjustments

Any adjustments made during the tests to any portion of the PV Power Plant or test measurement devices shall be documented by Contractor and reviewed and approved by Owner prior to execution. Owner, and Owner's Engineer, shall be available during test in order to grant such approval, which will not be unreasonably withheld.

12.87 Test Reporting

Contractor shall submit a detailed test report, within five (5) Business Days of completion of successful test, to Owner consisting of the following:

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1) Test procedures (as executed)
2) Instrument calibration sheets/certificates
3) Test data (manual and data acquisition) including table of averaged and filtered data
4) Test measurement and results uncertainty
5) Field notes
6) Calculations and results

12.88 Test Validation

Contractor shall validate the performance of the overall PV Power Plant through the following Capacity Test, which will be conducted by Contractor, in order to determine if the guarantees have been met.

5.0 CAPACITY TEST

12.89 General

The Capacity Test is used to determine the Facility Performance, by evaluating the Power Rating of the PV Power Plant compared to the expected Minimum Power Rating at the Reporting Conditions. The results of the Capacity Test are used to determine if Contractor has met the Guaranteed Capacity.

12.90 Data Collection - General

a) The pyranometers used to collect irradiance measurements shall be cleaned immediately prior to testing. Soiling will be accounted for by Contractor utilizing the average of the measurements from the on-site soiling stations, with data collected in accordance with the manufacturer's recommendations.
b) Owner shall be responsible for:
   i) Routinely reviewing collected weather and operating data for the PV Power Plant following Substantial Completion.
   ii) Agreeing to the Test Period proposed by Contractor for which there are sufficient valid data to meet or exceed the data requirements necessary to perform the procedures as described below.
c) Contractor shall collect, filter, and average data until 120 valid data points are obtained.
d) For PV plants comprising bifacial modules, rear pyranometers shall be used to collect irradiance measurements from the underside of the module. Rear pyranometers shall follow the same above criteria for testing and shall be mounted in the middle of any given PV string on the underside of the torque tube for optimal and representative irradiance collection. Care shall be taken to assure that the ground conditions in the vicinity of the rear-facing pyranometers is as typical of the ground conditions under the solar arrays to the extent practicable.

12.91 Data Collection and Selection of Reporting Conditions (RC)

a) Data collected on site per the above shall be used to determine the Reporting Conditions, per the following procedure. If site measured data is not available for determining Reporting Conditions, the contractual historical weather data file for the period of the test may be used.
b) For the Plane-of-Array (POA) and Rear Plane-of-Array (RPOA for bifacial modules) irradiance measurements, the data recorded from multiple pyranometers will be averaged for each time interval.

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CAPACITY TEST

i) In the event that data from one of the pyranometers is excluded due to malfunction or sensor discrepancy, the data from the un-excluded pyranometers shall be averaged (in the case of malfunctions), or the data from all the pyranometers may be excluded (in the case of sensor discrepancy out of range of sensor accuracy).

ii) In the event multiple ground coverage ratios (GCRs) exist on site, a meteorological station shall be provided in each differing GCR area.

c) The collected data set shall be filtered according to the following operations:

i) The guidelines and calculations described in ASTM E2848-13 will be followed.

ii) Any test data points in which the inverter is "clipping" shall also be excluded.

iii) POA irradiance below 400 W/m^2 will be excluded.

d) After filtering, the resultant data set shall be used to determine the Reference Irradiance (Irr_0) for the Reporting Conditions.

i) In order to determine the Irr_0, the test data (or data from PV Simulation Model using the contractual historical weather data file) shall be sorted according to POA irradiance from highest to lowest and examined to determine the highest POA irradiance value for which there is a nearly equal distribution of valid data points in the range of the selected POA irradiance +/- 20%. This irradiance shall be considered Irr_0.

ii) There shall be no more than a 40%/60% spread in the irradiance distribution, i.e., no more than 40% of irradiance data above Irr_0 and 60% of irradiance data below Irr_0, or vice versa.

iii) All test data where the irradiance is outside of the range of Irr_0 plus or minus the irradiance band ($Irr_0 \pm 20\%$) shall be excluded. At the agreement of Contractor and Owner, the irradiance band may be increased (not to exceed $Irr_0 \pm 50\%$), in order to obtain a necessary and reasonable number of data points.

iv) For bifacial modules, the same above criteria shall be used where POA irradiance shall be replaced with the variable Total Plane-of-Array (TPOA) Irradiance to represent the sum of the filtered POA and RPOA of the system outlined by the following Equation (Eq.1):

$$TPOA = POA + (RPOA^{*} \phi) \qquad \textbf{(Eq. 1)}$$

Where ϕ is the bifaciality factor of the module as provided in the module specification sheet. If the ϕ is available as tested by an independent nationally recognized testing laboratory then this value shall be used.

e) The Filtered Measurement Data shall be defined as the resulting data set of section d above, and it shall have a minimum of one hundred twenty (120) data points.

i) The one hundred twenty (120) or more data points are under the assumption of a five (5) minute averaged data interval.

ii) If the filtered data set does not contain enough data, then additional days (maximum 4 weeks) shall be added to the Test Period to collect enough valid data.

iii) A wider filter can be applied to irradiance band as mentioned above in section d (iii), if agreed upon by Owner and Contractor.

f) The average ambient temperature of the Filtered Measurement Data shall be calculated. This average ambient temperature shall be the reference (RC) temperature T_0.

g) The average wind speed of the Filtered Measurement Data shall be calculated. This average wind speed shall be the reference wind speed WS_0.

12.92 Minimum Power Rating (Pmin)

a) The PV Simulation Model, as derived from PVsyst simulations, shall be used to establish the Facility's expected output to be compared to the power output at the revenue meter as adjusted at

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the relevant conditions.

i) Owner and Contractor, upon execution of the Agreement, shall review and agree on all inputs to PVsyst for the creation of the PV Simulation Model, including (but not limited to): losses, weather data file, and component model files.

b) Each of the PV Simulation Model outputs shall include, as a minimum, the following columns in the respective output .csv files (or 8760 files) :
   i) Date & Time (formatted with Month; Day; Hour in separate columns)
   ii) POA Irradiance (GlobInc, W/m^2)
   iii) RPOA Irradiance (GlobBak, W/m^2)
   iv) Horizontal Irradiance (GlobHor, W/m^2)
   v) Ambient Temperature (T Amb, °C)
   vi) Wind Speed (WindVel, m/s)
   vii) Near Shadings Beam Loss (ShdBLss, W/m^2)
   viii) Inverter Loss Due to Low Voltage Maximum Power Point (MPP) Window (IL Vmin, kW)
   ix) Inverter Loss Due to Power Limitation (i.e., “clipping” loss) (IL Pmax, kW)
   x) Available Energy at Inverter Output (EOutInv, kW)
   xi) Energy Injected into Grid (E Grid, kW)

c) For the purposes of this procedure, the Target Period shall be derived from historical or site-measured weather data. Using the contractual historical weather data is an option to simplify the procedure. The Target Period shall consist of a minimum of fourteen (14) days: the seven (7)-Day period prior to and after the Test start. The Target Period may be extended further than fourteen (14) Days upon agreement of Contractor and Owner.

d) The **Minimum Power Rating (PMIN)** expected from the Plant at the Reporting Conditions shall be determined from the PV Simulation Model for the site in accordance with the following:
   i) Run PV Simulation Model with the contractual historical weather file, or the measured site weather data from the collected Target Period. (PVsyst will receive 1- minute or 5-minute data but will convert it to one-hour data)
   ii) Apply the following filters to the resulting Target Period data file:
      a) Exclude any data points with beam shading values ShdBLss > 0.
      b) Exclude any data points where the inverter is not in ‘Peak Power Point Tracking’ mode, as such term is defined in section 9.1.8 of ASTM E2848-13.
      c) Exclude any data with irradiance values outside of the range established section (3)(d)(iii) above.
   iii) After filtering, the resulting dataset shall have 50 one-hour data points, or more.
      a) If less than 50 data points remain in the set, then the Test Period shall be shifted and a new Target Period shall be identified per to section (3)(e)(ii) above.
      b) At Owner’s discretion, the irradiance threshold may be expanded to a larger range as described in (3)(e)(iii) above.
   iv) For the filtered Target Period dataset, a regression analysis shall be performed on the POA irradiance, ambient temperature, wind speed, and energy at the POI meter. The regression analysis shall be used to determine the modeled regression coefficients A, B, C and D in the following Equation 2 (Eq. 2):

$$E\ Grid = Irr_T * (A + B * Irr_T + C * TAmb + D * WindVel) \qquad \textbf{(Eq. 2)}$$

For bifacial modules use Irr_T in the regression where $Irr_T = GlobInc + (GlobBak * \phi)$ for bifacial modules. Otherwise, $Irr_T = GlobInc$.

Where ϕ is the bifaciality factor of the module as provided in the module specification sheet. (above adjustment assumes bifacial modules in single portrait configuration)

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v) The Minimum Power Rating (P_{MIN}) shall be calculated for the site by substituting in coefficients A, B, C and D and the appropriate Reporting Conditions (Irr_0, T_0 and WS_0) as shown in the following Equation 3 (Eq. 3):

$$PMIN = Irr_0 * (A + B * Irr_0 + C * T_0 + D * WS_0) \quad \textbf{(Eq. 3)}$$

For projects utilizing bifacial modules, use the Reference Irradiation, Irr0, from both sides of the module, i.e., the sum of the irradiation in the plane of array on the front side and back side as illustrated in Equation 1.

12.93 Power Rating (Prc)

a) The Filtered Measurement Data for the site identified in section (3)(e) above shall be used to calculate P_{RC} for the site.

b) Filtering of the test data and calculation of the P_{RC} shall be conducted according to section 9 'Calculation of Results' of ASTM E2848-13. The equation used for the final calculation (equation 2 in ASTM E2848-13, modified for the terminology used in this test report) is:

$P_{RC} = Irr_0 * (a_1 + a_2 * Irr_0 + a_3 * T_0 + a_4 * WS_0)$

Where Irr_0, T_0, and WS_0, are the Reporting Conditions and the coefficients a_1, a_2, a_3, and a_4 are calculated from the measured, filtered data as described in ASMT E2848-13. The regression shall be based on the below for determining the actual coefficients from the equation using the measured site data,

Revenue meter power (for each time stamp) = TPOA * (a1 + a2 * TPOA + a3 * TAmb + a4 * WindVel)

Where TPOA (=POA+RPOA*ϕ for bifacial modules), TAmb, and WindVel are the measured values

c) The results of this section (P_{RC}) shall be reported in accordance with section 10 'Report' of ASTM E2848-13.

12.94 Facility Performance

a) The Facility Performance shall be calculated as below and expressed as a percentage:

$$\text{Facility Performance} = (P_{RC} / P_{min}) * 100$$

b) If the Facility Performance is greater than or equal to the Guaranteed Capacity (97%), then Contractor has met the Guaranteed Capacity. If the PV Power Plant has so achieved the Guaranteed Capacity, then no further analysis is required.

c) If, however, the PV Power Plant did not so satisfy the Guaranteed Capacity, then Contractor shall follow the process outlined in the Agreement.

EXHIBIT 7 – PROJECT SCHEDULE

EXHIBIT 7
PROJECT SCHEDULE REQUIREMENTS

1.0 PROJECT SCHEDULE

Contractor is to provide a detailed work schedule (hard and native electronic copies) thirty days after the issuance of Full Notice to Proceed (FNTP). This work schedule, as subsequently accepted by Owner, shall become Attachment 1 to this Exhibit 7 of the Agreement.

2.0 KEY DATES SCHEDULE

Key Date Schedule shall include major project milestones, including substantial completion of each circuit. Milestones indicated in the Key Date Schedule will be used as a basis for milestone payments.

3.0 CRITICAL PATH SCHEDULE

The Critical Path Schedule shall identify Contractor’s plan of execution for the installation, commissioning and performance testing for the work. The Critical Path Schedule shall be a time-scaled critical path method logic diagram schedule (resource loaded) of all design and equipment procurement for the project and all material work activities so that substantial completion occurs on the substantial completion guaranteed date. The Critical Path Schedule shall include allowance for normal delays and difficulties that may be encountered in work of this nature including weather and holidays, etc. The Critical Path Schedule, as a minimum, must show an orderly array of activities in support of all the dates established in the Key Date Schedule), and shall be sufficiently detailed so that each of the following are included and will be readily apparent:

(A) the engineering and detailed design activities necessary to complete design, procurement and construction;

(B) materials and equipment purchases and deliveries;

(C) subcontractor interfaces and requirements;

(D) construction, by circuit and system;

(E) dates for the completion of key date items;

(F) contractor and subcontractor data cycles, and owner’s review cycles;

(G) functional tests, commissioning and capacity testing;

(H) a schedule for completion of post-substantial completion date items including as built drawings and specific non-critical deficiencies listed on the punchlist costing more than $100,000 to complete.

EXHIBIT 7
PROJECT SCHEDULE REQUIREMENTS

4.0 SUBMITTAL

The Critical Path Schedule shall be delivered both in native electronic form and in hard copy. The Functional and Capacity Test Schedules must be coded in such a way as to provide individual test progress and schedules in accordance with an agreed upon Commissioning Plan.

EXHIBIT 8 – ENERGY MODEL

EXHIBIT 8
ENERGY MODEL

1.0 OVERVIEW

Energy Model Overview

Using the Project Weather File, the PVSyst Parameters, and additional loss parameters, simulations will be run to model the expected energy output from the PV system at the revenue meter producing the expected energy production. This energy model will be used by Owner for its own financial monitoring and asset management, and by Contractor as the PVSyst model for use in the Capacity Test calculations.

The general procedure is as follows:

1) Project Weather File shall be defined and agreed upon by both Owner and Contractor for preliminary models, see section 4.0. Upon project completion, weather file and system operational data shall be gathered and recorded by SCADA to update the model with site data.
2) The Project Weather File will be compiled and used to generate a file that will be loaded into PVSyst.
3) PVSyst will produce an output for the Project Weather File, which will then be loaded into the Energy Model File.
4) Calculate any losses not modeled in PVSyst.
5) Add up the contributions from all the Circuits.
6) Result is the expected net output of the PV power plant which will serve as the Energy Model.

Wherever [ ] appears in this document, it is a value to be proposed by Contractor.

2.0 ACCOMPANYING RESOURCES

Associated Software, Files, and References:

- **Software:**
    a. Most recent version of PVSyst.
    b. Microsoft Excel
- **Files:**
    a. Energy Model File
        i. [ ].xls
    b. Module Equipment Files for PVSyst
        i. [ ].PAN
    c. Inverter Equipment File for PVSyst
        i. [ ].OND
    d. Shading Profile File for PVSyst
        i. [ ].SHD
    e. Project File, Variant Files by Array Type
        i. [ ].PRJ
        ii. [ ].VC2
        iii. [ ].VC3

    f. PVSYST Output Reports by Array Type or Circuit or Plant
        i. [ ].pdf
        ii. [ ].pdf
        iii. [ ].xlsx

    g. Energy Prediction Report by Circuit (if Circuits differ) with AC losses excluded
        i. [ ].xlsx
        ii. Contractor to include with Bid.

- **References**

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ENERGY MODEL

a. System design specifying module types, strings per inverter, inverters per Circuit.

3.0 DATA PREPARATION

Data Collection – Calibrated to actual Site data
Preliminary models to use Solar Anywhere TMY files as specified in section 4.0. Upon project completion, data points to be used in the Energy Model will be measured and recorded by the SCADA in one-minute increments. SCADA recorded weather file to be submitted to Owner with updated energy model as specified in Exhibit 2. Measurement data recorded by the SCADA and used in running the Energy Model will include:

Measured Meteorological Data (inputs to PVSyst):
- GHI Pyranometer irradiance (W/m^2)
- Ambient temperature, T_{amb} (˚C)
- Wind speed (m/s)
- DHI (W/ m^2)
- Albedo (W/ m^2) (If bifacial modules used)

Discussion:
- GHI will be used to calculate POA in the model and ambient temperature and wind speed will be used to calculate module temperature. Though POA and T_{bom} are measured and could be input directly, the Energy Model is based on the POA/GHI transposition and T_{amb}/T_{bom} calculation.

Data Preparation
- The necessary meteorological measurements will be averaged into time intervals consistent with the minimum input parameters required for analysis in PVSyst. Currently this time interval is one hour, but if a smaller time interval becomes available, this will become the default time interval. All data fed into and read from PVSyst should be in hour beginning format.
- The raw test data shall also be analyzed and reduced to eliminate data points that clearly exhibit a high degree of random error (such as errors caused by faulty instruments).
- Missing or obviously faulty data due to equipment error shall be discarded or be replaced in accordance with the Acceptance Test Procedures.
- All methods for data filtering and manipulation shall be agreed upon between Owner and Contractor. A report of all data filtering will be provided.

Load Weather File into PVSyst

The resulting Weather File created will be converted into a TMY3 or ASCII format compatible with the input requirements for PVSyst and will replace or modify the preliminary weather file (used during bid process) used to produce the base PVSyst energy model.

4.0 PVSYST SIMULATIONS

Determine PVSyst Simulations to Run

Although module types and string configurations can vary within a Circuit, each Circuit must be modeled by a single average configuration and single module degradation amount (one PVSyst .VC file per Circuit) Include 8760 data as an attachment.

PVSyst Parameters
1. Project Tab
    - Latitude = [ ] deg.
    - Longitude = [ ] deg.
    - Meteo Data File: Solar Anywhere, satellite data, SUNY model - TMY

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ENERGY MODEL

- Altitude = [ ] meters
- Time zone = [ ]
- Monthly Albedo = [These values assume a one-in-portrait tracker]

Month	PVsyst Inputs
January	[ ]
February	[ ]
March	[ ]
April	[ ]
May	[ ]
June	[ ]
July	[ ]
August	[ ]
September	[ ]
October	[ ]
November	[ ]
December	[ ]

- Lower temperature for V_{max} Abs limit = [ ] degrees C
- Winter operating temperature for V_{mpp} Max design = [ ] degrees C
- Usual operating temperature under 1000 W/m = [ ] degrees C
- Summer operating temperature for V_{mpp} Min design = [ ] degrees C

2. Orientation Tab
   - Unlimited sheds
   - See attached input and assumptions for Tracker parameters
3. Horizon Tab
   - As applicable
4. Near Shadings Tab
   - As applicable
5. System Tab
   - Module .PAN file
   - Inverter .OND file
   - Nb of inverters. = [ ]
   - Modules per String = [ ]
   - Strings per Inverter = This varies by array type. See the PVSyst Assumptions Attachment - Input and Assumptions System Definition section.
   - Detailed Losses section of System Tab
     i. Uc= 25.0 W/m^{2}k
     ii. Uv= 1.2 W/m^{2}k / m/s
     iii. Ohmic Losses = [ ]
        1. 1.5% DC loss at STC
        2. See AC circuit loss table below

Circuit	AC Circuit Losses: Inverter to Injection Point (@STC)
1	[ ]
2	[ ]
3	[ ]

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ENERGY MODEL

Table 1: AC circuit losses per Circuit for *n* Circuits
(Note: Contractor to fill out table with actual values)

1. 0.10% iron loss, 0.90% resistive/inductive losses at STC. Add 0.10% iron loss and 0.40% resistive/inductive losses if including GSU transformer.

iv. Module Quality, LID, Mismatch
   1. 1.5% for LID
   2. [ ] Module Quality loss
   3. 1.0% Mismatch loss at MPP

v. Soiling losses:

Month	PVsyst Inputs
January	[ ]
February	[ ]
March	[ ]
April	[ ]
May	[ ]
June	[ ]
July	[ ]
August	[ ]
September	[ ]
October	[ ]
November	[ ]
December	[ ]

vi. Incidence angle effect: b_0= see .pan file for table.

vii. Bifacial System:
   1. Shed transparent fraction = 2%
   2. Structure shading factor
      a. 15% for one-in-portrait
      b. 5% for two-in-portrait
   3. Mismatch loss factor = 10%

6. Module Layout Tab
   - Not used
7. Hidden Parameters Menu
   - Not used
8. Preferences Menu
   - Physical Model = Perez

Additional Loss Parameters

Some losses cannot be calculated in PVSyst or not calculated to the specifications necessitated by the Contractor. These losses must be fully completed in Microsoft Excel with all the formulas, constants, and justification spelled out here.

Module Degradation Amount

To account for accumulated module degradation that has occurred for the PV Plant from the beginning of

EXHIBIT 8
ENERGY MODEL

the start date of the long-term module warranty to the end of the Life of the plant, module degradation amount listed in the table below (values shown for example only. Actual values to be filled in by party responsible for module supply) shall be applied to the Energy Model for predicting the energy output for each year.

Year	If the module(s) has a power output less than the percentage below multiplied by the STC power nameplate rating on the back of the applicable module, then such Product shall be deemed to be in breach of the 30 Year Limited Power Output Warranty	% Degradation
1 (i.e., the first 365 days beginning on the Warranty Start Date, expiring the day before the first anniversary of the Warranty Start Date of the applicable Product)	97.50%	2.50%
2 (i.e., the second 365 days of such period until the day before the second anniversary of the Warranty Start Date of the applicable Product, etc.)	97.00%	0.50%
3	96.50%	0.50%
4	96.00%	0.50%
5	95.50%	0.50%
6	95.00%	0.50%
7	94.50%	0.50%
8	94.00%	0.50%
9	93.50%	0.50%
10	93.00%	0.50%
11	92.50%	0.50%
12	92.00%	0.50%
13	91.50%	0.50%
14	91.00%	0.50%
15	90.50%	0.50%
16	90.00%	0.50%
17	89.50%	0.50%
18	89.00%	0.50%
19	88.00%	0.50%

EXHIBIT 8
ENERGY MODEL

20	87.50%	0.50%
21	87.00%	0.50%
22	86.50%	0.50%
23	86.00%	0.50%
24	85.50%	0.50%
25	85.00%	0.50%
26	84.50%	0.50%
27	84.00%	0.50%
28	83.50%	0.50%
29	83.00%	0.50%
30	82.50%	0.50%

Table 2: Module Degradation.
(Note: Values shown are an example, not actual)

EXHIBIT 8
ENERGY MODEL

5.0 COMPILE AND ADJUST SIMULATION RESULTS

Once the Weather File has been compiled and input into the PVSyst model, a simulation will be run and exported in .csv format. This data can then be input into the Annual Hourly Energy Output spreadsheet to calculate the combined plant output. The procedure for running the simulation and generating the reports includes the following steps:

1. In the Simulation Screen input a unique output file name for each run/circuit. (not to exceed the number of Circuits).
2. The output parameters will include at least the following variables:
    a. Horizontal global irradiation
    b. Global incident in coll. Plane
    c. Ambient Temperature
    d. Average Module temperature
    e. Wind velocity
    f. Effective energy at the output of the array
    g. Available Energy at Inverter Output
    h. Energy injected into grid
    i. Inverter efficiency (operating)
3. Run the simulation.
4. A .csv file will be created for this simulation and will be saved with the designated file name. The .csv file can be opened in MS Excel where the data can be parsed.
5. Review the data for each case to verify the output calculated by PVSyst does not exceed the nameplate output of the inverter.

Copy and paste the output data into the appropriate column in the Energy Model File.

Energy Model File

There will be a single tab in the Excel file titled “Hourly Energy” that will include the energy production and subtract any additional losses (AC Losses, Aux Load, Availability, etc., if not already included in PVsyst). There will also be columns listing the metered energy production and the applicable project weather file (GHI, POA, wind speed and direction) for the corresponding time period.

6.0 FINAL ENERGY MODEL

If any changes occur to Contractor’s design (such as equipment selection) that would affect the energy model files that were used as the basis for the bid, these must be reviewed and approved by the Owner prior to modification or inclusion in Contract. If approved, updated energy model files will be created and submitted as a revision to Exhibit 8. All parameters to be submitted in PVSyst Assumptions Attachment, with explanation for any parameters differing from the those given in this Exhibit 8.

EXHIBIT 8
ENERGY MODEL

PVSyst Assumptions Attachment

Software	Version	Comment
PVsyst		
Microsoft Excel		Provide Native Post Processing File, if applicable

PVsyst File	Type	File Name
Project	.PRJ	
Variant(s)		
Meteorological	.MET	
Site	.SIT	
Module	.PAN	
	.PAN	
	.PAN	
Inverter	.OND	
Shade	.SHD	
Horizon	.HOR	
PVsyst Report	.PDF	
8760	.xlsx	

PVsyst Parameter	Value	Comment
Transposition Model		
MET File Source (e.g., SolarAnywhere)		
Latitude		
Longitude		
Altitude (m)		
Module/Tracker Orientation (e.g., 1-Portrait)		
Axis Tilt		
Axis Azimuth		
Minimum / Maximum Phi		
Backtracking (On/Off)		
Ground Coverage Ratio (GCR)		
Number of Sheds		
Pitch (m)		
Tracker/Collector Width (m)		
Inactive Band, Left (m)		
Inactive Band, Right (m)		
Axis Height Above Ground (m)		
Module Bifaciality Factor (%)		
Rear Shading Factor (%)		
Module Transparency (%)		

EXHIBIT 8
ENERGY MODEL

Rear Mismatch Loss (%)		
Monthly Albedo Profile	Jan =	
	Feb =	
	Mar =	
	Apr =	
	May =	
	June =	
	July =	
	Aug =	
	Sep =	
	Oct =	
	Nov =	
	Dec =	
Module Manufacturer		
Module Model		
Total Number of PV Modules		
Number of PV Modules (Bin Class 1)		
Bin Class 1 (W)		
Number of PV Modules (Bin Class 2)		
Bin Class 2 (W)		
Number of PV Modules (Bin Class 3)		
Bin Class 3 (W)		
Number of Modules per String		
Number of Strings in Parallel		
Inverter Manufacturer		
Inverter Model		
Number of Inverters		
Monthly Soiling Profile	Jan =	
	Feb =	
	Mar =	
	Apr =	
	May =	
	June =	
	July =	
	Aug =	
	Sep =	
	Oct =	
	Nov =	
	Dec =	
Thermal Loss Factor - Constant		
Thermal Loss Factor - Wind		
DC Wiring Loss at STC (%)		
Module Quality Loss (%)		

EXHIBIT 8
ENERGY MODEL

Module Mismatch Loss (%)		
String Mismatch Loss (%)		
LID - Light Induced Degradation (%)		
AC Circuit Loss at STC (%)		
External Transformer Iron Loss (%)		
External Transformer Resistive/Inductive Losses (%)		
Auxiliary Loss		
Grid Power Limit (MW)		
Power Factor		
Facility Availability (%)		

EXHIBIT 9 – APPROVED SUPPLIERS

EXHIBIT 9
APPROVED SUPPLIERS

1.0 GENERAL

This Attachment lists the acceptable suppliers/vendors that the Contractor may utilize on the Project.

2.0 ACCEPTABLE SUPPLIERS

Contractor shall provide equipment from the following vendors:

12.95 PV Module

A. Canadian Solar

B. First Solar

C. GCL

D. Hanwha Q-CELLS

E. JA Solar

F. Jinko Solar

G. LONGi Solar

H. Maxeon

I. Trina Solar

J. Vikram

K. VSUN

L. Heliene

12.96 Tracker

A. Array Technologies (ATI)

B. NEXTracker

C. GameChange

12.97 DC Combiner Box and/or Load Break Disconnect

A. Bentek (provisional)

B. Shoals/ConnectPV

C. Solar BOS

D. WTEC

12.98 Inverter

A. Power Electronics

B. SMA

C. Sungrow

D. TMEIC

EXHIBIT 9
APPROVED SUPPLIERS

12.99 Medium Voltage Transformer

A. ABB (conditionally)

1. Contractor shall specify manufacturing location of ABB transformers and Contractor's involvement in quality assurance / quality control as respective facility.

2. Owner reserves right to accept or reject ABB as the medium voltage transformer manufacturer for the Project.

B. Eaton Corporation (Cooper Power Systems)

C. Eaglerise (conditionally)

D. JSHP (conditionally)

E. WEG

F. Westrafo

G. Howard

H. Emco

I. Owner realizes others may be used in combination with selected inverter, but those must be reviewed and approved by Owner and may have bearing on the inverter selection.

12.100 Substation Transformer

A. SPX Transformer Solutions, Inc. - Waukesha

B. HICO

C. Hitachi

D. Siemens

E. WEG

12.101 SCADA System

A. AlsoEnergy

B. Green Power Monitor (GPM)

C. NorCal Controls

D. Trimark

E. Vertech

F. Saginaw Power and Automation

EXHIBIT 10 – MONTHLY PROGRESS REPORT

EXHIBIT 10
FORM OF MONTHLY PROGRESS REPORT

1.0 GENERAL

Description

Cover sheet to show the project name, the time span covered and the date of the report.

INDEX

1. Project Team

List personnel and functions of team comprising of:

- Contractor
- Subcontractors
- Major suppliers

2. Executive Summary

Provide high level summary delineating project status, milestones and issues. Limit to 1 page or less.

3. Health Safety and Environmental

Details may be represented using charts, graphs or narratives.

- Total man-hours worked, total recordables and total Lost Time Accidents (LTAs) and Lost Time Injuries (LTIs)
- Total man-hours since last LTA or LTI
- Total work force on site
- Reportable Incidents since last report
- Medical/incident details
- Details of any LTA
- Near-miss details
- Actions taken to mitigate any future near-miss, recordable or LTA
- Environmental compliance update (if applicable)

4. Project execution status

Overall

Describe for each category/bullet items:

- Major accomplishments/activities this month
- Goals and milestones for next month
- Key milestones – tabular form showing Plan, Forecast and Actual progress

Project Schedule

- Include % complete against time (Engineering Procurement, Construction, Overall)
- Progress curves for planned versus actual (Engineering Procurement, Construction, Overall)
- Overall project status

EXHIBIT 10
FORM OF MONTHLY PROGRESS REPORT

Permitting Progress

Detail any permitting progress and issues that have continued into construction phase, as applicable: site access, encroachments, building permits, etc.

Construction Report

List each area of major activity and its progress and any discussion points, key milestones, and goals for next month. This should include

- Interconnection and substation work
- PV field
- On site structures

Procurement Report

- Procurement Progress
- Manufacturing Status
- Factory Inspection and Testing
- Shipping, Expediting, and Delivery
- Procurement Status Report – Include a table of major equipment to be procured by Contractor (including its subcontractors).

EQUIPMENT DESCRIPTION	MANUFACTURER	CONTRACTED DELIVERY DATE	ACTUAL DELIVERY DATE

Start-up and Commissioning

- List major systems commissioned and turned over to owner during the reporting period
- List major systems to be commissioned and turned over to owner during the next month

Quality Assurance and Control

Report on QAQC status of project. List which areas have been inspected and the % of NCRs or some other acceptable tracking method to indicate overall quality of each installation.

EXHIBIT 10
FORM OF MONTHLY PROGRESS REPORT

5. Training

6. Key Issues and remedies (Areas of Concern)

- Late activities which impact the Project Schedule and mitigation plan
- Interface data problems
- Deviations of Work from Quality Assurance/Quality Control Plan
- Other concerns

7. Commercial

8. PHOTOS

9. APPENDICES

EXHIBIT 11 – QUALITY ASSURANCE

EXHIBIT 11
CONTRACTOR’S QUALITY ASSURANCE PROGRAM

1.0 GENERAL REQUIREMENTS

The following sections of this Exhibit describe the minimum requirements of Contractor's Quality Plan for this Agreement. The inspections, tests and related actions specified in this section and elsewhere in the Agreement are not intended to limit Contractor's own quality assurance/control procedures that facilitate overall compliance with requirements of the Agreement. Contractor may use its own Quality Assurance/Quality Control (QA/QC) procedures provided such procedures have been reviewed and commented on by Owner prior to start of Work. Contractor’s procedures must address, as a minimum, the information contained in this Exhibit and referenced documents.

2.0 QUALITY CONTROL PROGRAM

Basic objectives of Contractor's Quality Plan shall be as follows:

- To ensure that all work adheres strictly to all requirements of the Agreement and governing agencies where the work is being performed.
- To maintain QC procedures to ensure that tasks performed will comply with the Agreement.
- To prevent deficiencies through pre-construction quality control coordination.
- To detect and correct deficiencies in a timely manner.
- To provide an auditable record of all tests, inspections, procedures, non-compliances and corrections, and any other pertinent data as required.
- Verify compliance with Contractor’s QC procedures, including those QC procedures of subcontractors and suppliers.
- To provide a basis of measuring Contractor’s performance for input to Owner’s Contractor resource database.

Contractor may select either outside “agency” or in-house personnel to administer Contractor’s QC system. In either case, the Contractor’s on-site quality control staff shall only be responsible for quality control. The QC supervisor (or person designated as the QC representative) shall report directly to Contractor's Site Manager. Contractor’s QC staff shall not be involved in the management and/or control of the construction process. Contractor’s QC staff members shall interface with Owner, its inspectors and consultants, as required.

3.0 TESTING CRITERIA

Contractor shall perform all testing and inspection of all Work (including materials) both on and off site as required by the Agreement. This shall include pre-functional and functional tests. Test passing criteria shall be clearly spelled out on work instructions and check sheets.

4.0 RESPONSIBILITIES OF THE CONTRACTOR’S QC SUPERVISOR

Responsibilities and duties of the Contractor’s QC supervisor are:

- To communicate these minimum QC requirements to any suppliers and/or contractors.

EXHIBIT 11
CONTRACTOR’S QUALITY ASSURANCE PROGRAM

- To have the authority to stop Work for cause, reject work, order work removed, initiate remedial work, propose solutions, and reject material not in compliance with the Agreement.
- Is present on-site and shall designate alternate individual(s) to assume responsibilities in the temporary absence of the QC supervisor. Designated alternate individual(s) must be trained and experienced in the Work and be qualified to inspect the Work.
- Be completely familiar with the Agreement Scope of Work and Drawings.
- Establish and implement QC programs for Contractor and with its various subcontractors, and monitor their conformance.
- Inspect existing conditions prior to the start of new work segments.
- Conduct a pre-construction quality control meeting with Contractor’s responsible field and office representatives prior to the start of each major item of work required by the Agreement.
- Perform in-process and -follow-up- inspections on each of the work segments to ensure compliance with the Agreement. Upon request, accompany Owner on such inspections.
- Coordinate required tests, inspections, and demonstrations with Owner or any other authority having jurisdiction.
- Inspect Contractor purchased materials and equipment arriving at the Jobsite to ensure conformance to the requirements of the Agreement. Prepare and submit documentation as required by the Agreement.
- Inspect material to ensure conformance to the requirements of the Agreement.
- Identify, report and reject defective work not in conformance with the Agreement. Monitor the repair or reconstruction of rejected work and document corrective action. Confirm repaired work meets QC requirements.
- If necessary, retain specialists or sub-contractors for inspection of Work in areas where additional technical knowledge is required. Submit qualifications of subcontractors and specialists to Owner for approval.
- Work closely with Owner to ensure optimum quality control. Attend meetings as required by Owner.

5.0 SUBMITTALS

- A letter signed by a responsible officer of Contractor outlining the authority of the QC supervisor to include, among other things, the authority as described herein.
- Contractor shall submit its quality plan manual for review, comments, and approval prior to beginning any Work.
- Contractor shall submit an Inspection and Test Plan (ITP) for review, comments, and approval prior to beginning any Work.
- The ITP shall identify all items that are to be inspected and tested, the frequency of inspection and testing, vehicle that will be used to document the inspection, and who will witness the inspections. The ITP shall identify witness, review, and hold points.

- It shall be the responsibility of Contractor to submit all of the above documents for any and all subcontractors under their direction prior to beginning work.

- Contractor shall perform random quality audits on all disciplines and subcontractors to verify compliance of the quality program.

Contractor shall submit reports detailing the results of each test and describing each inspection. Submit separate reports for each test and inspection procedure immediately upon completion of each procedure and test.

6.0 GENERAL QC REQUIREMENTS

Inspection and test reports, as a minimum, shall include:

- Date issued
- Date of inspection or test
- Record of test conditions relevant to test
- Project title and number
- Testing agency name and address
- Name and signature of the inspector/tester
- Identification of the product (including serial number) and applicable specification section
- Type of inspection or test
- Pass/fail criteria
- The results as related to requirements

7.0 INSPECTION, MEASURING, AND TEST EQUIPMENT

Contractor shall provide and maintain all measuring and testing devices. Laboratory devices shall be calibrated as required by the Agreement specifications. The standards against which the measurement equipment is periodically calibrated shall have their accuracy verified directly by, or through a precise comparison with standards traceable to the National Institute of Standards and Technology or to a recognized national standard. Refer to traceability requirements and standards in other attachments.

