# EXHIBIT B-2 – BESS BOT SCOPE BOOK

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# 1 GENERAL DATA[1]

This Appendix, including its attachments, is the Scope Book. This Scope Book is part of Acquisition Agreement between Party developing or in ownership of a project as defined in model agreement "Seller" and Entergy Service LLC. "Buyer" and subject to the rules of interpretation set forth therein. Terms with initial capital letters used but not defined in this Scope Book shall have the meanings ascribed to such terms in the Agreement unless the context otherwise requires. For the avoidance of doubt, the rules of interpretation set forth in the Main Body of the Agreement shall apply to this Scope Book.

This Scope Book describes certain requirements with respect to the Work. In performing the Work, Seller shall comply with the requirements specified in this Scope Book, all laws, and applicable permits.

This Scope Book provides the Minimum Functional Specification (MFS) for the Project, including scope and design requirements. In addition to the requirements set forth in the Agreement (including this Scope Book), all requirements specified in the Generator Interconnection Agreement (GIA) or any other Required Deliverability Arrangement shall be met.

This Scope Book includes elements that apply to the work contemplated by and the provisions set forth in Appendices. These elements include, among others, project controls; cybersecurity; environmental requirements; site fire protection; site security; temporary site installation and laydown areas; tools, spare part, and consumables; project utilities and redundancy; and control system and communication requirements.

## 1.1 General

Seller shall provide the Project, including a Battery Energy Storage System, or BESS, to Buyer at the Project Site in accordance with the terms of this Scope Book and the other terms of the Performance Standard. The Work requires Seller to provide, among other things, necessary design, engineering, procurement, construction, commissioning, start-up, testing, performance verification, and training of Buyer personnel with respect to the BESS and the Project. The Project shall be engineered according to industry standards using prudent utility practices and in compliance with the Performance Standard. The entire BESS facility shall be controlled by the BESS Supervisory Control and Data Acquisition (SCADA) System and Controller as specified in this Technical Specification.

This Scope Book is an exhibit to and part of the B-O-T Acquisition Agreement between Seller and Buyer (i.e., the Agreement) and is subject to its terms, including Article I thereof. An initially capitalized term used but not defined in this Scope Book shall have the meaning assigned to such term in the Agreement except to the extent otherwise provided in the Agreement or the context otherwise requires. The priority of documentation and terms forming part of the Agreement (including this Scope Book) and Ancillary Agreements are set forth in Section 1.3 of the main body of the Agreement.

[1] NTD: The Scope Book remains subject in all respects to Buyer's continued due diligence and internal review (including by Buyer's subject matter experts). This draft may need to be revised to reflect certain matters included or not addressed in the Agreement or the request for proposal (RFP) or that have been reconsidered. Buyer reserves the right to issue an updated version of the Scope Book at a later date.

Buyer desires a qualified bidder (Seller) to provide engineering, procurement, and construction services to develop a Battery Energy Storage System (BESS) Project proposed power and energy capacity at a proposed facility location determined by the Seller.

The Project includes, without limitation, all necessary project development, land acquisition, permitting, design, engineering, commissioning, start-up, testing, performance guarantees, and performance verification. Operations, maintenance and spare parts to support continuous facility operation shall be provided by Seller. Seller shall provide waste disposal plan that covers disposal methods during and post construction as well as develop a Decommissioning Plan or recycling plan for the facility at End of Life (EOL) per Section 6.5 below.

Refer to Appendix 8 for project location and Project Site Map.

The supply of the battery and its rack, Power Conversion System (PCS), Medium Voltage step-up transformer (MVT), BESS SCADA, and the fire Protection and detection system within the BESS equipment enclosures are included in the Seller's scope of supply.

Notwithstanding the foregoing, the installation, commissioning and testing at site of these components are within the scope of Seller. Commissioning of and testing activities for the Project equipment shall be carried out with the support of each original equipment manufacturer (OEM).

The following referenced documents provide supplemental requirements to Seller's scope of supply under this Scope Book:

Appendix 1 - Collector Substation.

Appendix 2 - High Voltage Overhead Transmission.

Appendix 3 - Seller Provided Information.

Appendix 4 - Project Performance Tests and Liquidated Damages.

Appendix 5 - Buyer Provided Information.

Appendix 6 - Division of Responsibility (DOR).

Appendix 7 - Cyber Security Plan.

Appendix 8 - Project Site Map.

Appendix 9 – Approved Manufacturers and EPC Contractors List.

Appendix 10 - NERC Requirements.

Appendix 11 - Project Controls.

Appendix 12 – Equipment Warranties.

As described in detail in this Scope Book and required as set forth in this Agreement, Seller shall engineer, design, manufacture and deliver to Buyer at the Project Site the following equipment and services:

- Seller's Scope of Supply per Section 2 of this Scope Book.
- Equipment Scope of Supply per Section 3 of this Scope Book.
- Design Requirements per Section 4 of this Scope Book.
- Facility Requirements per Section 5 of this Scope Book.
- Engineering Services and Studies provided by Seller per Section 6 of this Scope Book.

- Testing, Commissioning and Startup services provided by Seller per Section 7 of this Scope Book.
- Maintenance services provided by Seller per Section 8 of this Scope Book.
- Training and Tools for all Seller-provided equipment per Section 9 of this Scope Book.
- Document Submittals provided by Seller per Section 10 of this Scope Book

## 1.2 Definitions and Abbreviations

**Table 1: Acronyms/Abbreviations**

| | |
|---|---|
| ºC | Celsius |
| °F | Fahrenheit |
| A | Ampere, unit of Electrical Current |
| AC | Alternating Current |
| AGC | Automatic Generation Control |
| ASCE | American Society of Civil Engineers |
| ASTM | American Society for Testing and Materials |
| BESS | Battery Energy Storage System |
| BOL | Beginning of Life |
| BOM | Bill of Materials |
| CPT | Control power transformer |
| dBA | A-weighted decibels |
| DC | Direct Current |
| DOD | Depth of Discharge |
| Down Reserve | The capability of the BESS to inject AC power to the grid at the POI in response to remote commands, and/or frequency response |
| DNE | Data Network Engineering |
| DNO | Data Network Operations |
| EL | Electroluminescence |
| EN | European Standard |
| EOL | End of Life |

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| EPC | Engineer-Procure-Construct as the primary or general Seller |
| EPS | Electric Power System |
| FNTP | Full Notice to Proceed |
| Frequency Response | The capability of the BESS to provide response for frequency deviations above and below the frequency set point (or dead band) of the BESS, within the ramp rate limits for the Project |
| FRT | Frequency Ride-Through |
| GHS | Global Harmonized System |
| GHz | GigaHertz |
| HMI | Human Machine Interface |
| HV | High Voltage |
| $HV_{AC}$ | High voltage alternating current |
| HVAC | Heating, Ventilation & Air Conditioning |
| Hz | Hertz, unit of electrical frequency |
| IEC | International Electrotechnical Commission |
| IED | Intelligent electronic device |
| IEEE | Institute of Electrical and Electronics Engineers |
| Inverter | All inverters in this specification refer to Four-Quadrant, Bidirectional, Smart Inverters. |
| ISO | Independent System Operator |
| kHz | Kilohertz |
| kW | Kilowatt |
| kWh | kilowatt-hour |
| kV | Kilovolt |
| LGIA | Large Generation Interconnection Agreement |
| LHFRT | Low and high frequency ride through |
| LHVRT | Low and high voltage ride through |

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| Load Following | The ability of the BESS to provide real power response to a specific, metered electrical location (i.e., POI) based on the variations of real power demand at the specified location |
| LPS | Lightning protection system |
| LV | Low Voltage |
| MHz | Megahertz |
| Mil | Unit of measurement for length (thousandth of an inch) |
| MPT | Main Power Transformer |
| MTBF or MTTR | Mean time between failures or Mean time to repair |
| Ms | Millisecond |
| MV | Medium Voltage |
| MVT | Medium Voltage Transformer |
| MVA | Mega Volt Amp |
| MW | Megawatt |
| $MW_{AC}$ | Megawatt alternating current |
| MWh | Megawatt-hours |
| NEC | National Electric Code |
| NEMA | National Electrical Manufacturers Association |
| NESC | National Electric Safety Code |
| NFPA | National Fire Protection Association |
| O&M | Operation and maintenance |
| OEM | Original Equipment Manufacturer |
| Output Frequency Range | The range of frequency under which the Project will operate according to its specification |
| Output Voltage Range | The range of AC grid voltage under which the Project will operate according to its specification |
| Buyer | Entergy Service, LLC |
| P/T/Z | Pan/tilt/zoom |
| PCB | Polychlorinated biphenyl |

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|---|---|
| PCC | Point of Common Coupling |
| PCS | Power Conversion System |
| Peak Shaving | The ability of the system to provide power to the grid above a threshold power demand level during peak demand periods to maintain net power demand at the substation below the threshold level. |
| PID | Proportional Integral Derivative loop control |
| PLC | Programmable Logic Controllers integrated with the BESS and SCADA System |
| POI | Point of Interconnection (or Electrical Interconnection Point), which shall be where the Project ties into the existing Transmission or Distribution Network |
| Project | BESS for grid support applications (without limiting the definition in the Agreement) |
| pu | per unit |
| PV | Photovoltaic |
| PVC | Polyvinyl chloride |
| QA/QC | Quality assurance/quality control |
| QP | quasi-peak |
| Ramp Rate | The rate, expressed in Megawatts per minute, that a generator changes its power output. |
| RAS | Remedial Actions Scheme |
| Rated Apparent Power | The real or reactive power (leading/lagging) that the BESS can provide at the POI continuously without exceeding the operating limits of the BESS |
| Rated Continuous Charge Power | The rate at which the BESS can capture energy for the entire SOC range of the BESS |
| Rated Continuous Discharge Power | The rate at which the BESS can continuously deliver energy for the entire specified SOC range of the BESS |
| Rated Discharge Energy | Total energy the fully-charged BESS can deliver to the POI at the rated continuous discharge power without recharging. |
| Revenue Metering Point | There are two Revenue Metering Points: Project Totalizing meter at the POI; the Project BESS (low side of the transformer). |