8.0 EXECUTION

Contractor's inspection shall be adequate to cover all operations, including both on-site and off-site and will be keyed to the proposed sequence of the Work and shall include as a minimum at least four (4) phases of inspection for all definable items or segments of the Work, as follows:

- Preparatory Inspection: To be performed prior to beginning any work on any definable segment of the Work and shall include:

  - A review of Agreement requirements
  - Verification that all materials and/or equipment have been visually inspected upon receipt, tested, submitted, and accepted
  - Verification that provisions have been made to provide required control testing
  - Examination of the work area to ascertain that all preliminary work has been completed

EXHIBIT 11
CONTRACTOR'S QUALITY ASSURANCE PROGRAM

– A physical examination of materials and equipment to assure that they conform to accepted shop drawings or submittal data and that all necessary material and/or equipment are available

As a part of this preparatory work, Contractor's organization will review and verify that all documents, including but not limited to, shop drawings, submittal data, method of quality control, product data sheets, test reports, affidavits, certification and manufacturer's instructions have been submitted and accepted by Owner as required herein. Each submittal to Owner shall bear the date and the signature of the Contractor's quality control manager (or authorized designee) indicating that he has reviewed the submittal and certified it to be in compliance with the Agreement Drawings or showing the required changes.

- Initial Inspection: To be performed as soon as a representative segment of the particular item of work has been accomplished and to include examination of the quality of workmanship and a review of control testing for compliance with Agreement requirements, exclusion of defective or damaged materials, omissions, and dimensional requirements. Contractor shall plan for first-in-place inspections of trenches, modules and trackers and inverters providing advance notice to Owner and vendors as applicable for inspection opportunities for all related parties.

- Follow-up Inspection: To be performed daily or as frequently as necessary to ensure continuing compliance with the Agreement requirements, including control testing, until completion.

- Final Inspection: To be conducted immediately prior to Mechanical Completion. Contractor shall inspect the work for quality, workmanship and completeness prior to notification that the item or segment of the Work has been completed.

- Specific tests and inspection procedures (including documentation) for each material or item of work are specified in the Agreement Scope of Work and the Drawings.

- Third-party inspections: Contractor shall have any third-party inspections performed as required by the authority having jurisdiction.

- Contractor's testing laboratory shall perform tests according to method(s) of testing specified in the Agreement.

- Contractor shall ensure that Owner is given sufficient time to witness tests and re-inspect work performed by Contractor.

- Contractor shall ensure that all work that does not comply with the requirements and references specified in the Agreement Scope of Work is identified and correctly dispositioned. All work installed or fabricated by the Contractor shall be inspected (i.e., punched) and resolved prior to notifying Owner the Work is ready for Mechanical Completion. Contractor shall record all punch list items (i.e., deficiencies) on a punch list record. Material or equipment that is supplied by Owner and is found by Contractor to have deficiencies is to be immediately identified to Owner for corrective action.

- Contractor shall package and prepare all inspection and testing documentation for turnover at the completion of construction. Turnover packages are to be developed by system as determined by Owner. Each system file will contain all field inspection and testing records for the components of the system. Unless otherwise specified, Contractor shall submit two (2) clean, legible copies of all turnover packages to Owner at the completion of construction. Refer to Exhibit 2 for submittal requirements.

EXHIBIT 12 – TRAINING

EXHIBIT 12
OWNER TRAINING

1.0 GENERAL

Contractor shall conduct site-specific training for Owner-assigned administrative, operations, technical, and maintenance personnel. The course shall be conducted during a standard 8-hour day. Classroom training will be augmented by field reinforcement and SCADA HMI viewing of the instruction topics. All students shall be taught in a one- or two-day class session, as required. Each training session shall be conducted in an air-conditioned classroom with the appropriate visual aids. A conference call in and online web instruction capability shall be provided. The training program will cover all related aspects of knowledge required by the individual disciplines to allow them to competently operate, troubleshoot, and maintain all plant processes and utility systems.

Beyond this classroom-based training, a minimum of 12 hours of on-the-job training of operation personnel will be conducted during start-up and commissioning activities, see 2.1.7 below.

Owner shall advise one month in advance of the number of personnel attending training. A training sign-up sheet shall document Owner's personnel attendance and Contractor's instructor(s). Contractor shall submit the proposed Training Schedule, Training Course Outline and Training Manual for Owner's review 20 business days prior to the training, refer to Exhibit 2.

Owner shall ensure that all Operating Personnel attendees (i) are adequately pre-trained in ALL safety aspects of an industrial electrical generation facility as required by Governmental Authorities and Applicable Law and (ii) shall arrive at the classroom with all appropriate personal protective equipment required for touring the PV Power Plant. Contractor shall provide site specific safety training to these personnel.

2.0 SITE-SPECIFIC TRAINING

This Program will encompass on-site training.

2.1 Contractor Responsibility

Contractor shall be responsible for:

A. Provide training facilities which present an environment conducive to learning (heating, lighting, low noise level and air conditioned and be furnished with an LCD projector or equivalent screen, whiteboards and markers and podium). Each student's desk (table) shall have enough working space for training manuals and the associated C size drawings.

B. Preparation of all classroom and training materials.

C. Scheduling and coordination of all classroom-training courses.

D. Provision of instructions, lesson plans, review, and on-the-job training of the students.

E. Coordination of the training schedule with Owner to allow Owner to conduct its own employee training.

F. Completion of training program scheduled close enough to the hands-on operating phase so that the material will remain fresh in the minds of the operating personnel.

G. On-the-job training throughout the start-up and commissioning period. During this time, Contractor's personnel, as well as representatives from the equipment representatives, shall be available to advise, support, and coach the operating staff.

EXHIBIT 12
OWNER TRAINING

2.2 Types of Training

This Program will be based on the Plant Operating and Maintenance Manuals to be prepared by Contractor and equipment manuals to be furnished by equipment providers. Training sessions will be grouped into logically organized modules. A trainer experienced in a specific subject matter will present each of the training modules. These modules will include lesson plans, system descriptions, and power point presentations for the systems. Each trainee will be provided with a copy of the classroom materials and other training documentation. Larger drawings of the solar power plant will be displayed for orientation and discussion.

All sessions shall be presented in an informal lecture style with each student having their own set of training material. Each student shall be encouraged to ask questions and to participate in group discussions. This shall be stated in the course objectives and expectations.

A. Two types of training shall be provided:

- PV System, Substation, and SCADA System, performed by Contractor's Training Staff.
- Vendor specific training by the appropriate equipment supplier or his duly authorized factory representative.

Training will consist of classroom instruction, discussions, site walk downs, and demonstration of ability to properly operate the facility. Contractor's training instructors will discuss the overall photovoltaic power plant, while representatives from the equipment manufacturers will address their scope of work.

2.3 Training Topics

A. PV Systems

During this section, Contractor will describe the process and discuss the principles of operation for the photovoltaic power plant.

Contractor shall provide experienced instructors to conduct its training program, which shall consist of classroom sessions bolstered by system walk downs and examinations. The course curriculum shall include the PV system design. The following outline of topics shall typically be covered but not limited to:

A. Introduction

B. PV Systems

C. Substation

D. Commissioning and Startup

E. SCADA Systems

F. Meteorological (MET) Stations

G. Security Systems

2.4 Lesson Format

EXHIBIT 12
OWNER TRAINING

Each session shall typically include the following information:

- Lesson Objectives
- Design Basis and List of Resources
- System Overview with Drawings
- Component Description with Supporting Documentation (figures, tables, graphs, etc.)
- Demonstration of ability to properly operate the facility

2.5 Lesson Content

A. Lesson Objectives

The major information the student is expected to learn and retain from the lesson shall be presented. Referenced materials utilized in the training session shall be displayed. Listed references shall include page numbers in manuals, diagram and/or drawing numbers, and appropriate procedure of section numbers.

B. Design Basis and List of References

The design basis and reference documents shall be presented. The student is expected to learn and retain this information from the lesson.

C. System Overview with Drawings

This section shall include a brief description of the intended use of the system.

D. Component Description with Supporting Documentation

This section shall include information on the major components of the system. Tables, figures, drawings and design details shall also be provided.

E. Principles of Operation, Including Start-up and Shutdown Procedures

The various operational modes of the system and documents shall be presented, including:

- Operating Philosophy
- Start-up
- Normal Operation
- Normal and Emergency Shutdown
- Understanding and responding to alarms
- Recognizing and Handling Abnormal Operating Conditions (Troubleshooting)

Trained Owner’s personnel will participate in the commissioning and start-up of Owner’s facility. Therefore, Contractor’s training shall emphasize safety practices and precautions throughout the entire program with the associated “dos and don’ts”.

F. Walk-downs

Walk-downs shall be conducted to familiarize the students with the physical location and appearance of equipment and to clarify equipment features, controls, and displays, as well as site features such as drainage, roads, access, and security.

EXHIBIT 13 – PV MODULE WARRANTY

EXHIBIT 13
PV MODULE WARRANTY REQUIREMENTS

1.0 OVERVIEW

Contractor shall supply, through the PV Module Supplier, a PV Module Warranty that is applicable to utility scale solar projects. This will include the following main features:

1. A linear module Power Output Warranty that is for the life of the project 30 years, providing no less than 82% power output at STC at the final year of the Design Life (year 30 preferably), and no more than 2.5% in the first year. See Power Output Schedule below.
2. A 10-year or 12-year product warranty. OWNER prefers 12-year option.
3. Provisions for on-site testing methodology to verify defective products.
4. Provisions for sharing in-and-out costs. OWNER prefers a warranty which will provide for labor to remove and re-install product, and shipping, at no cost to OWNER.
5. Commitments (guarantees) to maximum timeframes for testing, removal, shipment, and reinstallation of defective or deficient product.
6. 60-day notice prior to shipping if module power output mix is different than agree-upon values.

2.0 LIMITED WARRANTY

The following main elements shall be addressed in the PV Module Warranty:

1) Warranted Products

a. Photovoltaic modules including factory assembled junction box and cables and connectors, and
b. Mounting products including factory assembled basic hardware, if any.

2) **Warranty Descriptions and Durations**

a. Product Warranty

b. Power Output Warranty
To include warranted degradation amount for each successive year:

Power Output Schedule at STC (values provided as an example)

Year	If the module(s) has a power output less than the percentage below multiplied by the STC power nameplate rating on the back of the applicable module, then such Product shall be deemed to be in breach of the Power Output Warranty	% Degradation
1 (i.e., the first 365 days beginning on the Warranty Start Date, expiring the day before the first anniversary of the Warranty Start Date of the applicable Product)	97.50%	2.50%
2 (i.e., the second 365 days of such period until the day before the second anniversary	97.00%	0.50%

EXHIBIT 13
PV MODULE WARRANTY REQUIREMENTS

of the Warranty Start Date of the applicable Product, etc.)		
3	96.50%	0.50%
4	96.00%	0.50%
5	95.50%	0.50%
6	95.00%	0.50%
7	94.50%	0.50%
8	94.00%	0.50%
9	93.50%	0.50%
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28	83.50%	0.50%
29	83.00%	0.50%
30	82.50%	0.50%

3) Warranty Start Date

EXHIBIT 13
PV MODULE WARRANTY REQUIREMENTS

4) Exclusions and Limitations

5) Repair, Replacement or Refund Remedy

6) Rights and Remedies against Third Parties

7) Claims Procedure, Notice Periods, Dispute Resolution, Testing and Verification Procedures.

Exhibit 14 Minnesota Power Specifications

Game Fence Detail Sheet 1

Game Fence Detail Sheet 2

Native Seed Specification Section 32 92 00

Specification CL01CD REV2 Substation Clearance Chart

Specification TR09PA, Rev 14 and TR23PA Substation Transformer Specification

Facility Ratings and Methodology

Standard Equipment Specification CA01PA, Flame Retardant Power and Control Cable

Specification SA01PA Rev2, Station Class Surge Arrestors

Specification SB02PA, Battery Charger

Specification SB01PA, Lead Storage Battery

Specification PN01PA Rev3, Control Panel

Specification PN02PA, Distribution Panel 125V DC

Specification PN03PA, Distribution Panel-120/240 Volt, 600 Volts or less AC

Specification AB02PA, Gang Operated Switches

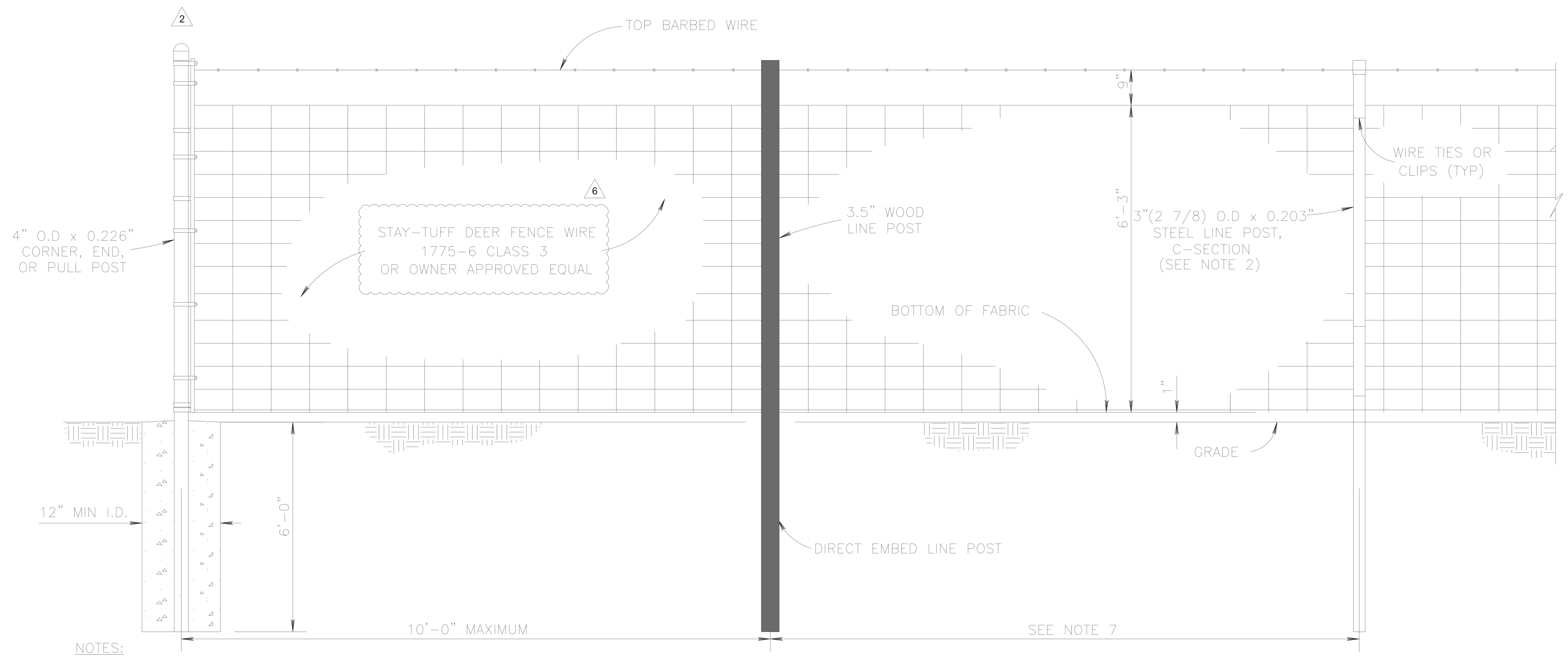
Specification CB01PA Rev4, SF6 Breakers

Specification CB08PA Rev 1, Vacuum Breakers

Specification EEE02CD – Electrical Equipment Enclosure

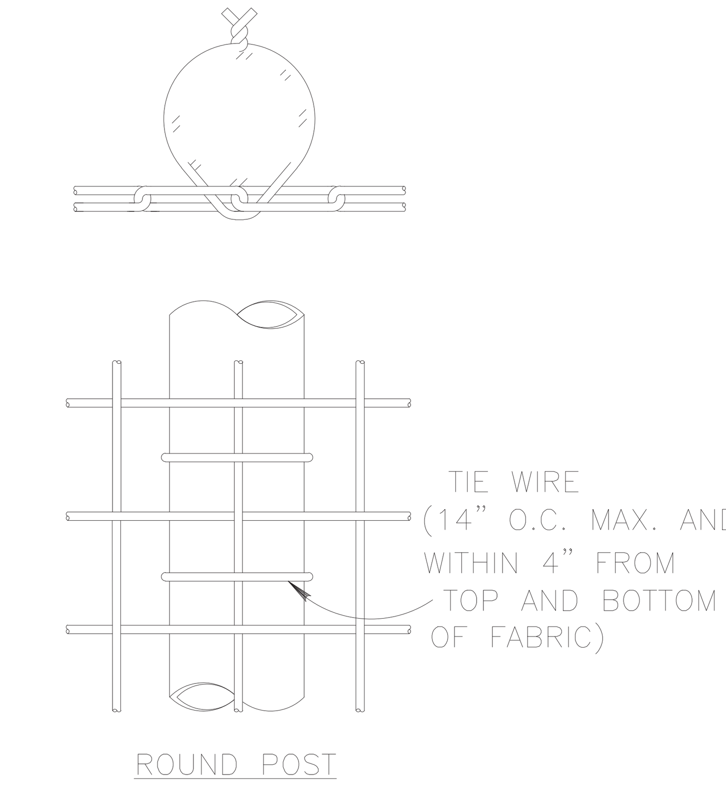
Specification IT01PA Rev 3, Transmission

Specification M001PA Rev 1, ABS Motor OP



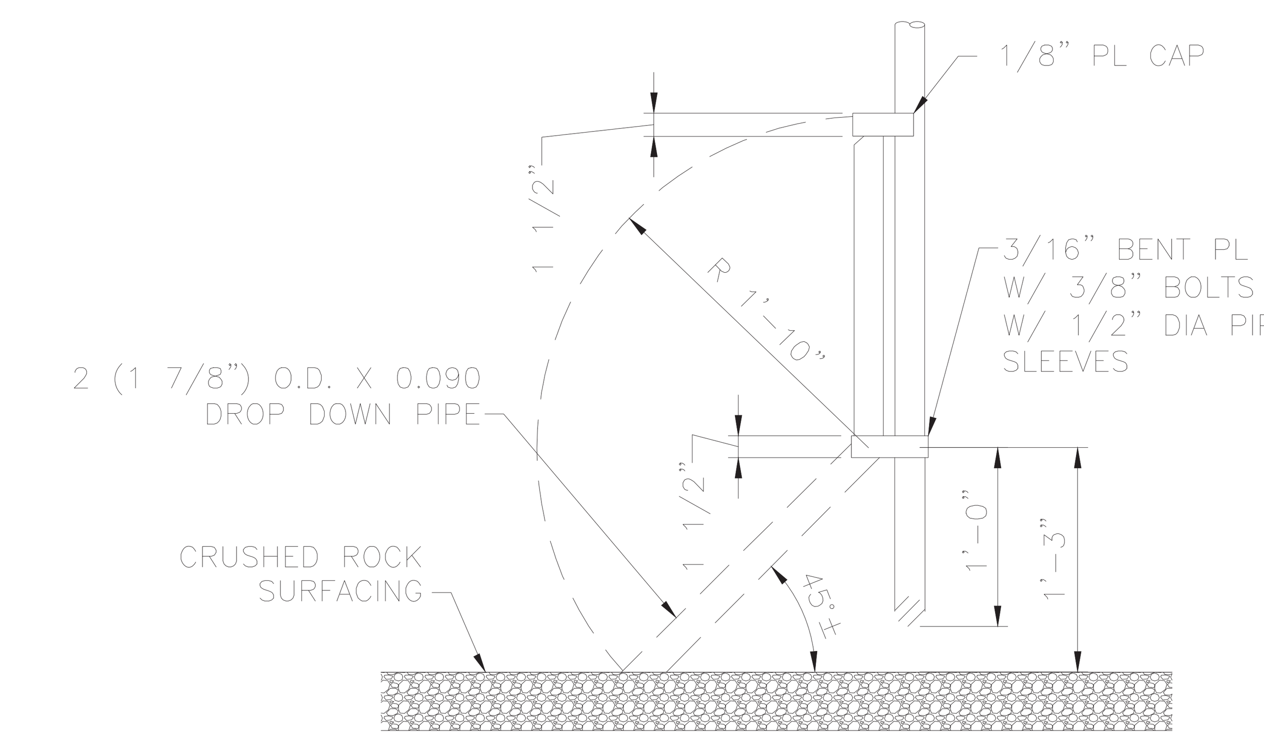
NOTES:
1. WIRE TIES, RAILS, POSTS, AND BRACES SHALL BE CONSTRUCTED ON THE SECURE SIDE OF THE FENCE ALIGNMENT. FENCE FABRIC SHALL BE PLACED ON THE OPPOSITE SIDE OF THE SECURE AREA.
2. REFER TO C004 FOR FENCE NOTES.
3. REFER TO C004 FOR CONCRETE COMPRESSIVE STRENGTH REQUIREMENT.
4. FENCE DESIGN LIFE IS APPROXIMATELY 10-15 YEARS. CORROSION ON LINE POSTS IS EXPECTED AND WILL REQUIRE FUTURE MAINTENANCE.
5. FABRIC SPLICE TO BE JOINED BY WEAVING A SINGLE STRAND TO FORM A CONTINUOUS PIECE OF FABRIC.
6. DETAILS SHOWN ARE TO CLARIFY REQUIREMENTS AND ARE NOT INTENDED TO LIMIT METHOD OF INSTALLATION TO ONE MANUFACTURER.
7. STEEL LINE POSTS SHALL BE INSTALLED AT 100-FOOT INTERVALS, AT ABRUPT CHANGES IN GRADE, AND AT CHANGES IN DIRECTION OF 15 DEGREES OR MORE.

TYPICAL PERMANENT FENCE DETAIL
NOT TO SCALE

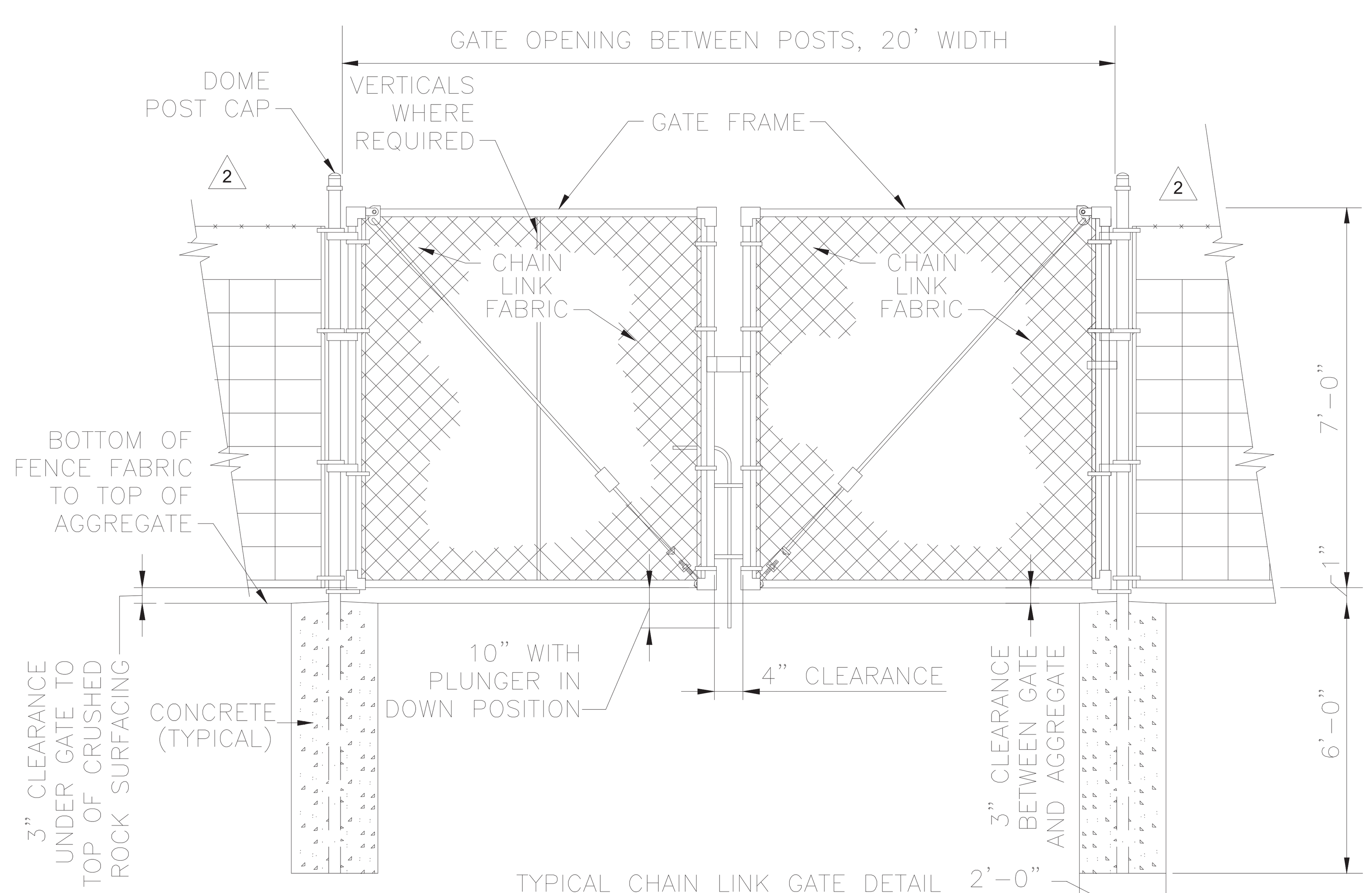


LINE POST ATTACHMENT
NOT TO SCALE

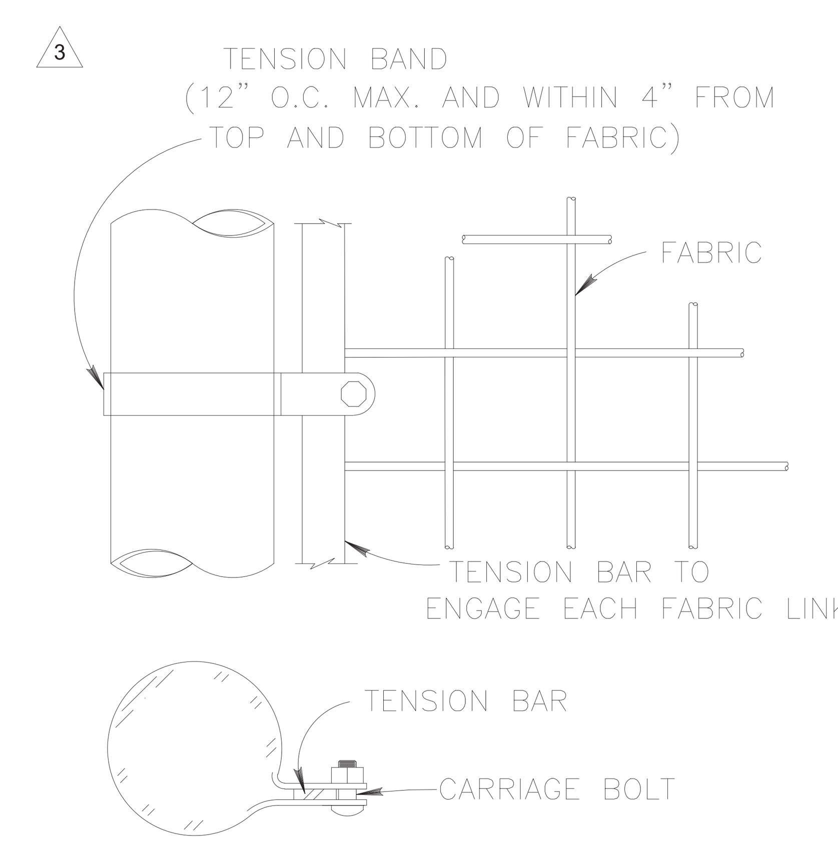
1. APPROVED ROLL-FORMED C-SECTIONS 3.25"X 2.50" (MIN) WITH A MINIMUM WALL THICKNESS OF 0.15" AND MINIMUM YIELD STRENGTH OF 50KSI MAY BE USED FOR TYPICAL LINE POSTS WHERE APPLICABLE, BUT SHALL NOT BE USED AT BRACED BAYS SUCH AS AT CORNERS, TERMINAL BAYS, OR ADJACENT TO GATES.



HOLDBACK DETAIL
NOT TO SCALE



TYPICAL CHAIN LINK GATE DETAIL
NOT TO SCALE



END OR GATE POST DETAIL

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature Kaitlyn Mores

Typed or Printed Name KAITLYN MORES

Date 05/03/22 Reg. No. 59103

CONSTRUCTION ISSUE
FIELD MARKUPS BY: ______
DEPT: _____ DATE: _____

GSOC GOPHER STATE ONE CALL

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	
6	05/03/22	IFC REVISION 2	DEY	KTM	3	11/10/21	ISSUED FOR 90% REDESIGN REVIEW	DEY	CJD	DRAWN BY H. FISCHELS
										APPROVED C. DOMINGUEZ
1	08/20/21	ISSUED FOR 30% REDESIGN REVIEW	JHF	CJD	4	12/20/21	ISSUED FOR CONSTRUCTION	DEY	KTM	DATE 09/27/21
2	09/27/21	ISSUED FOR 60% REDESIGN REVIEW	JHF	CJD	5	01/06/22	IFC REVISION 1	DEY	KTM	SCALE N/A

ALLETE

ALLETE ENTERPRISES, INC.
SYLVAN SOLAR PROJECT
FENCE DETAILS

SHEET C700 REV. 5

MD+32387

PERMANENT FENCES:

1. REFERENCE STANDARDS

   A. THE PUBLICATIONS LISTED BELOW FORM A PART OF THIS SPECIFICATION TO THE EXTENT REFERENCED. THE PUBLICATIONS ARE REFERRED TO WITHIN THE TEXT BY THE BASIC DESIGNATION ONLY. FEDERAL SPECIFICATIONS (FS):

      – FF–B–575 – BOLTS, HEXAGON, AND SQUARE.

      – RR–F–191J/GEN – FENCING, WIRE AND POST, METAL (AND GATES, CHAIN–LINK FENCE FABRIC, AND ACCESSORIES) (GENERAL SPECIFICATION).

      – RR–F–191/2 – FENCING WIRE AND POST, METAL (CHAIN–LINK FENCE GATES) (DETAIL SPECIFICATION).

      – RR–F–191/3 – FENCING WIRE AND POST, METAL (CHAIN–LINK FENCE POSTS, TOP RAILS AND BRACES) (DETAIL SPECIFICATION).

   B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):

      – A153 – ZINC COATING (HOT–DIP) ON IRON AND STEEL HARDWARE.

      – A392 – ZINC–COATED STEEL CHAIN–LINK FENCE FABRIC.

2. GENERAL:

   A. MANUFACTURER'S STANDARD MATERIALS WHERE SUCH MATERIALS CONFORM TO THESE SPECIFICATIONS.

   B. CONFORM TO FS RR–F–191J/GEN EXCEPT AS INDICATED OR SPECIFIED OTHERWISE.

   △2 C. FENCE FABRIC HEIGHT: 6'–3". GATE WIDTH AS INDICATED ON SHEET C700.

   D. FINISH FOR FRAMEWORK AND APPURTENANCES: PIPE SHOULD CONFORM TO FS RR–F–191/3. SQUARE TUBING, H–SECTIONS, AND C–SECTIONS ARE TO BE GALVANIZED WITH A MINIMUM WEIGHT OF 2.0 OUNCES OF ZINC PER SQUARE FOOT. HARDWARE AND ACCESSORIES ARE TO BE GALVANIZED PER ASTM A153. CHAIN LINK FABRIC FOR GATES IS TO BE GALVANIZED PER ASTM A392, CLASS 2 OR COAT WITH ALUMINUM PER ASTM A491.

3. POSTS, RAILS, AND BRACES

   A. POSTS (END, CORNER OR PULL POSTS, LINE POSTS, AND GATE POSTS ARE TO CONFORM TO FS RR–F–191/3.

   △2 B. STEEL LINE POSTS SHALL BE 3–INCH (2 7/8–INCH) X 0.203–INCH POSTS. APPROVED ROLL–FORM C–SECTIONS 3.25–INCH X 2.50–INCH MINIMUM WITH A MINIMUM 0.15–INCH WALL THICKNESS AND MINIMUM YIELD STRENGTH OF 50 KSI MAY BE USED FOR TYPICAL LINE POSTS WHERE APPLICABLE, BUT SHALL NOT BE USED AT BRACED BAYS SUCH AS CORNERS, TERMINAL BAYS, OR ADJACENT TO GATES. WOOD LINE POSTS SHALL BE 3.5–INCH DIAMETER IF ROUND, OR 3.5–INCH X 3.5 INCH IF RECTANGULAR.

   C. END OR CORNER POSTS, AND GATE POSTS SHALL BE 4–INCH X 0.226–INCH STEEL POSTS.

   D. POST TOPS ARE TO BE DESIGNED AS A WEATHERTIGHT CLOSURE CAP FOR TUBULAR POSTS AND MADE OF MALLEABLE IRON OR PRESSED STEEL, BOTH GALVANIZED.

   △3 E. BARBED WIRE SHALL BE TWO–STRAND, 12–1/2–GAUGE STEELWIRE WITH 4–POINT BARBS OF NO. 14–GAUGE STEEK WIRE, 5 INCHES ON CENTER. WIRE SHALL CONFORM TO FS RR–F–221/1, TYPE 1, CLASS 3.

   △2 F. BOLTS SHALL BE ZINC COATED AND CONFORM TO FS FF–B–575.

   △6 G. FABRIC IS TO BE STAY–TUFF DEER FENCE WIRE 1775–6 CLASS 3 OR OWNER APPROVED EQUAL.

   H. GATES ARE TO BE MANUAL SWING, CONFORMING TO FS RR–F–191/2C UNLESS OTHERWISE SPECIFIED. GATE FRAMING SHALL BE 2–INCH (1 7/8–INCH) OD X 0.09 INCH STEEL PIPES CONFORMING TO FS RR–F–191/3, INCLUDE INTERMEDIATE HORIZONTAL AND VERTICAL MEMBERS FOR PROPER GATE OPERATION AND FOR ATTACHMENT OF FABRIC, HARDWARE, AND ACCESSORIES. FRAMES SHALL BE ASSEMBLED BY WELDING. ALL WELDS SHALL BE COATED WITH A ZINC–RICH PAINT. GATES SHALL INCLUDE DIAGONAL CROSS BRACING OF 3/8–INCH DIAMETER ADJUSTABLE GALVANIZED TRUSS RODS TO PROVIDE FRAME RIGIDITY AS INDICATED.

4. HARDWARE

   A. ALL HARDWARE SHALL CONFORM TO FS RR–F–191/2 AND BE GALVANIZED AS PER ASTM A153. HINGES OF HEAVY–DUTY PRESSED OR MALLEABLE IRON, NONLIFT–OFF TYPE, 1 PAIR PER LEAF. HINGES SHALL ALLOW 180 DEGREE SWING OF ALL GATE LEAVES AND SHALL NOT TWIST OR TURN UNDER THE ACTION OF THE GATE.

   B. LATCHES AND GATE STOPS SHALL BE DOUBLE LEAF. PLUNGER–BAR TYPE LATCH, FULL GATE HEIGHT, DESIGNED TO ENGAGE GATE STOP OF FLUSH–PLATE TYPE WITH ANCHORS. LOCKING DEVICE AND PADLOCK EYES TO BE AN INTEGRAL PART OF LATCH. KEEPER TO AUTOMATICALLY ENGAGE GATE LEAF AND SECURE FREE END OF GATE IN FULL OPEN POSITION.

   C. PIVOTING DROP DOWN HOLDBACK SHALL BE WEPCO BRAND OR SIMILAR.

5. CONCRETE

   A. END, CORNER OR PULL POSTS, AND GATE POSTS SHALL BE SET IN HOLES AND BACKFILLED WITH CONCRETE. THE CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 4000 PSI AT 28 DAYS AND SHALL BE AIR ENTRAINED TO 6% ± 1 1/2%. CONCRETE SHALL HAVE 3/4" MAXIMUM AGGREGATE SIZE AND SLUMP SHALL NOT EXCEED 4". ALL CONCRETE SHALL BE MECHANICALLY VIBRATED OR RODDED FOR CONSOLIDATION.

6. EXECUTION

   A. PREPARATION:

      – PERFORM FINAL GRADING PRIOR TO INSTALLATION OF FENCE.

      △2 – FOLLOW GENERAL CONTOUR OF GROUND AND PROPERLY ALIGN FENCE. INSTALL AS INDICATED.

   B. INSTALLATION – POSTS:

      – END AND CORNER POSTS SHALL BE SET IN CONCRETE BASES AS INDICATED. TROWEL FINISH TOPS OF FOOTINGS AND DOME TO DIRECT WATER AWAY FROM POSTS. INSTALL PLUMB AND IN STRAIGHT ALIGNMENT. POST SPACING SHALL BE 10 FEET CENTER–TO–CENTER MAXIMUM.

      △2 – INSTALL STEEL LINE POSTS EVERY 100 FEET, AT ALL ABRUPT CHANGES IN GRADE, AT ALL CHANGES IN DIRECTION OF 15 DEGREES OR MORE, AND TEMPORARILY BRACE UNTIL CONCRETE IN BASES HAS SET.

   C. INSTALLATION – FABRIC:

      – FABRIC SHALL BE STRETCHED TAUT WITH EQUAL TENSION ON EACH SIDE OF LINE POSTS. FASTEN TO STEEL POSTS WITH WIRE CLIPS. SPACE WIRE TIES AT 14 INCHES ON CENTER MAXIMUM ON POSTS AND STAPLE TO WOOD POSTS. ROLLS OF FABRIC SHALL BE JOINED TOGETHER BY WEAVING A SINGLE STRAND INTO THE END OF THE ROLL TO FORM A CONTINUOUS PIECE.

   D. INSTALLATION – GATES:

      – MANUAL SWING GATES SHALL BE INSTALLED PLUMB, LEVEL, AND FREE SWINGING THROUGH FULL OPENING WITHOUT INTERFERENCE. ALL HARDWARE SHALL BE INSTALLED. INSTALL KEEPERS, GROUND SET ITEMS, AND FLUSH PLATE IN CONCRETE TO ENGAGE GATE STOP. ADJUST AND LUBRICATE AS NECESSARY FOR SMOOTH OPERATION.

7. REPAIRING DAMAGED COATINGS:

   A. REPAIR ANY DAMAGED COATINGS IN THE SHOP OR FIELD BY RECOATING WITH COMPATIBLE AND SIMILAR COATING APPLIED PER MANUFACTURER'S RECOMMENDATIONS.

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature Kaitlyn Mores

Typed or Printed Name KAITLYN MORES

Date 05/03/22 Reg. No. 59103

CONSTRUCTION ISSUE
FIELD MARKUPS BY: ____________
DEPT: ______ DATE: ______

GSOC
GOPHER STATE ONE CALL

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
6	05/03/22	ISSUED FOR CONSTRUCTION REVISION 2	DEY	KTM	3	11/10/21	ISSUED FOR 90% REDESIGN REVIEW	DEY	CJD
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DRAWN BY H. FISCHELS
APPROVED C. DOMINGUEZ
DATE 09/27/21
SCALE N/A

ALLETE

ALLETE ENTERPRISES, INC.
SYLVAN SOLAR PROJECT
FENCE NOTES

SHEET C004 REV. 5

MD+32387

CADD DRAWING – FOR REPRODUCTION ONLY

MICROFILMED / /

CODE

ImageSite: .

SECTION 32 92 00 - SEEDING

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes seedbed preparation, seeding, mulching, and fertilizing of areas indicated and/or disturbed by Contractor's construction activities. The entire disturbed area will receive temporary seed mix and will then be supplemented by Native Pollinator Array Seed Mix in all disturbed areas not otherwise stabilized.

1.02 RELATED DOCUMENTS:

A. Appendix 32 92 00-A: MNL Solar Native Pollinator Array Mix
B. Minnesota Pollution Control Agency (MPCA) Construction Stormwater General Permit

1.03 REFERENCE STANDARDS:

A. Section 31 20 50 - Site Preparation and Earthwork.
B. American Society for Testing and Materials (ASTM):
   1. Equivalent AASHTO standards may be substituted as approved.
   2. D977 - Emulsified Asphalt
C. Minnesota DOT Standard Specifications for Construction
   1. Section 2575 – Establishing Vegetation and Controlling Erosion
   2. Section 3881 – Fertilizer
   3. Section 3882 – Mulch Material
   4. Section 3884 – Hydraulic Erosion Control Products

1.04 SUBMITTALS:

A. Certificates: Includes, but not limited to, the following:
   1. Seed shall be accompanied by certificate from vendor that seed meets requirements of these Specifications.
   2. Fertilizer shall be accompanied by certificate from vendor that fertilizer meets requirements of these Specifications.

PART 2 - PRODUCTS

2.01 FERTILIZER:

A. Fertilizer shall be approved by Owner and comply with Minnesota DOT Specification 3881 for commercial fertilizer.
   1. Uniform in composition.
   2. Free flowing and suitable for application with approved equipment.
   3. Apply fertilizer and soil improvements as recommended by the soil test report.
B. Deliver to Site in labeled bags or containers.

2.02 SEED:

A. Seed shall conform to all applicable laws of the State of Minnesota.
B. Seed shall be labeled according to the U.S. Department of Agriculture Federal Seed Act and shall be furnished in containers with tags showing seed mixture, purity, germination, weed content, name of seller, and date on which seed was tested.
C. The solar production area is comprised of areas under and between the PV panel arrays. Seeding will be starting concurrently with site preparation.

- Phase 1 – As each construction work area grading and topsoil spreading are completed, permanent seed shall be planted in areas not otherwise stabilized.
- Phase 2 - Upon completion of the pile, tracker and solar panel installation, permanent seed shall be replanted in all areas not otherwise stabilized. This period shall include any soil grading, smoothing and preparation necessary to repair and prepare the seedbed to be reseeded in any areas which have been damaged (by Contractor or others) or cannot adequately be established. Contractor shall be paid on a per acre, unit price basis for all areas that are repaired.

D. Temporary seed mixture shall be applied through a broadcast method. Contractor to supply Owner with proposed temporary seed mixture and application rates for approval.

E. Permanent Seed – Permanent seed shall be planted on all disturbed areas of the project site not otherwise stabilized. Permanent seed mix and application rates shall comply with the project SWPPP.

F. Moldy seed or seed that has been damaged in storage shall not be used.

2.03 MULCH:

A. Shall comply with Minnesota DOT Standard Specifications for Construction, Section 3882.

B. May be any of the following at Contractor's option:

1. Vegetative Mulch: Mulch shall be straw from stalks of wheat, rye, oats, or hay from fields of timothy, redtop, bromegrass, or other approved materials, and shall be partially decomposed. Mulch shall be free of noxious and undesirable seed and material.
2. Tackifiers:
   a. Asphalt Emulsion: Conform to ASTM D977, Type SS-1.
   b. Organic Glue: Hydrobond as manufactured by Erosion Control Products or approved equal.
3. Wood Cellulose Fiber:
   a. Fiber shall be produced from nonrecycled wood such as wood chips or similar wood materials and shall be of such character that the fiber will disperse into a uniform slurry when mixed with water. Fiber shall not be produced from sawdust or from paper, cardboard, or other recycled materials.
   b. Mulch shall not contain germination or growth inhibiting ingredients.
   c. Mulch shall be dyed an appropriate color to aid in visual inspection.
   d. Mulch material shall be easily and evenly dispersed when agitated in water.
   e. Supply in packages of not more than 100 pounds gross weight, and be marked by the manufacturer to show the air dry weight content of the wood cellulose fiber.
   f. Mulch shall not be water-soluble and shall comply with the following properties:
      (1) Moisture content, 15% maximum.
      (2) Organic matter - wood fiber (oven-dried basis), 90% maximum.
      (3) pH: 4.3 to 8.5.
      (4) Water holding capacity (grams of water/100 grams fiber), minimum: 1,000.
   g. Submit wood cellulose fiber material and application rates for approval by Owner.

PART 3 - EXECUTION

3.01 SEEDBED PREPARATION:

A. Dispose of any growth, rocks, or other obstructions which might interfere with tilling, seeding, or later maintenance operations.

B. Thoroughly loosen and pulverize topsoil to a depth of at least 3 inches. Minimum depth of topsoil at seeded areas shall be 4 inches.

C. Maintain tilled areas until seeded and mulched to provide a smooth area with no gullies or depressions.

3.02 APPLICATION - HERBICIDES:

A. Herbicide treatments will be peformed by individuals with a current Commercial Pesticide Applicator license issued through Minnesota Department of Agriculture.
B. There are three types of herbicides that are applicable: non-selective, broadleaf-selective and grass-selective. Methods and timing used be based on a site-specific evaluation of target species, vegetation composition, and sensitivity of adjacent areas to herbicide applications.
C. Apply herbicides at the lowest concentration recommended on product labels.
D. Herbicide should be applied to plants when plants are most physiologically prone to injury by active ingredients. Plants are most prone to herbicide injury when they are actively growing. Plant life cycles targetable for herbicide application include the flower bud-stage and the cool season photosynthesizing rosette stage. Plants that have senesced following flowering or are inactive due to high heat or drought should not be treated.

3.03 APPLICATION - FERTILIZER:

A. If required to establish vegetation, apply fertilizer at the rate specified by manufacturer.
B. Incorporate fertilizer into the soil to a depth of at least 3 inches by discing, harrowing or raking. Fertilizer may be applied hydraulically on slopes 2 horizontal to 1 vertical or steeper. If fertilizer is applied hydraulically to these slopes, incorporation into the soil will not be required.

3.04 APPLICATION - SEED:

A. Dry Seeding: Accomplish sowing by use of approved equipment, having drills no more than 4 inches apart.
   1. Drill seed to an average depth of 1/2-inch.
   2. Overlap successive seed strips to provide uniform coverage. Repeat where skipped areas appear after a show of green.
   3. Cover seed with soil to an average depth of 1/4-inch by raking or other approved methods.
B. Hydraulic Seeding: Mix seed with water and constantly agitate. Do not add seed to water more than 4 hours before application.
   1. On slopes flatter than 2 horizontal to 1 vertical, apply seed separately from fertilizer. Mechanically incorporate fertilizer into the soil prior to seeding activities. Cover seed with either hydraulic mulch or soil. If hydraulic mulching is not used, cover seed with soil to an average depth of 1/4-inch by raking or other approved methods.
   2. On slopes 2 horizontal to 1 vertical and steeper, seed and fertilizer may be applied in a single operation. Incorporation into the soil will not be required. Hydraulic mulching will be required.

3.05 APPLICATION - MULCH:

A. Apply a mulch covering to all seeded areas within 24 hours after seeding. Mulch not required on areas that are to be covered by an excelsior blanket or by an erosion-control fabric. Jute netting alone will not be considered an erosion-control fabric.
B. Apply vegetative mulch by means of a mechanical spreader or other approved methods at the application rate specified in Minnesota DOT Standard Specifications for Construction, Section 2575.
C. Apply wood cellulose fiber mulch hydraulically at a minimum rate of 1,800 pounds per acre.

SECTION 32 92 00 - SEEDING: continued

1. Mulch and seed may be applied in a single operation on slopes 2 to 1 or steeper.
2. Apply mulch to achieve a uniform coverage of the soil surface.

D. Vegetative Mulch with Asphalt Emulsion:
1. Temperature of mulch at time of application shall be between 125 and 175°F.
2. Apply asphalt emulsion at the rate required in Minnesota DOT Standard Specifications for Construction, Section 2575.
3. Mulching machine shall inject emulsified asphalt at the proper rate directly into the air stream carrying the straw.
4. Hand-spray near structures.

E. Immediately following the application of the mulch, water the seeded area in one watering, at a minimum rate of 120 gallons per 1,000 square feet. Perform so as not to cause erosion or damage to the seeded surface.

3.06 MAINTENANCE:

A. Native Pollinator Array Seed Mix - Mow grass to a height of 6-10 inches during the first growing season whenever average height of grass exceeds 12 inches. During the transition phase, after more native plants are established, mow to 10-12 inches. Routinely mowing and mowing lower than 6-8 inches after establishment phase will harm native plants.

B. Remove weeds by approved chemical treatment.

C. Erect and maintain signs or barricades to exclude traffic from seeded areas.

D. Seeded Areas: Perform maintenance as required until permanent cover is achieved as defined by the MPCA Construction Stormwater General Permit.
1. Prior to acceptance, repair at Contractor's expense any portion of the seeded surface which becomes gullied or otherwise damaged, or destroyed.

END OF SECTION 32 92 00

Minnesota Native Landscapes

8740 77th Street NE Otsego, MN 55362

Date:	1/1/2020
PLS lbs/acre:	10.00

MNL Solar
Native Pollinator Array Mix

	Scientific Name	Common Name	% of Mix	PLS lbs/ac	Bloom Season
Grasses:	Bouteloua curtipendula	Side-Oats Grama	22.00	2.20	
	Bromus kalmii	Prairie Brome	8.00	0.80	
	Elymus trachycaulus	Slender Wheat-Grass	8.00	0.80	
	Elymus villosus	Silky Wild Rye	5.00	0.50	
	Elymus virginicus	Virginia Wild Rye	8.00	0.80	
	Schizachyrium scoparium	Little Bluestem	17.00	1.70	
	Sporobolus cryptandrus	Sand Dropseed	2.00	0.20	
Sedges:	Carex bicknellii	Copper Shouldered Oval Sedge	2.00	0.20	
	Carex sprengelii	Long Beaked Sedge	8.00	0.80	
Forbs:	Achillea millefolium	Yarrow	0.25	0.03	Summer
	Agastache foeniculum	Fragrant Giant Hyssop	1.00	0.10	Summer
	Aquilegia canadensis	Columbine	0.25	0.03	Spring
	Anemone canadensis	Canada Anemone	0.25	0.03	Spring
	Asclepias syriaca	Common Milkweed	1.50	0.15	Summer
	Asclepias tuberosa	Butterfly Milkweed	0.75	0.08	Summer
	Chamaecrista fasciculata	Partridge Pea	3.00	0.30	Fall
	Dalea candida	White Prairie Clover	2.50	0.25	Summer
	Dalea purpureum	Purple Prairie Clover	3.50	0.35	Summer
	Monarda fistulosa	Wild Bergamot	0.75	0.08	Summer
	Penstemon grandiflorus	Showy Penstemon	0.25	0.03	Spring
	Pycnanthemum virginianum	Mountain Mint	0.50	0.05	Summer
	Rudbeckia hirta	Black Eyed Susan	3.00	0.30	Summer
	Solidago nemoralis	Gray Goldenrod	0.25	0.03	Fall
	Symphyotrichum lateriflorum	Calico Aster	0.50	0.05	Fall
	Symphyotrichum oolentangiensis	Sky Blue Aster	0.50	0.05	Fall
	Zizia aurea	Golden Alexanders	1.25	0.13	Spring

Species subject to change based on availability.

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Office: (763) 295-0010
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STANDARD INSULATOR	TR205 TR202	TR205	TR208	TR210	TR214	TR216	TR286	TR288	TR291	TR304	TR312	TR324	TR391
INSULATOR "H" INCHES	10/7.5	10	14	18	22	30	45	54	62	80	92	106	152
STANDARD MINIMUM CREEP ANSI BUSHINGS	-	11"	17"	26"	35"	48"	79"	92"	114"	140"	205"	220"	318"
SWITCHING SURGE KV 100 x 1000µs	-	75	100	140	190	280	460	540	620	745	870		
CHOPPED WAVE KV 1.15(BIL) @ 3µs	-	120	165	220	270	385	605	715	825	990	1155		
TEST VOLTAGES													
RATED MAX VOLTAGE – kV	8.25	15.5	25.8	38	48.3	72.5	121	145	169	242	242	362	550
NOMINAL VOLTAGE RATING - kV	7.2 & below	14.4	23	34.5	46	69	115	138	161	230	230	345	500
FULL WAVE IMPULSE WITHSTAND kV 1.2 x 50 vs WAVE (kV CREST)	95	110	150	200	250	350	550	650	750	900	1050	1300	1800
RECOMMENDED PHASE SPACING FOR HORN GAP SWITCHES, (VERTICAL & SIDE BREAK) AND FUSES - EXPULSION TYPE (INCHES)	36	36	48	60	72	84	120	144	168	192	216	240	336
RECOMMENDED PHASE SPACING FOR VERTICAL BREAK DISC. SWITCHES, BUS SUPPORTS AND POWER FUSES OTHER THAN EXPULSION (INCHES)	18	24	30	36	48	60	96	108	120	132	156	174	300
SIDE BREAK (HORIZONTAL BREAK) DISC. SW.(S) (INCHES)	30	30	36	48	60	72	108	132	156	192	216	216	-
MINIMUM METAL TO METAL, PHASE TO PHASE DISTANCE FOR ALL DISC. SWITCHES, BUS SUPPORTS AND BUS CONDUCTORS (INCHES)	7	12	15	18	21	31	53	63	72	89	105	119	*1
RECOMMENDED CLEARANCE - PHASE TO GROUND FOR ALL METAL PARTS OR EQUIPMENT (INCHES)	7.5	10	14	18	22	30	47	52.5	61.5	76	90.5	106	*2
ABSOLUTE MINIMUM CLEARANCE - PHASE TO GROUND FOR ALL METAL PARTS OR EQUIPMENT (INCHES)	6	7	10	13	17	25	42	50	58	71	83	104	156
CLEARANCE OVER DRIVEWAYS INSIDE SUBSTATION - MINNESOTA POWER NEW CONSTRUCTION (FEET)	22	22	22	22	22	23	24	25	26	28	30	32	40
MINIMUM OVERHEAD CLEARANCE FROM LIVE PARTS TO GRADE FOR PERSONAL SAFETY (FEET)													
NESC C2 TABLE 124-1	8'-10"	9	9'-3"	9'-6"	10	11	12	13	14	15	16	18	-
RECOMMENDED CLEARANCES FOR NEW CONSTRUCTION	9	9	10	10	10	11	12	13	14	15	16	18'	32
RECOMMENDED CLEARANCES FOR BUS WORK (FEET)	10	10	10	10	12	15	15	16	17	18	18	-	-
HORIZONTAL STRAIN DISCS ANSI CLASS 52-3 PHASE TO GROUND (UNITS)	2	3	3	4	4	6	9	10	12	14	17	19	25
VERTICAL STRAIN DISCS ANSI CLASS 52-3 PHASE TO GROUND (UNITS)	1	2	3	4	4	6	7	8	9	12	13	18	24
VERTICAL STRAIN DISCS ANSI CLASS 52-3 PHASE TO PHASE (UNITS)	2	3	3	4	4	6	9	10	12	14	17	19	25
HORIZONTAL PHASE SPACING FOR TUBULAR & STRAIN BUS (INCHES) – REFER TO NOTE 1	36	36	48	60	72	84	120	144	168	192	216	240	336

REFERENCE DATA: NEMA STANDARDS SG6-8.03 AND HV-1, IEEE/ANSI STD. C37 AND C92, IEEE NESC C2-1993, LAPP INSUL. CAT., EXISTING MP ENGINEERING PRACTICES
*FORBES 500kV SUBSTATION DESIGN FOR 2.8 pu CREST 1250kV (550kV BASE)

*1 RCD TO PLANE 216
*2 RCD TO PLANE 206

NOTES: 1. PHASE SPACING IS CENTER TO CENTER

ENG Daniel J. Radloff	CHK Corbin Ringsred	APPR Daniel J. Radloff	DATE 5-3-23	REV 2	SH 1
minnesota power	SUBSTATION DESIGN STANDARDS CONSTRUCTION & ELECTRICAL CLEARANCE CHART			CL01CD	

MINNESOTA POWER

STANDARD SPECIFICATION TR09PA

TRANSFORMERS 5000kVA to 50000kVA BASE RATED
TWO WINDING AND AUTOTRANSFORMERS

STANDARD SPECIFICATION

ISSUE NO.	DATE	PREPARED BY	REVIEWED BY	PAGES/SECTIONS
Original				
Revision 1	12/03/08	ROM	ROM	4.01.10
Revision 2	5/23/12	RPS	RPS	Various
Revision 3	11/25/12	RPS	RPS	3.08, Added 3.09, 3.19 h.
Revision 4	5/08/13	RJB	RJB	4.01.6
Revision 5	12/04/13	ARH	RJB	Various
Revision 6	06/05/14	RJB	RJB	Various
Revision 7	08/26/15	RJB	RJB	Various
Revision 8	12/09/15	RJB	RJB	3.17
Revision 9	02/17/16	RJB	ARS	8.0, 4.09
Revision 10	11/19/19	DJS	RJB	9.03.9, 3.14, 3.18
Revision 11	6/14/2021	RJB	RJB	Various
Revision 12	07/1/2022	CKR	RJB	3.11.1
Revision 13	07/27/2022	CKR	RJB	4.02.6
Revision 14	12/27/2022	CKR	DJR	4.01.10

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.

Signature ______________________

Rev.

Typed or
Printed Name ______________________

Date ____________ Reg. No. ____________

MINNESOTA POWER

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1.0 APPLICATION

This specification outlines the requirements for an outdoor, oil filled power transformer, two winding, transmission step down/step up, or autotransformer winding type transformer to be installed at a Minnesota Power Substation.

1.01 Standards

The transformer shall be designed, manufactured and tested in accordance with latest applicable ANSI, IEEE and NEMA standards, except as otherwise required by this specification. If any of the requirements of this specification are in conflict with these standards, the manufacturer shall notify Minnesota Power.

1.02 Bidders Exceptions

Any exceptions to this specification shall be clearly stated by the vendor. The vendor shall acknowledge receipt of any addenda.

2.0 DESCRIPTION

2.01 See Minnesota Power Specification TR23PA Appendix 2A for a complete description of the transformer windings, voltage class, rated current, basic insulation level, nominal voltage and frequency, rated output and cooling class.

3.0 ELECTRICAL REQUIREMENTS

3.01 See Minnesota Power Specification TR23PA Appendix 2A for the test insulation requirements. It is preferred to have an insulation design that does not include non-linear devices such as varistors. The Company reserves the right to reject the use of non-linear devices and shall approve their use in advance of the completion of the design. If approved, all non-linear devices shall be shown on the nameplate and be located in the main tank so they are accessible.

3.02 Impedance

The impedance between windings shall be as indicated on Minnesota Power Specification TR23PA Appendix 2A. For dual voltage transformers, impedance shall be listed for both voltage configurations.

3.03 Tap Voltage Ratings (No Load Operation)

The following taps, full capacity shall be provided as indicated in Minnesota Power Specification TR23PA Appendix 2A. For dual voltage transformers, taps shall be listed for both voltage configurations.

The following reduced capacity taps shall be provided as indicated in Minnesota Power Specification TR23PA Appendix 2A.

3.04 Angular Displacement

The angular displacement shall be: ANSI Standard

3.05 Transformer Loading

All components shall be designed for continuous operation at the rated load, and to be loaded as allowed by the latest IEEE overload guide. Ancillary devices, including load tap changers, de-energized tap changers, leads and bushings, shall be sized so that the design of the windings and cooling shall be the limitation to overload.

Transformer shall be capable of carrying rated load continuously without exceeding an average winding temperature rise of 65°C above a maximum 40°C ambient and an average ambient (for any 24-hour

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period) not exceeding 30°C, and in addition shall be capable of satisfactory operation under daily overloads and short-time overloads, in accordance with ANSI standards C57.91, latest revision.

Temperatures for overload conditions 3.05.01 and 3.05.02 listed below are as follows:

Ambient Temperature: 40°C
Maximum top oil temperature: 110°C
Maximum hottest spot conductor temperature: 130°C

3.05.01 Transformers above 100 MVA maximum nameplate rating require overloading within the following limits:

a. All windings except tertiary 130% of maximum N. P. rating.
b. Duration of load: 6 hours
c. Steady-state load prior to overload: 100 % of maximum N. P. rating

3.05.02 Transformers below 100MVA maximum nameplate rating require overloading within the following limits:

a. All windings except tertiary 125% of maximum N. P. rating.
b. Duration of load: 30 minutes
c. Steady-state load prior to overload: 100% of maximum N. P. rating.

3.05.3 Simultaneous Loading

The maximum simultaneous loading in the windings without exceeding ANSI Standard temperature rise limitations under each cooling condition shall be as specified in Minnesota Power specification TR23PA Appendix 2A.

3.06 Parallel Operation

The Transformer shall be suitable for parallel operation at rated voltage and on taps of like turns ratio when specified in Minnesota Power Specification TR23PA Appendix 2A.

3.07 Regulation

Provide calculated values of voltage regulation and phase regulation for the following expected loading conditions: See Minnesota Power Specification TR23PA Appendix 2A.

3.08 Short Circuit Withstand Capability

The transformer under this specification will be designed to meet the Short Circuit characteristics defined in ANSI C57.12.00, latest revision.

The transformer shall be capable of withstanding without damage the stresses caused by three-phase, phase-to-phase, or single or double phase-to-ground short circuits limited only by the transformer impedance on the external terminals of any winding, with rated voltage maintained across the terminals of the other winding(s).

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When present, the tertiary shall be designed to be self protected for a three phase fault on the TV bushings. Available fault current at the Y bushing shall be limited to less than 20kA, rms, symmetrical three phase and phase-to-phase.

Values of system impedance to be used in calculating fault current magnitudes other than those indicated in ANSI/IEEE or described above are specified in Minnesota Power specification TR23PA Appendix 2A.

3.09 Overexcitation Capabilities

3.09.1 110% continuous at full load.

3.09.2 125% for 30 seconds at no load with the initial winding temperature stabilized at 65°C average winding temperature rise.

3.09.3 The core hot spot temperature shall be calculated for excitation conditions of 100% voltage and full load, 110% voltage and full load, and 115% voltage and no load. The maximum allowed core hot spot temperature is 130°C with an ambient temperature of 30°C for the worst case excitation condition listed above. The manufacturer shall be prepared to state the methodology of calculation and the means by which the calculations have been verified.

3.10 Exciting Current and Loss Guarantees

Performance data shall be guaranteed by the seller as in Section 3.09.1 and 3.09.2.

3.10.1 Excitation Current and Losses

The manufacturer shall provide excitation current and losses at rated voltage and 110% voltage and base MVA. This, in addition to excitation and losses at voltage tap positions.

3.10.2 The losses are both the no load loss in watts and the total loss in watts.

3.10.3 The manufacturer shall provide excitation current and losses at 100% rated voltage and base MVA at no load tap set at 0% and LTC or NLTC set at 0%. The losses shall include both no load and total losses.

The manufacturer shall supply calculated, exciting current, no load losses and total losses.

3.11 Operating Temperatures and Cooling

3.11.1 Ambient Temperature

The transformer shall be capable of operating at the specified loading and temperature rises and under no load conditions when installed in the conditions as specified in TR23PA Appendix 2A.

3.11.2 The transformer shall be capable of being energized at -20°F. Vendor shall confirm the lowest temperature at which the transformer can be energized.

3.12 Surge Arresters

Metal oxide type surge arresters and mounting bracket for each shall be furnished adjacent to the associated bushing of terminals H1, 2, 3, X1, 2, 3, Y1, 2, 3, and N (when specified). The surge arresters shall be ABB type POLIM-S or Hubbell type EVP.

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All hardware and conductor for connecting arresters to bushings shall be provided and sized to carry the full rating of the transformer continuously. Also provide electrical ground connections using Cu bus bar minimum of ¼" by 2" between arrester ground terminals and ground pads at the base of transformer tank.

The anticipated need for or proposed use of internal arrester resistors or other nonlinear device for any reason shall be described in the proposal, and indicated on the nameplate.

3.13 Bushings

3.12.1 All bushings shall be oil filled and shall meet the requirements of ANSI C57.12.00 and C76.1, latest revisions, for bushings interchangeable between transformers and oil circuit breakers.

3.12.2 Bushings shall be sky gray in color, ANSI 70.

3.12.3 Bushings shall meet the insulation levels and BIL levels required in Section 3.01. The bushing shall be as indicated in Minnesota Power Specification TR23PA Appendix 2B.

3.12.4 All bushings shall be equipped with power factor testing taps.

3.12.5 The bushings shall be of a draw through lead type to facilitate installation, when feasible.

3.12.6 The bushings shall be supplied with stud to Nema 4 hole pad fittings suitable for full current rating.

3.14 Bushing Current Transformers

The transformer shall be furnished with multi-ratio bushing current transformers as indicated in Minnesota Power Specification TR23PA Appendix 2B,

Those indicated above are in addition to those required for the LTC operation or temperature detection.

CTs shall be of the five lead distributed winding type with all tap leads brought out to General Electric type EB-27, or equal, shorting type terminal blocks in the control cabinet. One extra terminal shall be provided on each shorting-terminal block for the purpose of grounding CT secondaries when changing taps. All CT secondaries shall be shorted to ground prior to shipment.

The current transformers shall be in accordance with ANSI C57.13, latest revision.

3.15 No Load Tap Changer

An externally manually operated no load tap changer shall be provided with padlockable provisions.

The Dial plate shall clearly indicate position number.

For three phase transformers, there shall be one external operating mechanism that will change the tap positions in all three phases.

The tap changer(s) shall be mounted under oil with self-cleaning stationary and movable contacts sized to carry the full rated current at each position.

The drive shaft shall have adequate universal joints, bearings and oil seals for smooth operation.

The tap changer contacts shall be silver plated and shall not be required to be operated routinely as part of maintenance.

Tap changer shall be located and arranged to provide for inspection and maintenance without untanking. The covers shall be welded construction.

Tap voltages shall be provided as specified in TR23PA Appendix 2A. Transformers specified as dual voltages shall list the voltage taps for both voltage connections on the nameplate. This information shall be included in the bid documents.

3.16 Load Tap Changing

A load tap changing (LTC) switch shall be provided when specified in TR23PA Appendix 2A. The load tap changing equipment shall provide +/-10% regulation of the nominal voltage with 33 steps. One tap position shall be at exactly zero net voltage regulation at no-load. The regulating or tap changing winding shall be fully distributed.

The load tap changing equipment shall be designed for remote and local electrical and manual non-automatic control. Provisions shall be made of manually moving the tap changer for adjustment and test. Also provide for remote and local tap position indication. Remote tap position indication shall be provided by binary coded decimal (BCD). An additional remote tap position status shall be provided for neutral position indication.

The LTC compartment shall be located separate from the main tank to prevent oil contamination in the main tank, and designed to permit full vacuum. Provide an alternate for an oil filtration system. This heavy duty filtration system shall have replaceable filters. Manufacturer shall indicate design and model provided. There shall be no oil or gas connection between the LTC compartment and the main tank.

Provisions of the above paragraph may be waived if a resistance based LTC is provided.

Positive continuous control of the LTC shall be provided. Once a tap changing operation has been initiated, the operation shall be continuous until the tap change is completed.

An operation counter shall be provided to record the number of tap changes. A white indicating lamp shall be provided to indicate when LTC is in the neutral or zero phase shift position.

The LTC shall be sized and applied in a manner that will provide extended contact life and low maintenance. The current carrying contacts shall have a minimum life of 500,000 operations.

A tap position indication for SCADA remote shall be provided. The signal shall be -1, 0, +1 milliampere from lowest position to highest position.

The transformer LTC shall be controlled with the following: Reinhausen Tapcon Controller or Beckwith M2001B tap changer control, Beckwith M5329 LTC backup control, and a Beckwith 2067 adapter. The vendor shall furnish and install the unit LTC control. The vendor shall propose a performance test to demonstrate the proper functioning of LTC and controller.

Automatic control shall have inputs from a source of line to ground voltage external to the transformer and from a current transformer located internally on bushing X2. The current transformer secondary current shall be compatible with the LTC control.

A means of disabling the automatic control shall be provided by bringing the input to the raise/lower contactors out to terminal blocks and inserting a jumper.

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The LTC contacts shall be silver plated and shall not be required to operate periodically as part of maintenance if LTC is out of service for extended periods.

A sudden pressure relay shall be provided in the LTC tank per Minnesota Power specification TR23PA Appendix 8 and 9.

3.17 Dual Voltage Transformer Connection

Transformers specified as dual voltages shall have the variable connections made on a terminal board. The use of switches for this connection are specifically prohibited.

The terminal board shall be easily accessible and not require entry into the transformer tank for access. The board should be adequately electrically insulated and require minimal draining of transformer oil to change connections.

The board shall be clearly marked for each terminal and voltage connection. Similar markings shall be denoted on the transformer nameplate.

The proposed design or method of the variable voltage connections shall be included in the submitted bid documents. Number of units, years in service, and any warranty or in service issues shall be listed for the proposed design.

3.18 Control Cabinet

A control cabinet housing the electrical control devices and terminal blocks shall be provided with a hinged gasketed door(s) and a gasketed removable plate in the bottom which can be drilled for conduits. Door shall have provisions for padlocking. Cabinet shall be NEMA 3R (dust-tight, rain-tight and weather-resistant). The interior of the cabinet shall be painted gloss white enamel.

Ventilation and heaters thermostatically controlled shall be provided to prevent condensation. Heaters to be located to prevent damage to control cables or other devices. A separate 2PST fused switch shall be provided for each heater circuit. Also provide a 120 volt, 20 amp duplex grounded receptacle outlet with built-in ground fault circuit interrupter and a 100 watt lamp receptacle with toggle switch and a door operated switch.

Control cabinet shall contain terminal blocks for terminating all auxiliary equipment wiring, including cooling equipment control, LTC control, all alarm and relay contacts and all current transformer secondary leads. All wire shall be 600 volt flame retardant, moisture proof in conduit. CT wiring and wiring to tripping circuits shall be #10 AWG; control wiring shall be #14 AWG; auxiliary relay wiring and indicating lights shall be #16 AWG.

All wiring shall be terminated with ring lugs on screw terminal blocks. CT ring lugs shall be insulated.

The control panel shall be dead front with all switches, circuit breakers, relays enclosed and no 240 volt circuits exposed. 240 volt terminals and devices should be located separate from CT terminals and 120 VAC or 125 VDC equipment.
AC terminal blocks shall be able to accommodate Purchaser’s 6 AWG power cable.

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3.19 Auxiliary Power and Control Wiring

Auxiliary control power shall be 120/240, 1-phase, 3-wire.

Provide two auxiliary power supply systems: one for fan and/or pump power; one for lighting and 120V duplex receptacle.

Alternate when specified in Minnesota Power Specification TR23PA Appendix 2B.

3.20 Alarms and Monitors

All alarm and relay contacts shall be rated for use with purchaser's 125 volt DC system. Each alarm shall be wired independently to terminal blocks in the control cabinet. The following standard alarms and monitors shall be furnished when indicated in Minnesota Power Specification TR23PA Appendix 8:

a. Winding hot-spot dial type temperature indicator with contacts for controlling both stages of cooling and for alarm and tripping.

b. Liquid temperature dial type indicating device with adjustable alarm contacts so arranged to permit true temperature indication after alarm point is passed.

c. Magnetic liquid level gauge and alarm contact to close at the minimum safe operating level.

d. A cover mounted self resealing mechanical type pressure relief device with semaphore and alarm contacts on each compartment.

e. The oil pumps shall be equipped with flow indication with alarm contact to indicate low oil flow. (When necessary.)

f. Pressure alarms to indicate low pressure differential across a cooler which is in operation. (When necessary.)

g. Cooling equipment loss of power alarms with a 30 second time delay to avoid nuisance alarms.

h. A sudden fault pressure relay will trip a local lockout relay per Minnesota Power Specification TR23PA Appendix 9. The circuit shall contain a loss of power alarm.

i. Gas accumulator/detector relay with alarm and tripping contacts.

3.21 Loss Evaluation

The transformer losses and capital costs will be evaluated at the rates indicated in Minnesota Power Specification TR23PA Appendix 2A. If final tests determine load and/or no load losses exceed the guaranteed, the loss dollar/kilowatt values will be used to determine any price adjustment. Individual loss dollars will be combined to determine the price adjustment. No price adjustment will be applied if the total loss dollars are lower than guaranteed.

4.0 <u>MECHANICAL REQUIREMENTS</u>

4.01 Tank and Fittings

The main tank shall be of welded construction with welded joints as required for removal of top and necessary sections. Tank welds with oil on one side shall be welded inside and outside with continuous bead welds.

The tank shall be designed for vacuum filling in the field and for a positive pressure of at least 10 psig.

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4.01.1 Manholes

Manholes shall be large enough to permit access to lower end of bushings, terminals, tap changer and accessories without removal of tank cover. Manholes shall allow removal of any current transformers mounted internally on bushings. Minimum manhole size shall be 18" in diameter.

Cover shall be designed to avoid any space which would allow gas accumulation and defeat a gas accumulator relay. Provisions and design shall be such that internally generated gases are directed to the gas accumulator relay.

4.01.2 Base

The base shall be designed such that it can be moved with rollers along the major transformer axis.

The manufacturer shall show centerlines for both the shipping center of gravity, and the assembled center of gravity on the outline drawing. Both centers of gravity shall be marked on all sides of the base of the transformer with a weld line and a label. The label shall be permanent and survive any environmental fading. A triangular notch cut in the baseplate signifying assembled center of gravity is preferred.

4.01.3 Handling

For moving and handling the transformers, the following appurtenances shall be provided:

a. Pulling eyes near base.

b. Lifting lugs for lifting assembled transformer tank plus oil.

c. Jacking bosses for raising assembled transformer, minimum height 17".

d. Lifting accessories for manhole covers.

4.01.4 Standard ANSI and NEMA ground pads shall be provided on the tank.

4.01.5 The tank shall be equipped with replaceable valving for cooling equipment and tank mounted mechanical relays.

4.01.6 A combination drain and lower filler valve shall be provided. This lower valve shall drain the oil to within one inch of the bottom of the tank. The size of the lower drain valve shall be 2-inch NPT, with a brass plug provided.

The lower valve shall have a built-in lower sampling valve, 3/8-inch, located between the main valve and brass plug. The sampling device shall be supplied with 5/16-inch x 32 male thread and supplied with cap.

Valves shall be suitable for vacuum filling. All valves shall have suitable packing silicone or otherwise to prevent leakage.

The upper filler valve shall be one-inch NPT with a brass plug and located near the top of the tank.

4.01.7 Tank mounted accessories

Self-resealing mechanical type pressure relief device shall be provided. This device shall be located above oil liquid level. The device shall be located on top of tank for conservator type units.

4.01.8 The transformer will be installed on a slab foundation.

4.01.9 Winding Hot Spot Well (Spare)

Provide a spare winding hot spot well with hot spot CT for future temperature monitoring.