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| rms | root mean square |
| RSP | Remote Shutdown Panel |
| SCADA | Supervisory Control and Data Acquisition |
| SCCR | Short-circuit current rating |
| SGIA | Small Generator Interconnection Agreement |
| SOC | State of Charge, measured in % relative to the maximum possible amount of energy that can be stored by the system, with fully charged being 100% and fully discharged being 0%. |
| SOH | State of Health |
| SPCC | Spill Prevention Control and Countermeasures Plan |
| SPD | Surge protection devices |
| Standby mode | BESS standby mode means that the battery is charged to the specified level and is not providing or receiving power from the grid |
| SWPPP | Storm Water Pollution Prevention Plan |
| System Round-Trip Efficiency | The ratio of the delivered output energy of the BESS to the absorbed input energy required to restore it to the initial SOC under specified conditions through the Design Life. |
| Total Response Time | Starting when the command is received at the BESS boundary and continuing until the BESS discharge power output reaches 100 +/- 2% of its rated power, measured at the POI |
| DOT | Department of Transportation |
| UL | Underwriters Laboratories, Inc. |
| Up Reserve | The capability of the BESS to absorb AC power from the POI in response to remote commands, and/or frequency response |
| UPS | Uninterruptible Power Supply |
| Utility Grade | Project and Equipment which is designed to last through the Design Life with only typical routine maintenance and planned consumable goods. |
| µV/m | microVolts per meter |
| V | Volt, unit of Voltage (Electric Potential) |

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|---|---|
| VA | Volt-Ampere, unit of Apparent Power |
| $V_{AC}$ | Volts alternating current |
| VAR | Volt-Ampere Reactive, unit of Reactive Power |
| $V_{DC}$ | Volts direct current |
| VDE | Association for electrical, electronic, and information technologies |
| VESDA | Very Early Smoke Detection Apparatus |
| $V_{OC}$ | Open Circuit Voltage |
| VRT | Voltage Ride-Through |
| W | Watt, unit of Real Power |

## 1.3 Seller Responsibilities

The Seller shall provide:

- BESS Equipment specified in Section 3.1 and 3.2.
- BESS Inverters specified Section 3.3.
- BESS MV Transformers specified in Section 3.4.
- Power Plant Controller and SCADA Equipment specified in Section 3.5.
- System Documentation.
- Design and Engineering.
- Equipment to meet the requirements of these specifications and the project specific requirements specified in Appendix 5.
- Commissioning and startup on-site support.
- Site compliance certifications regarding work completion to applicable agencies (e.g., as-built certification of storm water management system, if required).
- Site Testing of all works.
- Maintenance plan and spare parts locations and list.
- Decommissioning Plan.

All as described herein, including all referenced appendices and standards, which will subsequently become a part of the Agreement.

For building or special built enclosures, the Project consists of all the direct current (DC) components from the BESS modules through the PCS plus the MVT.

For containerized solutions the Seller shall furnish a fully integrated energy storage system, including battery modules, battery management system, thermal management system, inverters, power electronics and inverters (as an AC block). Each battery module shall include an integrated inverter module for power conversion. The battery modules shall be connected in parallel to an internal AC bus, each with an AC power and communications output connections.

The BESS shall be Utility Grade as defined in Table 1. The balance of the Project (from the output of the PCS to the point of interconnection as defined in the Interconnection Agreement shall comply with this Technical Specification and be compatible with Buyer standards specified herein. The balance of plant items includes, but are not limited to:

- Wiring, conduit, trenches, and grounding.
- Thermal Management System.
- Safety Subsystems to include Remote Shutdown Panel (RSP) and any Fire Department Connections required either by the BESS equipment supplier or by the AHJ.
- Switchgear and current limiters.
- Transformers.
- Power poles.
- Equipment pads.
- Communications to Buyer equipment.
- Special built building if required.

The Project shall be designed by the Seller to maintain the guaranteed performance metrics presented in this Technical Specification. The Project shall include BESS equipment capable of exceeding the technical and operating requirements set forth in Appendix 5 and Appendix 3.

The Seller shall provide construction services to complete the following:

- Earthworks
- Roads
- Foundations
- Electrical systems
- Control systems, monitoring systems, communications, and ancillary structures
- Storage facilities
- Security systems
- Fencing
- Safety markings and labeling
- Special built or building enclosures (if required).

Seller shall also install and commission the OEM equipment provided by Buyer in the locations and orientations set forth in the approved site layout drawing and in accordance with this specification, and all related specifications that relate thereto.

The Seller shall be responsible for the design, engineering, procurement, supply, installation, commissioning and testing of the following equipment: Medium Voltage (MV) Switchgear, Auxiliary Transformers/Switchboards, Auxiliary AC and DC Power Supply System, and all associated Cables.

Refer to Appendix 6 for delineation of Seller’s scope of supply relative to the Buyer’s scope of supply.

## 1.4 BESS Availability

The Seller shall design, engineer, and furnish equipment with the objective of producing a BESS system that will meet or exceed stated guaranteed energy availability performance, measured at the point of interconnection, based on expected equipment availability and degradation consistent with Seller's bid and these specifications. Refer to Appendix 5 and Appendix 3 for Availability requirements.

## 1.5 Approved Supplier List

The Seller shall provide equipment and material per the Appendix 9.

## 1.6 Codes and Standards

Seller shall, to the maximum extent feasible, be in compliance with one of the nationally recognized model building codes and with other applicable national, state, and local codes. The latest edition of the local and nationally recognized codes and any updated supplements in effect at the time of contract award shall be used throughout the project design and construction. Codes and standards applicable to the BESS project can be found below.

The BESS components must comply with all codes and standards relevant to the operation and installation of energy storage equipment. All installed equipment must be tested and approved by Underwriters Laboratories (UL) or another nationally recognized testing facility. Batteries, enclosures, inverters, and other balance of system components must be certified to comply with the latest version of the following requirements:

All work must follow current National Electrical Code requirements as well as:

- NFPA 855 Standard for the Installation of Stationary Energy Storage Systems

Other general codes are:

- ANSI C2 National Electrical Safety Code
- IFC International Fire Code
- NFPA 70 National Electrical Code
- IEEE 979 Guide for Substation Fire Protection
- NFPA 13 Standard for the Installation of Sprinkler Systems
- NFPA 68 Standard on Explosion Protection by Deflagration Venting
- NFPA 69 Standard on Explosion Prevention Systems
- NFPA 72 National Fire Alarm and Signaling Code
- IBC International Building Code
- IMC International Mechanical Code
- ASHRAE 169 Climatic Data for Building Design Standards
- ASCE 7 Minimum Design Loads
- ACI 318 Building Code Requirements for Structural Concrete
- UL 752 Protection Standards for Bullet Resistant Glass

Battery cell:

- UL 1642 Standard for Lithium Batteries

Battery module:

- UL 1973 Batteries for Use in Light Electric Rail Applications and Stationary Applications

Battery system:

- UL 9540 Energy Storage Systems and Equipment
- UL 9540A Test Method for Evaluating Thermal Runaway Fire Propagation in BESS

Grid interconnection standards, as applicable to the project as a whole:

- IEEE 1547 Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
- UL 1741 Standard for Static Inverters and Charge, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
- UL 62109-1 Safety of power converters for use in photovoltaic power systems – Part 1: General requirements
- IEEE 2800 Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems

Other codes and standards that will apply include:

- UN 38.3 Certification for Lithium Batteries (Transportation)
- ANSI C12.1 Code for Electricity Metering
- ASCE/SEI 7-22 Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- IEEE 2030.2 Guide for the Interoperability of Energy Storage Systems Integrated with the Electric Power Infrastructure
- IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations

Alternative International Electrotechnical Commission [IEC] standards where applicable:

- IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications
- IEC 63056 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems
- IEC 62933-5-2 Electrical energy storage (EES) systems - Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems

HVAC, Thermal Management and Fire Protection

- NFPA 90A — Standard for the Installation of Air Conditioning
- ASHRAE 183 Res. Buildings — Peak Cooling and Heating Load Calculations in Buildings Except Low-rise
- ASHRAE 90.1 — Energy Standard for Buildings Except Low-Rise Residential Buildings
- NFPA 855 — Standard for the Installation of Stationary Energy Storage Systems
- NFPA 13 — Standard for the Installation of Sprinkler Systems

Arresters, Circuit Breakers, and Disconnect Switches

- IEEE C62 — Standards Collection: Guides for Surge Protection
- IEEE C62.11 — Standard for Metal-Oxide Surge Arresters for AC Power Circuits
- IEEE 142 Power Systems — Recommended Practice for Grounding of Industrial and Commercial
- IEEE 1100 Equipment — Recommended Practice for Powering and Grounding Electronic
- NEMA LA 1 — Surge Arresters
- IEEE C37 and Fuses — Standards Collection: Circuit Breakers, Switchgear, Relays, Substations,
- IEEE C37.37 Volts) — Standard Loading Guide for AC High Voltage Switches (in excess of 1000
- NEMA SG 6 — Fuses
- IEEE C37.46 — Specifications for Power Fuses and Fuse Disconnection Switches
- IEEE C37.47 — Specifications for Distribution Fuse Disconnecting Switches
- NEMA FU 1 — Low Voltage Cartridge Fuses

Protection

- IEEE C37.91 — Guide for Protective Relay Applications to Power Transformers
- IEEE C37.99 — Guide for Protection of Shunt Power Capacitors
- IEEE C37.90 Apparatus — Standard for Relays and Relay Systems Associated with Electric Power
- IEEE C37.90.1 — Standard Surge Withstand Capability (SWC) Tests for Protective Relays
- IEEE 242 Systems — Recommended Practice for Protection and Coordination of Power
- IEEE 141 — Recommended Practice for Electric Power Distribution for Industrial Plants
- IEC 255-5 — Electric Relays. P5: Insulation Tests for Electric Relays
- IEC 255-22 Relays — Electric Relays. Part 22: Electrical Disturbance Tests for Measuring

Control Equipment

- IPC 2615 Printed Board Dimensions and Tolerances
- IPC A-610 Acceptability of Printed Boards

SCADA

- IEEE C37.90.1 Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- NFPA 70 National Electrical Code UL 50, “Cabinets and Boxes
- UL 508 Industrial Control Equipment
- UL 1449 Surge Protective Devices” (SPD)
- NERC/CIP:007-3R2 Ports and Services
- ANSI/TIA-568.3 Optical Fiber Cabling and Components Standard

Harmonics, Grounding and Seismic

- IEEE 519 Guide for Harmonic Control and Reactive Compensation
- IEEE 80 Guide for Safety in AC Substation Grounding
- IEEE 693 Recommended Practice for Seismic Design of Substations

Codes and Standards will comply with the following codes and standards at a minimum.

- Aluminum Association (“AA”)
- American Association of State Highway and Transportation Officials (“AASHTO”)
- American Concrete Institute (“ACI”)
- American Institute of Steel Construction (“AISC”)
- Association of Iron and Steel Engineers (“AISE”)
- American Iron and Steel Institute (“AISI”)
- American National Standards Institute (“ANSI”)
- American Society of Civil Engineers (“ASCE”)
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (“ASHRAE”)
- American Society of Mechanical Engineers (“ASME”)
- American Society of Nondestructive Testing (“ASNT”)
- American Society of Testing and Materials (“ASTM”)
- American Water Works Association (“AWWA”)
- American Welding Society (“AWS”)
- Applicable state requirements, including State Department of Transportation and Environmental Protection
- Avian Power Line Interaction Committee (“APLIC”)
- Code of Federal Regulations (“CFR”)
- Concrete Reinforcing Steel Institute (“CRSI”)
- Crane Manufacturer Association of America (“CMAA”)
- United States Environmental Protection Agency (“EPA”)

- Federal Aviation Agency, Department of Transportation (“FAA”)
- Federal Energy Regulatory Commission (“FERC”).
- Federal Highway Administration (“FHWA”)
- IAPMO Uniform Plumbing Code
- Illuminating Engineering Society (“IES”)
- Institute of Electrical and Electronic Engineers (“IEEE”)
- International Society of Automation (“ISA”)
- Insulated Cable Engineering Association (“ICEA”)
- International Building Code (“IBC”)
- International Code Council (“ICC”)
- International Electrotechnical Commission (“IEC”)
- Metal Building Manufacturer’s Association (“MBMA”)
- Modular Energy Storage Architecture (“MESA”)
- National Electric Code (“NEC”)
- National Electrical Contractors Association (“NECA”)
- National Electric Safety Code (“NESC”)
- National Electrical Manufacturers Association (“NEMA”)
- National Electrical Testing Association (“NETA”)
- National Fire Protection Association (“NFPA”)
- National Safety Council (“NSC”)
- North American Electric Reliability Corporation (NERC)
- Occupational Safety and Health Administration (“OSHA”)
- Post-Tensioning Institute (“PTI”)
- Scientific Apparatus Makers Association (“SAMA”)
- Sheet Metal and Air Conditioning Contractors National Association (“SMACNA”)
- Society for Protective Coatings (“SPC”)
- Telecommunications Industry Association/Electronic Industries Association (“TIA/EIA”)
- Underwriter’s Laboratories (“UL”)
- Uniform Building Code (“UBC”)

# 2 SELLER SCOPE OF SUPPLY

## 2.1 General Requirements

The Seller or Seller’s scope of work includes permitting, design, engineering, procurement, installation, commissioning, start-up, and performance verification of the Project systems for the commercial operation of the Project.

The Seller or Seller scope of Supply is detailed in Appendix 6.

The Project design shall comply with all current local, state, and federal regulations, codes, and applicable standards.

All equipment supplied shall be designed to ensure satisfactory operation under the specified site temperature conditions and other atmospheric and environmental conditions prevailing at the site.

All equipment, components, and materials shall be new and free of defects in material or workmanship.

The Seller or Seller shall verify all information provided by Buyer, by OEMs, and third-party suppliers prior to incorporating the information into Seller's design.

The Project must comply with all codes and standards relevant to the operation and installation of energy storage equipment. All installed equipment must be tested and approved by Underwriters Laboratories (UL) or another nationally recognized testing facility. In the case where standards have conflicting requirements, Seller must notify Buyer in writing.

The Seller shall be responsible for executing and completing the work, employing personnel who are experienced, qualified, and properly licensed in their respective fields, regardless of any omission in this Scope Book or the Agreement. Where feasible, components shall be manufactured to standard dimensions to facilitate cost-effective replacements and repairs when required.

The Project design shall adhere to the requirements outlined herein. All equipment, materials, and components shall meet the standards set forth in this Scope Book All equipment supplied and Work by Seller shall be designed to ensure satisfactory and reliable operation under the full range of seismic and ambient conditions and under all Plant operating conditions and variation ranges specified. The Seller shall provide sufficient access around all equipment in accordance with good industry practices and OSHA regulations to allow for safe and effective operation, monitoring, maintenance, and removal.

The Seller shall apply for and obtain all permits and authorizations necessary for construction of the Project. Copies of all applicable permits shall be provided to Buyer within five business days after they are obtained or completed. Seller shall provide a permit matrix to Buyer for approval.

The Seller's scope includes but is not limited to providing the following:

- All site preparation including any necessary civil work
- Site Storm Water Pollution Prevention Plan (SWPPP)
- Supports and foundations for all buildings, enclosures, structures, transformers, switchgear, conduit, and overhead cabling
- All the Balance of Plant components
- DC system with voltage sources and panel boards for communications networks and relay protection equipment
- If UPS is not furnished by the BESS OEM, the Seller shall provide a redundant, industrial grade uninterruptible power supply (UPS) system for Project control and protection systems and communication equipment. UPS system shall allow for minimum of 10 hours power supply for ventilation for explosion prevention system. UPS system shall also supply power for 24 hours for alarms, strobes, and other protection in standby.
- Project related medium voltage (MV) terminations, duct banks and cable routing and collection bus connections including but not limited to AC panel boards, circuit protection, and backup distribution sources with necessary isolation/step-down transformers.
- The codes and standards to be complied with can be found in Section 1.6.

- Seller shall provide comprehensive safety data sheets (formerly called MSDS) in the new Global Harmonized System (GHS) format as a written chemical inventory of every hazardous chemical in the Project to which employees are exposed.
- Should any of the components within the Project require an operating environment less severe than the site environment, the Project shall provide appropriate conditioning of the enclosed space.
- All portions of the Project must be sufficiently hospitable to installation, inspection, and service personnel to not restrict the performance of those duties. The Project is to be automated with no operator presence required. Seller to provide solution for remote monitoring of BESS.

The Seller shall furnish a construction schedule, in a format acceptable to Buyer as part of the bid package and in accordance with the project schedule. Upon approval by Buyer, the construction schedule shall become part of the Contract and may be revised only with written approval of Buyer in the form of a contract change order.

The Seller shall provide a material management plan for all procured items, consumables and construction, installation, and commission works.

The Seller shall provide overall project administration and management for the Project. The Seller's management team shall be technically competent, shall be adequately trained, and experienced in the construction and startup of BESS Equipment. The Seller's team shall be present onsite during all construction and commissioning work and shall instruct the Seller's construction and commissioning personnel in the proper construction, initial operation, and maintenance of the BESS equipment consistent with Prudent Utility Practice.

## 2.2 Permitting Services

The Seller shall apply for and obtain all permits and authorizations necessary for construction of the Project. Copies of all applicable permits shall be provided to Buyer within five business days after they are obtained or completed. Seller shall provide a permit matrix to Buyer for approval.

The Seller will also be required to prepare and submit all site compliance certifications regarding work completion to applicable agencies (e.g., as-built certification of storm water management system, if required). Federal permits shall be submitted by Buyer.

## 2.3 Engineering Services

- Seller shall design and engineer the Project in accordance with prudent utility practices and relevant codes/standards as listed in Section 1.6 for grid-connected BESS projects for electric utilities in the United States.
- The design must conform to the requirements and conditions of all applicable permits and laws and be in compliance with the operating guidelines and meet Buyer specifications.
- Seller is responsible for all engineering of the Project. All design drawings, specifications, and calculations shall be signed by a professional engineer-of-record licensed in the state or jurisdiction of the project. Seller shall submit to Buyer all completed drawings, data, and documents for review and comment. These engineered design drawings, data, and documents must be submitted to Buyer for review and comment before construction is to begin.
- Seller is responsible for ensuring that all components are installed above the 100-year flood plain (battery system, PCS, SCADA system, Security System, control building, transformers, etc.).

- Any third-party study or independent engineering reviews (such as the geotechnical study) shall be provided to Buyer for review.

Seller's design requirements are further specified in Section 4.

## 2.4 Construction Services

Prior to beginning construction and not later than 30 days prior initial site mobilization. The Seller shall provide the following to the Buyer:

- A comprehensive onsite construction management plan in accordance with all applicable laws and policies
- Health, Safety, and Environmental Plan.
- Emergency and Fire response plan coordinated with responding AHJ consistent with NFPA-855
- An evaluation and appropriate documentation of the safety record for any licensed Subcontractor that will be performing work on the Project.
- Reference projects where the above plans and actions have been taken. When the above plans and actions have been taken, the Seller will establish goals for the project, during the project the Seller will report back to the Buyer on deviations and near misses. Seller and subcontractors must register with and be approved by ISNetworld.

Seller shall assemble, construct, and install with its own labor forces and/or with Subcontractors labor, tools, and equipment, including but not limited to the following Works:

- Site preparation, site grading, site improvements, stormwater management facilities and removal of excess debris.
- DC cabling and junction boxes.
- AC trenching and cabling.
- Inverters, switchgear, transformers and accompanying supports and/or concrete pads.
- Perimeter security fencing (described in Section 0).
- Security lighting.
- Installation of the monitoring system and revenue-grade metering (provided by Buyer).
- Remote Shutdown Panel (described in Section 4.4.1).
- BESS enclosures and accompanying supports and/or concrete pads.

## 2.5 Temporary Construction Facilities

The Seller shall provide all temporary power needed for construction, commissioning, and testing of the Project or performance of the Work in each case or any portion thereof.

The Seller shall provide all utility interconnections needed for construction, commissioning, and testing of the Project or performance of the Work in each case or any portion thereof (e.g., offices, security, parking, potable and non-potable water, wastewater, sanitation (including sewage), temporary power,

telecommunications, broadband internet, and fuel). The Seller shall provide a Facilities Plan to define all temporary construction facilities for Buyer review.

## 2.6 Quality Assurance/Quality Control Requirements

The Seller shall submit a Quality Assurance/Quality Control (QA/QC) Plan for the proposed project delivery. The QA/QC Plan shall define the systems and procedures which will be used by Seller to ensure that the Project will comply with the requirements detailed in this Technical Specification in addition to any other standards and policies determined by Buyer.

The Seller shall submit to Buyer a copy of its QA/QC Plan for review not later than 45 days after contract execution for Buyer review and comment. The Project shall be managed in accordance with the program.

The Seller shall notify Buyer of Factory Acceptance Testing 14 days (domestic) and 28 days (international) before testing. Buyer shall have right to elect to witness such testing or have representatives witness testing.

The QA/QC Plan shall include, but is not limited to, such procedures and systems as the following:

- Road construction and compaction.
- Reinforcing steel and conduit placement.
- Concrete placement and testing.
- All wire insulation testing—Megger testing or very low frequency testing.
- Fuse tests.
- Terminations pull testing.
- All visual inspections.
- Factory Acceptance Test reports.
- Grounding continuity testing.
- Earth-ground resistivity testing.
- Metering and instrumentation calibration testing.
- SCADA indication, control, and operator interface verification.
- Weld testing for transformer support including other anchorage.
- Weld testing for racking supports.
- If required, weld testing for:
    - BESS containers
    - Inverters if not included with the BESS container
    - MV Transformers if not supplied with the BESS container
- Inverter phase rotation and matching with utility.
- Protective relay settings.