4.01.10 Neutral Bushing Connection

A dedicated copper bus bar shall be run from the neutral bushing to the base of the transformer. The neutral bus bar shall be insulated with a minimum dielectric strength of 2kV. The minimum size of the copper bus bar is ¼" by 4".

4.02 Cooling and Heat Exchangers

4.02.1 Cooling class shall be ONAN/ONAF/ONAF, ONAN/ONAF/OFOF, or ONAN/ODAF/ODAF, as indicated in Minnesota Power Specification TR23PA Appendix 2A.

4.02.2 Cooling equipment shall be controlled from winding hot-spot temperature (necessary current transformers shall be in addition to all other current transformers specified). Each set shall include a dial-type temperature indicating relay; dial indicator design and mounting arrangement shall permit reading from ground level near the transformer.

4.02.3 Leads from the current transformers and heating coils used for winding temperature simulation shall be wired to suitable terminal blocks in the cooling equipment control compartment to permit complete calibration testing at ground level.

4.02.4 All radiators shall be removable. Manufacturer shall furnish suitable shutoff valves on the transformer side of the radiator mounting flanges. Top and bottom drain valves with plugs (minimum 1/2-inch) in the radiators, shall be provided to permit draining and removal of the radiators without draining oil from the transformer.

4.02.5 Oil pumps shall be located near foundation level; manufacturer shall furnish suitable valves on both sides of each pump and pipe tap with plug (minimum 1/2-inch) at the lowest point on the pump section between valves, to permit draining, or removal. If power supply to pumps is made through connectors which must also seal the oil system, suitable mechanical guards shall be furnished to prevent breakage of the connectors and resultant oil leakage.

4.02.6 Cooling fans shall be located only on the sides or bottom (not on the top) of the radiators to provide maintenance accessibility with adequate safety clearances from transformer live parts. Bottom mounted fans shall be adequately located to be unobstructed from snow when installed in the conditions as specified in TR23PA Appendix 2A

4.02.7 Cooling equipment requirements, their estimated ratings, and loadings shall be as follows:

a. Cooling medium will be air at 40°C maximum.

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b. Cooling devices shall be separated into two completely separate groups.

c. Automatic control of fans and pumps shall be in two steps.

d. For triple rated transformers, control shall be actuated in each winding by winding temperatures to pick up three or four separate and isolated contacts.

4.02.8 Radiators shall be supplied with the hot dip galvanized exterior finish.

4.02.9 The radiators shall be designed to withstand full vacuum and up to 10 psig positive. The radiators shall be adequately braced to prevent any movement.

4.03 Oil Preservation System

4.03.1 Manufacturer shall state what type of oil preservation system is provided. If a nitrogen (or other inert gas) pressure system is provided, it shall be complete with the following:

a. Gas cylinder

b. Three stage pressure regulation

c. Pressure relief valves and alarm

d. Pressure vacuum gauge

- Pressure vacuum gauge shall be visible from ground level.
- Transformer shall be shipped with pressure vacuum gauge installed.

e. Alarms for low nitrogen cylinder gas pressure.

f. Alarms to indicate high and low gas pressure in transformer.

4.04 Manufacturer shall furnish the necessary quantity of insulating oil. The oil shall be supplied in tank trucks or in drums and barrels if a smaller quantity, (less than 15 barrels). The oil shall conform to Minnesota Power Specification TR01PA "Standard Specifications for Inhibited Insulating Oil".

4.05 Audible Sound Level

The predicted audible sound level shall be provided. The transformer shall be designed so mechanical features will not be in any resonance with naturally generated sound of transformer.

When specified in Minnesota Power Specification TR23PA Appendix 2A, an audible sound level evaluation shall be required. For the purposes of this evaluation, the sound level shall be measured on the "A" weighted scale in accordance with NEMA TR1.

If the normal sound level as measured previously exceeds this amount, an alternate quotation for acoustical treatment will be considered.

4.06 Painting and Cleaning

The tank accessories and tank interior and exterior shall be thoroughly cleaned. The interior shall be treated or painted white to maintain cleanliness. The exterior surfaces shall be primed and painted, with ASA70 gray, silicone base, alkyd enamel (Sherwin Williams) or equal, the prime and final coat on the exterior surfaces shall be oil resistant, moisture-proof, three mils dry film thickness. The top of the tank shall be treated such that its paint will give a non-skid surface.

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4.07 Maintenance Accessibility

Gauges, including pressure vacuum (whenever possible), liquid level, liquid temperature, and winding hot spot temperature shall be located at an appropriate viewing height and in close proximity to each other.

Externally accessible grounding points shall be provided for the core. The ground connection shall be brought through the cover with bushings protected with an enclosure. If auxiliary transformers such as series transformers or preventive autotransformers are placed within the main tank, separate core grounds shall be brought out for each auxiliary transformer.

4.08 Safety Railings

Safety railings shall be provided (see TR23PA Appendix 5).

4.09 Safety Rescue Brackets

Safety Rescue Brackets (Manufacturer DBI-SALA-UCL - Part Number 8517266) shall be provided. Brackets shall be located at each mahole on the transformer cover per TR23PA Appendix 6 and installed per manufacturer’s instructions.

5.0 NAMEPLATE

A diagram nameplate shall be provided and located at eye level above the base of the transformer. The information furnished shall include nameplates for all current transformers and be in accordance with nameplate "C" of ANSI C57.12.00, Section 5.12, latest revision.

6.0 TESTS

The results of all tests shall be reported in the manufacturers certified test reports. All tests shall be in accordance with the latest revision of ANSI C57.12.90, latest revision and referenced standards therein, unless specifically listed otherwise.

For dual voltage transformers, all tests shall be performed for both voltage configurations. Testing will be performed with transformer configured for 161/115kV operation first and reconfigured and tested for 138/115kV second. After successful completion of all tests, transformer will be shipped in 138/115kV configuration. Vendor may propose an option to waive redundant testing. The option must clearly state which tests do not require testing in both voltage configurations and documentation why the testing is not required. Tests not requiring redudant testing shall be done in most limiting case.

6.01 The manufacturer shall perform all routine tests as listed in ANSI C57.12.90, latest revision.

6.02 A series of dielectric tests shall be performed on all terminals which are brought out from the tank. Unless mentioned otherwise, terminals “H”, “X”, and “Y”, if present, are to be tested as such. The dielectric tests shall be in accordance with ANSI C57.12.14, latest revision.

6.02.1 Impulse tests shall be performed on terminals and windings indicated in Section 6.02. This shall include the "chopped wave" and "full wave" BIL value. The value shall be as listed in ANSI C57.12.14, latest revision.

6.02.1.1 Impulse tests shall be performed on both voltage configurations of the “H” winding.

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6.02.2 The manufacturer shall perform a switching surge test. The value shall be in accordance with ANSI C57.12.14, latest revision.

6.03 Low frequency tests shall be performed. Both applied and induced potential tests shall be included as part of the low frequency tests.

6.03.1 Applied voltage tests shall be performed in accordance with ANSI C57.12.14, latest revision, when required.

6.03.2 The induced voltage test shall be performed in accordance with ANSI C57.12.14, latest revision. In addition to the voltage impressed during the induced voltage tests, an enhancement period shall be added. This enhancement shall be to 1.73 p.u. for approximately 7200 cycles, as close as practical to the start of the test.

6.03.3 Partial discharge measurements shall be made during the tests as outlined in 6.03.2 and in accordance with ANSI C57.12.14, latest revision.

The transformer shall be deemed to be acceptable from a partial discharge test standpoint if there is no sustained increase in partial discharge during the last 20 minutes of the test, the increase in partial discharge does not exceed 30μV, and the magnitude of the partial discharge does not exceed 300ρC and the RIV does not exceed 100μV.

6.04 Capacitance - dissipation or power factor tests shall be made. Capacitance - dissipation or power factor shall be measured at maximum allowable voltage up to 10kV AC. For two winding transformers the measurements are to be made on H to X, H to "Ground" and X to "Ground". The insulation resistance shall be measured at 2.5kV.

6.05 A test for unintentional core grounds shall be made prior to shipment.

6.06 Provide alternate pricing. Temperature rise tests shall be performed at the self cooled rating (ONAN) and at the maximum forced cooled rating in accordance with ANSI C57.12.90, latest revision.

6.07 Zero sequence impedances, at nominal rated voltage, at each tap position specified in TR23PA Appendix 2A.

6.08 Gas in Oil Testing shall be made after all dielectric tests, and Dissolved Gas Analysis shall be performed on the transformer oil before and after each test. The acceptance criteria for the DGA are as follows as a measurement of change in the gases before and after the specific test involved: hydrogen – 15ppm, methan – 5ppm, ethan – 2ppm, ethylene – 2ppm, acetylene – not detected, carbon monoxide – 25ppm, and carbon dioxide – 250ppm.

6.09 Manufacturer shall describe and perform test to determine tank and seal integrity. The tank shall withstand hot insulating oil under slight pressure, for a suitable time period without leaks.

6.10 CT Ratio tests are required for all provided current transformers

6.11 When LTC is present, resistance tests of all windings H, X, and Y. Test with the LTC on neutral, all DETC taps; with the DETC on the highest tap, test half the LTC taps (16R-1L).

6.12 Temperature guage alarm point testing will be performed by using a test thermal well to test the thermocouple, guages, and alarm and/or trip settings.

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6.13 The manufacturer shall perform the following field tests once the transformer has been set in place.

6.13.1 DC Winding Resistance

6.13.2 Transformer Turns Ratio

6.13.3 Capacitance – disipation or power factor tests

7.0 SHIPMENT INSTRUCTIONS

The unit shall be shipped in the upright position and filled with dry air at 3 psig pressure. The insulating fluid shall be shipped via tank truck, (lesser volumes may be via drums or barrels). When possible the transformer shall be shipped oil filled.

The manufacturer shall provide two vertical and horizontal impact recorders for the shipment with capability for 60 days of recording. Each recorder shall be adequately attached. The vendor shall make provision that the recorders shall function throughout the duration of the shipment. The impact recorders shall receive an impact directly before being placed on the transformer with the impact visible on the recorder records. Impact recorder setting limits to be provided to Minnesota Power before offloading.

All exposed transformer terminals shall be grounded for shipment.

Dual voltage transformers shall be shipped in the 138/115kV configuration.

The transformer shall be wrapped to prevent road grime accumulation. In the case where it is unreasonable to have the transformer wrapped, it shall be cleaned by Manufacturer after it has been set on the pad.

See TR23PA Appendix 3 for delivery point and contacts.

8.0 DRAWINGS AND TEST REPORTS

8.01 Manufacturer shall furnish one (1) paper copy of applicable full size drawings and other information and one electronic copy (AutoCad 2012 and Adobe Acrobat format) of same from the following list. The paper copy shall be included in the transformer control cabinet when shipped. If all required information is not available at time of shipment, one (1) additional paper copy shall be sent once all required information is available. The electronic copy is to be provided to the engineer listed in Minnesota Power Specification TR23PA.

8.01.1 Assembled transformer outline drawing (including structural details of transformer base; center of gravity of installed unit and of unit prepared for shipment; and minimum dimensions and weight of unit prepared for shipment).

Control cabinet outline drawing including device locations, labels, and Bill of Material.

8.01.2 Nameplate drawing (including identification of type of winding construction and conductor material used in each winding) for the main unit and LTC as required. The nameplate drawing shall show the final tested impedance of the transformer. Nameplate shall contain a statement that the transformer has been designed for step-up and/or step-down operation.

8.01.3 Bushing outline and nameplate drawings and test reports. Drawings shall show test tap voltage ratio and voltage withstand capabilities.

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8.01.4 Tap Changer Outline and Operation and Maintenance Manual, including drawings, Bill of Materials and description literature for tapchanger position indicator transducers.

8.01.5 Surge arrester outline drawings.

8.01.6 Terminal fitting drawings.

8.01.7 Schematic and wiring diagrams showing number, size, and power requirements of fans and pumps; fan and pump control; load tap changing equipment control; alarm and relay connections; and current transformer connections.

8.01.8 Test circuit diagram (including complete identification of all devices and terminal points), calibration curves, and complete factory test data.

8.01.9 Current transformer nameplate drawings, and current transformer characteristic curves showing ratio correction and secondary excitation for relaying accuracy CT's, and ratio and phase angle correction for metering accuracy CT's.

8.01.10 Complete lists of renewal parts for the transformer and all auxiliary equipment, including identification of each part by name and part number. Renewal parts list for LTC equipment shall be accompanied by detailed drawings and exploded views as required to facilitate complete maintenance by purchaser. Parts, lists and drawings shall not be merely typical, but rather shall relate specifically to the equipment covered by this specification.

8.01.11 Certified test reports, shall be sent as indicated in Minnesota Power Specification TR23PA Appendix 3, as soon as possible after manufacture. This shall include electronic copies of capacitance tests in Doble format.

8.01.12 Instruction Books

Manufacturer shall supply one (1) paper copy and one electronic copy (Adobe Acrobat format) of all necessary instruction booklets for installation, operation and maintenance of the transformer and associated devices. The paper copy shall be included in the transformer control cabinet when shipped. The electronic copy is to be provided to the engineer listed in Minnesota Power Specification TR23PA.

Instruction booklets shall include information of all transformer and auxiliary equipment i.e. bushings, arresters, LTC equipment, cooling equipment, transformer and instruments. Information shall include settings for fan and pump overload relays, pickup and/or dropout timing, etc.

8.01.13 Pictures of the core and coil assembly and pretanking must be provided to Minnesota Power as soon as possible during manufacturing.

9.0 INFORMATION TO BE FURNISHED WITH PROPOSAL

In addition to any information required elsewhere in the specification, the following information shall be provided with the proposal and will be used in the Minnesota Power evaluation:

9.01 Delivery; manufacturer shall state earliest delivery

9.02 Shipment point

9.03 Drawing and data submittal

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The attached Minnesota Power Project Data Sheet Appendix 1A shall be completed and returned with the proposal. The proposal shall be deemed incomplete without Appendix 1A complete and attached. For dual voltage transformers, data shall be stated clearly and exclusively for each dual voltage winding connection.

Submit dates when the approval drawings listed can be furnished.

When a design review is required per Minnesota Power Specification TR23PA, submit dates when the design review is required to take place. Minnesota Power will not committ to material selection prior to the design review and only after resolution of all requests arising from the design review.

9.03.1 Outline drawing

9.03.2 Electrical data

9.03.3 Mechanical data

9.03.4 Oil type, quantity, and preservation system

9.03.5 Tap Changers: Both DETC and LTC, if applicable

9.03.6 Transformer weights and dimensions

9.03.7 Shipment:
List of items shipped separately

9.03.8 List of Manufacturers Tests

9.03.9 Spare Parts

The vendor shall provide pricing to furnish the following spare parts:

a. Spare H, X, Y, and Neutral bushings; cost per each.

b. One spare cooling fans and motors for same.

c. One spare cooling pump motors and impellers, if any.

d. Optional pricing for composite bushings.

9.04 Failure Rate

A transformer failure is defined as any difficulty requiring return of the transformer to a manufacturing or repair facility or a difficulty which requires a field repair of core and coil assembly.

$$\text{Annual Failure Rate} = \frac{\text{Total Failure Since 1/1/78}}{\text{Transformer Service Years Since 1/1/78}}$$

9.04.1 The manufacturer to supply the following data for units 50 MVA and above and 450kV BIL and greater:

All units shipped since 1/1/78
Transformer service years since 1/1/78
Number of failures

10.0 <u>OTHER OPTIONS</u>

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10.01 Field Engineering Services

The manufacturer shall furnish an alternate to provide field engineering services. The representative shall be present for installation, testing and checkout to provide technical advice and inspection as required.

10.02 Installation

When specified, the manufacturer shall provide a separate proposal to install the transformer complete on-site. The installation shall include: receiving, moving, oil filling, installation of all equipment, testing and final checkout. The manufacturer shall specify the lifting distance assumed in the bid. If no lifting distance is provided, it is assumed there is no distance restriction for transformer offloading. Outriggers will not be allowed to be placed inside of oil containment basins under any circumstances.

Contractor shall conduct and provide lift planning services in accordance with Minnesota Power safety policies and all applicable regulations, including, but not limited to, State and Federal OSHA requirements.

Offloading with crane requires Supplier to provide a site-specific lift plan using a MN Power foundation plan or drawing as a background. A site visit is required by the Supplier or Supplier's representative prior to submittal of the lift plan. Item 1 is to be provided five (5) weeks prior to delivery. Items 2-4 are to be provided 48 hours prior to delivery.

1. Rigging plan and information
    a. Location of truck/trailer
    b. Location of crane
    c. Final outrigger locations
    d. Distance from center of crane to center of extended outrigger post
    e. Dimensions from center of crane to cetnerline of outriggers, sides, front and back
    f. Copy of crane load charts and note pages
2. Copy of Operator's NCCCO card
3. Copy of Annual 3rd Party Crane Inspection
4. Copy of insurance certificate

Offloading by jack and slide requires Supplier to provide a site-specific plan using a MN Power foundation plan or drawing as a background. The following information should be included with the plan, five (5) weeks prior to delivery. A site visit is required by the Supplier or Supplier's representative prior to submittal of the plan. If a crane is to be used to set equipment on the slide, the lift plan requirements also apply.

1. Location of truck/trailer
2. Location and orientation of equipment on trailer
3. Maximum height of equipment on:
    a. Trailer
    b. Rails
    c. Foundation
4. Cribbing and rail dimensions with description
5. Positioning of all equipment used for offload

Minnesota Power will provide all power wiring, grounding, control wiring necessary for the transformer. Minnesota Power will also provide all foundation work.

10.03 Warranty

Manufacturer shall state period of warranty and terms. The manufacturer shall indicate any extended warranty options and provide optional pricing for a five (5) year warranty. Minimum warranty shall be 24 months from date of energization.

All gaskets and welds shall be guaranteed to be leak free for five years. The manufacturer shall be responsible for repair of any leaks within the five-year period.

10.04 Apparatus in Service Requiring Repair

If, after the apparatus has been installed, it is discovered that it, or any part thereof is functioning but nonconforming and may require correction as herein elsewhere provided, Minnesota Power shall nevertheless have the right to use such apparatus until such time as it is convenient to Minnesota Power that such apparatus be removed from service for correction.

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No.:
Date:

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ISSUE NO.	DATE	PREPARED BY	REVIEWED BY	PAGES AFFECTED
Original	02/17/15	RJB		
1	10/16/15	RJB	RJB	
2	11/13/15	RJB	RJB	Appendix 8
3	02/17/16	RJB	ARS	Appendix 6
4	11/19/19	DJS	RJB	Appendix 2A, 3.09
5	8/27/2021	RJB	RJB	Appendix 1A
6	7/1/2022	CKR	RJB	1.01-1.04
7	7/23/2022	CKR	RJB	1.05

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.

Signature .

Rev.

Typed or
Printed Name .

Date . Reg. No. .

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TECHNICAL EVALUATION
VENDOR SUPPLIED INFORMATION
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All manufacturers submitting a bid under this specification are required to answer the information listed below.

MANUFACTURER	______________
SHIPMENT DATE	______________
SHIPMENT ORIGIN	______________
RECEIPT OF ADDENDA	______________

DRAWINGS: (Drawing Transmittal Time in weeks)

Outline Preliminary	______________
Base Loading	______________
Center of Gravity	______________
Wiring Diagram	______________

ELECTRICAL DATA:

Cooling Class	______________
Phase	______________
Core/Form	______________

Flux Density @ 1.0 pu V______T @ 1.1 pu V________T

WINDING:	H	X	Y	N
Conductor				
Nominal Sys Volts				
Transf Connection				
Rated Wind Volts				
Current Density A/mm^2 @ Top Rating				
MVA Ratings				
Self Cooled				
Second Stage				
Third Stage				
65C Top Rating				

VOLTAGE TAPS: (H/X)

(Off Load)	kV				
(Off Load)	kV				
(Off Load)	kV (Nominal Tap)				
(Off Load)	kV				
(Off Load)	kV				
Other					

INSULATION LEVELS:

BIL				

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TEST LEVEL WINDINGS				
Applied Potential kV	______	______	______	______
Induced Potential kV	______	______	______	______
Partial Discharge uV	______	______	______	______
	H	X	Y	N
Chopped Wave Crest kV	______	______	______	______
Full Wave kV	______	______	______	______
SWITCHING SURGE:				
Crest kV	______	______	______	______
BUSHINGS:				
Manufacturer	______	______	______	______
Catalog No/Type	______	______	______	______
BUSHING INSULATION CLASS:				
BIL (kV)	______	______	______	______
RATED CURRENT AMPS:	______	______	______	______
EFFICIENCY:				
Full Load				
50%	______			
IMPEDANCE:				
H-X: DETC Max:	______			
DETC Neutral	______			
DETC Min:	______			
H-Y	______			
X-Y	______			
For LTC Units at tap positions				
16 raise (H-X)	______			
8 raise (H-X)	______			
Neutral (H-X)	______			
8 lower (H-X)	______			
16 lower (H-X)	______			
REGULATION %:	Base MVA			
pf unity	______			
Pf .8%	______			

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RESISTANCE:
H Winding __________
X Winding __________

LOSSES:
NO LOAD LOSS kW
100% V __________
110% V __________

LOAD LOSSES kW
100% V __________
110% V __________

Auxiliary losses kW:
First Stage __________
Second Stage __________

ZERO SEQUENCE IMPEDANCE:
Excitation Current 100% V __________
Excitation Current 110% V __________

SHORT CIRCUIT CAPACITY:
Standard __________

MECHANICAL DATA:

ASSEMBLED PHYSICAL SIZE:

Assembled Transformer		Transformer Base	
Height	__________	Skids or flat base	__________
Width	__________	Width	__________
Depth	__________	Depth	__________

HEIGHT OVER BUSHINGS:
Height above "H" __________
Height Over Tank __________

WEIGHT (In Pounds):
Core & Coils __________ Shipping Weight ____________
Oil __________
Tank &Fittings __________
Untanking Weight __________

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TRANSFORMER OIL:
- Oil Type ____________
- Gallons ____________
- Oil Preservation System ____________

COOLERS (when furnished)
- Surface Area ____________
- Number of Tubes ____________

COOLER OR FAN CONTROL
- 1st Stage Cooling Set @ °C ____________
- 2nd Stage Cooling Set @ °C ____________
- Alarm Stage Set @ °C ____________
- Trip Contact @ °C ____________

	Capacity (cfm or Gpm)	Number	Type	Size (hp)	Speed (rpm)	Locked Rotor (amp)
FANS						
PUMPS						

SOUND LEVELS:
- Level (dBA): ____________
- Base Rating ____________
- 1st Stage Cooling ____________
- 2nd Stage Cooling ____________

CURRENT TRANSFORMERS:
- Manufacturer: ____________
- Ratio & Accuracy ____________

SURGE ARRESTERS:
- Manufacturer: ____________

SEPARATELY SHIPPED ITEMS: ____

SHIPPED OIL FILLED: ______________

EXCEPTIONS: ____

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(Contractor to fill in data below)

1.0 APPLICATION

1.01 Site Name:

1.02 Site Location:
1.03 Approximate Elevation:

1.04 Temperature Requirements

Maximum Daily Average:
Minimum Recorded:
Maximum Recorded:

1.05 Average Snow Fall:

2.0 DESCRIPTION

2.01 Type:
Cooling Class:
Rated Output:
Voltage Class:
Rated Full Load Current:
Connections:

2.01.1 _______ Provide an alternate for the following:

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3.0 ELECTRICAL REQUIREMENTS

3.01 Insulation Requirements

	Full Wave	Chopped Wave	Switching Surge
H, primary	________kV BIL	________kV	________kV
X, secondary	________kV BIL	________kV	________kV
Y, tertiary	________kV BIL	________kV	________kV
N, Neutral bushing	________kV BIL	________kV	________kV

3.02 Impedance

The impedance between windings shall be :

	Winding	%Z	**@ Base MVA**
H-X	________	________	
H-Y	________	________	
X-Y	________	________	

3.03 Tap Voltage Ratings (No Load Operation)

The following taps, full capacity shall be provided as indicated below:

H winding ________, ________, ________, ________, ________, ________, ________, kV
X winding ________, ________, ________, ________, ________, ________, ________, kV
Y winding ________, ________, ________, ________, ________, ________, ________, kV

_______ The following reduced capacity taps shall be provided as indicated below:

Capacity ________,________, ________, ________, ________, ________, ________, MVA
H winding ________, ________, ________, ________, ________, ________, ________, kV
X winding ________, ________, ________, ________, ________, ________, ________, kV
Y winding ________, ________, ________, ________, ________, ________, ________, kV

3.04 Load Tap Changing

_______ Load Tap Changing is to be provided.

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3.05 Transformer Loading

_______ Simultaneous Loading

The maximum simultaneous loading in the windings without exceeding ANSI Standard temperature rise limitations under each cooling condition shall be as follows when specified: The transformer should be designed for simultaneous loading provided the arithemetic sum of the XV and TV does not exceed the full rating of the transformer

Duty Cycle	Winding kV	Type of MVA	Pf	Type of Cooling	Temperature Rise by Resistance °C
Continuous					

3.06 Parallel Operation

__N/A__ The Transformer shall be suitable for parallel operation at rated voltage and on taps of like turns ratio with the following units:

MVA	kV to kV	%Z	MFR	Serial No.

3.07 Short Circuit Withstand Capability

_______ Values of system impedance to be used in calculating faults current magnitudes are as follows:

HV Kv % impedance

LV kV, % impedance

_______ All impedances are on a ***100*** MVA base. The ratio of X_0 /X_1 equals has been used for both systems.

_______ The transformer shall be designed to meet ANSI C57.12.00.

_______ The transformer shall be designed for infinite bus

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3.08 Surge Arresters

_______ ***Station class*** ______ ***Intermediate class*** metal oxide type surge arresters and mounting bracket for each shall be furnished adjacent to the associated bushing of terminals. Arrester rating shall be ***84 kV*** line to ground maximum continuous operating voltage for H1, 2, 3, ***29 kv*** for X1, 2, 3, ***N/A*** kV for Y1, 2, 3 and ***N/A*** kV for N respectively.

3.09 Auxiliary Power and Control Wiring

_______ Provide auxiliary power supply to allow two separate sources to feed transformer loads. Purchaser will provide two full capacity 120/240 volt, 1-phase, 3-wire power supplies with a manual transfer switch between them to the control cabinet for cooler pumps, fans and LTC motor and control.

_______ Purchaser to provide two 120/240 volt, 3 wire single phase services. One for fan and/or pump power if present; one for auxiliary power.

_______ Minnesota Power Drawing CR10.05.121587 for typical power supply wiring is attached.

_______ Vendor shall provide two 3PDT manually operated power supply selector switches to permit connecting either or both cooler groups to either power supply.
Separate control transformers, if necessary, shall be provided, one for each cooler group.

The control relays and circuits shall be designed for ____________ **VDC.**

3.10 Loss Evaluation

_______ The transformer losses and capital costs will be evaluated at the following rate:

	A	B (alternate loss numbers If supplied)
3.19.1 No Load Losses ($/kW)	$____________	____________________
3.19.2 Load Losses ($/kW)	$____________	____________________
3.19.3 Capital Cost Factor	____________	____________________
3.19.4 Auxiliary Equipment power costs, all stages	____________	____________________

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NEW UNITS ONLY

3.11 Audible Sound Level

_______ An audible sound level evaluation will be made. For the purposes of this evaluation, the sound level shall be measured on the "A" weighted scale in accordance with NEMA TR1. The transformer shall be designed to meet a dBA sound level at MVA.

_______ If the normal sound level as measured previously exceeds this amount, an alternate quotation for acoustical treatment will be considered.

_______ Provide an alternate for audible sound tests to be performed in accordance with ANSI C57.12.90, latest revision.

Purchaser's Identification
No.: 113177.FIF.EL.10.05
Date: 07/27/2022

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

APPENDIX 2B
ELECTRICAL DATA – BUSHINGS & CURRENT TRANSFORMERS
TRANSFORMERS 5000kVA to 50000KVA BASE RATED
(MINNESOTA POWER SUPPLIED INFORMATION)
NEW TRANSFORMERS ONLY

3.12 Bushings

3.12.1 All bushings shall be oil filled and shall meet the requirements of ANSI C57.12.00 and C76.1, latest revisions, for bushings interchangeable between transformers and oil circuit breakers.

3.12.2 Bushings shall be sky gray in color, ANSI 70.

3.12.3 Bushings shall meet the insulation levels and BIL levels required in Section 3.01, Insulation Requirements, unless noted otherwise below. Bushing ampacities to be sized to carry rated current. TV and Neutral bushings to be matching model numbers.

Bushings	H	X	Y	N
BIL Level	_______ kV	_______ kV	_______ kV	_______ kV
Continuous Current	_______ ampere	_______ ampere	_______ ampere	_______ ampere
Minimum Creep	_______ inches	_______ inches	_______ inches	_______ inches

3.12.4 All bushings shall be equipped with power factor testing taps.

3.12.5 The bushings shall be of a draw through lead type to facilitate installation, when feasible.

3.12.6 Current Transformers:

H winding position X ____, Y _____________, Z _____________

X winding position X ____________, Y _____________, Z ____________

Y winding position X ____________, Y _____________, Z ____________

N winding position X ____________, Y _____________, Z ____________

Accuracy ______C800__________, unless indicated otherwise

Rating Factor ______2.0______, unless indicated otherwise

Does not include hot spot winding CT or other current transformers required for instruments on or in tank, including LTC.

3.12.7 Two external bushings for permanent installation for the internal delta, if present, for field test purposes shall be provided. Basic insulation level same as teriary winding.

3.12.8 Add a "spark plug" rated a minimum of 2.5kV for core ground tests, minimum current rating 50 amps. Add insulating cover.

Purchaser's Identification
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MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

APPENDIX 3
DELIVERY AND CONTACTS
GENERAL ALL TRANSFORMERS
ALL TRANSFORMERS

Page 1 of 1

Contact for Technical Questions: ____

Email: ____

Telephone: _________

Contact for Delivery: _______________________

Address: ____

Telephone: ____

Fax: ____

Email: ____

Delivery Point: ____________________

____

____

Contact 48 Hours prior to delivery

Map Attached: ________ Y, ________ N

Delivery: FOB foundation on Site, Oil filled

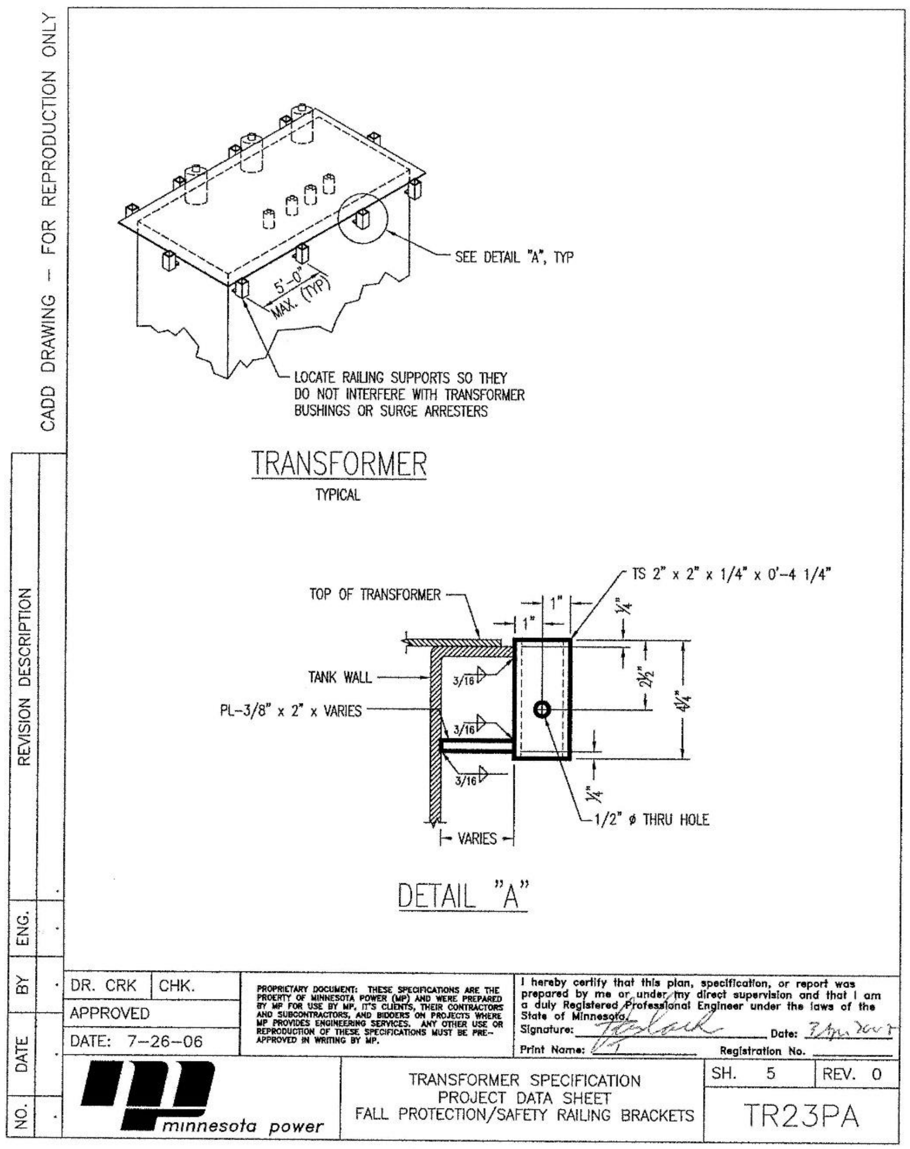
Warrantee: 60 months after energization or 66 months after shipment

Purchaser's Identification
No.: 113177.FIF.EL.10.05
Date: 07/27/2022

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

APPENDIX 5
SAFETY RAILINGS
GENERAL ALL TRANSFORMERS

Page 1 of 1



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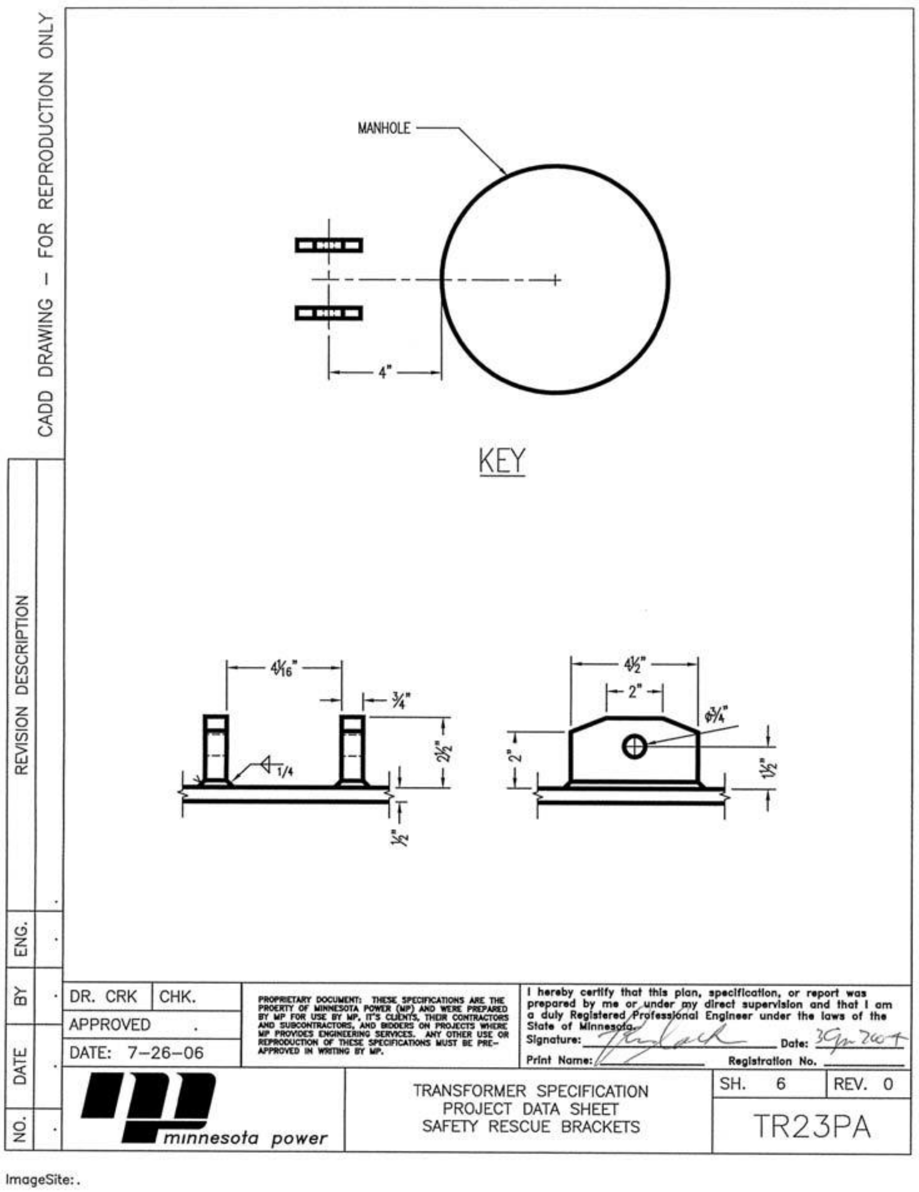
Purchaser's Identification
No.: 113177.FIF.EL.10.05
Date: 07/27/2022