- Verification of security camera system operations, including device points, sequences, and communications.
- Other Seller-prescribed procedures.

The Seller shall notify Buyer of Factory Acceptance Testing 14 days (domestic) and 28 days (international) before testing. Buyer shall have right to elect to witness such testing or have representatives witness testing.

All onsite QA/QC testing procedures shall be witnessed and documented by a qualified representative of Seller. Buyer shall observe and witness QA/QC as necessary and at its discretion. A qualified engineer of Seller shall date and sign documentation indicating completion and acceptance of each onsite QA/QC test procedure.

## 2.7 Environmental, Health and Safety Program

The Seller shall provide a comprehensive project-specific Environmental, Health and Safety Program in accordance with all applicable laws and policies.

## 2.8 Storage of Materials and Equipment

Prior to the arrival of equipment and materials at the Site, The Seller shall install a fenced, secured area and provide security for the storage of such equipment and materials. Construction storage and laydown shall be sufficiently drained and elevated above the flood plain. Seller shall notify Buyer of the location and layout of intended staging areas, parking areas, storage areas, office areas, workshops, and other temporary facilities. Temporary construction roads and staging areas not converted to permanent roads (if any) shall be restored in accordance with all permit requirements.

The Seller shall be responsible for receiving, protecting, moving, and storing all material at the Site in a secure manner and a manner that maintains temperature control for battery cells and modules required under warranties. OEM recommended requirements to guarantee temperature controls are maintained for BESS including the battery cells so that warranties are not violated if needed climate-controlled facilities should be constructed before BESS including the battery cells arrive on site as well. BESS module staging during construction shall be separated to limit fire propagation between units consistent with final placement analysis. Laydown area vegetation height should be managed to reduce wildfire potential.

# 3 EQUIPMENT REQUIREMENTS

## 3.1 General BESS Requirements

The major equipment items shall include a battery, four-quadrant bi-directional PCS, MV step-up transformer, and local, remote control/monitoring equipment, container cooling system, and integrated explosion protection systems. Additional equipment shall include battery monitoring system (BMS), rack management system (RMS, if applicable), Energy Management System (EMS) harmonic filters, HVAC system, fire suppression system, auxiliary cooling systems, wiring, connectors, protective devices, grounding, junction boxes, enclosures, instrumentation, and all other items needed for a fully functional, utility-interactive BESS, installed to meet the requirements set forth in this Technical Specification.

### 3.1.1 HVAC / Thermal Management

The Seller shall provide all components to operate the BESS within acceptable operating temperatures of the projects described in Appendix 5. If necessary, provide any thermal management systems and operating strategies required to always maintain the BESS and inverter temperatures within manufacturer's recommendations.

### 3.1.2 BESS Augmentation

Seller will manage augmentation needs to account for degradation. Seller shall prepare a strategy for future augmentation, including the following requirements:

- Current and future design must allow for future augmentations in proposed site layouts and electrical designs for purposes of developing firm cost proposals. This includes allowing for additional site area that may be required and allowing for additional MV circuits to be connected into the substation switchgear as examples.
- Augmentation plan shall account for obsolescence of products and provide a solution with available technology.
- DC augmentation will not be accepted.

## 3.2 Battery Energy Storage System (BESS)

The Battery Energy Storage System scope of supply is specified in Appendix 6.

### 3.2.1 BESS Enclosure

A BESS Enclosure, if utilized, shall be one of the following three options:

ISO Container
Special Built Enclosure
Building

All options require the exterior of the structure to be built to a bullet resistant standard of UL 752 Level 4.

Battery enclosures or structures shall comply with the guidance of NFPA-855 with the following special requirements apply to each enclosure type.

Enclosure and/or enclosure assets shall be no more than the lesser of fifty-percent total capacity or 25.0 MWh capacity will be lost due to an event.

For building enclosure designs Seller shall demonstrate design layout adequately addresses all fire risks. Seller shall provide compartmentation plan, ventilation/exhaust design, fire area calculations, fire barrier rated drawings, detection zoning, smoke/toxic management plan, and suppression zoning with valve location plan.

**Table 2: Site Dimensions**

| | | | |
|---|---|---|---|
| A | Fence line to Battery | 100 ft | Minimum distance or must maintain distance so that <1psi shall be felt at fence on explosion per NFPA 855 Remote Requirements. |
| B | Distance between BESS units or other equipment | 20 ft | Minimum Distance required between BESS units unless an NFPA 80A exposure protection Thermal Flux Calculation demonstrates acceptable separation with no fire service intervention. |

ISO Container

- Container shall be constructed per International Standard ISO 1496-1 or similar standards.
- Access to the battery's modules shall be from external swing doors.
- Hydrogen, Li-ion Tamer, or similar UL listed early off gas detection shall be included and designed per results of UL9540A test.
- Fire detection per NFPA-72.
- HVAC shall go into purge mode on receipt of early off gas detection.
- Container environmental sample tube routed to exterior of container for Fire Department air sampling.
- Deflagration vents to exterior sized for structure integrity.
- Provide a manual open head sprinkler typical of NFPA 13 riser(s) internal to the container, supplied by a dry FDC connection exterior to the container. No releasing or alarm hardware required.

Special Built Enclosure

- Access to the battery's modules shall be from external swing doors.
- Hydrogen, Li-ion Tamer, or similar UL listed early off gas detection shall be included and designed per results of UL9540A test.
- Fire detection per NFPA-72
- Deflagration vents to exterior sized for structure integrity
- HVAC shall go into purge mode on receipt of early off gas detection
- Container environmental sample tube routed to exterior of container for FD air sampling.
- Provide a manual closed head sprinkler typical of NFPA 13 riser(s) internal the container, supplied by a dry FDC connection exterior the container. No releasing or alarm hardware required.

Building

- The building is expected to be Tilt-Up style on a pre-stressed slab floor
- Two-hour fire walls shall separate the energy storage system into no more than the lesser of fifty-percent total capacity or 25.0 MWh capacity will be lost due to an event.
- Deflagration vents to exterior sized for structure integrity

- Compartment environmental sample tube routed to exterior of container for FD air sampling.
- Hydrogen, Li-ion Tamer, or similar UL listed early off gas detection shall be included and designed per results of UL9540A test.
- Fire Detection per NFPA-72 HVAC shall go into purge mode on receipt of early off gas detection
- NFPA 13 or NFPA 15 automatic suppression shall be provided in each fire zone. An acceptable water supply shall be provided.

### 3.2.2 Building Design

Structural Framing:

Primary and secondary structural members and exterior covering materials: Design for applicable loads in accordance with the MBMA “Common Industry Practices”.

Structural Steel: For design of structural steel members, comply with the requirements of the ANSI/AISC 360 for design requirements and allowable stresses.

Light Gauge Steel: For design of light gauge steel members, comply with requirements of AISI S100-16 and AISI S310-16 for design requirements and allowable stresses.

Welded Connections: Comply with requirements of the AWS D1.1 for Welding procedures.

Basic Design Loads:

All loads shall be based on the site-specific conditions and latest IBC, ASCE 7, state, and local codes.

All structures on the Site need to be designed using environmental loads as specified in ASCE/SEI 7and the applicable state building code if more stringent requirements. These include wind loads, snow loads, rain loads, ice loads, and earthquake loads. Each structure on Site shall be grouped in Risk Category III as defined in ASCE/SEI 7. The corresponding importance factor shall be used for each load determination.

Live Load shall be in accordance with IBC and the state local code.

Auxiliary Loads:

Include dynamic live loads such as those generated by suspended ceilings, sprinkler systems, electrical or mechanical systems or any suspended HVAC units, and exterior frames and doors.

Design:

Each member shall be designed to withstand stresses resulting from the combination of loads that produce the maximum allowable stresses in that member as prescribed in MBMA’s “Common Industry Practices”.

### 3.2.3 ISO Container

If applicable, containers shall be in accordance with the International Standard ISO 1496-1 or similar standards.

### 3.2.4 BESS Operational Requirements

Seller shall specify the method used to determine discharge and charge cutoff voltages.

The BESS operating functions shall be programmed in a programming language defined by the Buyer in Appendix 5 and made available to Buyer so that software modifications can be made, or new functions can be added if the need arises at some point in the future. Any required supporting software such as compilers and linkers shall also be made available to Buyer.

The operating functions described below will be limited and confirmed with the battery vendor by the charge and discharge limit to prevent damage to the battery. Termination of any operating scenario by the discharge limit, without reaching rated capacity discharge, will be deemed a failure for the purposes of calculating availability.

The following sections discuss common inverter control functions that shall be implemented in the BESS as part of the local and remote automatic BESS controls.

#### 3.2.4.1 Real Power Controls

- Direct Charge/Discharge Storage – This is a basic function that can be used to discharge or recharge the BESS to a specified state of charge (SOC) and at a specified rate.
- No-Grid-Charging Mode – System should accommodate programming times and conditions under which grid charging will not be active.
- RPS: Real Power Smoothing – This is a real power control mode function for the BESS that could monitor the potential hybrid renewable energy plant real time power output for fluctuations. The BESS should be capable of responding to smooth out the renewable systems fluctuations and mitigate any power quality issues due to renewable systems output variability. The BESS response shall be capable of smoothing the net power output from the combined renewable systems and BESS while also preserving the BESS available stored energy.

#### 3.2.4.2 Reactive Power Controls

If reactive power is for the Facility, it will be based on the point of interconnection agreement and the BESS services agreement identified by Buyer. Below are examples of what may be required under this section:

- Direct Voltage Control – In this function the BESS shall output VARs to control the POI voltage to a specified setpoint voltage and a specified droop, and with a specified maximum and minimum kVAR range which shall not be exceeded. The BESS shall be normally operated with voltage control enabled.
- Watt-Var Function – In this function the BESS shall actively control its reactive power output as a function of the real power output. The reactive power output follows a user defined Watt-Var or P-Q curve. The Watt-Var curve is a piece-wise linear user defined curve entered as X,Y point pairs where the x-axis is the power output and the y-axis is the corresponding VAR output.
- Function CV: Constant VARs – This function allows the BESS to produce a constant VAR output at a specified level.
- Fixed Power Factor Function – This function allows the BESS to produce or absorb power with a user entered constant power factor. The power factor range is +/- 0.00 to 1.00.

- Watt Power Factor Function – In this function the BESS actively controls the BESS power factor as a function of the real power output of the BESS. This function utilizes a piece-wise linear curve defined by X, Y point pairs, to determine the power factor of the BESS output at any BESS real power output.

### 3.2.4.3 Miscellaneous and Support Functions

Below are examples of what may be required under this section:

- Scheduling Function - This function is used to perform the real and reactive control functions via a time-based schedule and/or a load-based schedule. The Schedule function can define when different X-Y curves become active and what the ramp rate will be when transitioning between scheduled functions. When more than one function is active for Real Power or Reactive Power control then the schedule shall define a priority order for the functions.
- Event Logging and Reporting Function - This function shall be used to record any protection events triggered by the inverters including but not limited to e.g. over current, over voltage, over temperature, sequence of event reporting (SER), etc.
- Status Monitoring Function - This function shall include voltages, SOC, Inverter Status, Usable Energy, BESS rack and module temperature, Present Operating Mode, Inverter Active and Reactive Power output, power factor, present line frequency, Connect/Disconnect Status, Operating Time, Connected Time, and possibly other BESS information.
- Function Connect/Disconnect - This function shall be implemented by two sets of commands, one being a virtual command and the other being a physical command. The virtual Disconnect command sets the real and reactive output of the BESS to zero. A physical Disconnect provides galvanic isolation between the inverter and the grid. Additional details regarding Shutdown, Disconnect, and Operate modes are provided in the Sections 3.2.4.7, 3.2.4.8, and 3.2.4.9 below.
- LHVRT Function - This function shall be used to specify the low and high voltage ride through characteristics of the BESS. This function will be used to specify the trip, suspend and normal operation ride through voltage characteristics as per IEEE 1547, and IEEE 2800 protection coordination studies, and Buyer policies.
- Local/Remote Mode Function – This function when in Local Mode shall block commands by offsite sources to enable safe local maintenance and diagnostics and provide a means for secure on-site management. This function shall also allow the return to remote control.
- Automatic/Manual Mode – This function shall enable and disable the BESS from performing any of the automated control functions for real and reactive power. When switching from automatic to manual mode the BESS real and reactive outputs shall ramp down to zero at a specified ramp rate.

### 3.2.4.4 VAR Support

The BESS may be required to provide VAR support for voltage regulation under steady state and contingency operating conditions as described below. The BESS shall be capable of up to full rated output, when operating within the normal sustained voltage and frequency ranges specified in Appendix 5, or as determined by Seller's system studies. The voltage regulator controls shall not be affected by changes in

system frequency. The voltage regulator controls shall include Buyer selectable setpoint and droop characteristic and shall be capable of being set by Buyer's SCADA system or by a local control interface.

Nothing in this section shall be construed as limiting the ability of the BESS to operate in other modes. The VAR output of the BESS may be limited based on remaining inverter capacity used for real power output unless supplemented as described above. The final VAR requirements will be provided to Seller per Section 10.

### 3.2.4.5 Charging

Seller shall specify charging requirements.

Seller shall design the charging system to ramp up from zero to the maximum capacity at a Buyer selectable ramp rate as described in Appendix 5 to avoid shocking the system and allow generation to follow load easily.

Seller shall provide a curve showing how demand from Buyer's system varies with time throughout the charging cycle. The BESS control system shall allow Buyer's dispatcher to initiate remotely Seller-specified/programmed charge cycle. The maximum demand required by the charging cycle shall be Buyer selectable but shall not exceed Seller specified charge rate. Seller shall provide data showing how the recharge period varies as maximum demand decreases.

Seller shall also specify restrictions, if any, on operation of the BESS during any portion of the charge cycle. Seller shall provide a curve or table and data showing the state of charge of the battery as a function of time.

Automatic or programmed charge cycles shall be implemented to prevent SOC going below the battery vendor specified charge/discharge limits (defined in Section 3.2.4).

Seller shall provide adequate energy storage capacity and SOC to accommodate the number of charge/discharge occurrences and total energy requirements in Appendix 5.

### 3.2.4.6 Charge Rate

There will be times when the BESS may be directed to use overload charging capability exceeding the normal maximum charging rate for a short duration. Seller shall provide, a curve showing the inherent overload capability of the proposed BESS as a function of time. It is not a requirement to design specific overload capability into the BESS. Overload charging will not be allowed if the batteries are charged above the Seller specified maximum charge limit. When the BESS is nearing the Seller specified maximum charge limit, the BESS charging shall ramp down linearly to zero at a Buyer selectable ramp rate.

### 3.2.4.7 Shutdown State

The shutdown state is the state in which battery DC contactor/breakers and PCS AC breaker are open; non-critical power supplies are de-energized; control system power may remain energized. This mode includes both normal shutdown and system trips requiring reset.

The control system shall initiate shutdown under the following conditions and remain in the shutdown state until a reset signal, either local or remote, is initiated:

- Emergency trip operation.

- AC circuit breaker trips (either main or PCS breaker) that isolate the BESS.
- Door interlock – initiate shutdown when the door to the PCS is opened. A “defeat” feature shall allow for maintenance. Interlocks shall be self-resetting.
- Smoke/fire alarm.
- Fire Suppression operation.
- Control logic trouble.
- DC ground fault – field adjustable setting.
- Failure to restart from disconnect state after automatic restart attempts.
- Remote disable (no reset required).

#### 3.2.4.8 Disconnect State

The disconnect state shall be defined as balance of plant (BOP) DC contactors/breakers, battery DC contactors/breakers, and PCS AC breaker open; non-critical power and control system power energized.

Some faults or failures are expected to be temporary. The control system shall open contactors upon fault occurrence and may be manually started up after a manual reset or operational procedures. Seller shall determine these manual reset or operational procedures in agreement with Buyer. The control system shall go to the disconnect state under the following conditions:

- Synchronization Error – The PCS is unable to synchronize with the utility grid.
- Grid transient conditions (i.e., line switching or reclosure action).
- Utility voltage out of emergency operating range as defined in this Technical Specification.
- Utility line frequency out of emergency operating range as defined in this Technical Specification (field adjustable in 0.1 Hz increments).
- Over-temperature on the battery, PCS, controls or other equipment.
- Excess explosive gas level.
- Buyer and grid operator requested outages.

#### 3.2.4.9 Operate State

The Operate state shall be defined as all contactors/breakers closed and power available to flow to or from the BESS, PCS and transformer system to the utility system. Normal operation shall include all operating scenarios as described herein and discharge and charge modes. It also may include additional modes and sequences deemed necessary by Seller.

#### 3.2.4.10 Specific Operational Requirements

Seller will indicate any required rest (neither charging nor discharging of the BESS) periods, their duration and what event they must follow or precede.

The BESS shall have appropriate functionality to accept an emergency disconnect input. Once the emergency disconnect is activated, the BESS project must immediately enter Shutdown State as defined in Section 3.2.4.7.

During manual operation of the BESS project, the system must indicate which, if any, autonomous functions are disabled.

Buyer may impose rest intervals, such as charging off-peak and discharging on-peak. If no other tasking is done, this will create a rest period between each half cycle. This shall not adversely affect BESS performance and shall be included in capacity calculations. Seller shall provide the maximum rest period allowed (days, weeks, months) in Appendix 3.

Seller to disclose to Buyer additional conditions which require special action (e.g. type of reconditioning (holding at 100 percent DOD) or charge equalization (holding at 100 percent SOC)), disclosure to include description of this condition, including frequency of occurrence, cause of occurrence, corrective actions if any, and operational limitation of BESS caused by this condition.

The cells within a battery module shall either be self-balancing, or their periodic balancing be handled automatically by battery module management electronics. Similarly, the modules within a string shall either be self-balancing or periodic balancing handled automatically by string/bank management electronics.

The design must include prudent provisions for technology improvement. Battery modules shall allow for upgrade or replacement with higher performance cells to the extent practical. Where such changes are made to a battery module, all modules in that battery string must also be upgraded before the upgraded modules are placed into service.

## 3.3 Power Conversion System (PCS)

The PCS is the interface between the DC battery system and the AC system and provides for charging and discharging of the battery and may consist of one or more parallel units.

The PCS scope of supply is specified in Appendix 6.

### 3.3.1 PCS Requirements

The PCS shall be a smart static device (charger and inverter) using solid-state electronic switch arrays in a self-commutated circuit topology. Line-commutated systems or systems that require the presence of utility voltage or current to develop an AC output are not acceptable.

The PCS, in conjunction with the BESS Master Controller, shall be capable of completely automatic unattended operation, including self-protection, synchronizing and paralleling with the utility, and disconnect functions.

The control of the PCS shall be integrated with the overall BESS Master Controller. A proven and established combined instrumentation and control system shall be provided for the BESS SCADA System. Each SCADA system shall feed into a central controller that shall be the primary interface with the Buyer's controls and shall be compatible with the utility's existing SCADA system.

The PCS shall include all necessary self-protective features and self-diagnostic features to protect itself from damage in the event of component failure or from parameters beyond safe range due to internal or external causes. The self-protective features shall not allow the PCS to be operated in a manner that may be unsafe or damaging.

Seller shall design the PCS, including its controls, power supplies and connections to sensors, to be compatible with utility system voltage and/or frequency transients and similar events. The PCS shall be capable of operating continuously at rated output under the normal voltage and frequency ranges and providing full output for the required operating modes specified.

All PCS components shall be designed to withstand the stresses associated with steady state operation, transient operation and overload conditions. Seller shall design PCS to withstand all relevant aspects of overvoltage stresses.

The PCS shall have provisions to prevent moisture condensation and entrance of rodents, insects, and/or other foreign material beyond design threshold into air intake/exhaust ports or any required structure penetration.

The PCS system shall include provisions for disconnection on both the AC and DC terminal, for maintenance work. Conductor separation must be clearly visible. These disconnects shall be capable of being locked open for maintenance work. PCS capacitors shall be provided with bleeder resistors or other such means of discharging capacitors to less than 50 V within one minute of de-energization.

An interlock system shall be provided for access to the PCS or enclosures if live parts are exposed when opened. A disconnect switch or draw-out breaker and grounding devices shall be provided for maintenance of the PCS equipment. It is preferred that the PCS has a switchgear for disconnect and provide ground connection. The interlock system shall prevent access to the PCS equipment until the AC and DC circuit breakers or disconnect switches are open and the PCS bus is grounded.

### 3.3.2 Interference and Harmonic Suppression

The PCS shall not produce Electromagnetic Interference that will cause interference with instrumentation, communication, or similar electronic equipment within the Project or on Buyer's system. The PCS shall be designed in accordance with the applicable IEEE standards to suppress Electromagnetic Interference effects.