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

APPENDIX 6
SAFETY BRACKETS
<u>GENERAL ALL TRANSFORMERS</u>

Page 1 of 1

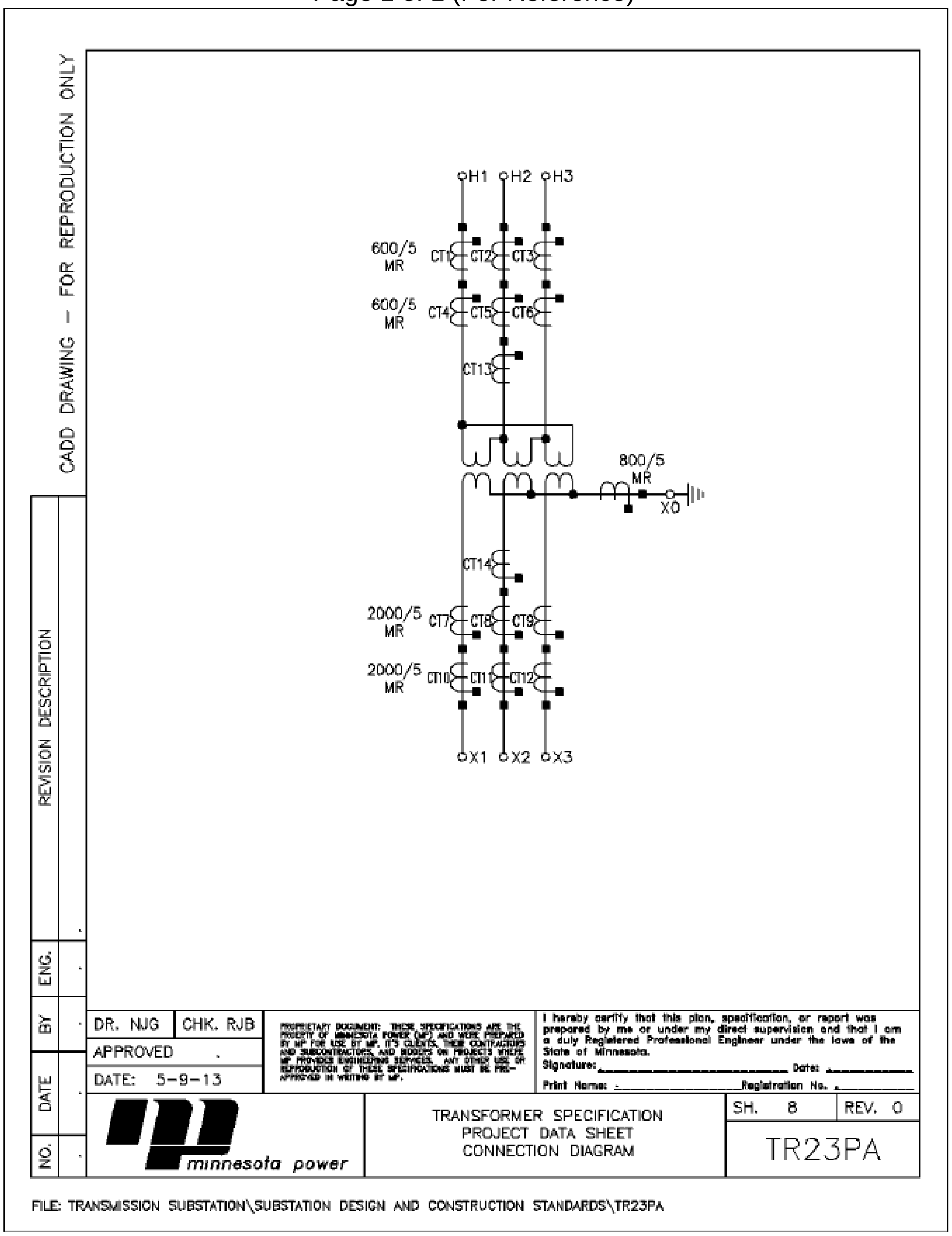


Purchaser's Identification
No.: 113177.FIF.EL.10.05
Date: 07/27/2022

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

APPENDIX 7
CONNECTION DIAGRAM
<u>GENERAL ALL TRANSFORMERS</u>

Page 1 of 1 (For Reference)



Purchaser's Identification
No.: 113177.FIF.EL.10.05
Date: 07/27/2022

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

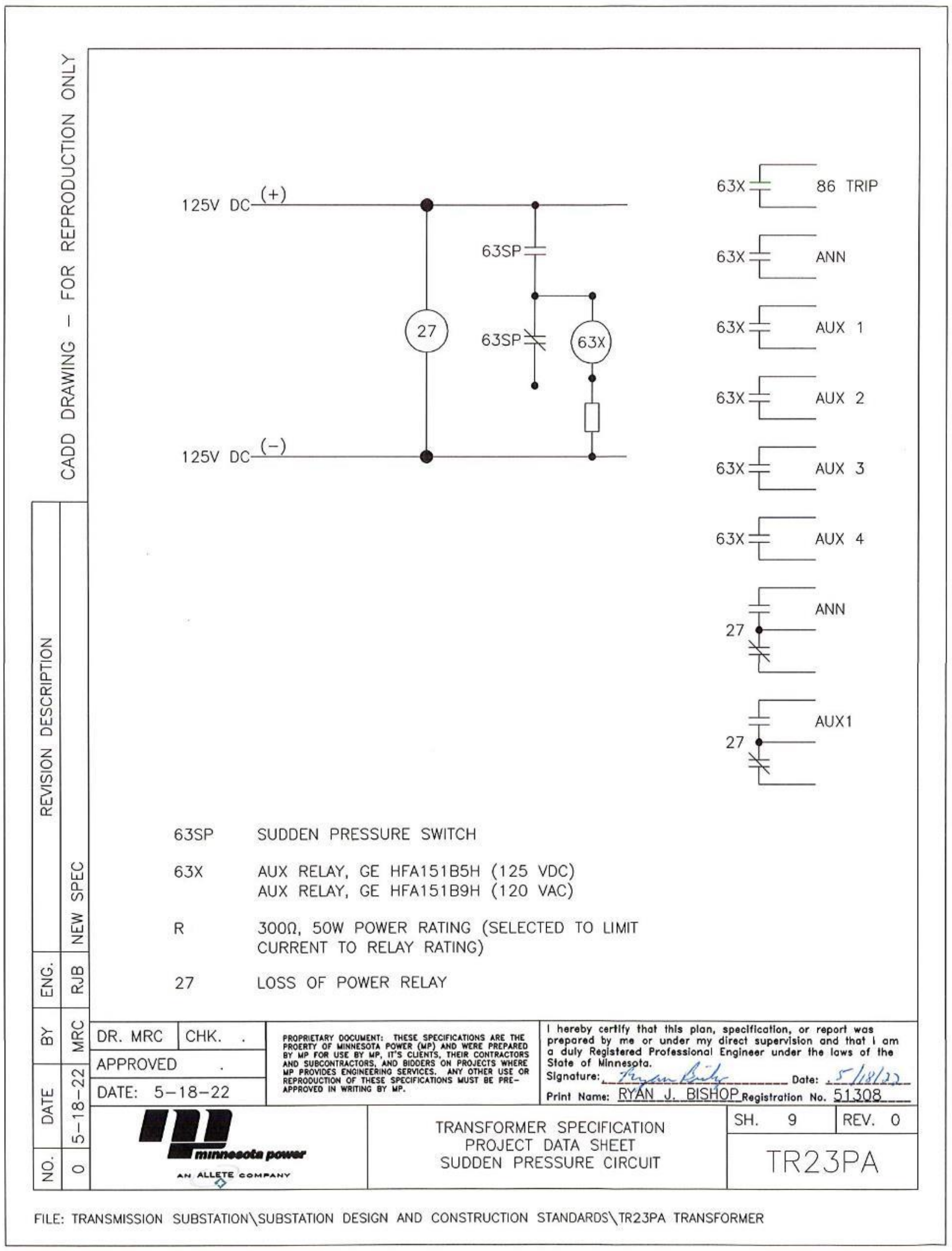
APPENDIX 8
ALARMS AND MONITORS
GENERAL ALL TRANSFORMERS

REFURBISH	NEW	NO ACTION NOT APPLICABLE	ITEM	MANUFACTURER	CATALOG NO.
	X		MAIN LIQUID LEVEL GAUGE	QUALITROL	CAS-803-1-CS-34345*
			LTC LIQUID LEVEL GAUGE	QUALITROL	CAS-786-2-CS-33348*
	X		LIQUID TEMP GAUGE	QUALITROL	104-330-01*
	X		WINDING TEMP GAUGE	QUALITROL	104-314-01*
	X		PRESSURE VACUUM GAUGE	THUEMLING IND. PRODUCTS	421-552A
	X		MAIN PRESSURE RELIEF DEVICE	QUALITROL	208-009-01*
			LTC PRESSURE RELIEF DEVICE	QUALITROL	208-009-01*
	X		SUDDEN PRESSURE RELAY - Oil	QUALITROL	900-FLA-A-NO-STD*
	X		SUDDEN PRESSURE RELAY - Gas	QUALITROL	910-FLA-A-NO-STD*
	X		RELIEF DEVICE SEMAPHORE	QUALITROL	207-60-3*
	X		PRESSURE VACUUM SWITCHES	QUALITROL QUALITROL	146-036-01* 146-036-02 6-02
	X		OIL FLOW INDICATOR	QUALITROL	092-301-03*
	X		LOSS OF POWER RELAY (FANS)	TELEMECANIQUE	CADREQ3836G3 LADR26
	X		LOSS OF POWER RELAY (COOLING CTRL)	TELEMECANIQUE	CADREQ3836G1 LADR26
		X	LTC SUDDEN PRESSURE RELAY – OIL	QUALITROL	900-FLA-A-NO-STD*
	X		SUDDEN PRESSURE AUXILIARY RELAY – 125VDC	GE	HFA151B5H
		X	SUDDEN PRESSURE AUXILIARY RELAY – 120 VAC	GE	HFA151B9H
	X		LOSS OF POWER RELAY - SUDDEN PRESSURE CIRCUIT	POTTER & BRUMFIELD	KRPA-11DY-110
			* or equal		

Purchaser's Identification
No.: 113177.FIF.EL.10.05
Date: 07/27/2022

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

APPENDIX 9
SUDDEN PRESSURE DIAGRAM – GENERAL ALL TRANSFORMERS



Purchaser's Identification
No.: 113177.FIF.EL.10.05
Date: 07/27/2022

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
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APPENDIX 10
CONTROL POWER SUPPLY DIAGRAMS
GENERAL ALL TRANSFORMERS

_______ Minnesota Power Drawing CR10.05.121587 for typical power supply wiring is attached.

Purchaser's Identification
No.: 113177.FIF.EL.10.05
Date: 07/27/2022

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

APPENDIX 11
Transformer Design Considerations
GENERAL ALL TRANSFORMERS

Minnesota Power Facility Ratings Methodology

- Rigid Bus Systems
  - IEEE 605-2008
  - Atmospheric Conditions: Clear
  - Emissivity: 0.5
  - Ambient Temperature: 40˚C
- Bare Overhead Conductors
  - IEEE 738-1993
  - Emissivity: 0.5
  - Absorptivity: 0.5
  - Summer Ambient Temperature: 30˚C
  - Atmospheric Conditions: Clear
  - Wind: 2 ft/sec perpendicular to conductor
  - Orientation: 90˚ from North
  - Latitude: 47˚N
  - Solar Gain: June 21
  - Elevation: 1200’

AN ALLETE COMPANY

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

FLAME RETARDANT POWER & CONTROL CABLE

Date	Prep
XX/XX/XX	BAH

Standard Number

CA01PA

(Rev 0)

Table of Contents

1. SCOPE

This specification covers flame retardant power and control cable. This includes but is not limited to control cable used for AC Signals, low voltage AC distribution circuits, and DC controls.

2. REFERENCE STANDARDS

The design, materials, manufacturing and testing of electrical cables shall comply with the latest revisions in effect as of date of manufacture of all currently approved applicable regulations, safety codes, specifications and standards, including technical definitions, whether or not specifically mentioned herein. The applicable codes/standards shall include, but not necessarily be limited to, the following:

These set forth the minimum requirements:

ASTM B3	Standard Specification for Soft or Annealed Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tinned Soft of Annealed Copper Wire for Electrical Purposes
ICEA S-66-524	ICEA/NEMA Standards Publication Cross-linked-Thermosetting-Polyethylene-Insulated Wire and Cable for Transmission and Distribution Electrical Energy
ICEA P-46-426	Power Cable Ampacities
ICEA P-54-440	Ampacities: Cables In Open Top Cable Trays
ICEA S-68-516	ICEA/NEMA Standards Publication Ethylene Propylene-Rubber Insulated Wire and Cable for Transmission and Distribution Electrical Energy
ICEA T-29-520	Guide for Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 BTU/HT
ICEA P-53-426	Ampacities Including Effect of Shielding for Single Conductor Solid Dielectric Power Cable 15kV through 69kV Copper and Aluminum Cables
ICEA S-73-532	ICEA/NEMA Standard Publication "Control Cable"
ICEA S-82-552	ICEA/NEMA Standards Publication "Instrumentation Cable and Thermocouple Wire"
WC-26-90	NEMA Standard Wire and Cable Packaging
UL 1581	Reference Standard for Electric Wires, Cables and Flexible Cords
UL 44	Rubber Insulated Wires and Cables
UL 1277	Electric Power & Control Tray Cables with Optional Optical Fiber Members
IEEE 98	Standard for the Preparation of Test Procedures for the Thermal Evaluation of Solid Electrical Insulating Material

IEEE 99	Recommended Practice for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electrical Equipment (where specified)
IEEE 101	Guide for the Statistical Analysis of Thermal Life Test Data IEEE 383 Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations (where specified)
IEEE 383	Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations (Sect. 2.5)
OSHA	

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The multiple conductor cable shall be suitable for AC and DC control, relay and instrument circuits. It shall be suitable to be installed in exposed conduits, cable tray, ducts above and below grade and wet or dry locations.

3.1.2 The multiple conductor shielded cable shall be suitable for exposed conduit, tray, underground ducts above and below grade in wet or dry service. When paired cables are specified, the pairs shall be individually shielded.

3.1.3 The single conductor cable shall be suitable for AC and DC power circuits, motor circuits, heater circuits and lighting. The single conductor cable shall be suitable to be installed in exposed conduits, cable tray, ducts above and below grade and wet or dry locations.

3.1.4 Single conductor cable shall be jacketed and insulated.

3.1.5 The cable, insulation and jacket, shall be suitable for installation at -20°C.

3.2 CONDUCTOR

3.2.1 Conductors shall be stranded, uncoated, annealed copper, meeting ASTM B-3, B-8 and ASTM Class B.

3.2.2 The required number of conductors are to be cabled round with a nonhydroscopic filler, flame resistant, for circular configuration.

3.2.3 For multiple conductor cable the effect of stray magnetic fields shall be minimized by constructing the cable with twisted conductor configuration.

3.3 CONDUCTOR INSULATION

3.3.1 Conductor insulation shall be cross linked polyethylene or ethylene propylene rubber (preferred), rated 600 Volts, (or 300 Volt where specified) and conform to ICEA/NEMA standard ICEA S-66-524, S-68-516.

3.3.2 The insulation shall be thermosetting type suitable for continuous operation at a conductor temperature not to exceed 90°C (194°F) in an ambient temperature not to exceed 40°C (104°F) and shall be flame and moisture resistant, meeting the electrical and physical requirements of above listed standards. The insulation shall meet the requirements of section 2

3.3.3 The insulation thickness shall be in accordance with applicable ICEA standards for the rated voltage and conductor size.

3.3.4 Conductor insulation (multiple conductor cables) shall be color coded as per ICEA Method 1 using colored compounds with tracers. No other method is acceptable. The color sequence shall be in accordance with standard ICEA S-73-532. Appendix E, Table E-2. The base and tracer colors shall match the color shades as given in Table K-2 in Appendix K of the same standard.

3.4 CABLE JACKET

3.4.1 Jacket to be permanently marked with manufacturers' identifications, cable size, and ratings at approximately two foot intervals. The overall jacket shall be in accordance with standard ICEA S-68-516 Table 4.4, 4.5 and 4.6. The jacket shall meet the requirements of section 2.

3.4.2 Jacket shall be oil, heat, weather, flame, abrasion and moisture resistant, meeting the physical requirements of ICEA standards. If a jacket material not covered in ICEA standards is offered, Seller shall furnish its physical characteristics in such a way as to permit a direct comparison with those of ICEA jackets.

3.4.3 Polyvinyl chloride (PVC) jacket is not acceptable for any cable construction. The jacket material shall be less than 20% chlorine content by weight. The jacket material may be neoprene, rubber, chlorosulphonated polyethylene, hypalon, non-halogenated cross linked polyolefin, chlorinated polyethylene (CPE) or other materials which meet the requirement stated above.

3.5 CABLE SHIELDING

Electrostatic shielding methods (listed in order of preference).

3.5.1 Aluminum coated nylon or polyester with tinned annealed copper drain wire. Drain wire to be same size or two AWG size smaller than insulated conductors and to be in continuous contact with the aluminum shield.

3.5.2 Copper coated nylon or polyester with untinned annealed copper drain wire. Drain wire to be same size or one gauge size smaller than insulated conductors and to be in continuous contact with copper shield.

3.5.3 5 mil copper tape shield

4. TESTS

4.1 GENERAL

4.1.1 Minnesota Power reserves the right to witness any and all tests or inspections. Vendor shall notify Minnesota Power 10 days in advance of any inspection or tests required by this specification. Minnesota Power will advise in writing as to which tests or inspection will be witnessed.

4.1.2 The cables shall meet the qualification tests, acceptance tests and tests on completed cable as outlined in ICEA S-66-524 or S-68-516 and IEEE 383, IEEE 101, UL 1277, ICEA T-29-520.

4.2 FACTORY INSPECTION

4.2.1 Tests on completed cables shall be performed on the shipping reel lengths before shipment. Minnesota Power shall reserve right to witness these tests. He may reject any portion of the cables being tested which do not meet the specification. Vendor shall furnish certified test reports if Minnesota Power waives the right to inspect the cable.

4.3 QUALIFICATION TESTS

4.3.1 The qualification tests shall be made on the cable or a representative sample to demonstrate the fabricated cable design conforms to the specification. Those tests are:

4.3.1.1 Long Term Aging Test. The cable shall have a projected 40 year life in (at 90°C) accordance with IEEE 98,IEEE 99, IEEE 101 and IEEE 383.

4.3.1.2 Accelerated Water Absorption Test. These tests shall be conducted per ICEA S-68-516 or S-66-524.

4.3.1.3 Accelerated Water Absorption Test. (Jacket) These Tests shall be conducted per ICEA S-68-516 or S-66-524. The water absorption shall not exceed 40 mg. per square inch of surface

4.3.1.4 Heat Distortion Tests. These tests shall be conducted per ICEA S-68-516 or S-66-524.

4.3.1.5 Oil Immersion Test. These tests shall be conducted per ICEA S-68-516 or S-66-524.

4.3.1.6 Flame Retardancy. These tests shall be conducted per UL 1277, IEEE 383 and/or ICEA T-29-520 and demonstrate flame retardancy to a 210,000 BTU, heat source.

4.4 ACCEPTANCE AND FACTORY TESTS

4.4.1 Acceptance and Factory Tests shall be per ICEA S-68-516 or S-66-524.

4.5 TESTS ON COMPLETED CABLES

4.5.1 Voltage Proof Tests - Completed reels of cables shall be tested following the general procedures of ICEA S-68-516 Section 6.27 or ICEA S-66-524 Section 6.14. Control cable shall be tested following ICEA S-73-532 section 3.4.

4.5.2 Insulation Resistance - The insulation resistance shall be measured as per ICEA S-68-516 Section 6.28 or S-66-524 Section 6.15. Control cable shall be measured as per ICEA S 73 532 section 3.5.

4.5.3 Partial Discharge - The insulation shall meet the requirements of S-66-524 Section 6.16.

5. DOCUMENTATION

5.1 INFORMATION REQUIRED WITH PROPOSAL

Manufacturer shall provide the following:

5.1.1 A statement of compliance with the specification shall be furnished if Vendor complies with all requirements of these specifications. Vendor shall also furnish copies of certified test reports required in these specifications. List all exceptions to the specification.

5.1.2 Ampacity data for conduit, underground duct and different depths of tray fill installations, if deviating from those of ICEA P-46-426 and P-54-440 standards.

5.1.3 Cable emergency overload and short-circuit ratings.

5.1.4 Vendor's recommendations for cable installation, including minimum installation temperature.

5.1.5 Month and year the cable was manufactured.

6. PACKAGING AND DELIVERY

6.1 REEL AND CABLE PACKAGING

6.1.1 Seller shall prepare all cable reels covered by this specification for shipment in such a manner as to protect them from damage in transit, and shall be responsible at his own expense for any and all damage caused by improper preparation.

6.1.2 Vendor shall furnish cable on nonreturnable wood reels. These shall withstand all the effects of shipment, handling in the field, and outdoor storage for a period of one (1) year in all handling and installation of the cables without damage to the cable or reel itself. Plywood flange reels are not acceptable. The nonreturnable wood reels shall meet the requirements of NEMA Standards Publication No. WC-26-90. Protective coverings for reels shall meet the requirements of NEMA Standards Publication No. WC-26-90. The minimum diameter of the drum of the shipping reels shall be not less than prescribed in NEMA Publication No. WC-26-90. There shall be no damage and no corrosion in the completed cable when shipped. The reels shall be lagged or covered with suitable material to provide physical protection for the cables during transit and during storage and handling operations.

6.1.3 Both cable ends shall be sealed against entrance of moisture prior to shipping. Cables shall be sealed with tight-fitting heat shrinkable end caps.

6.2 REEL MARKING

6.2.1 Each cable reel shall be marked on both sides with indelible lettering or tag as follows:

6.2.1.1 Reel no. (minimum 1-inch high). This reel number shall consist of the Minnesota Power Cable Item No. and Reel No., ie, for Item No. C-12-3 and Reel No. 2, the Reel lettering is C-12-3-2.

6.2.1.2 PO number/supplement

6.2.1.3 Cable symbol

6.2.1.4 Cable voltage, No. of conductors, size

6.2.1.5 Reel length

6.3 CABLE MARKING

6.3.1 Completed cable to be furnished under this specification shall be identified by the printed marking applied to the outside surface. This marking is to include the following information:

6.3.1.1 Manufacturer's name

6.3.1.2 Number of conductors/pairs

6.3.1.3 Shield (if applicable)

6.3.1.4 Size of conductor

6.3.1.5 Conductor material

6.3.1.6 Insulation material

6.3.1.7 Voltage rating

6.3.1.8 Temperature rating (if cable is UL listed omit this marking)

7. REVISION TABLE

Number	Date	By	Reviewed	Description
0	3/29/19	BAH		Converted from old format, No Technical Changes

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MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

STATION CLASS SURGE ARRESTERS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

SA01PA

(Rev 3)

Table of Contents

1. SCOPE

This standard covers outdoor, high-voltage, station class surge arresters used within Purchaser's transmission substations. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The surge arresters shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including:

2.1 IEEE Std. C62.11-2012.

2.2 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The surge arresters shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification SA01PA-S1***.

3.1.2 Surge arresters shall be of all new materials and of the latest manufacture and design. A rebuilt or used surge arrester will not be acceptable.

3.2 ELECTRICAL CHARACTERISTICS

3.2.1 The surge arrester electrical ratings shall be per ***Supplement Specification SA01PA-S1***.

3.2.2 The line terminals shall be furnished with a standard aluminum or tin-plated bronze 4" NEMA 4-hole terminal pad.

3.2.3 Corona mitigation shall be furnished for nominal system voltages above 230kV.

3.2.4 A NEMA two-hole bolted bronze, stainless or galvanized steel terminal shall be provided to attach Purchaser's 4/0 copper to ground. Single bolt terminals are not acceptable.

3.2.5 The arrester shall meet the requirements for a discharge Voltage-Current wave shape of 8x20 microsecond at various crest impulse values of current. The maximum impulse discharge voltages shall be per ***Table 1***.

3.2.6 The arrester shall meet the requirements for a discharge Volt-Time curve for a wave shape of .5 microsecond equivalent front-of-wave at various crest impulse values of current. The maximum front-of-wave discharge voltages shall be per ***Table 1***.

3.2.7 The arrester shall meet the requirements for a discharge Volt-Time characteristics for a wave shape of .45 microsecond switching surge (classifying current) at various crest impulse values of current. The maximum switching surge discharge voltages shall be per ***Table 1***.

3.3 PHYSICAL CHARACTERISTICS

3.3.1 The surge arrester shall be designed per the Physical Characteristics outlined in ***Supplement Specification SA01PA-S1***.

3.3.2 Surge arresters shall be capable of being mounted upright or underhung, per ***Supplement Specification SA01PA-S1***.

3.3.3 Surge arrester base shall be provided with three (3) mounting slots uniformly spaced on a 10” diameter bolt circle.

3.3.4 Surge arrester shall be sky gray in color and conform to standard color designation ANSI #70.

3.3.5 All ferrous parts exposed to the weather and subject to corrosion shall be galvanized.

3.3.6 Each arrester unit shall have a means for relieving internal pressure in the event of arrester failure.

3.3.7 In addition to the nameplate for the complete arrester stack, a nameplate for each unit of the stack shall be integrally attached to the respective unit.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C62.11-2012.

4.2 The surge arrester shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C62.11-2012.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each surge arrester.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of surge arrester:

5.1.1 Data as indicated in ***Section 13***.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of surge arrester:

5.2.1 Outline Drawings

5.2.2 Nameplate Drawing

5.2.3 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each surge arrester to be used for Purchaser's final records:

5.3.1 Outline Drawings.

5.3.2 Nameplate Drawing

5.3.3 Instruction Manual

5.3.4 Installation Instructions

5.3.5 Certified Test Reports

One set of instruction books and drawings shall be shipped with the surge arrester in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the surge arrester, and to perform all tests that may be necessary. The cost of a competent installation technician shall be included as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Surge arresters shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 Surge arrester shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Surge arrester shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery day.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: **See *Bid Documents***.

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification SA01PA-S1***: Ratings and Technical Requirements completed by Purchaser, and Section 13: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Supplement Specification SA01PA-S1 and Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification SA01PA-S1***

12.2 Table 1 and Table 2 Technical Information: ***See Next 2 Pages***

Table 1							
Nominal System Voltage (kV)	**System Maximum Operating Voltage (kV)**	**Arrester Voltage Rating (kV rms)**	**MCOV Rating (kV)**	**Maximum Switching Surge Discharge Voltage (kV)***	**Maximum Front of Wave Discharge Voltage (kV)**	**Maximum Impulse 10kA Discharge Voltage (kV)**	**Maximum Impulse 15kA Discharge Voltage (kV)**
13.8	15.5	18	15.3	48	64	58	-
23	25.8	24	19.5	66	87	79	-
34.5	38	36	29	87	116	105	-
46	48.3	48	39	109	145	132	-
115	121	108	84	240	318	289	-
138	145	120	98	284	376	342	-
161	169	132	106	328	434	395	-
230	242	192	152	393	521	474	-

* 500A for 15kV - 46kV and 1000A for 115kV - 230kV

Table 2				
Nominal System Voltage (kV)	**Minimum Creep (In)**	**Minimum Phase to Ground Live Parts (In)**	**Minimum Height (In)**	**Maximum Height (In)**
13.8	11	7	10	24
23	17	10	14	30
34.5	26	13	15	36
46	35	17	18	48
115	79	42	47	70
138	92	50	52.5	75
161	114	58	61.5	80
230	146	71	76	95

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. **One form shall be used for each unique item quoted.** Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Line Item/Description/Label		
b. Manufacturer		
c. Point of Manufacturer		
d. Point of Shipment		
e. Domestic Content		%
f. Delivery Date		Weeks ARO
g. Price per Unit (Tax NOT included)	$	
h. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft.
c. Maximum Wind Speed		miles/hr.
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a. Class		
b. Design (MOV, etc)		
c. Duty-cycle Voltage		kV
d. Maximum Continuous Operating Voltage		kV
e. Duty-cycle Voltage		kV
f. Maximum Continuous Operating Voltage		kV
g. Switching Surge Discharge Voltage		kV
h. Front of Wave Discharge Voltage		kV
i. Impulse 10kA Discharge Voltage		kV
j. Pressure Relief Class (Symmetrical)		kA
k. Energy Capability		kJ/kV MCOV

13.5 Physical Characteristics

a. Height (bottom of base to top of terminal)		in
b. Diameter (not including base)		in
c. Unit Weight (Approximate)		lb.
d. Maximum Design Cantilever Load		ft-lbs
e. Housing Type		
f. Arrester Orientation (Upright, Underhung)		

13.6 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$
	$

13.7 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$
	$

13.8 Adder for services per Section 8.

Service	Price
	$
	$
	$

13.9 Exemption(s)

13.10 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
1	01/16/18	ARS		Added 6.6kV to Table
2	01/17/20	DJS	KJB	Added PE Stamp, updated IEEE standard name, updated sections 3.2.4, 5.2.2, 5.3.2 and Table 2.
3	10/15/21	PJK/BV	RJB	Created SB01PA-S1 Supplemental Spec and Changed section numbering, rearranged sections 12, 13 & 14. Revised 3.3.2

Purchaser's Identification
File No.: [XXXX.XXX].EL.65.05
Date: [Date]

MINNESOTA POWER
STANDARD SPECIFICATION SB02PA

BATTERY CHARGER

XXXXXX Substation
DC Station Battery Charger

ISSUE NO.	DATE	PREPARED BY	REVIEWED BY	PAGES AFFECTED
Rev. 0	4/25/2012	BAF	SAL & RPS	
Rev. 1	3/13/2013	BAH	RPS	1, 2
Rev. 2	9/18/2013	BAH	RPS	1, 2
Rev. 3	4/16/2014	BAH	RPS	1
Rev. 3	7/7/2016	BAH	JJL	ALL

MINNESOTA POWER

STANDARD SPECIFICATION SB02PA

BATTERY CHARGER

INDEX

Section

Purchaser's Identification
File No.:XXXXX.XXX.CV.55.05
Date: [Date]

MINNESOTA POWER
STANDARD SPECIFICATION SB02PA
BATTERY CHARGER

The manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

1.0 STANDARDS

This equipment shall be designed, manufactured, and tested in accordance with applicable ANSI, NEMA standards. Shall meet latest revision of NEC, NEMA, and ANSI applicable standards. Surge withstand capability to meet the requirements of ANSI C37.90a-1974 (IEEE 472-1974).

2.0 GENERAL DESCRIPTION

2.01 Quantity required ***1***.
2.02 Nominal DC output ***130*** volts.
2.03 DC output ***XX*** amperes.
2.04 Acceptable types of charges are:
Ferro-resonant
Controlled ferro-resonant
SCR
2.05 Charger output shall be filtered when connected and disconnected from a battery bank.
2.06 Filtered voltage ripple shall not be greater than 100 mV RMS, when disconnected from a battery bank.
2.07 AC input ***240*** volts ***single*** phase 60 hertz.
2.08 Charger shall be of the constant voltage design type.
2.09 Circuitry shall permit recharging a completely discharged battery without overloading or opening breakers, contactors, or fuses. Charger shall be completely self-protected and be able to withstand a short circuit on the output terminals with no resultant damage to the charger.
2.10 Charger shall be convection cooled and capable of continuous operation at an ambient temperature range of 0° to 40°C.
2.11 Regulation within 1% from no load to full load with AC input variations of ± 10%.
2.12 The charger shall be current limiting to 110% or less or adjustable to 100% of rating.
2.13 Provide an AC input breaker with a rating of no less than **22kAIC** at the input voltage outline in section 2.07.
2.14 Provide internal terminal board for easy connection of AC input, DC output, and alarm terminals.
2.15 Enclosure shall be painted with ANSI 61 gray paint. All components shall be readily accessible from the front.
2.16 Enclosure shall be NEMA class 1 for indoor use.
2.17 Charger shall provide full output, undistorted in accordance with section 2.06, continuously, when disconnected from station battery.

3.0 OPTIONAL ACCESSORIES

3.01 72-hour manually set equalizing charge timer shall be provided.
3.02 Switch for continuous equalizing to by-pass timer shall be provided.
3.03 Continuously connected ground detector lamps shall be provided.
3.04 Individual form C alarm contacts shall be provided for the following:
3.04.01 Ground detector alarm
3.04.02 Low DC voltage alarm
3.04.03 High DC voltage alarm
3.04.04 Battery Open alarm
3.04.05 Battery Charger Summary Fail alarm
3.04.06 Loss of AC input alarm

MINNESOTA POWER
STANDARD SPECIFICATION SB02PA
BATTERY CHARGER

3.06 Provide a DC output breaker with a rating of no less than **5kAIC** at the rated nominal output voltage of the charger specified in section 2.03.
3.07 DC ammeter and voltmeter to have 2% accuracy and minimum scale length of 2-1/2 inches.
3.08 Provide individual controls for float and equalize voltage adjustments.
3.09 Provide high voltage alarm contacts, set at ***(vendor to provide)*** or factory set ***(vendor to provide).***
3.11 Provide standard spare parts list.
3.12 Provide loss of AC alarm.

4.0 INFORMATION REQUIRED WITH PROPOSAL

4.01 Manufacturers Catalog No.
4.02 Guarantee period.
4.03 Tabulation of all optional accessories.
4.04 Charger basic ratings with manufacturer's catalog sheet.
4.05 Charger is required on site by ***required delivery date*****.** Manufacturer shall provide estimated shipping date.
4.06 Cabinet size and mounting.
4.07 Provide "mean time to failure" data with this proposal.
4.08 Instruction manual

5.0 RECORD DRAWINGS REQUIRED BY *3 weeks after reciept of approved purchase order*

Provide one electronic and one paper copy of the following:

5.01 Instruction Manual
5.02 Cabinet outline drawing
5.03 Charger wiring diagram
5.04 Charger specification sheet or manufacturer's catalog sheet

6.0 WARRANTEE

The manufacturer shall provide a one (1) year from date of energization warrantee not to exceed 18 months from date of shipment.

7.0 SHIPMENT

7.01 The equipment shall be shipped FOB Destination, Prepaid & Allowed.
7.02 Vendor shall ship to:

LOCATION

8.0 REMARKS

This equipment shall be manufactured to be in strict conformance with all applicable standards pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970.

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

LEAD STORAGE BATTERY

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:____________________________________

Typed or Printed Name: Name Here
Date: January 1, 2018 License No.: #####

Date	Prep
XX/XX/XX	XXX

Standard Number

SB01PA

(Rev 0)

Table of Contents

1. SCOPE

1.1 This specification sets forth the minimum technical requirements for a lead storage battery (battery) to be provided to Minnesota Power (Purchaser) by the Supplier. The Supplier shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted proposal.

1.2 Section 11.1 can be used to look up drawing numbers for references to Purchaser's drawings contained in this specification.

1.3 Delivery of the battery is required by [MM,DD,YYYY].

2. STANDARDS

The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:

2.1 National Electric Safety Code (NESC) (IEEE C2)

2.2 National Electric Code (NEC) as amended and adopted by the state in which the EEE will be installed.

2.3 All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, NEMA, ASTM, ICEA, IEEE, NFPA, UL, etc.)

3. GENERAL DESCRIPTION

3.1 The battery shall be rated:

3.1.1 Nominal control voltage see Table 1.

3.1.2 Number of cells see Table 1.

3.1.3 The battery shall be sized in accordance to IEEE Std 485-2010 utilizing the design parameters provided in the Table 1 and the load profile provided in Table 2.

3.1.4 Full charge specific gravity range 1.200 to 1.240.

3.2 Expected operating temperature range 10°C to 30°C.

3.3 Plates shall be of tubular construction.

4. ACCESSORIES

4.1 All necessary lead-plated inter-cell connectors, bolts, and hardware to allow 1/2" spacing between jars.

4.2 One portable hydrometer.

4.3 One set of necessary lifting devices.

4.4 One vent mounted thermometer.

4.5 One syringe holder for hydrometer.

4.6 One vent mounted hydrometer syringe.

4.7 One set of cell labels numbered 1 to 58.

4.8 One set of tools for inter-cell connections.

4.9 One set of flip top safety vent caps.

4.10 One battery rack for complete battery,

4.11 Battery rack shall be finished with two coats of acid resisting ANSI 61 gray paint. Rack zinc coated steel, with .06" of rail insulation.

4.12 Battery rack to be 2-Step/1-Tier construction arrangement.

4.12.1 Battery rack shall have provisions to be grounded with a NEMA 2 hole pad.

4.12.2 Rack shall provide for spill containment.

4.13 Terminal connectors, solderless.

4.14 Dead Front or Dead Top protection with direct testing access to posts and inter-cell connectors via probes.

4.15 2 oz. containers of no-oxide grease.