The BESS must meet the harmonic specifications of IEEE 519 and Buyer's power quality standards. Harmonic suppression may be included with the PCS or at the Project AC system level. However, Seller shall design the Project electrical system to preclude unacceptable harmonic levels in the Project auxiliary power system.

Buyer will not be required to change or modify the existing system to accommodate the Project. Compliance with electromagnetic and harmonic distortion requirements will be based on field measurements after commissioning.

### 3.3.3 PCS Cooling System

The purpose of the PCS cooling system is to remove the heat produced by the PCS operation and transfer this heat to the outside ambient air or to be used as auxiliary heat for the building or enclosures as appropriate.

Either water cooled or air-cooled systems are allowed. However, the final rejection of waste heat shall be to the outside ambient air. No discharge of cooling system water shall be allowed. Seller shall provide the anticipated failure rates of a year related to the cooling system in Appendix 3.

The cooling circuit for water cooling systems shall be a closed loop de-ionized water or water/glycol mixture recirculating system. If a water/glycol system is proposed, Seller shall prepare a Spill Prevention Control and Countermeasures plan and provide secondary containment for accidental discharges of the mixture.

The high purity (high resistivity) water (if used) in the closed loop system shall be circulated through the heat producing electrical equipment at a constant flow rate. A purifying loop to maintain the high purity in the closed system shall be provided. Freeze prevention equipment / plan shall be provided by Seller.

Non-recirculating (once-through) or recirculating air systems are allowed. If a recirculated air system is used, a heat exchanger shall be provided. If a non- recirculated (once-through) air system is used, a two-stage air filtering system shall be provided. The air handling systems shall include filtering to the appropriate Ingress Protection (IP) level as defined by manufacturer of PCS system.

## 3.4 Medium Voltage Step-Up Transformers

Seller shall provide Medium Voltage Step-Up Transformers per the following requirements.

Transformers shall meet transformer efficiency standards. Transformer voltage to match POI transmission voltage with the secondary voltage of the PCS.

The transformer may be configured with any specified winding configuration.

If a Grounding Transformer is required it shall be designed, provided, and installed by the Seller.

Transformers shall at a minimum be rated for 115% of the inverter rated working load and the environment in which they will operate. The Transformer shall be supplied with a no-load tap changer with high voltage taps capable of operating at 2.5 and 5 percent above and below nominal voltage at full rating. The transformer shall be supplied with a disconnect switch on the transformer high-voltage side to isolate the transformer once de-energized. Transformer shall have in the high side voltage a disconnect switch with fuses or switchgear. It is preferred to have a switchgear for disconnect and to provide ground connection. The switch/transformer configuration shall be designed for loop feed. Transformers shall be either dry-type, or oil filled, FR3 or equivalent is not acceptable. Enclosure finish shall be a top powder coat that is designed for a 40-year service life. Buyer shall reserve the right to attend factory witness testing of step-up transformers per Project QA/QC plan (refer to Section 2.6).

The transformer may be used to aid in harmonic cancellation. If the transformers are a liquid-filled type, PCBs (Polychlorinated Biphenyls) shall not be used. Seller shall provide a SPCC if transformers are liquid-filled type.

If the Project is a Special-built enclosure or building enclosed project, Seller shall account for the thermal loading design of the Medium Step-Up Transformers.

## 3.5 Power Plant Controller & BESS SCADA

The BESS SCADA system shall store historic performance data metrics which describe the quality of system performance for each function over the last 168 hours minimum. Seller to ensure interface with Buyer to offload reports at an agreed interval. Historical performance data metrics shall be stored for performance analysis and warranties.

The Buyer and Seller scope of supply shall generally include design, supply, and installation of, but not limited to, the following:

### 3.5.1 Scope of Seller

- Seller shall provide a redundant fiber-based network connecting all the inverters, battery management systems, energy management system, power plant controller, and safety systems.

- Seller shall provide SCADA enclosures to integrate the inverters, battery management systems, energy management system, power plant controller and safety systems. Seller to develop communication system single line and network block diagram.
- Seller shall provide communication rack layout, including BOM Bill of Materials and elevation drawings. Project to have redundant SCADA system with primary and secondary switches and connections.
- Seller shall provide appropriate SCADA, communications, wiring, fiber, and splice details.
- Seller shall provide field installed SCADA communication panels at each inverter with layer 2,3 looped switch and fiber patch panel in a National Electrical Manufacturers Association (NEMA) 4X enclosure.
- Seller provided SCADA System controller shall provide 20% spare hardware capacity input/output (I/O).
- Seller shall provide all fiber optic cable. which shall contain at minimum 20% spare pairs for future use.
- Seller shall land the Buyer controlled fiber (i.e., ATT) on a Buyer supplied and installed firewall (Palo Alto or CheckPoint are acceptable firewalls)
    - Seller shall configure firewall in compliance with Buyer's Information Technology requirements (e.g. allow by exemption principle and opening only ports and protocols necessary for required functionality)
    - Seller shall configure VLAN Access Control Lists to manage routing for only necessary functions
- Seller shall provide redundant core switches (IE4010 switch or similar) and connect to upstream SM SFPs (Single Mode Small Form-factor Pluggable).
- Seller shall provide fiber patch panels.
- Seller shall provide 42U server rack.
- Seller shall provide the UPS (uninterruptible power supply), system shall provide for 72 hr. back-up.
- Seller shall provide miscellaneous fiber, ethernet jumpers, and cable management
- Seller shall configure the SCADA system for access credentials
- Seller shall supply and configure a Power Plant Controller.
- Power Plant Controller shall be configured to support the use cases in conformance to Appendix 5.
- A narrative of the control configuration shall be supplied.
- Seller shall supply and configure the plant's SCADA system.
- Seller shall supply IT rack for Buyer's exclusive use:
    - 19" rack with 24"x36" footprint
    - Front and back lockable mesh doors and cable entry slots in roof
    - 36" front clearance and 24" rear clearance
    - Dual 120 Vac UPS backed power strip with UPS ethernet monitoring capability, with UPS capable of 72 hours of backup run-time
- Seller shall provide all cables and shall be labeled on both termination ends with "from" and "to" designations including port or terminal numbers. Cable labels shall be self-laminating vinyl wraps or zip tied. Flat labels wrapped around a cable are not acceptable.

- If PV solar panels are included in scope of Project, Seller shall supply a solar array irradiance meter for the Power Plant Controller.
- Seller shall supply a fully functional Power Plant Controller and BESS SCADA System that meets all requirements herein.

The BESS SCADA system shall store historic performance data metrics which describe the quality of system performance for each function over the last 168 hours minimum. Seller to ensure interface with Buyer to offload reports at an agreed interval. Historical performance data metrics shall be stored for performance analysis and warranties.

### 3.5.2 Scope of Buyer

- Buyer shall supply and install a firewall managed Level II switch with 3 VLANs configured (Buyer to supply subnet information)
    - The 3 VLANs consist of the following
        - Collector Substation
        - BESS Yard (Physical Site Security)
        - Power Plant Controller
- Buyer shall provide controlled fiber to the site. Temporary cellular connection to support commissioning activities may be required by Seller.
- Buyer to provide the fiber from the Buyer network at the POI to the BESS SCADA. Fiber shall be 96-strand, single mode, meeting Telecommunications Industry Association (TIA) 568.3-E. The fiber loop from the BESS SCADA to the BESS Assets shall be a minimum of 12 strand single mode, meeting Telecommunications Industry Association (TIA) 568.3-E

### 3.5.3 Fiber Installation

#### 3.5.3.1 Underground Fiber Installation

The below criteria and requirements apply to a transmission connected Project.

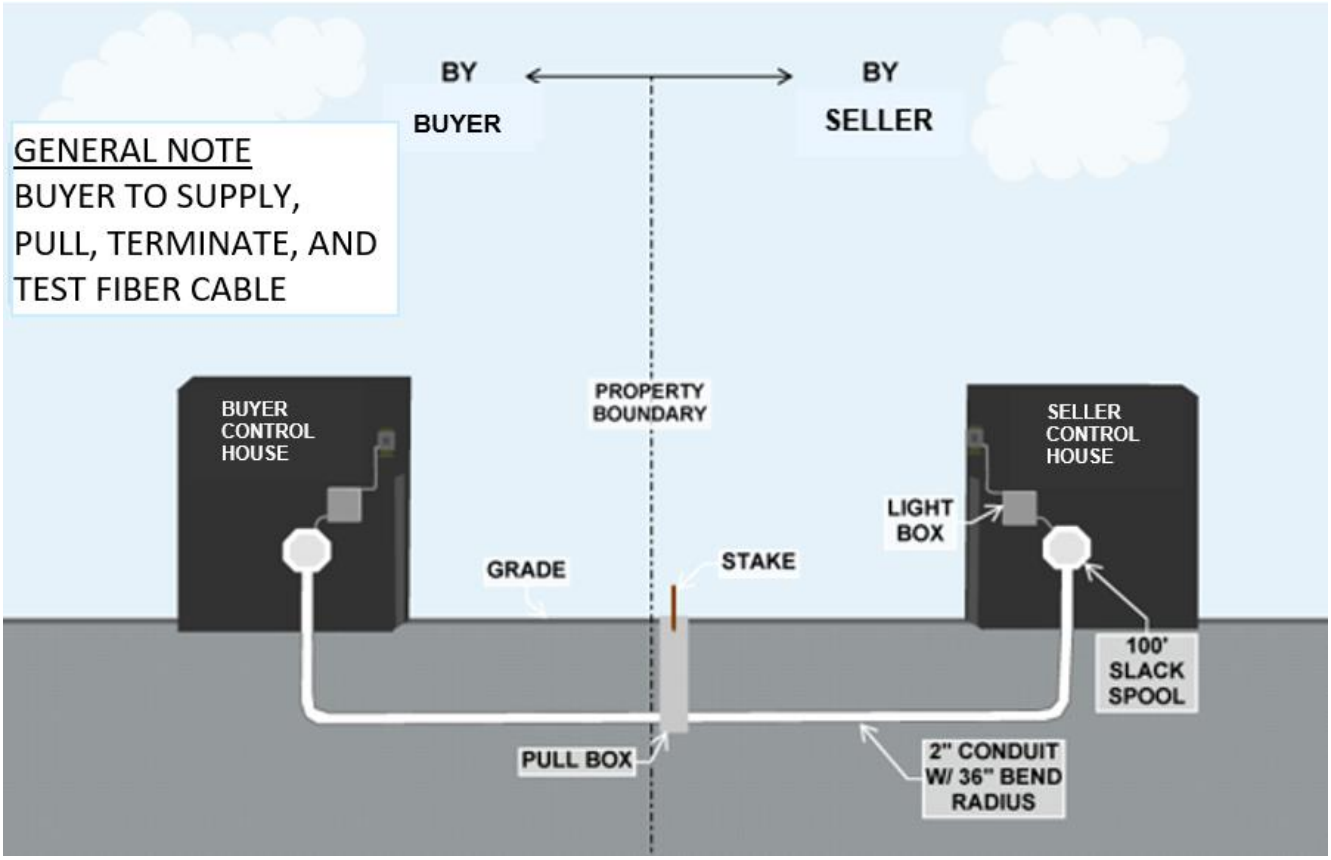
The description below is provided for information and reference only for Seller to understand the overall design concept for the Power Plant Controller. Seller shall incorporate these requirements as applicable to equipment furnished by Buyer under these specifications

For the fiber between the Buyer network at POI to the BESS SCADA as called out above:

- If the distance from the Buyer interconnecting substation to the Collector Substation <~1000’ and Buyer owns the property rights, then: (refer to Figure 1)
    - Underground the fiber
    - Buyer supplied fiberoptic cable shall be underground rated
    - ADSS (All-Dielectric Self-Supporting) fiber to be pulled in microduct/conduit
    - Demarcation point between Buyer/Seller installed microduct/conduit from Control House and Buyer’s installed innerduct/conduit is a Seller installed pull box or similar at a mutually agreed to point, typically at or the near the property boundary, between the interconnect substation and Control House (often initially marked as a stake in the ground) – refer to Figure 1 below

- Innerduct/Conduit shall be conduit or microduct (e.g., 2” PEX) with a minimum 2” diameter and 36” bend radius
- Seller shall install lightbox and 100 ft slack spool and associated innerduct/conduit in the Collector Substation
- Buyer shall supply and terminate fiber on both ends

Figure 1: SCADA Connection Less than 1,000 FT.

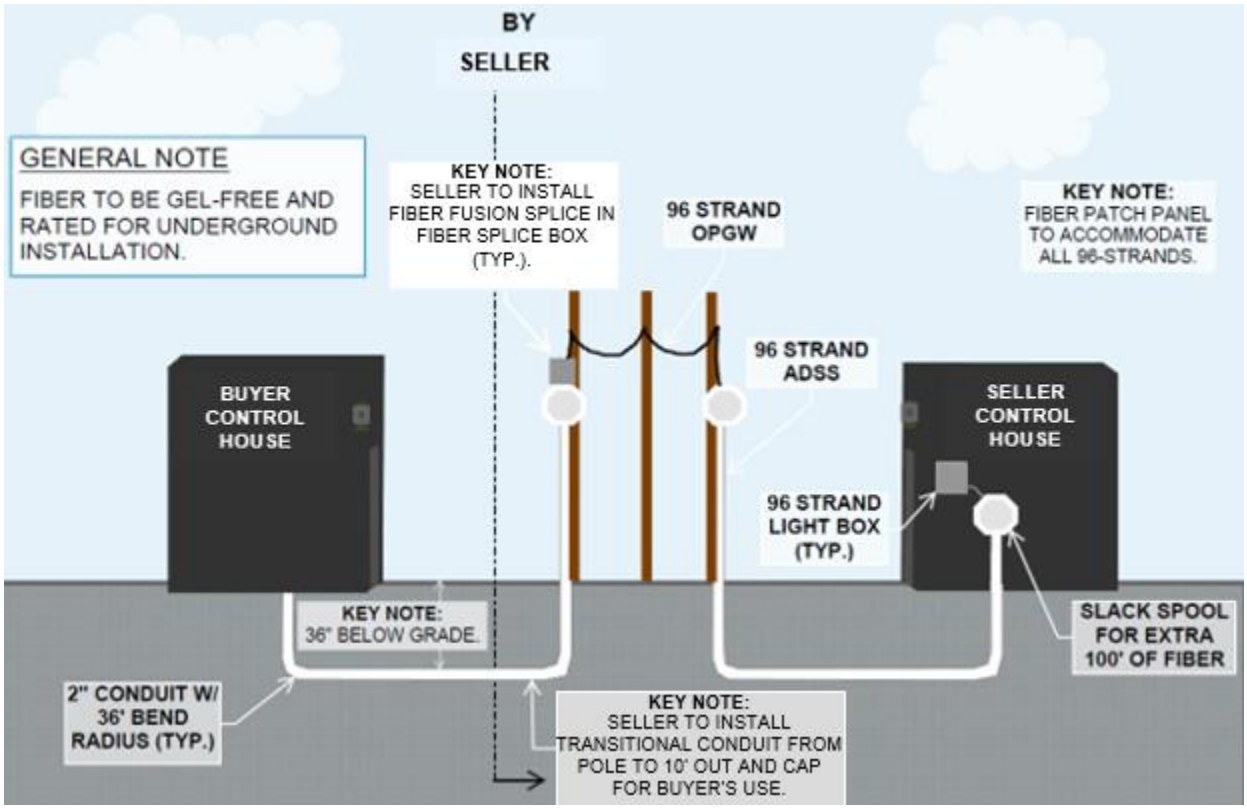



### 3.5.3.2 Overhead Fiber Installation

- If the distance from the Buyer interconnecting substation to the BESS SCADA >~1000’, OR if <~1000 and Buyer does not own property rights, then (refer to Figure 2):
  - Seller to install 96-strand Optical Ground Wire (OPGW) fiber and associated fiber splice box on pole to transition to underground to the Control House, including all fiber fusions in the splice box as required.
  - Seller supplied fiberoptic cable shall be underground rated (from existing control house to dead end pole)
  - Seller fiber shall OTDR (Optical Time Domain Reflectometer) reel test at 1550 nm and results provided to Buyer in .SOR format
  - OPGW fiber shall be installed at a height >15’ on structures

- At all splice locations, a 100’ plus height above ground level reel of fiber shall be installed on a Seller supplied and installed coil bracket
- Between the final structure and the Control House lightbox, Seller to supply and install innerduct/conduit and associated ADSS fiber
- Seller to terminate ADSS fiber with Control House
- Seller to leave 100’ of fiber and slack spool on an Buyer supplied and installed coil bracket within the Control House
- Microduct/Schedule 40 PVC conduit with a minimum 2” diameter with 36” bend radius
- For purpose of developing a project, the Seller can assume the following:
  - Demarcation point between Buyer/Seller installed Innerduct/conduit from the first structure and Buyer’s installed innerduct/conduit is a Seller installed splice box or similar at a mutually agreed to point, typically at or the near the property boundary, between the interconnect substation and first structure Control House (often initially marked as a stake in the ground)
  - Seller to supply and install a splice box on the first structure.
  - Buyer will supply and terminate fiber on both ends.
  - Buyer to perform OTDR on all splices with no losses greater than 0.10 dB allowed.

Figure 2: SCADA connection greater than 1,000 ft



# 4 DESIGN REQUIREMENTS

## 4.1 Civil/Structural Requirements

All structures on the Site shall be designed using environmental loads as specified in the American Society of Civil Engineers (ASCE/SEI) 7 code book *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* and the applicable state building code if more stringent requirements. These include wind loads (Chapter 6), snow loads (Chapter 7), rain loads (Chapter 8), ice loads (Chapter 10), and earthquake loads (Chapter 11). Each structure on Site shall be grouped in Occupancy Category III as defined in ASCE 7. The corresponding importance factor shall be used for each load calculation.

Seller shall design all systems and site improvements in accordance with applicable codes and standards. Seller shall design necessary road improvements to meet state and local transportation codes and meet or exceed requirements presented by construction equipment, delivery vehicles, and operation and maintenance traffic. All BESS equipment, building or enclosure foundations and structures shall be engineered by or under the direct supervision of a qualified professional engineer or architect licensed in the state of the project as applicable. All final IFC (Issued for Construction) drawings, specifications and calculations shall be wet stamped by civil/structural engineer or architect licensed in the state of the project. All stormwater calculations and design documents shall be overseen, signed, and sealed by a civil engineer or landscape architect familiar with local codes and requirements, and licensed in the state or jurisdiction of the project. All design shall be in accordance with seismic design standards, and by the Seller provided geotechnical study.

Seller shall gain access to the site from existing public and private roads. Existing roads shall not be blocked or restricted without prior approval of Buyer and local agencies. Seller shall be responsible for damage to public roadways resulting from the work performed. Seller shall also be responsible for the facility's access road's preparation/interconnection with the main road.

Seller shall perform required Site preparation, to include earthworks, SWPPP, and erosion control. Seller shall attempt to minimize earthwork and vegetation disruption for the installation of the Project to the extent it is compliant with the use permits; however, vegetation should be controlled to minimize fire danger and provide the ability to operate and maintain the Project. Any land contours that may affect BESS electrical generation should be included in the BESS system performance estimate. If required, Seller shall import engineered fill to slope the Site and prevent accumulation of standing water. Seller shall provide other Site maintenance as needed during construction.

Existing structures and utilities that are adjacent to or within the limits of the Project area shall be protected against damage. Seller shall be fully responsible to Buyer or other property Buyers for all repairs in the event of removal or damage of any existing structure, equipment or systems that are intended to remain in place.

### 4.1.1 Geotechnical Analysis and Hydrology Report

A geotechnical analysis shall be provided by Seller and performed by a qualified geotechnical engineering firm. The required number of boreholes and location shall be determined by the engineer to meet project design requirement. An engineering firm shall prepare a hydrology report.

In addition to the above minimum requirements, local jurisdictional regulations may require site specific hydrologic and infiltration testing. Seller should determine specific requirements and coordinate with geotechnical engineering firm to obtain any required testing information, related to proposed stormwater management facility designs.

A detailed geotechnical report shall be provided outlining the tasks performed and the results of the testing. Included in the report should be any recommendations for the foundation designs, structural support designs, corrosion protection for both underground steel and concrete, pile drive frequency, minimum pile size, and any geologic conditions that may prevent the development of the Project. Geotechnical report shall include recommendation of type of cement to be used based off the sulfate content to meet concrete durability and design life of foundations.

The procedure shall include performing onsite resistivity testing and conducting laboratory analyses on soil samples collected from the site. Seller shall ensure the number and type of soil samples is representative of the overall project site and accounts for the areas with most aggressive exposure. Perform laboratory testing to determine saturated electrical resistivity, pH, and chloride and sulfate concentrations.

### 4.1.2 Excavation

Seller shall perform all common and deep excavation necessary for the installation of all foundations and utilities. All excavation shall be in accordance with OSHA regulations. Excavation spoils shall be the Seller's responsibility and may be used for backfilling or embankment if suitable, per ASTM D 2487 for this application. Unsuitable or excess excavated material shall be properly disposed of.