5. <u>INFORMATION REQUIRED SWITH PROPOSAL</u>

5.1 Supplier shall provide the following information with the proposal:

5.1.1 Manufacturers Catalog Number.

5.1.2 Number of cells per unit.

5.1.3 Guarantee period and expected life.

5.1.4 8-hour ampere hour capacity to 1.75 volts per cell at 25°C.

5.1.5 1-minute ampere rate to 1.75 volts per cell at 25°C.

5.1.5.1 Testing methods and results for 1-minute ampere rating.

5.1.6 Rack and cell dimensions and weight.

5.1.7 Short circuit available at output terminals (+, -).

5.1.8 Amount and type of gas generated during normal and equalize charging at a temperature of 70°F.

5.1.9 Discharge Characteristic Curve.

5.1.10 Annual Failure Rate of quoted cell type.

5.1.10.1 A cell failure is defined as any difficulty requiring return of a cell to a manufacturer.

5.1.10.2 Annual Failure Rate = $\frac{\text{Total Cell Failures since 1/1/2003}}{\text{Cell Service years since 1/1/2003}}$

5.1.11 All exceptions to these specifications or any standard in section 2.

6. RECORD DRAWINGS REQUIRED

6.1 Supplier shall provide one electronic and one paper copy of the following with the delivery of the battery:

6.1.1 Instruction Manual.

6.1.2 Rack outline drawing.

6.1.3 Battery unit outline drawing.

6.1.4 Manufacturer's battery specification sheet.

7. WARRANTY

7.1 Manufacturer shall provide a 20 year guarantee

8. SHIPMENT

8.1 The equipment shall be shipped FOB Destination, Prepaid & Allowed.

8.2 Vendor shall ship to:

LOCATION

8.3 The cells shall be shipped assembled and charged, ready for service, with the electrolyte in the cells.

8.4 Cells shall be properly packed and crated to protect them from damage in transit.

9. TABLES

9.1 Table 1: Individual Battery and Design Specifications

Project	Nominal Voltage	# Cells	Design Margin	Aging Factor	Temperature Correction Factor
Substation Name	130VDC	58	1.15	1.25	1.19 (10 °C)

9.2 Table 2: Load Profile

Period	Load (in Amps)	Time (in minutes)
1	Load	1
2	Load	478
3	Load	1

10. REVISION TABLE

Number	Date	By	Reviewed	Description
0	12/11/2019	BAH		Reformat of existing SB01PA Spec, Changed section numbering, Reset Revision to 0.

11. ATTACHMENTS AND DRAWINGS

11.1 The following drawings are referenced in the above specifications and include the battery that is to be provided by the Supplier.

Drawing #	Drawing Name
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]

[Site]

[Project]

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

CONTROL PANELS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: XXX
Date: XXXX XX, 20XX License No.: XXXX

Date	Prep
XX/XX/XX	XXX

Standard Number

PN01PA

(Rev 3)

Table of Contents

1. STANDARDS

2. GENERAL CONSTRUCTION

2.1 The panel enclosure shall be constructed per Minnesota Power Steel Detail drawings as outlined in Section 14.

2.2 Panel enclosure, 19” rack mounted control plate, and “blanks” shall be 10 or 11 gauge steel.

2.3 The panel shall be fabricated with no welds, rivets or bolt heads visible from the outside.

2.4 Each piece of equipment shall be mounted and wired so that removal and replacement may be accomplished without interruption of adjacent devices.

2.5 All devices to be located as shown on Purchaser’s elevation drawings. Any deviation requires written approval from Purchaser Relay and Control Engineering.

2.6 The drawings listed in Section 14 are attached to and form part of this specification:

2.7 Purchaser provides the Supplier with wiring schematics for fabrication.

2.7.1 If the Supplier requires wiring diagrams to complete construction of the panels it is the responsibility of the Supplier to take the Purchaser provided wiring schematics and develop the wiring diagrams. The wiring diagrams will need to be approved by the purchaser.

2.7.2 During the bid process Purchaser can, upon request, provide an example of Purchaser’s wiring schematics.

3. DESIGN DETAILS

3.1 The mounting position of indicating lights and control switches is critical to the purchaser's identification decals.

3.2 Control switch mounting centerlines should be approximately 42.5 inches above the floor or as specified on the elevations.

3.3 Equipment mounted on the inside of the panel shall be mounted on unistrut, attached to the panel, or the panel may be drilled and tapped to accept screws which shall be flush to the outside of the panel.

3.4 Purchaser's cables will come in from the top of the panel, usually landing on the left wing of the panel as viewed from the rear of the panel. SCADA cables will come in from the top and are landed on the right wing S blocks as viewed from the rear of the panel.

3.5 Termination blocks shall be mounted at a 45 degree angle from the wing as viewed from the rear of the panel.

3.6 Interior panel wiring shall be landed on the right side of terminal blocks located on the left wing and on the left side of terminal blocks located on the right wing as viewed from the rear of the panel or as specified on purchaser's termination block layout drawings.

3.7 S Terminal Blocks shall be mounted with the disconnect switch towards the rear of the panel. Plug-in bridges shall be used for jumpers between S Terminal Blocks. The bridges shall be marked with permanent black ink to indicate bridge configuration when installed.

3.8 9/16" diameter holes shall be provided near each corner of the bottom frame for anchoring the panel to the floor.

3.9 Lifting provisions shall be provided on the top of the panel.

3.10 Plastic wire trough will be supplied by the Supplier and mounted on the wing of the panel for routing and connecting wires were applicable.

3.11 The following information shall be supplied on the rear surface of each panel where it will be visible after assembly:

3.11.1 Substation Name

3.11.2 Purchase Order Number

3.11.3 Supplier's Name

3.11.4 Suppliers' Shop Order Number

3.12 Each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary devices excluding test switches shall be permanently labeled on the back and front of the panel, where applicable to coincide with the identification indicated on the Purchaser's drawings.

3.13 Terminal blocks shall be marked with white marking strips and permanent black ink.

4. INSPECTION

4.1 All work performed shall be subject to inspection. The Purchaser shall have the right to visit the Supplier's plant at any time.

5. PAINTING

5.1 All metal parts shall be cleaned and bonderized, followed immediately by a prime coat of rust resistant paint.

5.2 The control panel finish exterior color shall be ANSI-61 gray.

5.3 The control panel interior color shall be white.

6. CONTROL WIRING

6.1 All wiring shall be free of abrasions and tool marks.

6.2 Terminals interconnected by a solid line on wiring schematics are to be interconnected exactly as shown. Terminals interconnected by a dotted line on wiring schematics are to be interconnected via the shortest route. **The supplier shall follow the sequence provided on the wiring schematics or mark-up the wiring schematics indicating the sequence in which the circuit was wired.**

6.3 All wiring to devices shall come from nearest top or bottom edge. This will keep the back of devices clear between mounting studs for future mounting of other equipment.

6.4 Provide type SIS extra flexible stranded tinned-copper control wire rated 600V for panel wiring.

6.4.1 SIS Conductor Insulation shall be 90°C Rated.

6.5 All current transformer (CT) circuits used for tie or revenue metering are to be wired with #10 AWG wire. All other CT circuits are to be wired with #12 AWG wire.

6.6 All control circuits are to be wired with #12 AWG.

6.7 Alarm circuits are to be wired with #16 AWG wire.

6.8 RTU circuits are to be wired with #18 AWG wire.

6.9 Uninsulated ring tongue lugs shall be used for all terminations except where compression terminals exist.

6.9.1 At RTU compression terminals, terminate wiring using single and twin insulated ferrules.

6.10 No more than two wires shall be terminated on a given terminal block point.

6.11 The conductors shall be bundled, routed and secured in a manner that will not obstruct additional wiring that could be installed by the Purchaser to the terminals of Fabricator installed components.

6.12 Splices are not permitted in control wiring or instrument leads.

7. ELECTRICAL TESTS

7.1 Each circuit shall be given a continuity test after the panel is completely wired.

7.2 Perform any Supplier's acceptance tests for each of the relays and devices.

7.3 Check relays to ensure that all internal AC and DC voltage taps are at proper settings as applicable.

7.4 Using the panel schematics as a reference, apply AC voltages and currents to the Voltage Transformer (VT) and CT circuits from a test source.

7.4.1 Record readings and outputs of meters, recorders, transducers, etc.

7.4.2 Apply voltage and current of proper phase and magnitude to cause all devices to operate under simulated field conditions.

7.4.3 Allow sufficient time for devices to reach normal operating temperature.

7.4.4 Check all devices for abnormal heating.

7.5 Using schematics as a reference, apply DC voltage from a test source to the DC circuits.

7.5.1 Where a circuit breaker or other external device is shown, connect a mock device or DC test board to simulate the external device.

7.5.2 Operate all DC circuits to simulate field conditions, causing devices to trip or function as designed.

7.5.3 Check relay targets, coils, contacts, etc. for correct operation. Verify electro-mechanical relay targets are consistent with test applied.

7.5.4 Check timing relays for correct sequence and operation.

7.6 The tests specified in this section shall be performed in accordance with all applicable standards. The results of all tests and supporting data shall be included in the final test report.

8. SHIPMENT

8.1 The Supplier shall prepare all equipment covered by this specification for shipment in such a manner as to protect it from damage in transit.

8.2 Any and all damage resulting from improper preparation shall be repaired or replaced at the Supplier's expense.

9. DOCUMENT SUBMITTAL

9.1 All drawings for submittal should be sent electronically to:

[Engineer Name]
[Engineer Email]

9.2 All submittals are to include one (1) paper copy or one (1) electronic set in AutoCad or compatible drawing format approved by the Purchaser.

9.3 Supplier to fill in attached (PN01PA – Section 9.3Panel Schedule) within one week of receipt of order.

9.4 Dimensioned elevations and section drawings are required for approval within two weeks of receipt of order. Catalog numbers of the panel equipment are to be included with this submittal.

9.5 Steel Fabrication drawings are required for approval within two weeks of receipt of order.

9.6 If Supplier will be developing wiring diagrams per Section 2.7.1, the wiring diagrams are required for approval within two weeks after the receipt of schematics from the Purchaser.

9.7 Redlined as constructed Purchaser's wiring schematics for each panel are required with shipment of the panel. As-builts drawings shall be printed with color on 18x24" paper.

9.8 Record drawings are required within two weeks of panel shipment. Record drawings to include the following:

9.8.1 Final drawings from Section 9.4, 9.6, and 9.7.

9.8.2 Copy of the final test reports

10. INSTRUCTION MANUALS

10.1 Supplier shall provide:

10.1.1 One (1) set of instruction manuals bound per panel at time of panel shipment.

10.1.2 Two (2) CD's containing electronic versions of all documentation shall be included with instruction manuals at time of panel shipment.

10.2 The set of instruction manuals shall contain manufacturer's literature for each device as specified on the front elevation drawings.

11. INFORMATION REQUIRED WITH QUOTATION

11.1 Shipping cost for the panels is to be included [in each panel cost.] [in the shipping cost for the associated Electrical Equipment Enclosure (EEE)]. Price F.O.B. destination.

11.2 Delivery Date

11.2.1 Desired delivery date is no later than [Date]

11.3 Date wiring schematics are required from the purchaser.

11.4 Exceptions to these specifications

11.5 Complete Bill of Materials

11.6 Quality Control Checklist

11.7 Completed price breakdown, see attached (PN01PA – Section 11.7 Bid Tab)

12. QUALITY SYSTEM REQUIREMENTS

12.1 VERIFICATION

12.1.1 The Purchaser shall have access to perform assessments, quality audits, or witness test activities during the manufacturing process and to review applicable records. Purchaser may designate an authorized agent to perform these activities. The authorized agent may be an employee of the Purchaser or an outside agency. When an outside agency is designated as an authorized agent for the Purchaser, such designation shall be in writing with a copy provided to the Supplier. Hereinafter, when the term "Purchaser's representative" is used, it may also mean the Purchaser or the authorized agent.

12.1.2 The following requirements apply for Purchaser's inspection at the Supplier's mill, factory, yard, warehouse, or subtier supplier's facilities.

12.2 ACCESS

12.2.1 The Purchaser shall have the right to access the Supplier's and subtier supplier's work and related documents at any time during the manufacturing process without delaying the schedule. The Supplier shall provide, without cost, reasonable facilities including tools, personnel, and instruments for demonstrating acceptability of the work.

13. REVISION TABLE

Number	Date	By	Reviewed	Description
0	04/6/2018	BAH	BAF	1. Updated Format, reset Revision Number to 0 2. Added S-Block Mounting Info 3. Added #10 AWG requirement for Metering CT Circuits 4. Clarified Wiring Schematic vs Wiring Diagram requirements and responsibilities
1	10/3/2018	BAH	DJS, SLM, BAF, KJR	1. Changed Control Wiring Size to #12 2. Added Requirement for SIS Insulation rating of 90°C
3	7/26/2022	TJC	DPJ	1. Added PE signature block to the front page.

14. ATTACHED DRAWINGS

DRAWING #	DRAWING NAME	STEEL DETAIL DRAWING
ME-XXXXX-XX SH. X	*[Communications Panel]*	*N/A*
ME-XXXXX-XX SH. X	*[Metering Panel/Cabinet Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[Sync Panel Panel]*	*MB+19414-03 SH.XX*
ME-XXXXX-XX SH. X	*[Termination Cabinet]*	*N/A*
ME-XXXXX-XX SH. X	*[RTU Panel]*	*N/A*
ME-XXXXX-XX SH. X	*[HMI Panel]*	*N/A*
ME-XXXXX-XX SH. X	*[XXkV Bus Differential Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[DFR Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[X Transformer Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[XX Line Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[XX Capacitor Bank Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[XX Feeder Panel]*	*MB+19414-02 SH.XX*

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

DISTRIBUTION PANEL

250 VOLT DC

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Name Here
Date: January 1, 2018 License No.: #####

Date	Prep
XX/XX/XX	XXX

Standard Number

PN02PA

(Rev 0)

Table of Contents

1. SCOPE

This specification sets forth the minimum technical requirements for an electric distribution panel of 250 volts DC to be provided to Minnesota Power (Purchaser) by the Supplier. The Supplier shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted proposal.

Section 9.1 can be used to look up drawing numbers for references to Purchaser's drawings contained in this specification.

Delivery of the panel is required by [MM,DD,YYYY].

2. STANDARDS

The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:

2.1 National Electric Safety Code (NESC) (IEEE C2)

2.2 National Electric Code (NEC) as amended and adopted by the state in which the panel will be installed.

2.3 All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, NEMA, ASTM, ICEA, IEEE, NFPA, UL, etc.)

3. GENERAL DESCRIPTION

3.1 The panel shall be rated 250 volts DC, 2 Wire for use on a 130 Volt DC System.

3.2 The main bus shall be one piece continuous tin or silver plated copper rated [XXX]A.

3.3 The minimum short circuit rating of the bus and breakers shall be [XX]kA.

4. ENCLOSURE

4.1 The enclosure shall be NEMA class [1, 2, 3, 3R or 4] construction.

4.2 The box shall be without knockouts.

4.3 The minimum wireway space shall be as follows: Sides 3 inches; Top and bottom 5 inches. The box depth shall be a minimum of 5 1/2 inches.

4.4 The enclosure shall be a maximum of 80 inches high.

4.5 The enclosure shall be [surface/flush] mounting.

4.6 The exterior and interior paint shall be ANSI 61 gray.

4.7 The box shall have welded seams throughout.

5. MAIN BREAKER

5.1 Provide [value] ampere, 250 volts DC, 2 Pole main breaker.

5.2 The interrupting capacity of the main breaker shall be as listed in Section 3.3.

5.3 The main breaker or main lugs shall be [top/bottom] feed and suitable for [1, 2, or 3, value] AWG/kcmil copper cable per pole.

5.4 Provide feed through lugs, same ampacity as main bus.

6. BRANCH CIRCUITS

6.1 Provide subfeed lugs, [value] ampere capacity.

6.2 All branch circuit breakers will be thermal magnetic unless noted otherwise and rated 250 volts DC.

6.3 All branch breakers shall be bolt on style.

6.4 All branch breakers shall have an interrupt rating as listed in Section 3.3.

6.5 The branch circuit breakers shall meet or exceed UL, E-11592, NEC latest issue, NEMA standard AB1, and Federal specifications WC-375A.

6.6 [The circuit breakers shown on the 125V DC Distribution Diagram shall be included as part of this DC Panel./The following circuit breakers as indicated below shall be included as part of this DC Panel:]

Quantity	Continuous Amps	Mag Trip Only	Adj Mag Trip

7. ALTERNATE

7.1 Provide an alternate for a 125 volt DC pilot light.

7.2 Provide gasketed doors and fronts.

7.3 Provide an alternate for a panel rating including branches of [value] amperes short circuit symmetrical/asymmetrical.

8. REVISION TABLE

Number	Date	By	Reviewed	Description
0	12/11/2019	BAH		Reformat of existing PN03PA Spec, Changed section numbering, Reset Revision to 0.

9. ATTACHMENTS AND DRAWINGS

9.1 The following drawings are referenced in the above specifications and include the panel that is to be provided by the Supplier.

Drawing #	Drawing Name
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

DISTRIBUTION PANEL

600 VOLTS OR LESS AC

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Name Here
Date: January 1, 2018 License No.: #####

Date	Prep
XX/XX/XX	XXX

Standard Number

PN03PA

(Rev 0)

Table of Contents

1. SCOPE

This specification sets forth the minimum technical requirements for an electric distribution panel of 600 VAC or less to be provided to Minnesota Power (Purchaser) by the Supplier. The Supplier shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted proposal.

Section 10.1 can be used to look up drawing numbers for references to Purchaser's drawings contained in this specification.

Delivery of the panel is required by [MM,DD,YYYY].

2. STANDARDS

The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:

2.1 National Electric Safety Code (NESC) (IEEE C2)

2.2 National Electric Code (NEC) as amended and adopted by the state in which the panel will be installed.

2.3 All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, NEMA, ASTM, ICEA, IEEE, NFPA, UL, etc.)

3. GENERAL DESCRIPTION

3.1 The panel shall be rated:

3.1.1 120/240 volts AC, single phase, three wire for use on a 120/240 volt, single phase three wire system.

3.1.2 240 volt AC, three phase, four wire for use on a 240 volt AC three phase, four wire, midpoint grounded delta system, or 120/208 volt AC three phase, four wire, grounded wye system.

3.1.3 240 volt AC, three phase, three wire for use on a three phase, three wire, grounded "B" phase system.

3.1.4 480 volt AC, three phase, four wire, for use on a three phase, four wire, midpoint grounded delta, or a three phase, four wire, 277/480 volt AC grounded wye system.

3.2 The main bus shall be rated [XXX] ampere, and one piece continuous tin or silver plated copper.

3.3 The minimum symmetrical/asymmetrical short circuit rating of the bus and breakers shall be [XX,XXX] amperes.

4. ENCLOSURE

4.1 The enclosure shall be NEMA class [1, 2, 3, 3R or 4] construction.

4.2 The box shall be without knockouts.

4.3 The minimum wireway space shall be as follows: Sides 4 1/2 inches; Top and bottom 7 inches. The box depth shall be a minimum of 5 1/2 inches.

4.4 The enclosure shall be a maximum of 80 inches high.

4.5 The enclosure shall be [surface/flush] mounting.

4.6 The exterior and interior paint shall be ANSI 61 gray.

4.7 The box shall have welded seams throughout.

5. MAIN BREAKER

5.1 Provide [value] ampere, [1 or 3] phase, [3 or 4] wire value volt AC, main lugs only.

5.2 Provide [value] ampere, [1 or 3] phase, [3 or 4] wire value volt AC, main breaker, bolt on style.

5.3 The main breaker shall have an adjustable magnetic trip range of [value] amperes.

5.4 The interrupting capacity of the main breaker shall be as listed in Section 3.3.

5.5 The main breaker or main lugs shall be [top/bottom] feed and suitable for [1, 2, or 3, value] AWG/kcmil copper cable per pole.

5.6 Provide feed through lugs, same ampacity as main bus.

6. BRANCH CIRCUITS

6.1 Provide subfeed lugs, [value] ampere capacity.

6.2 All branch circuit breakers will be thermal magnetic unless noted otherwise and rated [value] volts AC.

6.3 All branch breakers shall be bolt on style.

6.4 All branch breakers shall have an interrupt rating as listed in Section 3.3.

6.5 The branch circuit breakers shall meet or exceed UL, E-11592, NEC latest issue, NEMA standard AB1, and Federal specifications WC-375A.

6.6 The following circuit breakers as indicated below shall be included as part of this AC Panel:

Quantity	Continuous Amps	No. Poles	Mag Trip Only	Adj Mag Trip	GFI Breaker

7. NEUTRAL CONNECTION

7.1 Provide a [value] ampere solid neutral connection lug.

8. ALTERNATE

8.1 Provide a green 120 volt AC pilot light with control power transformer when necessary.

8.2 Provide gasketed doors and fronts.

9. REVISION TABLE

Number	Date	By	Reviewed	Description
0	12/11/2019	BAH		Reformat of existing PN03PA Spec, Changed section numbering, Reset Revision to 0.

10. ATTACHMENTS AND DRAWINGS

10.1 The following drawings are referenced in the above specifications and include the panel that is to be provided by the Supplier.

Drawing #	Drawing Name
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

OUTDOOR GANG OPERATED

AIR BREAK SWITCHES

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

AB02PA

(Rev 5)

Table of Contents

1. SCOPE

This standard covers outdoor, high-voltage, air break switches used on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

Switches shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including:

2.1 IEEE Std. C37.30.1-2011.

2.2 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The switches shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification AB02PA-S1***.

3.1.2 Switches shall be of all new materials and of the latest manufacture and design. Rebuilt or used switches will not be acceptable.

3.1.3 Motor operators, if required, will be supplied by others.

3.1.4 Manufacturer shall provide all provisions necessary to mount the switch and operating mechanism components to Purchaser supplied structural steel. Refer to the ***Bid Documents*** for steel mounting details.

3.2 ELECTRICAL REQUIREMENTS

3.2.1 The switch electrical ratings shall be per ***Supplement Specification AB02PA-S1***.

3.2.2 Switches shall be furnished with standard NEMA size terminal pads, compatible with aluminum or copper terminal connectors. Terminal pads shall be appropriately sized to carry the entire ampacity of the switch.

3.2.3 Switch live parts shall be aluminum.

3.2.4 The switch shall have arcing horns/accessories to protect the current-carrying contacts.

3.2.5 Unless otherwise indicated in the Bid Documents, insulators shall be supplied and switches shall ship with the insulators installed.

3.2.6 Insulators shall be porcelain or composite per ***Supplement Specification AB02PA-S1*** and comply with Minnesota Power Standard Specification BS03PA – Station Post Insulators.

3.3 PHYSICAL/MECHANICAL REQUIREMENTS

3.3.1 The switch shall be designed per the Physical Characteristics outlined in ***Supplement Specification AB02PA-S1***.

3.3.2 All switch components shall be sky gray in color and conform to standard color designation ANSI #70.

3.3.3 Each switch blade shall form one solid piece and shall be so assembled that no parts of the blade can move relative to one another.

3.3.4 All jaw contacts shall be stationary and designed so that wiping action is provided with a minimum of roughening or wear on the surfaces.

3.3.5 Bearings for the rotating insulator stacks shall be tapered roller or double ball type. If of the latter type, the bearings shall be of the combination radial and thrust type. All ball or roller bearings shall be of the sealed, permanently lubricated type.

3.3.6 Interphase linkage shall be of the torsional type or an acceptable substitute. All interphase connections and mounting hardware shall be supplied for single gang throw operation. All interphase connecting pipe fittings shall have piercing screws. All interphase connecting pipe shall have means of preventing water retention inside pipe by way of weep holes, open ends or combination thereof.

3.3.7 Leveling nuts shall be incorporated for plumbing all insulator stacks.

3.3.8 The switch linkage shall over-toggle into the fully open or fully closed positions and shall have adjustable mechanical stops for both the open and closed positions.

3.3.9 Operating mechanisms shall effect a smooth, thoroughly controlled movement throughout the entire opening and closing cycle and all rods, shafts, pipe linkages, connectors, operating levels, supports, and fittings shall show no noticeable deflection. Cable connections in lieu of rigid interphase rods are not acceptable.

3.3.10 A means shall be provided on each switch for taking up loose motion in each part of the mechanism and for adjusting the travel of each blade independently. The design of the mechanism shall be such that the main blades are positively toggled when in the fully open or fully closed position.

3.3.11 The manual operator shall be easily turned by a person of average strength without need for extension pipes or levers (35 lbs. for a worm gear operator and 60 lbs. for a swing handle operator).

3.3.12 The switch operator rod shall be supplied with an open/close indicator to identify current position of switch.

3.3.13 A swing handle or gear operator accessible for operation at ground level shall be provided.

3.3.14 There shall be provisions for padlocking the operator in both the open and closed positions.

3.3.15 An appropriately sized, flexible ground jumper shall be provided for the operating handle.

3.3.16 The switch shall have quick break whip/accessories to protect the current-carrying contacts **See *Supplement Specification AB02PA-S1* if applicable.**

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C37.30.1-2011

4.2 Switches shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C37.30.1-2011. Manufacturer shall provide a list of factory tests performed to verify proper mechanical or electrical operation of the switches.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each switch.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of disconnect switch:

5.1.1 Data as indicated in Section 03.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of switch:

5.2.1 Outline drawings.

5.2.2 Base detail.

5.2.3 Nameplate Drawing

5.2.4 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each switch to be used for Purchaser's final records:

5.3.1 Outline drawings.

5.3.2 Base detail.

5.3.3 Nameplate Drawing with serial number

5.3.4 Instruction Manual

5.3.5 Installation Instructions

5.3.6 Certified Test Reports

One set of instruction books and drawings shall be shipped with the Switches in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the switches, and to perform all tests that may be necessary. All quotations must include the cost of a competent installation technician as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery. ***See Bid Documents*** for delivery location.

10.2 All switch components shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 All switch components shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Switches shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: ***See Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification AB02PA-S1***: Ratings and Technical Requirements completed by Purchaser, and **Section 0:** Specific Information Required with Quotation for Manufacturer to complete.

11.1 Purchaser Proposed Schedule: ***See Supplement Specification AB02PA-S1 and Bid Documents***

11.2 Contact for Technical Questions: ***See Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***See Supplement Specification AB02PA-S1***

12.2 Table 1 Technical Information: ***See Next Page***

Table 1			
Nominal System Phase-to-Phase Voltage (kV)	**Maximum Voltage (kV)**	**Power Frequency Withstand Voltage Wet (kV)**	**Lightning Impulse Withstand Voltage (kV)**
13.8	15.5	45	110
23	25.8	60	150
34.5	38	80	200
46	48.3	95	250
69	72.5	140	350
115	121	230	550
138	145	275	650
161	169	315	750
230	242	385	900

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. **One form shall be used for each unique item quoted.** Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Line Item/Description/Label		
b. Manufacturer		
c. Point of Manufacturer		
d. Domestic Content		%
e. Delivery Date		Weeks ARO
f. Price per Unit (Tax NOT included)	$	
g. Warranty		Months Post Delivery
		Months Post Install
h. Type/Model Number		

13.2 Documentation Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a.	Rated Maximum Voltage		kV
b.	Power Frequency Withstand Voltage		kV
c.	Lightning Impulse Withstand Voltage		kV
d.	Continuous Current Rating		A
e.	Peak Withstand Current Rating		kA
f.	Short-Time Withstand Current Rating		kA
g.	Short-Time Withstand Duration		Sec
h.	Line Charging Current Rating (Phase Spacing per Supplement AB02PA-S1 and/or Bid Documents)		A
i.	Magnetizing Current Rating (Phase Spacing per Supplement AB02PA-S1 and/or Bid Documents)		A

13.5 Physical Characteristics

a.	Blade Opening (Vertical, Double End, etc.)		
b.	Mounting (Horizontal, Vertical, Inverted)		
c.	Style		
d.	Operator (Manual, Motor Operator)		
e.	Insulator T.R No		
f.	Insulator Material (Porcelain or Composite)		
g.	Direction of Operation (to open)		
h.	Degrees of Operation		
i.	Interrupter Accessories (Arcing Horns, Quick Break Whips, etc.)		
j.	Height (bottom of base to top of terminal)		in

k. Height (bottom of base to top of open blade)		in
l. Width		in
m. Depth		in
n. Shipping Height		in
o. Unit Weight (Approximate)		Lbs.

13.6 Applicable Factory Testing

13.7 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$

13.8 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.9 Adder for services per Section 8.

Service	Price
	$
	$
	$

13.10 Exemption(s)

13.11 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
5	08/19/21	PJK/BV		Created AB02PA-S1 Supplemental Spec and Changed section numbering, rearranged sections 12, 13 & 14, revised 3.2.6 for insulator type.
2	09/27/18	ARS		
3	11/04/19	DJS/KJB	DJS	Added PE Stamp to Title Page, revisions pages 1,3,,4 and updated Table 2 on page 7
4	12/11/19	LAG/KJB	DJS	Revision to page 2 Section 3.3.6
5	10/15/21	PJK/BV	RJB	Created AB02PA-S1 Supplemental Spec and Changed section numbering, rearranged sections 12, 13 & 14. Revision to 3.1.4, 3.2.6, 5.3.3 and 13.5. Updated Table 1 & removed Table 2

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

OUTDOOR THREE POLE

SF6 GAS CIRCUIT BREAKERS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

CB01PA

(Rev 4)

Table of Contents

1. SCOPE

This standard covers outdoor, high-voltage, SF_6 gas circuit breakers (breakers) used on Purchaser's transmission and distribution system. The manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The circuit breaker shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including:

2.1 IEEE Std. C37.04

2.2 IEEE Std. C37.09

2.3 IEEE Std. C37.11

2.4 NEMA Power Circuit Breaker Standard Publication No. SG 4, latest revisions

2.5 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The circuit breaker shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification CB01PA-S1***.

3.1.2 The breaker shall be furnished complete and ready for operation with operating mechanism, structural steel support, and all accessories necessary for operation.

3.1.3 The breaker shall be of all new materials and of the latest manufacture and design. A rebuilt or used circuit breaker will not be acceptable.

3.2 OPERATING MECHANISM

3.2.1 The operating mechanism shall be mechanically and electrically trip-free per IEEE Std. C37.04.

3.2.2 The operating mechanism shall be anti-pumping per IEEE Std. C37.11.

3.2.3 A latch check device shall be provided per IEEE Std. C37.11.

3.2.4 The stored energy mechanism shall be spring charged. Charging motors shall be at a voltage as indicated in ***Supplement Specification CB01PA-S1***. The storage device shall be of sufficient size to permit one (1) complete opening-closing-opening operation at rated short circuit current.

3.2.5 The operating mechanism shall be capable of manual operation upon complete power failure. Any special tooling required to manually operate the breaker shall be supplied.

3.2.6 A mechanically operated operation counter designed to increment on a trip operation shall be supplied.

3.2.7 A readily visible position indicator shall be supplied.

3.2.8 Provisions for a travel analyzer recorder shall be provided.

3.3 GAS SYSTEM

3.3.1 Stainless steel piping and piping fittings is preferred. Manufacturer shall provide the necessary valving to allow maintenance and testing of all density monitors and SF6 pressure switches without removal of SF6 gas or de-energization of the circuit breaker. Manufacturer shall provide piping and a position for a SF6 monitor or provisions for such a device.

3.3.2 A temperature compensated pressure/density gauge(s) shall be supplied for monitoring SF6 gas pressure/density.

3.3.3 Separate from the pressure/density gauge, a temperature compensated “low gas alarm” and “low gas lockout alarm” SF6 gas pressure/density switches shall be provided.

3.3.4 There shall be a shutoff valve between the SF6 enclosure(s) and the temperature compensated pressure/density gauge or switches.

3.3.5 A single fill valve shall be provided to allow for simultaneous filling of all SF6 enclosures.

3.3.6 All fittings shall be self-sealing DILO fittings.

3.3.7 Manufacturer shall supply a diagram indicating the position and function of all valves, monitors, pressure switches and any ancillary equipment in the SF6 piping system.

3.3.8 Each circuit breaker shall be supplied with SF6 gas conforming to ASTM standards of less than 77 ppm moisture content.

3.3.9 Gas enclosures shall be stamped with ASME “U” stamp for pressure vessel documentation purposes.

3.3.10 The tank finish shall be resistant to chipping and shall have a primer coat and a final outer coat of high corrosion resistant material.

3.3.11 Manufacturer shall supply the necessary SF6 gas with the circuit breaker along with all necessary equipment including hoses, adapters, and regulators required to fill the breaker to rated pressure.

3.4 CONTROL CIRCUIT AND WIRING

3.4.1 All control wiring, except BCTs, shall be a minimum of 14 AWG SIS wire, terminated on suitable terminal blocks in the mechanism housing.

3.4.2 AC terminal blocks shall be able to accommodate Purchaser's 6 AWG power cable.

3.4.3 All relay accuracy bushing current transformer (BCT) taps shall be brought out to General Electric Co. shorting type terminal blocks able to accommodate Purchaser's 8 AWG control cable. One extra terminal shall be provided on each BCT terminal block for the purpose of grounding BCTs when changing taps. At a minimum, **relay accuracy BCT wiring shall be 12 AWG SIS**.

3.4.4 All metering accuracy bushing current transformer (BCT) taps shall be brought out to General Electric Co. shorting type terminal blocks able to accommodate Purchaser's 6 AWG control cable. One extra terminal shall be provided on each BCT terminal block for the purpose of grounding BCTs when changing taps. At a minimum, **metering accuracy BCT wiring shall be 10 AWG SIS**.

3.4.5 All other terminal blocks not specified above shall be able to accommodate Purchaser's 8 AWG control cable.

3.4.6 All BCT secondaries shall be shorted to ground prior to shipment.

3.4.7 Double pole fused knife switches shall be furnished for protection of control circuits.

3.4.8 A minimum of ten (10) normally open and ten (10) normally closed spare auxiliary switches shall be furnished in addition to those required for the circuit breaker control circuit.

3.4.9 Two trip coils designed for operation at the control voltage outlined in ***Supplement Specification CB01PA-S1*** shall be provided.

3.4.10 Trip circuit current shall be greater than 2 amps and not exceed 10 amps.

3.4.11 Operating mechanism limit switches shall be provided to prevent operation of the closing coil and closing motor contactor during abnormal or incomplete operation of the operating mechanism

3.4.12 No electrical manual trip or close shall be provided.

3.4.13 The following alarms shall be wired to the terminal board for the purchaser's use:

a. Spring Charge Failure

b. Low Gas Pressure

c. Low Gas Lockout

d. Loss of AC

e. Loss of DC

f. Tank Heater Failure for each phase

3.4.14 The anti-pumping relay (52Y) shall be provided with one spare contact wired to the terminal board for the purchaser's use.

3.4.15 The operating mechanism and all auxiliary components shall be enclosed in a weather tight housing with a lockable door.

3.4.16 The gas density / pressure relay (63G) shall block breaker operation at and below the acceptable low-gas density safe for operating temperature range.

3.4.17 Closing circuit shall have an X relay to limit current to 1 amp.

3.5 ACCESSORIES

3.5.1 The interior of housing shall have a functional 120 VAC light mounted inside.

3.5.2 Each circuit breaker shall have a 120 VAC, 20 A, GFCI outlet. Preferred mounting of the outlet is on the exterior of the circuit breaker in a weatherproof junction box with weatherproof cover. The junction box shall be protected by a metal shroud welded and painted on the exterior of the breaker. Outlet wiring shall be terminated on suitable terminal blocks in the mechanism housing.

3.5.3 Two space heaters, designed for operation on 240 VAC single phase, shall be provided. The heaters shall be low surface temperature or operable at half voltage. One heater shall be continuously energized for condensation control. The second heater shall be thermostatically operated. Manufacturer shall size heaters to provide condensation control and ensure operation at an exterior ambient temperature outlined in ***Supplement Specification CB01PA-S1***.

3.5.4 The construction of the control cabinet and any other housing or compartment for control or operation shall be designed for operation per ***Supplement Specification CB01PA-S1***. If necessary, Manufacturer shall filter, vent, insulate, and/or heat these compartments. Manufacturer shall test and supply information from such tests to indicate proper operation.

3.6 ELECTRICAL CHARACTERISTICS

3.6.1 The circuit breaker electrical ratings shall be per ***Supplement Specification CB01PA-S1***.

3.6.2 The SF6 gas interrupter shall be able to withstand 1.0 times line-to-ground voltage at zero gauge pressure with loss of the SF6 gas insulating medium.

3.6.3 Bushings shall have the same voltage and current rating as the breaker.

3.7 PHYSICAL CHARACTERISTICS

3.7.1 The circuit breaker shall be designed per the Physical Characteristics outlined in ***Supplement Specification CB01PA-S1***.

3.7.2 Breakers shall be sky gray in color and conform to standard color designation ANSI #70.

3.7.3 The breaker shall be furnished with one grounding pad on each leg of the base. The grounding pads shall accommodate Purchaser's 2-hole 2" NEMA grounding pad.

3.7.4 A ground connection tied to the control cabinet ground shall be brought external to the control cabinet.

3.7.5 Bushing terminal shall be aluminum or tin plated bronze 4-hole 4" NEMA terminal pads.

3.7.6 A weatherproof gasket shall be provided on enclosure doors with a drip lip supplied above cabinet doors.

3.7.7 Breaker height shall be sufficient to ensure all energized or live parts are not less than outlined in ***Supplement Specification CB01PA-S1*** when measured to the bottom of frame. The maximum height of the circuit breaker shall be per ***Supplement Specification CB01PA-S1***.

3.7.8 The breaker frame shall be adjustable with the lowest setting within 1" of the minimum height required per **Section 3.7.1**.

3.7.9 The maximum horizontal distance between the centerlines of the outermost phases shall be per ***Supplement Specification CB01PA-S1***.

3.7.10 The structural steel frames shall be hot dipped galvanized per ASTM A123 and A153. A weep hole is required at the lowest point of any box steel construction to prevent water from accumulating inside.

3.7.11 Breaker frame shall withstand service conditions outlined in ***Supplement Specification CB01PA-S1***.

3.7.12 Typical loading calculations shall be supplied with bid.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C37.09, latest revision.

4.2 The circuit breaker shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C37.09, latest revision.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each circuit breaker.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of Breaker:

5.1.1 Data as indicated in ***Section 13***

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of breaker:

5.2.1 Outline Drawings

5.2.2 Bushing Outlines

5.2.3 Gas System Diagram

5.2.4 Nameplate Drawings

5.2.5 Schematic Diagrams

5.2.6 Wiring Diagram/Junction Box Layout

5.2.7 BCT Excitation and Saturation Curves

5.2.8 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each Breaker to be used for Purchaser's final records:

5.3.1 Outline Drawings

5.3.2 Bushing Outlines

5.3.3 Gas System Diagram

5.3.4 Nameplate Drawings

5.3.5 Schematic Diagrams

5.3.6 Wiring Diagram/Junction Box Layout

5.3.7 BCT Excitation and Saturation Curves

5.3.8 Instruction Manual

5.3.9 Installation Instructions

5.3.10 Certified Test Reports

One set of instruction books and drawings shall be shipped with the breaker in a weatherproof envelope.

6. <u>TOOLS</u>

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the circuit breaker, and to perform all tests that may be necessary. All quotations must include the cost of a competent installation technician as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Breaker shall be completely assembled except the structural steel support legs may be shipped separately for bolting on in the field.

10.3 Breaker shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Bushings shall be wrapped for shipping

10.5 Breaker shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.6 Purchaser shall be notified a minimum of three working days before delivery.

10.7 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.8 Contact for Delivery: **See *Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification CB01PA-S1***: Ratings and Technical Requirements completed by Purchaser; and **Section 13**: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Supplement Specification CB01PA-S1 and Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification CB01PA-S1***

12.2 Table 1, Table 2, and Table 3 Technical Information: ***See This Page and Next Page***

Table 1

Nominal System Phase-to-phase Voltage (kV)	Rated Maximum Voltage (kV)	Power Frequency Withstand Voltage 10 sec wet (kV)	Chopped Wave Withstand 2 μs to sparkover (kV)	Lightning Impulse Withstand Voltage (kV)
46	48.3	95	322	250
69	72.5	140	452	350
115	121	230	710	550
138	145	275	838	650
161	170	315	968	750
230	245	350	1160	900

Table 2

System Phase-to-phase Voltage (kV) & Amperage (if applicable) (XXXXA)	Minimum Isolated Capacitor Bank Current (A)	Minimum Line Charging Current (A)	Minimum Back to Back Capacitor Bank Current (A)	Minimum Peak Transient Inrush Current (kA)	Minimum Transient Inrush Current Frequency (kHz)
46 (1200A)	630	100	630	20	6.8
46 (2000A)	1000	100	1000	20	6.8
46 (3000A)	1600	100	1600	20	6.8
69 (1200A)	800	100	630	25	3.4
69 (2000A)	1000	100	1000	25	3.4
69 (3000A)	1600	100	1600	25	3.4
115	1200	160	700	16	4.3
138	1200	160	700	16	4.3
161	1200	160	700	20	4.3
230	1200	200	700	20	4.3

Table 3

Rated Maximum Voltage (kV)	Minimum Creep (In)	Minimum Clearance to Live parts (Ft)	Maximum Height (Ft)
48.3	35	10	13
72.5	48	11	14
121	79	12	15
145	92	13	16
170	114	14	17
245	156	15	18

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Domestic Content		%
d. Delivery Date		Weeks ARO
e. Price per Unit (Tax NOT included)	$	
f. Warranty		Months Post Delivery
		Months Post Install
g. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Wiring Diagram		Weeks ARO
c. Final Outline		Weeks ARO
d. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a.	Maximum Voltage		kV
b.	Rated Operating Duty Cycle		
c.	Power Frequency Withstand Voltage		kV
d.	Lightning Impulse Withstand Voltage		kV
e.	Continuous Current		A
f.	Short-Time Withstand Current		kA
g.	Short-Time Current Duration		sec
h.	Maximum Interrupting Time		Cycles
i.	Short Time 3 Seconds		kA
j.	Out of Phase Switching Current		kA
k.	Close and Latch Current		kA
l.	Capacitive Current Switching Class		
m.	Isolated Capacitor Bank Current		A
n.	Back to Back Capacitor Bank Current		A
o.	Line Charging Current		A
p.	Peak Current Transient Inrush Current		kA
q.	Transient Inrush Current Frequency		kHz
r.	BCT Information (N/A if no Z BCT)	Turns Ratio	Burden/Accuracy
	(i) X (1, 3, 5 terminals) BCT		
	(ii) Y (1, 3, 5 terminals) BCT		
	(iii) Z (1, 3, 5 terminals) BCT (closest to Interrupter)		

r. BCT Information (Continued)	Turns Ratio	Burden/Accuracy
(iv) Z (2, 3, 4 terminals) BCT (closest to Interrupter)		
(v) Y (2, 4, 6 terminals) BCT		
(vi) X (2, 4, 6 terminals) BCT		

13.5 Control Characteristics

a. Tripping Voltage Range		Volts
b. Closing Voltage Range		Volts
c. AC Voltage Range		Volts
d. Trip Current		A
e. Close Current		A

13.6 Physical Characteristics

a. Maximum Height		Inches
b. Maximum Width		Inches
c. Min Height to Live Parts		Inches
d. Insulating Medium		
e. Insulating Medium Weight		Lbs.
f. Net Weight		Lbs.

13.7 Operational Characteristics

a. Operations Between Servicing	
b. Full Fault Operations	
c. Mech. No Load Operations	
d. Continuous Current Operations	

13.8 Added for special tooling per Section 6.

Tool or Device	Price
SF6 and Filling Tools per Section 3.3.11	$ Included
Manual Operating Tools per Section 3.2.5	$ Included
	$
	$

13.9 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.10 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.11 Exemption(s)

13.12 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	
(v) Gas System Diagram	
(vi) Schematic Diagrams	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
1	10/04/18	ARS		Updated Section 3.4.11 and 14.1
2	04/19/19	ARS/LAG		Updated BCT, term block, and enclosure requirements, chopped wave values, and added 46kV & 69kV
3	10/02/19	DJS/BAH	KJB	Modified Section 3.4.1, 3.4.3, 3.4.4, 3.4.12, 3.4.13.f, 5.3, Table 2; Added Section 3.4.16 and 3.4.17
4	10/15/21	PJK/BV	RJB	Created CB01PA-S1 Supplemental Spec and Changed section numbering, rearranged sections 12, 13 & 14

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

OUTDOOR THREE POLE

VACUUM CIRCUIT BREAKERS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Daniel Radloff
Date: August 11, 2022 License No.: 60050

Date	Prep	App
08/11/22	TRM	DJR

Standard Number

CB08PA

(Rev 1)

Table of Contents

1. SCOPE

This standard covers outdoor, medium-voltage, vacuum circuit breakers (breakers) used on Purchaser's distribution system. The manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The circuit breaker shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including

2.1 IEEE C37.04,

2.2 IEEE C37.09,

2.3 IEEE C37.11

2.4 NEMA Power Circuit Breaker Standard Publication No. SG 4, latest revisions.

2.5 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The circuit breaker shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification CB08PA-S1***.

3.1.2 The breaker shall be furnished complete and ready for operation with operating mechanism, structural steel support, and all accessories necessary for operation.

3.1.3 The breaker shall be of all new materials and of the latest manufacture and design. A rebuilt or used circuit breaker will not be acceptable.

3.2 OPERATING MECHANISM

3.2.1 The operating mechanism shall be mechanically and electrically trip-free per IEEE Std. C37.04.

3.2.2 The operating mechanism shall be anti-pumping per IEEE Std. C37.11.

3.2.3 A latch check device shall be provided per IEEE Std. C37.11.

3.2.4 The stored energy mechanism shall be spring charged or magnetically actuated. Charging motors shall be at a voltage as indicated in ***Supplement Specification CB08PA-S1***. The storage device shall be of sufficient size to permit one (1) complete opening-closing-opening operation at rated short circuit current.

3.2.5 The operating mechanism shall be capable of manual operation upon complete power failure to trip and close the breaker. Any special tooling required to manually operate the breaker shall be supplied.

3.2.6 A mechanically operated operation counter designed to increment on a trip operation shall be supplied.

3.2.7 A readily visible position indicator shall be supplied.

3.2.8 Provisions for a travel analyzer recorder shall be provided.

3.3 INTERRUPTERS

3.3.1 Interrupters shall be porcelain or epoxy weather-case type, vacuum insulated.

3.3.2 Each side of the interrupter shall be capable of line or load connection and will not have a preferred current direction.

3.3.3 The interrupter shall be able to withstand 1.0 times line-to-ground voltage with loss of the vacuum insulating medium.

3.3.4 The vacuum interrupter shall be able to operate normally in the service conditions outlined in ***Supplement Specification CB08PA-S1***.

3.3.5 The tank finish shall be resistant to chipping and shall have a primer coat and a final outer coat of high corrosion resistant material.

3.4 CONTROL CIRCUIT AND WIRING

3.4.1 All control wiring shall be a minimum of 14 AWG SIS wire, terminated on suitable terminal blocks in the mechanism housing.

3.4.2 AC terminal blocks shall be able to accommodate Purchaser's 6 AWG power cable.

3.4.3 All relay accuracy bushing current transformer (BCT) taps shall be brought out to General Electric Co. shorting type terminal blocks able to accommodate Purchaser's 8 AWG control cable. One extra terminal shall be provided on each BCT terminal block for the purpose of grounding BCTs when changing taps. At a minimum, relay accuracy BCT wiring shall be 12 AWG SIS.

3.4.4 All other terminal blocks not specified above shall be able to accommodate Purchaser's 8 AWG control cable.

3.4.5 All BCT secondaries shall be shorted to ground prior to shipment.

3.4.6 Double pole fused knife switches shall be furnished for protection of control circuits.

3.4.7 A minimum of ten (10) normally open and ten (10) normally closed spare auxiliary switches shall be furnished in addition to those required for the circuit breaker control circuit.

3.4.8 Trip circuit current shall be greater than 2 amps and not exceed 10 amps.

3.4.9 Operating mechanism limit switches shall be provided to prevent operation of the closing coil and closing motor contactor during abnormal or incomplete operation of the operating mechanism

3.4.10 No manual trip shall be provided.

3.4.11 The following alarms shall be wired to the terminal board for the purchaser's use:

a. Spring Charge Failure

b. Energy Failure

c. Loss of AC

d. Loss of DC

e. Tank Heater Failure

3.4.12 The anti-pumping relay (52Y) shall be provided with one spare contact wired to the terminal board for the purchaser's use.

3.4.13 The operating mechanism and all auxiliary components shall be enclosed in a weather tight housing with a lockable door.

3.5 ACCESSORIES

3.5.1 The interior of housing shall have a functional 120 VAC light mounted inside.

3.5.2 Each circuit breaker shall have a 120 VAC, 20 A, GFCI outlet. Preferred mounting of the outlet is on the exterior of the circuit breaker in a weatherproof junction box with weatherproof cover. The junction box shall be protected by a metal shroud welded and painted on the exterior of the breaker. Outlet wiring shall be terminated on suitable terminal blocks in the mechanism housing.

3.5.3 Two space heaters, designed for operation on 240 VAC single phase, shall be provided. The heaters shall be low surface temperature or operable at half voltage. One heater shall be continuously energized for condensation control. The second heater shall be thermostatically operated. Manufacturer shall size heaters to provide condensation control and ensure operation at an exterior ambient temperature outlined in ***Supplement Specification CB08PA-S1***.

3.5.4 The construction of the control cabinet and any other housing or compartment for control or operation shall be designed for operation per ***Supplement Specification CB08PA-S1***. If necessary, Manufacturer shall filter, vent, insulate, and/or heat these compartments. Manufacturer shall test and supply information from such tests to indicate proper operation.

3.6 ELECTRICAL CHARACTERISTICS

3.6.1 The circuit breaker electrical ratings shall be per ***Supplement Specification CB08PA-S1***.

3.6.2 The interrupter shall be able to withstand 1.0 times line-to-ground voltage at complete loss of vacuum.

3.6.3 Bushings shall have the same voltage and current rating as the breaker.

3.7 PHYSICAL CHARACTERISTICS

3.7.1 The circuit breaker shall be designed per the Physical Characteristics outlined in ***Supplement Specification CB08PA-S1***.

3.7.2 Breakers shall be sky gray in color and conform to standard color designation ANSI #70.

3.7.3 The breaker shall be furnished with one grounding pad on each leg of the base. The grounding pads shall accommodate Purchaser's 2-hole 2" NEMA grounding pad.

3.7.4 A ground connection tied to the control cabinet ground shall be brought external to the control cabinet.

3.7.5 Bushing terminal shall be aluminum or tin plated bronze 4-hole 4" NEMA terminal pads.

3.7.6 A weatherproof gasket shall be provided on enclosure doors with a drip lip supplied above cabinet doors.

3.7.7 Breaker height shall be sufficient to ensure all energized or live parts are not less than outlined in ***Supplement Specification CB08PA-S1***. when measured to bottom of frame. The maximum height of the circuit breaker shall be per ***Supplement Specification CB08PA-S1***.

3.7.8 The breaker frame shall be adjustable with the lowest setting within 1" of the minimum height required per **Section 3.7.1**.

3.7.9 The maximum horizontal distance between the centerlines of the outermost phases shall be per ***Supplement Specification CB08PA-S1***.

3.7.10 The structural steel frames shall be hot dipped galvanized per ASTM A123 and A153. A weep hole is required at the lowest point of any box steel construction to prevent water from accumulating inside.

3.7.11 Breaker frame shall withstand service conditions outlined in ***Supplement Specification CB08PA-S1***.

3.7.12 Typical loading calculations shall be supplied with bid.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C37.09, latest revision.

4.2 The circuit breaker shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C37.09, latest revision.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each circuit breaker.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of Breaker:

5.1.1 Data as indicated in ***Section 13***

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

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Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of breaker:

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5.2.2 Bushing Outlines

5.2.3 Nameplate Drawings

5.2.4 Schematic Diagrams

5.2.5 Wiring Diagram/Junction Box Layout

5.2.6 BCT Excitation and Saturation Curves

5.2.7 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each Breaker to be used for Purchaser's final records:

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5.3.7 Instruction Manual

5.3.8 Installation Instructions

5.3.9 Certified Test Reports

One set of instruction books and drawings shall be shipped with the breaker in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the circuit breaker, and to perform all tests that may be necessary. All quotations must include the cost of a competent installation technician as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

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10.1 Manufacturer shall quote FOB site delivery.

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10.4 Bushings shall be wrapped for shipping

10.5 Breaker shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.6 Purchaser shall be notified a minimum of three working days before delivery.

10.7 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.8 Contact for Delivery: **See *Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by ***Supplement Specification CB08PA-S1***: Ratings and Technical Requirements completed by Purchaser, and **Section 13**: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Supplement Specification CB08PA-S1 and Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification CB08PA-S1***

12.2 Table 1, Table 2, and Table 3 Technical Information: ***See Next Page***

Table 1				
System Phase-to-phase Voltage (kV)	Rated Maximum Voltage (kV)	Power Frequency Withstand Voltage 10 sec wet (kV)	Chopped Wave Withstand 2 μs to sparkover (kV)	Lightning Impulse Withstand Voltage (kV)
13.8	15.5	45	142	110
23	25.8	50	194	150
34.5	38	80	258	200

Table 2					
Breaker Continuous Current Rating (A)	Minimum Isolated Capacitor Bank Current (A)	Minimum Line Charging Current (A)	Minimum Back to Back Capacitor Bank Current (A)	Minimum Peak Transient Inrush Current (kA)	Minimum Transient Inrush Current Frequency (kHz)
1200	630	100	630	6	1.2
2000	1000	100	1000	6	0.8
3000	1600	100	1600	6	0.5

Table 3			
Nominal System Class (kV)	Minimum Creep (In)	Minimum Overhead Clearance to Live parts (Ft)	Maximum Height (Ft)
13.8	11	9	12
23	17	9.25	12
34.5	26	9.5	12

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Domestic Content		%
d. Delivery Date		Weeks ARO
e. Price per Unit (Tax NOT included)	$	
f. Warranty		Months Post Delivery
		Months Post Install
g. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Wiring Diagram		Weeks ARO
c. Final Outline		Weeks ARO
d. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a. Maximum Voltage		kV
b. Rated Operating Duty Cycle		
c. Power Frequency Withstand Voltage		kV
d. Lightning Impulse Withstand Voltage		kV
e. Continuous Current		A
f. Short-Time Withstand Current		kA
g. Short-Time Current Duration		sec
h. Maximum Interrupting Time		Cycles
i. Short Time 3 Seconds		kA
j. Out of Phase Switching Current		kA
k. Close and Latch Current		kA
l. Capacitive Current Switching Class		
m. Isolated Capacitor Bank Current		A
n. Back to Back Capacitor Bank Current		A
o. Line Charging Current		A
p. Peak Current Transient Inrush Current		kA
q. Transient Inrush Current Frequency		kHz
r. BCT Information (N/A if no Y BCT)	Turns Ratio	Burden/Accuracy
(i) X (1, 3, 5 terminals) BCT		
(ii) Y (1, 3, 5 terminals) BCT (closest to interrupter)		
(iii) Y (2, 4, 6 terminals) BCT (closest to interrupter)		

r. BCT Information (Continued)	Turns Ratio	Burden/Accuracy
(iv) X (2, 4, 6 terminals) BCT		

13.5 Control Characteristics

a. Tripping Voltage Range		Volts
b. Closing Voltage Range		Volts
c. AC Voltage Range		Volts
d. Trip Current		A
e. Close Current		A

13.6 Physical Characteristics

a. Maximum Height		Inches
b. Maximum Width		Inches
c. Min Overhead Clearance to Live Parts		Inches
d. Insulating Medium		
e. Net Weight		Lbs.

13.7 Operational Characteristics

a. Operations Between Servicing	
b. Full Fault Operations	
c. Mech. No Load Operations	
d. Continuous Current Operations	

13.8 Added for special tooling per Section 6.

Tool or Device	Price
Manual Operating Tools per Section 3.2.5	$ Included
	$
	$
	$

13.9 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.10 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.11 Exemption(s)

13.12 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	
(v) Schematic Diagrams	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	10/15/21	PJK/BV	RJB	Original; Created from & reformatted off of existing CB01PA Spec, changed section numbering, rearranged sections 12, 13 & 14
1	8/11/22	TRM	DJR	Revised 3.2.5 to require both manual trip and manual close operation under complete power failure.

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

ELECTRICAL EQUIPMENT ENCLOSURE

FACILITIES AND STRUCTURE

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Name Here
Date: January 1, 2018 License No.: #####

Date	Prep
XX/XX/XX	XXX

Standard Number

EEE02CD

(Rev 0)

Table of Contents

1. SCOPE

This specification sets forth the minimum technical requirements for an electric equipment enclosure, herein referred to as Electrical Equipment Enclosure (EEE) to be provided to Minnesota Power (Purchaser) by the Supplier. The Supplier shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted proposal.

Section 17.3 can be used to look up drawing numbers for references to Purchaser's drawings contained in this specification.

Delivery and installation of the EEE is required by [MM,DD,YYYY].

2. STANDARDS

The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:

2.1 Minnesota State Building Code (MSBC)

2.2 Minnesota Energy Code (MEC)

2.3 International Building Code (IBC) as amended and adopted by the state in which the EEE will be installed.

2.4 American Society of Civil Engineers ASCE/SEI 7-10

2.5 National Electric Safety Code (NESC) (IEEE C2)

2.6 National Electric Code (NEC) as amended and adopted by the state in which the EEE will be installed.

2.7 American Welding Society (AWS)

2.8 All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, IEC 60529, NEMA, NEMA 250, ASTM, ICEA, IEEE, NFPA, UL, etc.)

3. ENVIRONMENTAL DATA

The EEE shall be designed to meet all rating and performance requirements specified in this document while operating in the site and environmental conditions listed in this document.

3.1 VOLTAGE

3.1.1 The EEE will be used in an outdoor [Insert Substation Voltage] electrical substation.

3.1.2 The equipment shall be designed to withstand electrical and magnetic fields and transients that are present in an electrical substation.

3.2 ELEVATION

3.2.1 The structures and apparatus designed herein shall be rated for use at an altitude of less than 3000 feet.

3.3 TEMPERATURE

3.3.1 Maximum ambient temperature recorded is XX°F

3.3.2 Maximum daily average ambient temperature is XX°F

3.3.3 Minimum ambient temperature recorded is -XX°F

3.3.4 Minimum daily average ambient temperature is -XX°F.

3.4 LOADINGS

3.4.1 The required Ultimate Design Wind Speed (3 second gust) is 120 mph, using Risk Category III and Exposure Category C.

3.4.2 Ground Snow Load of 60 lbs/ft^2, using an Exposure Factor of 1.0.

3.4.3 Floor Live Load of 350 lbs/ft^2 throughout, unless noted otherwise.

3.4.4 Walls and wall framing shall be capable of supporting a concentrated wall loading of up to 175 lbs. to support hanging of equipment at any location, with a minimum eccentricity of 3 inches measured from the interior face of the wall.

3.4.5 Seismic Design: Not required per MSBC.

4. GENERAL DESCRIPTION

4.1 Supplier shall be responsible for all required work including the furnishing (See Section 17.3), delivery (See Section 13), and installation/erection (See Section 14) of one (1) pre-assembled, pre-engineered, complete steel EEE acceptable for the intended use as specified herein.

4.2 Supplier shall design, prepare plans and specifications, furnish all materials, provide supervision and construct the EEE including the auxiliary systems and lighting.

4.3 Supplier shall supply plans and calculations stamped and signed by a Licensed Professional Engineer for the state where EEE is to be installed, and is responsible for obtaining all Approvals, Third Party Inspections, and State Industrial Building Commission Approvals if required by the state or local jurisdiction in which the EEE is installed.

4.4 Supplier shall complete all internal control panel wiring and all interconnection wiring.

4.4.1 If interconnection wiring must be disconnected during shipment, Supplier is responsible for termination and retesting continuity of this wiring upon delivery.

4.5 Building materials, equipment and fittings shall be suitable for industrial use and require minimal maintenance. Materials, equipment and fittings which are available in the continental United States are preferred to facilitate future maintenance.

4.6 The materials used to construct the EEE shall be new, unused, and fabricated in a workmanlike manner in a factory environment.

4.7 The EEE structure shall contain all the equipment indicated in this specification and associated drawings (See Section 17.3) making up part of this specification.

4.8 The EEE shall be fully assembled and suitable for human occupancy upon completion of installation.

5. <u>ELECTRICAL SYSTEMS</u>

5.1 ELECTRICAL WIRING METHODS AND MATERIALS

5.1.1 All grounding, workmanship and materials shall conform to the NEC and NESC as outlined in Section 2.

5.1.2 If conduit is used, it shall be electrical thin wall metallic tubing (EMT) except service runs which may be run in cable troughs and flexible metallic conduit used for motor and fixture connections.

5.1.3 All cable and conductors shall meet Minnesota Power Standard Equipment Specification CA01PA, Flame Retardant Power & Control Cable.

5.1.4 All interior conductors shall be low-halogen, flame-resistant, 600V rated EPR cables for all applications other than the electrical switchgear assembly wiring.

5.1.5 All interior junction boxes shall be NEMA Class 1.

5.1.6 All wiring, cable troughs, and conduit shall be surface-mounted and run tight to walls and ceiling with adequate clamps and supports.

5.1.7 All cable splices and terminations shall be on terminal blocks.

5.2 AC STATION SERVICE

5.2.1 AC Station service shall be single phase 120/240V.

5.2.2 The normal station service source will be provided by Purchaser from a 115kV Station Service Voltage Transformer in the station yard.

5.2.3 The alternate station service source is supplied by Purchaser from a pad mount step-down transformer located inside the substation fence.

5.2.4 Each AC Station Service source shall either enter the EEE through wall penetrations via a 3” Rigid type LB conduit body into an Automatic Transfer Switch or via Service Disconnect Switches into an Automatic Transfer switch as shown on the Electrical Equipment Enclosure (EEE) Layout Plan drawing.

5.2.5 Metering CT Cabinet(s) shall be provided on the outside of the EEE if shown on the Electrical Equipment Enclosure (EEE) Layout Plan drawing and wired as shown in the provided Purchaser schematics (See Section 17.3).

5.2.6 AC Distribution Panels shall be furnished in accordance with Minnesota Power Specification PN03PA, Distribution Panel – 120/240 Volt, 600 Volts or Less AC.

5.3 DC STATION SERVICE

5.3.1 The EEE shall have 130VDC power for all control functions. The 130VDC Battery System shall include:

5.3.1.1 130VDC 58 Cell Battery String

5.3.1.2 130VDC Battery Charger meeting the requirements of Minnesota Power Standard Specification SB02PA, Battery Charger

5.3.1.3 Midpoint fuse, holder, and fiberglass enclosure with viewing window

5.3.1.4 Grounded battery rack, spill containment, and neutralizing pillows

5.3.1.5 Honeywell Fendell 1000 Eyewash Station, Cat. No. 32-001000-0000

5.3.1.6 Honeywell Fendell Eyewash Cartridge, 3.5 gal., PK2, Cat. No. 32-001005-0000

5.3.1.7 Supplier shall provide all other items related to the battery system including items as required by Minnesota Power Standard Specification SB01PA, Lead Storage Battery.

5.3.2 The eyewash station shall be installed in close proximity to the 130VDC battery string.

5.3.3 The 130VDC Battery Charger float and equalize voltages shall be set per the Battery Manufacturer’s recommendation for the cell type and quantity installed.

5.3.4 A Wall Penetration for battery system test cables and temporary battery trailer connection cables to be provided

5.3.4.1 Wall Penetration to be 3” capped UV resistant PVC and located between the battery rack and safety switch

5.3.5 DC distribution panel(s) shall be furnished per the 125VDC Distribution Diagram drawings in accordance with Minnesota Power Specification PN02PA, Distribution Panel 125 Volt DC and located per the Electrical Equipment Enclosure (EEE) Layout Plan drawing.

5.4 LIGHTING

5.4.1 The EEE shall have normal and emergency lighting.

5.4.2 Emergency lighting shall be designed and installed to deliver not less than 1fc at floor level in all areas of the EEE with a 90-minute back-up.

5.4.3 Emergency lighting system shall be self-contained with a five (5) year life, containing no nuclear reactive substances or isotopes.

5.4.4 No emergency lighting circuits shall emanate from the 130VDC Battery System.

5.4.5 The normal lighting shall be designed to deliver not less than 50fc at desk level in all areas of the EEE.

5.4.6 Illuminated Exit Signs shall be provided

5.4.7 Both normal and emergency light fixtures shall be LEDs and have diffuser covers.

5.4.7.1 LED light color temperature shall be 5000k

5.4.8 Light switches shall be 20A, three way, wall-mounted with standard cover plates, mounted at 44" above the floor, and placed conveniently near the entrances to the EEE.

5.4.9 The EEE shall have vandal-resistant, photo-eye-sensor-controlled exterior LED lighting to illuminate all entryways into the EEE, set to automatically be on from dusk until dawn.

5.5 GROUNDING

5.5.1 Any steel structure supplied as part of the EEE shall be permanently and solidly grounded to the ground bus or grounding conductor referenced in section 5.5.2.

5.5.2 A ground bus or grounding conductor shall be provided in the EEE to ground all communication, control and SCADA panels, and all AC and DC distribution panels.

5.5.2.1 The grounding conductor or grounding bus shall be placed at the top of the walls near the ceiling.

5.5.3 The ground lugs shall be an integral part of the steel and shall not be bolted to the frame.

5.5.4 Ground lugs to be indicated on the submitted drawings.

5.5.5 The exterior of the EEE shall have grounding pads at each corner of the EEE.

5.5.6 The raceway system shall not be considered to be a ground conductor except for grounding of itself.

5.5.7 All metal conduits containing power circuits shall be provided with grounding type bushings and shall be wired together inside enclosures and connected internally to the enclosure grounding pad or grounding bus with bar copper conductor.

5.5.7.1 The grounding bushing ground conductor shall be sized in accordance with NEC or other internationally recognized standards but shall not be less than #8 AWG bare copper conductor.

5.5.8 Ground conductors shall be soft drawn, bare stranded copper strand class B as defined in NEMA WC 3 (formerly ICEA S-19-81) (or Class II in IEC 60228).

5.5.9 All clamps, conductors, bolts, washers, nuts, and other hardware used with the grounding system shall be copper.

5.6 CONTROL, RTU, HMI/ALARM, COMMUNICATION, METERING & TERMINATION PANELS

5.6.1 Refer to the Electrical Equipment Enclosure (EEE) Layout Plan drawing for the necessary panel line-up and placement.

5.6.2 The panels shall meet Minnesota Power Standard Equipment Specification PN01PA, Control Panels.

5.6.3 The panels shall be installed and delivered with the EEE by the Supplier.

5.6.4 Panels will be individually grounded to the cable tray and connected as shown on the panel drawings provided by the Purchaser (See Section 17.3)

5.6.5 The Termination Panel(s) shall have the following features:

5.6.5.1 LED lighting switched ON/OFF via door contacts

5.6.5.2 Designed for bottom cable entry or as shown on the termination cabinet drawing provided by the Purchaser (See Section 17.3)

5.6.5.3 A 10 gauge aluminum removable bottom cover plate for the termination panel floor opening

5.6.5.4 The location of the termination panel(s) may be subject to change due to foundation design.

5.7 EEE ALARM ENCLOSURE

5.7.1 The EEE Alarm Enclosure shall be wall-mounted 12" x 12" NEMA 1 enclosure, with terminal blocks mounted and alarms wired as outlined in Section 5.7.3.

5.7.2 The EEE Alarm Enclosure shall be mounted in close proximity to the telco plywood board.

5.7.3 The following alarms shall be wired to the EEE Alarm Enclosure:

5.7.3.1 Fire Alarm: Ceiling-mounted, 120VAC smoke detector(s) and relay(s) shall be installed; contacts shall be interlocked to disable HVAC system(s) and exhaust fans(s).

5.7.3.2 Intrusion Alarm: Each door shall have a magnetic contact entry alarm that provides two (2) closed contacts for an open door condition per Section 6.5.5.2

5.7.3.3 High Temperature Alarm: One (1) high temperature alarm shall be provided.

5.7.3.4 Low Temperature Alarm: One (1) low temperature alarm shall be provided

5.7.3.5 Hydrogen Detector Alarm: Alarm on Hydrogen concentrations 2% or greater per Section 6.14.6.1.

5.8 RECEPTACLES

5.8.1 Interior convenience outlets shall be wall-mounted 20A, 120VAC duplex receptacles installed at 18" above floor level with cover plates.

5.8.2 Supplier shall determine number and placement of receptacles and indicate on approval drawings.

5.8.3 Exterior weatherproof, 20A, 120VAC, GFCI duplex convenience outlets shall be provided at each corner of the EEE.

5.8.4 At least one exterior weatherproof, 20A, 120VAC, GFCI duplex convenience outlet shall be installed next to air conditioner(s) and at any other locations to be indicated by Supplier on the approval drawings.

5.8.5 The ground wire for the receptacles shall be insulated over its entire length.

5.9 GPS ANTENNA

5.9.1 A GPS Antenna shall be provided and mounted on a south facing gable end facing cell tower with 360 degree sky exposure and shall extend above the roofline a minimum of 2 feet.

5.9.2 The GPS Antenna surge protector is to be mounted on the inside of the wall in close proximity to the wall penetration.

5.9.3 The conduit on the outside of the EEE shall include a junction (conduit STYLE TB) to allow the exit of a cable for cellular phone repeater antenna at communication cable tray level. The conduit is to be 1” diameter.

5.10 EXTERNAL TELEPHONE RINGER

5.10.1 An external telephone ringer shall be provided on the wall facing the substation per the Electrical Equipment Enclosure Layout Drawing and Communication Panel Bill of Material Drawing.

5.10.2 A wall penetration for the cable to the external telephone ringer shall be provided via 1” conduit.

5.11 TELEPHONE CONNETIONS

5.11.1 Conduits and CAT 5e cabling shall be provided from each door location to the Communication Panel.

5.11.2 Conduits and CAT 5e cabling shall be provided from the Communications Panel to the desk phone location

5.11.3 Quad Junction Boxes shall be provided at each phone location.

6. MECHANICAL SYSTEMS

6.1 Heavy duty lifting plates or similar hardware shall be supplied and mounted to the base as needed for lifting the EEE.

6.2 FOUNDATION LOADING

6.2.1 The EEE foundation (drilled piers or slab-on-grade) will be designed by Purchaser.

6.2.2 The Supplier shall provide all static and dynamic loading calculations, foundation reactions, and all critical mounting features for the EEE to Purchaser 2 weeks ARO.

6.2.3 Supplier to provide foundation loads for both drilled pier and slab-on-grade foundation options.

6.2.4 For the drilled pier option, Supplier to provide the assumed or maximum drilled pier spacing.

6.3 ENERGY USE AND INSULATION

6.3.1 The EEE shall be designed and insulated to meet all requirements of the most current version of the code listed in Section 2.2. Including thermal spacer blocks or similar thermal breaks as part of the building envelope requirements as required by the referenced code.

6.3.2 The following minimum insulation values are required:

6.3.2.1 Walls: R-20 + R-13 Continuous Insulation

6.3.2.2 Roof: R-30 + R-11 Liner System and R-5 Thermal Blocks

6.3.2.3 Floor: R-38

6.3.2.4 Doors: R-15

6.4 INGRESS AND EGRESS

6.4.1 The EEE shall have two (2) single-door entrances/exits.

6.4.2 One single-door entrance/exit shall be a nominal minimum opening size of 48"W x 96"H and the other single-door entrance/exit shall be a nominal minimum opening size of 36"W x 84"H taking into account the frame height.

6.4.3 Entrance/exit doors shall swing out and be equipped with panic bars, safety chain, pressure plates, or other devices that are normally latched but open under simple pressure.

6.4.4 All doors shall be completely weather-stripped.

6.5 DOORS AND FRAMES

6.5.1 Doors shall comply with Steel Door Institute directive SDI-100.

6.5.2 Doors shall have an insulated core and be constructed of no less than 18-gauge steel-faced leafs with stiffeners and 16-gauge door frames.

6.5.3 Doors and frames to be hot-dipped galvanized to ASTM-A924 and ASTM-A653, and then factory primed and painted with epoxy enamel to match the EEE or the trim.

6.5.4 The size and quantity of doors are indicated in Section 6.4.

6.5.5 Door Hardware:

6.5.5.1 NRP stainless steel ball bearing hinges, minimum of three (3) per door.

6.5.5.2 Von Duprin 99NL X US26D exit device

6.5.5.3 Von Duprin 990TP thumb latch exterior

6.5.5.4 Schlage large format removable core rim cylinder lock

6.5.5.5 GE Interlogix 1076D DPDT steel door contact

6.5.5.6 Door closer with hold open arm

6.5.5.7 Weather stripping and sweep

6.5.5.8 Removable threshold (for double wide doors only)

6.5.5.9 Watershed, at top of door

6.5.5.10 Drip cap, extending 3" past door edge

6.5.5.11 Safety chain to limit door swing

6.5.6 Door Lock Boxes

6.5.6.1 Manufacturer shall supply a wall-mounted lock box mounted on the external of the building near doors to store the door key. Refer to the Electrical Equipment Enclosure (EEE) Layout Plan drawing for locations.

6.5.6.2 The lock boxes shall be capable of being securely locked by Purchaser provided padlocks.

6.5.6.3 The door key shall be affixed to the inside of the lock box by a retaining chain long enough to unlock the entrance door to the EEE while the key is affixed to the retaining chain.

6.5.6.4 The lockbox shall be placed at a height in close proximity to the door lock.

6.6 EXPANSION

6.6.1 The EEE [shall/shall not] be required to be expandable in one direction for possible future substation expansion. Refer to the Electrical Equipment Enclosure (EEE) Layout Plan drawing.

6.7 DESIGN REQUIREMENTS

6.7.1 The structure design and manufacture shall, at a minimum, conform to the Codes and Standards listed in Section 2 of this Specification.

6.7.2 The entire structure including primary framing, secondary framing and cladding, shall be designed in accordance with the IBC as adopted and amended by the current applicable State Building Code. The structure shall be designed utilizing Occupancy Category III.

6.7.3 Structural Load Combinations shall be in accordance with the IBC (ASD or LRFD).

6.8 EXTERIOR TREATMENTS, WALLS, AND ROOF

6.8.1 The EEE shall have a complete, internal, self-supporting, structural steel frame that meets or exceeds the specified design load criteria without reliance on exterior sheeting, exterior panels, or roof cover panels for its structural strength or framing.

6.8.2 Metal exteriors and roofing shall have a PVDF resin-based paint coating, over either a Galvalume or galvanized substrate, with a twenty (20) year warranty against rust perforation, a twenty (20) year warranty against fading and chalking, and a twenty-five (25) year warranty against flaking, peeling, and checking.

6.8.3 The roof shall be pitched 1 inch in 12 or greater and shall have a roof covering of mechanically-seamed, standing-seam roofing with a minimum seam height of 2". Standing seam roof panels shall be baked-on, resin-base pre-finished steel and shall have no visible fasteners on the main run. Roof to include a matching, die-formed ridge cap, and a fully supported 3" overhang. Properly sized attic space ventilation shall be provided. All attic openings shall be screened to prevent entrance of bees or larger insects or birds.

6.8.4 A steel canopy of sufficient size shall be provided over the entrance doors to prevent ice formation outside the EEE exits during the winter months and to channel rain water from the roof away from the doorway.

6.8.5 Snow guards shall be provided on the roof above positions where equipment is mounted on the exterior of the EEE.

6.8.6 The wall exteriors shall be galvanized steel panels with a PVDF resin-based finish in manufacturer's standard colors. Exterior siding panels to be overlapped and installed with appropriate self-tapping fasteners with integral gaskets, and shall be removable without any disturbance to interior panels.

6.8.7 Butted seams are not allowed.

6.8.8 Repair or replacement of panels must be able to be done entirely from outside the EEE structure.

6.8.9 Exterior trim package shall include stepped or boxed eave, rake, fascia, base, corner, jamb, and header trim in 26 gauge Galvalume material with Purchaser's choice of standard KYNAR colors.

6.8.10 Hood covers shall be provided on the exterior wall above positions where equipment is installed on the sides of the EEE.

6.9 WALL PENETRATIONS

6.9.1 The Supplier shall provide wall penetrations per the Electrical Equipment Enclosure (EEE) Layout Plan drawing. Unless otherwise stated the following wall penetrations are required:

6.9.1.1 Penetrations for AC Station Service per Section 5.2

6.9.1.2 Penetration for battery system test cables per Section 5.3.2

6.9.1.3 Penetration for GPS antenna and cellular phone repeater cable per Section 5.9

6.9.1.4 Penetration for external telephone ringer per Section 5.10

6.9.2 All openings in walls are to be structurally framed, sleeved, trimmed, watertight, and provided with external drip caps with piping or formed metal of the same composition as the exterior panels.

6.10 INTERIOR TREATMENTS, WALL, CEILING, AND FLOOR

6.10.1 The EEE's interior walls and ceiling shall be lined with flush-fit 24 gauge, roll-formed liner panels, fully reinforced, with concealed fasteners and a baked-on polyester finish over G-90 galvanized substrate.

6.10.2 The EEE interior shall feature a complete matching trim system including base, jamb, header, and ceiling trim. Supplier to provide color options for both the interior panels and trim.

6.10.3 The ceiling height of the EEE shall be designed to allow the vertically-stacked cable tray design per Section 6.17, with a minimum ceiling height of 10'.

6.11 INSULATED STRUCTURAL STEEL FLOOR SYSTEM

6.11.1 Floor system shall have a hot rolled, welded steel framework, with interior hot-rolled steel or steel tube supports to meet required loads, with maximum live load deflection of L/360 and total load deflection of L/240, and cold formed joists sized and spaced to meet design loads.

6.11.2 Floor insulation system shall be comprised of fiberglass batt insulation or spray closed cell foam between joists, and 2" of continuous extruded rigid polystyrene insulation between joists and the fully hot-dipped galvanized steel rodent and insect barrier.

6.11.2.1 Floor perimeter area and roof perimeter at the wall/roof juncture shall be either dense packed with fiberglass or similar batt or covered with spray closed cell foam.

6.11.3 A fully hot-dipped galvanized steel rodent and insect barrier shall be provided below insulation.

6.11.4 Floor insulation system to provide specified insulation value called out by all applicable codes with a minimum insulation value as listed in Section 6.3.2.3.

6.11.5 Hot-rolled steel shall be ASTM A36, A572 or A992, and shall be galvanized in accordance with ASTM A653. Tube steel shall be hot-dip-galvanized ASTM A500, Grade B.

6.11.6 Steel floor surface shall be welded plate steel of sufficient thickness (1/4" minimum) to support specified design loads and meet the deflection limitations stated above, with a painted, slip-resistant finish.

6.11.7 Floor system shall be designed to be anchored to and supported by [Drilled Piers or Slab on Grade] foundation.

6.11.8 Floor framework and floor deck plates shall be fully chemically cleaned, primed and painted with a self-priming, catalyzed coating system designed to provide an extremely durable finish, suitable for heavy resistance to fading. Paint system shall have a minimum Dry Film Thickness, per coat of 3 - 5 mils. Color to be ANSI 61. Floor shall have a non-slip texture added to paint. Approved coating: Rustoleum High Performance Polyurethane 9800 Urethane Mastic System.

6.11.9 Floor system weld standards shall meet all AWS recommended practices.

6.11.10 Protective temporary floor covering shall be installed and delivered with the EEE made out of corrugated fiberboard with size “A” flute.

6.12 FASTENERS, ADHESIVES, AND SEALANTS

6.12.1 The fasteners, adhesives, and sealants utilized shall be of types approved for use on this type of structure as required by the appropriate agency or governing body, as covered in Section 2.

6.13 CLOSURES

6.13.1 Matching, pre-molded, closed cell elastomer closures provided by the siding and roof panel manufacturer shall be installed according to the manufacturer's recommendations at the eave line, beneath the roof panels, and where the trim meets the wall panels.

6.14 INTAKE AND EXHAUST FAN

6.14.1 Intake to have a filter rack, pleated high-efficiency filter, insect screens and painted steel weather hood.

6.14.2 Exhaust to have a back draft damper, insect screen, and painted steel weather hood.

6.14.3 Intake and exhaust units to be louvered aluminum with motorized dampers

6.14.4 Intake and exhaust to be sized by Supplier based on size of EEE and/or any specific requirements based on battery system being used.

6.14.5 Exhaust fans are not to be mounted directly above the battery bank.

6.14.6 Exhaust fan to be controlled by a manual on-off switch, hydrogen sensor, and a separate wall-mounted thermostat.

6.14.6.1 The Hydrogen Sensor shall be wired to turn on the exhaust fan at 1% Hydrogen concentration and to alarm to the RTU at 2% Hydrogen concentration via the EEE Alarm Enclosure as referenced in Section 5.7. Hydrogen sensor to be mounted on ceiling in close proximity to the batteries, while still being accessible by ladder for testing and replacement. Hydrogen sensor shall not be mounted directly above the batteries.

6.14.6.2 The wall-mounted thermostat shall turn on the fan when temperatures are above the thermostat setpoint.

6.15 DRIP LEDGE AND RAIN GUTTERS

6.15.1 The EEE shall have a drip ledge placed appropriately to encourage water draining off of the roof away from the side of the EEE.

6.15.2 Rain gutters are not acceptable.

6.16 FURNISHINGS

6.16.1 Manufacture shall supply a desk, filing cabinet, storage cabinet, print rack, and two print clamps for placement in the building per the Electrical Equipment Enclosure (EEE) Layout Plan drawing (See Section 17.3).

6.16.1.1 The provided desk shall be HON Company, Right Single Pedestal, Model Number HONP3251RCL or equivalent.

6.16.1.2 The filing cabinet shall be Sandusky Company, 4 Drawer Vertical Letter, MODEL HS384PL or equivalent.

6.16.1.3 The storage cabinet shall be Sandusky Company, 2 door, Model Number VF31301572-07 or equivalent.

6.16.1.4 The print rack and print clamps shall be capable of holding to 12” to 36” wide prints.

6.17 CABLE TRAY

6.17.1 The EEE shall have 24" wide and 18” wide ladder-type aluminum cable tray with 6" rung spacing and 4" loading depth for power and control cables

6.17.2 The EEE shall have 6" wide cable tray with 6” rung spacing and 4" loading depth section for communications cables.

6.17.3 The entire raceway system will be trapeze-supported from the ceiling.

6.17.4 The EEE ceiling shall be reinforced to support the cable tray system with an additional working load of 100lbs/lineal ft.

6.17.5 The cable tray spans shall not exceed manufacturer's recommended distances between support hangers.

6.17.6 Cable tray shall extend to allow cable runs to all panels, including the AC and DC distribution panels.

6.17.7 The EEE Supplier shall maintain sufficient vertical spacing between cable tray and the top of the panels.

6.17.8 The control and power cable tray and communications cable tray shall be vertically stacked.

6.17.8.1 The vertical spacing between cable trays shall be 6”

7. HEATING AND COOLING SYSTEMS

7.1 HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

7.1.1 Minimum Standards: Unit(s) to be sized by EEE manufacturer to be readily available, wall-mounted, commercial-grade air conditioner with integral heater with a cold weather package if available.

7.1.2 Unit(s) supplied by manufacturer shall have service representation within a 150-mile radius of installation site.

7.1.3 Size and Quantity: The minimum and maximum interior ambient temperatures shall be calculated using ambient site conditions and expected internal heat gains as outlined in Sections 7.2 and 7.3.

7.1.4 HVAC Unit quantity to be determined by the Supplier

7.1.5 Power feed is assumed to be 208/240VAC, single phase unless noted otherwise by manufacturer.

7.1.6 HVAC Unit(s) to have supply and return grilles, and a replaceable pleated high efficiency filter on the return side.

7.1.7 HVAC Unit(s) to be controlled by a separate wall-mounted, auto-change-over thermostat, or a lead-lag controller if two (2) units are used.

7.1.8 Thermostat or controller shall be AC powered.

7.2 HEATING SIZING

7.2.1 The primary heating source is to be thermostatically controlled electric heating and shall be provided, sized, and preset at the factory, to maintain the EEE at a minimum average ambient temperature of 70°F throughout the EEE when subjected to the atmospheric temperature in Section 3.3.3 and Coldest Month 0.4% occurrence wind speed per ASHRAE.

7.2.1.1 The heat load calculations shall be calculated using the initial EEE design thermal gain, not taking into account the ultimate design heat loading.

7.2.1.2 The heating load calculations shall take into account the exhaust fan operation and building ACH (air changes per hour).

7.2.2 Secondary Electric Heater

7.2.2.1 A secondary electric unit heater with controlled by a wall mounted thermostat shall be provided, and preset at the factory, to maintain the

EEE at a minimum average ambient temperature of 40°F throughout the EEE when subjected to the atmospheric temperature in Section 3.3.3 and coldest month 0.4% occurrence wind speed per ASHRAE.

7.2.2.2 A built in thermostat is not acceptable

7.2.2.3 The heating load calculations shall follow Sections 7.2.1.1 and 7.2.1.2

7.2.2.4 The electric unit heater is not to be included in the heating calculations for sizing the primary heat source. The electric unit heater is intended for partial redundancy in the event of a failure of the primary heating source.

7.3 AIR CONDITIONING SIZING

7.3.1 Air conditioning shall be provided, sized, and preset at the factory, to maintain the EEE at a maximum of 80°F with all heat producing sources on during the maximum ambient temperature found in Section 3.3.1 using the ultimate EEE design and following all other ASHRAE requirements.

8. TESTS

The EEE and all associated equipment, amenities, apparatus, spare equipment/parts/tools, and ancillary devices shall be acceptance-tested and function-tested in accordance with all required specific ANSI, NEMA, IEEE, UL, IEC, UBC, IBCO tests or special Purchaser tests that apply.

8.1 Test Reports: Supplier to provide two copies of all test reports in electronic format (i.e. CD-ROM or e-mail). These are required no later than two weeks prior to delivery of the EEE to avoid delays in critical path schedule.

8.2 Supplier to provide any certified test reports required by Purchaser or regulatory bodies.

8.3 Test for protection against ingress of water.

8.4 Supplier to provide option for Building Air Blower Test

9. INFORMATION REQUIRED WITH PROPOSAL

One (1) electronic copy of all proposal drawings and documents are required by close of business four (4) weeks after Supplier acknowledging receipt of RFQ. The following is required to be provided by the Supplier with the submitted proposal:

9.1 EEE outline dimensions, physical requirements, floor plan, interior and exterior dimensions, elevations, suggested foundation elevations and dimensions, and the location of all primary accessories included with the EEE.

9.2 Equipment and electrical performance data, including cut sheets and technical specifications adequate to determine quality of equipment being provided concerning the EEE and all components included as part of the EEE (i.e. HVAC equipment, lights, batteries, battery charger, AC & DC panels, etc.).

9.3 Proof of being in the EEE design and manufacturing business for a minimum of 5 years, and be able to supply proof of supplying at least 25 EEE's of a similar type in that timeframe.

9.4 Mechanical and mechanical performance data

9.5 Shipped and installed weights.

9.6 Mounting provisions and structural loading

9.7 Exceptions to these specifications or any required standards

9.8 Supplier shall state latest date of receipt of order to meet the delivery date stated in Section 1

9.9 Supplier shall state latest date of receipt of schematics from customer to meet the delivery date stated in Section 1

9.10 Outline of all tests which will be performed

9.11 Delivery Date

9.12 Shipment point

9.13 Shipment method

9.14 Schedule of all submittals after receiving order

9.15 Completed Price Breakdown per attached "EEE02CD – Section 9.15 Bid Tab.xlsx"

9.16 Complete Bill of Materials

9.17 Cost for optional Building Air Leakage Test per Section 8.3

10. APPROVAL DOCUMENTS

10.1 Supplier to provide one (1) electronic copy (PDF or AutoCAD) of design loads for [Drilled Piers or Slab on Grade] foundation design, all static and dynamic loading calculations, foundation reactions, and all critical mounting features for the EEE to Purchaser 2 weeks ARO.

10.2 One (1) electronic copy (PDF or AutoCAD) of all other approval documents are required by close of business within 4 weeks ARO. Approval documents shall include:

10.2.1 Bill of Material

10.2.2 Outline

10.2.3 Mounting and Moving Provisions

10.2.4 Schematics

10.2.5 Nameplate

10.2.6 Other rating data furnished with Section 9.

10.2.7 A standard color chart shall be provided to Purchaser for interior and exterior color selection prior to manufacturing.

10.2.8 Door and door frame details.

10.2.9 Roof and wall sections with proposed framing

10.2.10 Design loads for Foundation Design.

10.2.11 HVAC Calculations

10.2.12 Secondary Heating Calculations

10.2.13 Structural Submittals: The structure manufacturer shall submit a structural design criteria document stating the basis of structural design in the form of a drawing, letter or calculation package, certified by an Engineer licensed in the state of the project. Fabrication of the structure shall not commence until this document has been reviewed and approved by the Purchaser. This document shall include, as a minimum, the following items:

10.2.13.1 Live Loads: Floor and roof live loads.

10.2.13.2 Snow Loads: Ground snow load, flat-roof snow load, exposure factor, importance factor and thermal factor.

10.2.13.3 Wind Loads: Ultimate and nominal design wind speeds (mph), risk category, exposure category, internal pressure coefficient and components and cladding wall and roof wind pressures (psf).

10.2.13.4 Seismic Loads (if applicable): Risk category, importance factor, mapped spectral response acceleration parameters, site class (assume D unless other information is provided), seismic design category, basic force resisting system(s), design base shears, seismic response coefficients, response modification coefficients and analysis procedure used.

10.2.13.5 Base support frame layout including dimensions, maximum foundation support spacing (assuming support by multiple drilled pier foundations).

10.2.13.6 Foundation reactions for both drilled pier and slab foundation options. Identify whether foundation reactions are service load or factored reactions, and provide breakdown of forces by load type. Include maximum vertical compressive and uplift forces, shear and moment (if applicable), including units. Include recommended or maximum support spacing for drilled pier foundation option.

10.2.13.7 Structural framing and floor plate deflection calculations or written statement outlining maximum live and total load deflections as a ratio of element length.

10.2.14 Anchor bolt and clip drawings

11. RECORD DOCUMENTS

One (1) electronic copy (i.e. CD-ROM, e-mail) of all record drawings are required by close of business no later than two weeks prior to EEE delivery date. Electronic documents shall be in PDF and AutoCAD format. One (1) paper copy is required to be shipped with the EEE.

11.1 The following are required record documents:

11.1.1 Photos of the following before liners or flooring material are installed:

11.1.1.1 Floor, wall, and ceiling assemblies while open

11.1.1.2 Floor rim area

11.1.1.3 Roof / wall juncture

11.1.2 A copy of the production (routine) tests

11.1.3 Instruction, installation and maintenance manuals

11.1.4 Manufacturer’s drawings of equipment supplied

11.1.5 EEE Supplier as built control and layout drawings

11.1.5.1 Drawings shall be centered on 18” x 24” paper

11.1.6 Completed price breakdown of assets from Section 9.15 that reflects completed EEE.

11.1.7 Report of all OEM warranty periods per Section 12.2

11.1.8 Quality Control Program documentation per Section 15.1.1

12. WARRANTY

12.1 Supplier shall guarantee that the complete EEE will have no defects in materials and workmanship as well as warranted against water leakage per IEEE requirements for a period of five (5) years from date of shipment, except as limited or extended by the Original Equipment Manufacturer (OEM).

12.2 Supplier to provide report of all OEM components and equipment with their respective warranty periods

12.3 Manufacturer warranties shall pass through to Purchaser for 3rd party equipment, software, etc. (ex. SEL Relays, GE RTU).

12.4 Supplier to also adhere to Section 6.8.2

13. SHIPMENT

13.1 The delivery point will be: Minnesota Power [XXXXXX] Substation at the following address:

[XXXXXX] Substation
[Address]
[City, STATE Zip]

13.2 The EEE shall be able to be shipped via semi-tractor trailer method. The EEE may not be separated into two or more sections for shipment unless approved by Purchaser.

13.3 The Supplier shall prepare all equipment covered by this specification for shipment in such a manner as to protect it from damage in transit.

13.4 Any and all damage resulting from improper preparation or damage during transit shall be repaired or replaced at the Supplier's expense.

13.5 The EEE shall be wrapped such to protect it from dirt and debris during shipment.

13.6 The Supplier shall be responsible for delivery of the EEE to the substation, including shipping, placement on the Purchaser provided foundation, and performing all finishing work to make the unit ready for service.

14. INSTALLATION

14.1 The Supplier is responsible for the delivery and installation of the EEE and installation cost thereof. This is to include, but not limited to, cranes, rigging, and all associated materials and labor required to install the EEE on its foundation to include marking and chalking correct placement on the foundation and install any equipment removed from the EEE for shipment. The Supplier is solely responsible for providing the correct equipment for the terrain and ground conditions encountered at the site.

14.1.1 Anchor Bolts and Clips shall be provided by Supplier and included with the EEE delivery.

14.1.2 An initial site review can be scheduled with the Purchaser.

14.1.3 Installation cost is to be included in the quote as a separate line item.

14.2 The following shall be required five weeks before first date of shipment to avoid delays in critical path of assembly:

14.2.1 EEE facility lifting/crane/rigging plan shall be provided using a Purchaser foundation plan or drawing as background. The lift plan must include the following:

14.2.1.1 Location of truck/trailer

14.2.1.2 Location of crane

14.2.1.3 Final outrigger locations

14.2.1.4 Distance from center of crane to center of extended outrigger post

14.2.1.5 Dimensions from center of crane to centerline of outriggers, sides, front and back

14.2.2 Order of sections for final field assembly

15. QUALITY SYSTEM REQUIREMENTS

15.1 QUALITY ASSURANCE

15.1.1 Supplier shall have a Quality Control Program that follows the EEE from design through completion that shall be passed onto Purchaser with all instruction manuals and final record drawings.

15.2 VERIFICATION

15.2.1 The Purchaser shall have access to perform assessments, quality audits, or witness test activities during the manufacturing process and to review applicable records. Purchaser may designate an authorized agent to perform these activities. The authorized agent may be an employee of the Purchaser or an outside agency. When an outside agency is designated as an authorized agent for the Purchaser, such designation shall be in writing with a copy provided to the Supplier. Hereinafter, when the term "Purchaser's representative" is used, it may also mean the Purchaser or the authorized agent.

15.3 The following requirements apply for Purchaser's inspection at the Supplier's mill, factory, yard, warehouse, or sub tier Supplier's facilities:

15.3.1 The Purchaser shall have the right to access the Supplier's and sub tier supplier's work and related documents at any time during the manufacturing process without delaying the schedule. The Supplier shall provide, without cost, reasonable facilities including tools, personnel and instruments for demonstrating acceptability of the work.

15.3.2 If any items or articles are identified as not meeting the requirements of the specifications, the lot, or any faulty portion thereof, may be rejected. Before offering specified material or equipment for shipment, the Supplier shall inspect the material and equipment and eliminate any items that are defective or do not meet the requirements of the purchase order. The fact that equipment or materials have been previously inspected, tested, and accepted does not relieve the Supplier of responsibility in the case of later discovery of flaws or defects.

15.3.3 Materials or equipment purchased under this purchase order may be inspected at the specified receiving points and will either be accepted or rejected. Receipt inspection will include testing to determine compliance with the purchase specifications. Initial receipt inspection acceptance tests will be performed by the Purchaser at the Purchaser's expense. Items found to be defective may be returned to the Supplier for correction at the Supplier's expense, including shipping cost or the cost to correct and inspect the item will be charged to the Supplier.

15.3.4 Purchaser's review of drawings and other submittals will cover only general conformity of the data to the Specifications and Drawings, external connections, interfaces with equipment and materials furnished under separate specifications, and dimensions that affect plant arrangements. Purchaser's review does not include a thorough review of all dimensions, quantities, and details of the equipment, material, device, or item indicated or the accuracy of the information submitted. Review and comment by Purchaser of Supplier's Drawings or other submittals shall not relieve Supplier of its sole responsibility to meet the Completion Dates requirement of this Purchase Order and to supply Goods that conform to the requirements of this Purchase Order.

16. REVISION TABLE

Number	Date	By	Reviewed	Description
0	12/19/19	BAH	BAF	Reformat of existing EEE02CD Spec, Updated all sections, Changed section numbering, Added requirements

17. ATTACHMENTS, SPECIFICATIONS, AND DRAWINGS

17.1 The following attachment(s) will be referenced in the above specification. The Supplier is required to complete the attachment(s) and return the attachment(s) with the Supplier's proposal

Attachment
EEE02CD – Section 9.15 Bid Tab.xlsx

17.2 The following specifications are provided by the Purchaser, are referenced in this specification and are to be included in the EEE design.

Standard #	Standard Name
CA01PA	Flame Retardant Power & Control Cable
EEE02CD	Substation Electric Equipment Enclosure (EEE) Facilities and Structure
PN01PA	Control Panel
PN02PA	Distribution Panel – 125V DC Distribution Panel
PN03PA	Distribution Panel – 120/240 Volt 600 Volts or Less AC
SB01PA	Lead Storage Battery

17.3 The following drawings are referenced in the above specifications and include the panel elevations and associated lists of equipment that is to be provided by the Supplier and included in the EEE.

Drawing #	Drawing Name
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]

[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

HIGH VOLTAGE INSTRUMENT TRANSFORMERS

SINGLE PHASE VOLTAGE TRANSFORMER

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

IT01PA

(Rev 3)

Table of Contents

1. SCOPE

This standard covers outdoor, high-voltage inductive voltage transformers used as instrument transformers on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The voltage transformers shall be designed, manufactured, tested, and furnished according to the latest editions, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including IEEE Std. C57.13, latest revision. The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

The Supplement Specification, ***IT01PA-S1***, shall be considered.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The voltage transformer shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification IT01PA-S1***.

3.1.2 Voltage transformers shall be of all new materials and of the latest manufacture and design. A rebuilt or used voltage transformer will not be acceptable.

3.2 ELECTRICAL CHARACTERISTICS

3.2.1 The voltage transformer electrical ratings shall be per ***Supplement Specification IT01PA-S1***.

3.2.2 The voltage transformer will be configured per ***Supplement Specification IT01PA-S1***.

3.2.3 The voltage transformer shall have a simultaneous accuracy on all windings.

3.2.4 The voltage transformer shall have two secondary windings. Each winding shall have a turns ratio and a tapped section per ***Table 1***.

3.2.5 Voltage transformer thermal rating shall be equally distributed on all windings.

3.3 PHYSICAL CHARACTERISTICS

3.3.1 The voltage transformer shall be designed per the Physical Characteristics outlined in ***Supplement Specification IT01PA-S1***.

3.3.2 Voltage transformers shall be mounted upright.

3.3.3 Voltage transformer shall be sky gray in color and conform to standard color designation ANSI #70.

3.3.4 All ferrous parts exposed to the weather and subject to corrosion shall be galvanized.

3.3.5 An oil level sight glass shall be provided, if oil is used.

3.3.6 The line terminals shall be furnished with a standard aluminum or tin plated bronze 4" NEMA 4-hole terminal pad.

3.3.7 A NEMA 2-hole pad shall be provided for Purchaser's grounding connection.

3.3.8 Lifting eyes or other lifting means shall be provided.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C57.13, latest revision.

4.2 The voltage transformer shall be subjected to all applicable production or routine tests described in NEMA and IEEE Standards including IEEE Std. C57.13, latest revision.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for voltage transformer.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of voltage transformer:

5.1.1 Data as indicated in ***Section 13***.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD 2018 or Adobe Acrobat Format) of the following for each unique type of voltage transformer:

5.2.1 Outline Drawings.

5.2.2 Nameplate Data

5.2.3 Schematic Diagrams

5.2.4 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2018 or Adobe Acrobat Format) of the following for each voltage transformer to be used for Purchaser's final records:

5.3.1 Outline Drawings.

5.3.2 Nameplate Data

5.3.3 Instruction Manual

5.3.4 Installation Instructions

5.3.5 Safety Data Sheet for insulating medium

5.3.6 Certified Test Reports

One set of instruction books and drawings shall be shipped with the voltage transformer in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the voltage transformer, and to perform all tests that may be necessary. The cost of a competent installation technician shall be included as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Voltage transformer shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 Voltage transformer shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Voltage transformer shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: **See *Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by ***Supplement Specification IT01PA-S1*** for Ratings and Technical Requirements completed by Purchaser, and ***Section 13***: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***See Supplement IT01PA-S1***

12.2 Table 1 and Table 2 Technical Information: ***See Next Page***

Table 1				
Nominal System Voltage (kV)	Maximum Voltage (kV)	Rated Phase to Ground (kV)	Lightning Impulse Withstand Voltage (kV)	Turns Ratio
115	121	69	550	1000/600:1:1
138	145	80.5	650	1200/700:1:1
161	170	92	750	1400/ 800:1:1
230	245	138	900	2000/1200:1:1

Table 2		
Nominal System Voltage (kV)	Minimum Creep (In)	Minimum Phase to Ground Clearance (In)
115	79	47
138	92	52.5
161	114	61.5
230	140	76

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each unique item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Point of Shipment		
d. Domestic Content		%
e. Delivery Date		Weeks ARO
f. Price per Unit (Tax NOT included)	$	
g. Warranty		
h. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Nameplate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a. Type		
b. Primary Voltage		kV
c. Secondary Voltage		V
d. Thermal Rating		
e. Rated Voltage Factor (30 sec)		
f. Power Frequency Withstand Voltage		kV (Wet)
g. Lightning Impulse Withstand Voltage		kV
h. RIV Test Voltage		kV
i. Accuracy (at specified burden)		
j. Burden		
k. Turns Ratio		

13.5 Physical Characteristics

a. Housing Type		
b. Height (bottom of base to top of unit)		in
c. Diameter (not including base)		in
d. Unit Weight (Approximate)		lbs
e. Creep		in
f. Phase to Ground Clearance		in
g. Maximum Primary Terminal Load		lbs
h. Insulating Medium		
i. Volume Insulating Medium		

13.6 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$
	$

13.7 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.8 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.9 Exemption(s)

13.10 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
1	02/16/18	ARS		Updated Section 13
2	02/09/21	DJS	RJB	Added PE Block, rearranged sections 12, 13 & 14 and added ratings and technical requirements to a supplement specification
3	10/15/21	PJK/BV	RJB	Updated Sections 3.2.2 and 3.2.4 per supplemental specification updates.

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

OUTDOOR MOTOR OPERATOR FOR

AIR BREAK SWITCHES

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 26, 2021 License No.: 51308

Date	Prep	App
10/18/21	PJK/BV	RJB

Standard Number

MO01PA

(Rev 1)

Table of Contents

1. SCOPE

This standard covers outdoor air break motor operators for switches used on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The motor operator shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE. The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The motor operator shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification MO01PA-S1***.

3.1.2 Motor operators shall be of all new materials and of the latest manufacture and design. Rebuilt or used motor operator will not be acceptable.

3.1.3 Manufacturer shall provide all provisions necessary to mount the motor operator and operating mechanism components to Purchaser supplied structural steel.

3.2 OPERATING MECHANISM

3.2.1 The operating mechanism shall be capable of manual operation upon complete power failure. Any special tooling required to manually operate the motor operator shall be supplied.

3.3 ELECTRICAL REQUIREMENTS

3.3.1 The motor operator electrical ratings shall be per ***Supplement Specification MO01PA-S1***.

3.3.2 Motor operator shall be able to turn the switch operator at a torque minimum per ***Supplement Specification MO01PA-S1***.

3.3.3 Individual mechanically interlocked open and close contactors.

3.3.4 Single pole 120 VAC circuit breaker protection for lighting and GFCI outlet.

3.3.5 Single pole 120VAC or double pole 240VAC circuit breaker for protection of heater circuits. Heater circuit voltage shall be per ***Supplement Specification MO01PA-S1.*** Manufacturer to confirm voltage in ***Section 13***.

3.3.6 Double pole 125 VDC circuit breakers for protection of control circuits.

3.4 CONTROL CIRCUIT AND WIRING

3.4.1 Local/remote selector switch

3.4.2 Motor operator shall be provided with open and close pushbuttons designed for outdoor operation.

3.4.3 Motor operator shall be provided with a stop pushbutton designed for outdoor operation.

3.4.4 Motor operator shall be provided with open and close indicators designed for outdoor operation.

3.4.5 All control wiring shall be a minimum of 14 AWG SIS wire, terminated on suitable terminal blocks in the mechanism housing.

3.4.6 AC terminal blocks shall be able to accommodate Purchaser’s 6 AWG power cable.

3.4.7 A minimum of ten (10) spare auxiliary switches shall be furnished in addition to those required for the motor operator control circuit. The auxiliary switches shall be located in the motor operator control cabinet and located above the de-coupler to reflect the switch status at all times.

3.4.8 Operating mechanism limit switches shall be provided to prevent operation of the closing coil and motor contactor during abnormal or incomplete operation of the operating mechanism.

3.4.9 Trip circuit current shall be greater than 2 amps and not exceed 10 amps.

3.5 ACCESSORIES

3.5.1 The interior of the housing shall have a functional 120 VAC light mounted inside.

3.5.2 The interior of the housing shall have a functional 120 VAC, 20A, GFCI outlet inside.

3.5.3 Two (2) space heaters, designed for operation on 120 VAC or 240 VAC single phase (per ***Supplement Specification MO01PA-S1***), shall be provided. The heaters shall be low surface temperature or operable at half voltage. One heater shall be continuously energized for condensation control. The second heater shall be thermostatically operated. Manufacturer shall size heaters to provide condensation control and ensure operation at an exterior ambient temperature outlined in ***Supplement Specification MO01PA-S1***.

3.5.4 The construction of the control cabinet and any other housing or compartment for control or operation shall be designed for operation per ***Supplement Specification MO01PA-S1***. If necessary, Manufacturer shall filter, vent, insulate, and/or heat these compartments. Manufacturer shall test and supply information from such tests to indicate proper operation.

3.6 PHYSICAL/MECHANICAL REQUIREMENTS

3.6.1 The motor operator shall be designed per the Physical Characteristics outlined in ***Supplement Specification MO01PA-S1***.

3.6.2 All motor operator components shall be sky gray in color and conform to standard color designation ANSI #70.

3.6.3 Interphase linkage shall be of the torsional type or an acceptable substitute. All interphase connections and mounting hardware shall be supplied for single gang throw operation. All interphase connecting pipe fittings shall have piercing screws. All interphase connecting pipe shall have means of preventing water retention inside pipe by way of weep holes, open ends or combination thereof.

3.6.4 The motor operator linkage shall over-toggle into the fully open or fully closed positions and shall have adjustable mechanical stops for both the open and closed positions.

3.6.5 Operating mechanisms shall effect a smooth, thoroughly controlled movement throughout the entire opening and closing cycle and all rods, shafts, pipe linkages, connectors, operating levels, supports, and fittings shall show no noticeable deflection. Cable connections in lieu of rigid interphase rods are not acceptable.

3.6.6 A means shall be provided on each motor operator for taking up loose motion in each part of the mechanism and for adjusting the travel of each blade independently. The design of the mechanism shall be such that the main blades are positively toggled when in the fully open or fully closed position.

3.6.7 The manual operator shall be easily turned by a person of average strength without need for extension pipes or levers (35 lbs. for a worm gear operator and 60 lbs. for a swing handle operator).

3.6.8 The motor operator rod shall be supplied with an open/close indicator to identify current position of motor operator.

3.6.9 A swing handle or gear operator accessible for operation at ground level shall be provided.

3.6.10 There shall be provisions for padlocking the operator in both the open and closed positions.

3.6.11 An appropriately sized, flexible ground jumper shall be provided for the operating handle.

3.6.12 The motor operator shall have maintenance free removable door.

3.6.13 The motor operator shall have an internal de-coupler.

3.6.14 A viewing window shall be provided on the front door to allow a confirmation of decoupling position.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards.

4.2 Motor operators shall be subjected to all applicable production tests described in NEMA and IEEE standards. Manufacturer shall provide a list of factory tests performed to verify proper mechanical or electrical operation of the motor operators.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each motor operator.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of motor operator:

5.1.1 Data as indicated in ***Section 13***.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of motor operator:

5.2.1 Outline drawings

5.2.2 Wiring drawings

5.2.3 Nameplate Drawing

5.2.4 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each motor operator to be used for Purchaser's final records:

5.3.1 Outline drawings

5.3.2 Wiring drawings

5.3.3 Nameplate Drawing

5.3.4 Instruction Manual

5.3.5 Installation Instructions

5.3.6 Certified Test Reports

One set of instruction books and drawings shall be shipped with the Motor operator in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the motor operator, and to perform all tests that may be necessary. All quotations must include the cost of a competent installation technician as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery. ***See Bid Documents*** for delivery location.

10.2 All motor operator components shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 All motor operator components shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Motor operator shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: ***See Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification MO01PA-S1***: Ratings and Technical Requirements completed by Purchaser, and ***Section 13***: Specific Information Required with Quotation for Manufacturer to complete.

11.1 Purchaser Proposed Schedule: ***See Supplement Specification MO01PA-S1 and Bid Documents***

11.2 Contact for Technical Questions: ***See Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification CB01PA-S1***

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13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. **One form shall be used for each unique item quoted.** Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a.	Line Item/Description/Label		
b.	Manufacturer		
c.	Point of Manufacturer		
d.	Domestic Content		%
e.	Delivery Date		Weeks ARO
f.	Price per Unit (Tax NOT included)	$	
g.	Warranty		Months Post Delivery
			Months Post Install
h.	Type/Model Number		

13.2 Documentation Transmittal Time

a.	Preliminary Drawings		Weeks ARO
b.	Wiring Diagram		Weeks ARO
c.	Final Outline		Weeks ARO
d.	Name Plate		Weeks ARO

13.3 Service Conditions

a.	Ambient Temperature Rating		
b.	Maximum Altitude		ft
c.	Maximum Wind Speed		miles/hr
d.	Maximum Ice Loading		inches

e. Maximum Seismic Performance	

13.4 Electrical Characteristics

a. Motor Running Range		Volts
b. Heater Circuit Voltage		V

13.5 Physical Characteristics

a. 6 Second Operating Time Torque		lb.-in
b. 10 Second Operating Time Torque		lb.-in
c. Direction to Open (Clockwise, CCW)		
d. Degrees of Full Operation		deg.
e. Operator Pipe Size		IPS
f. Height		in
g. Width		in
h. Depth		in
i. Shipping Height		in
j. Unit Weight (Approximate)		lbs

13.6 Applicable Factory Testing

13.7 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$
	$

13.8 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.9 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.10 Exemption(s)

13.11 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/06/20	DJR		Original
1	10/18/21	PJK/BV	RJB	Created MO01PA-S1 Supplemental Spec and Changed section numbering, rearranged & updated sections 12, 13 & 14. Revised 3.3.5 to allow 120VAC heater, added wiring drawings to submittals