Seller shall verify that earth materials exposed in excavations are consistent with those assumed for Seller's foundation designs. If earth materials are different than assumed for foundation design, Seller shall modify the design and/or treat the earth material (over excavate, replace, etc.) as necessary to ensure compliance with structural requirements.

Seller should be familiar with type of soil by review the geotechnical report and boring logs, it's the responsibility of Seller to determine the most efficient method to excavate considering the project schedule.

Seller shall provide adequate measures to retain excavation side slopes to ensure that structures, equipment, and persons working in or near the excavation are protected.

Seller shall protect all above grade and below grade utilities. Protect below grade liquid systems from frost.

### 4.1.3 Construction Surveying

Seller shall furnish all labor, equipment, material, and services to perform all surveying and staking essential for the completion of the Project in conformance with the plans and specifications. Surveying shall include but not limited to arial, topographic, and subsurface utility engineering (SUE level B and A). Seller shall locate or have located all underground utilities within the area of work prior to excavating.

Seller shall have necessary entities to locate all underground and overhead facilities at site. This will include sewer, irrigation, water, gas, electric, and communication that will be in direct conflict with the works.

Seller shall retain qualified survey crews knowledgeable in proper and up-to-date survey techniques and shall use these qualified survey crews when conducting the survey. Such crews shall be under the supervision of a Professional Land Surveyor licensed in the state or jurisdiction of the project.

Surveying crew shall establish a permanent benchmark at the project to be used as basis to perform current and future surveying activities.

### 4.1.4 Fills

Earth fill material adjacent to and below structures shall conform to Seller's design requirements for the structure. Seller prepared specifications and drawings shall indicate the types of soil to use for fills, compaction, and compaction testing requirements. These same requirements apply to access roads to the Project site.

Samples of fill material shall be tested and classified, if the fill material meets project soil requirements, then the fill material shall be tested in accordance to determine "Max. Density – optimum moisture test" for compaction requirement.

Fill shall be placed as uniformly as possible on all sides of structural units. Fill placed against green concrete or retaining walls shall be placed in a manner that will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly.

### 4.1.5 Foundations and Concrete Work

All foundations and supports must be designed in accordance with the applicable state building code using the calculated environmental loads discussed in Section 4.1 and soil properties provided in the project geotechnical report. All foundations and supports must be designed according to the civil/structural design criteria to meet all loads combinations. In addition, all placed concrete shall at a minimum comply with ACI 301 and ACI 117 publications. Form materials and required steel reinforcement shall comply with local regulations and site specifications. At a minimum, reinforcing bars shall comply with ASTM A 615 or ASTM A 706 for Low-Alloy-Steel Reinforcing bars.

Concrete work shall, as a minimum, be designed, specified, and installed in accordance with applicable ACI requirements. Reinforced concrete structures and foundations shall be designed in accordance with the applicable provisions of ACI 318, "Building Code Requirements for Structural Concrete." Concrete work shall conform to the requirements of ACI 301, "Specifications for Structural Concrete".

Concrete mix design shall be submitted for engineering review/approval prior to any concrete works per project specifications. All concrete works shall be tested before pouring concrete for temperature, slump, and air content. Samples shall be collected and tested for concrete strength test by an NRTL (Nationally Recognized Testing Laboratory).

### 4.1.6 Corrosion Protection

Corrosion protection shall be utilized on the structures of the Project. The type and amount shall depend on the selected materials of construction and conditions at the Site. A study of these conditions along with recommendations from the project geotechnical report shall be used to design the corrosion protection.

Seller shall account for the corrosion of steel components on structures and pile foundations that are expected to be encountered on the Project Site. Seller shall galvanize all steel structures, steel foundations, and their components. No bare steel structures or components are allowed.

Seller shall use ASTM A123 (From ASTM A123 Table 1: W6x9 – grade 75: 3 mils, W6x9 grade 85: 3.3 mils) for the minimum coating thickness on all hot dipped steel sections including steel piles. A minimum of 3.0 mils of galvanizing shall be used on all piles. All fasteners and bolts shall be galvanized using an ASTM approved methodology such as Hot-Dip Galvanization or Zinc-Flake Coating.

Galvanization thickness greater than 3.9 mils up to 5.0 mils are acceptable on steel sections and components if the Corrosion Engineer and the pile Engineer of Record provide written confirmation from

the galvanizer that they will be able to achieve such a nonstandard coating thickness on the steel components and that the quality and adhesion strength will be in accordance with ASTM A123.

If galvanized materials are used, field-applied zinc coatings shall meet American Society for Testing and Materials (ASTM) A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings. This standard contains minimum requirements for the material, surface preparation, and application process. For example, repairs due to vibratory pile driving shall conform to ASTM A780.

It is required that all holes in structural members requiring galvanization shall have the holes drilled before the galvanization is applied. Should holes be drilled in the field, galvanizing shall be applied to the exposed steel as specified in ASTM A780. All field welds shall have a field-applied galvanization as specified in ASTM A780. For example, if torque tubes with a 3.0-mil (0.003-inch) hot-dip galvanization are to be welded in the field, a field-applied coating, such as hot stick repair, shall meet or exceed the original 3.0-mil coating thickness of the torque tube per ASTM A780 requirements.

Only steel bolts with pre-applied corrosion inhibitors or stainless-steel bolts and fasteners shall be allowed in the entire mounting structure.

#### 4.1.6.1 Corrosion Rate Estimation Methodology and Requirements

The corrosion protection study shall be performed by a qualified corrosion expert and documented with references and calculations showing that the foundations, supports, fasteners, and conduit shall meet a Design Life in aboveground and belowground conditions, as specified in Appendix 5.

Estimate the corrosion rates of buried ferrous structures in the soil using a similitude analysis.

Use the corrosion database compiled by Melvin Romanoff in the National Institute of Standards and Technology (formerly National Bureau of Standards (NBS)) Circular 579 entitled Underground Corrosion[2]. This procedure requires some corrosion knowledge and experience and shall only be performed by a Corrosion Engineer[3].

A soil in the corrosion database shall be selected that most closely matches the worst-case onsite parameters in the soil samples. It may be necessary to select two or more soil samples based on site heterogeneity. Select the sample(s) with special emphasis on the following parameters:

- Lowest electrical resistivity
- Lowest pH
- Highest concentration of chloride ions
- Highest concentration of sulfate ions
- Geographic location
- Site drainage conditions

[2] Romanoff, Melvin. (1989). Underground Corrosion, NBS Circular 579. Houston, TX, United States of America: Reprinted by NACE.
[3] The Corrosion Engineer is herein defined as a licensed Professional Engineer with certification or licensing that includes education and experience in corrosion of buried or submerged metal structures, or a person certified by NACE International at the level of Corrosion Specialist or Cathodic Protection Specialist (i.e. NACE International CP4). The Corrosion Engineer shall have not less than five years' experience with corrosion control at solar facilities.

Use the corrosion database to estimate the uniform corrosion rates after selecting the soil sample(s). If multiple soil samples are selected report the highest corrosion rate amongst the soil samples.

- Report the steel corrosion rate in Mils Per Year (mpy)
- For galvanized steel, estimate the corrosion rate of zinc and steel separately and report in mpy; and
- Utilize a safety factor of 1.5 on the calculated corrosion rate when reporting the corrosion rates.
- Calculate the anticipated section loss of the steel substrate based on the corrosion rate and desired service life. Include this value in the design as the corrosion allowance.
- On galvanized piles subtract the consumption life of the zinc layer from the structure design life and calculate the steel corrosion rate on the remaining years.
- Consider the structure geometry to determine if the corrosion progresses from one side or both sides. For example, for an H-beam section, multiply the corrosion rates by 2 to account for corrosion progression occurring form both sides of steel surfaces exposed to soil (referred to as “two-sided” corrosion rates). The corrosion rate for hermetically sealed pipe piling where only the outer steel surfaces are exposed to soil is “single-sided” and do not need to be multiplied by 2.
- The localized corrosion rates listed in the corrosion database can be disregarded unless pitting and localized corrosion penetration could either compromise the structure integrity during the service life of the structure or alter the estimated corrosion rate. For example, a through-wall pit in a pipe pile would cease to be hermetically sealed and a single-sided corrosion rate would not be appropriate.
- There are other corrosion mechanisms such as galvanic coupling between steel piles and copper grounding, and pH concentration cells between steel piles and concrete pile caps. Either include corrosion allowances for these mechanisms or ensure the design prevents these mechanisms from occurring.

An alternative method for determining the corrosion rates is to perform Linear Polarization Resistance (LPR) laboratory testing per ASTM G59 or with suitable proprietary instrumentation that integrates the Stern-Geary equation. This method also requires representative soil samples from the project site.

- Ensure that the LPR testing is conducted by a qualified laboratory with a minimum of 5 years of experience performing such tests. Submit documented experience along with proof of up-to-date device calibrations along with the results.
- Report corrosion rates for both steel and zinc in mpy
- Report initial and steady state corrosion rates.
- If utilizing proprietary instruments additionally report the imbalance, which is a measure of pitting tendency.

Calculate the anticipated section loss as detailed above.

Seller shall provide calculations for galvanization thickness and corrosion allowance steel structures in contact with soil for the stated design life of the plant. The depletion rate for galvanization and steel loss after depletion of galvanization shall be considered constant over the life of the plant using the values developed by Romanoff in “Corrosion of Galvanized Steel in Soils.”

### 4.1.7 Erosion Control & NPDES Coverage

Seller shall submit a site-specific Erosion and Sedimentation Control Plan. If required by local regulations, this plan is to be reviewed and approved by the local jurisdiction prior to construction. The erosion and

sedimentation control plan will be consistent with and incorporate applicable elements of the SWPPP in addition to local regulations. All areas of temporary soil disturbance are to be graded, if necessary, and re-vegetated in a timely manner to limit erosion as required by the local jurisdiction. In addition to the Erosion and Sedimentation Control Plans, depending on state regulation the site may need to apply for coverage under the National Pollutant Discharge Elimination System (NPDES). This coverage is normally issued by the state environmental agency and is normally required for any site disturbing 1 acre or more. Seller to investigate and apply for any permit authorizations related to earth disturbing activities.

### 4.1.8 Grading and Drainage

The grading and drainage plan shall be designed and installed in accordance with local code and permit requirements. The grading and drainage plan will be consistent with and incorporate applicable elements of the SWPPP and the erosion control plan. All structures required for the drainage plan, if any, shall comply with state standard specifications for drainage facilities. Grading and drainage will be designed to efficiently convey water away from the site, prevent ponding and point source discharge, promote sheet flow of water, and limit long-term maintenance of the Project site. Stormwater Management facility designs, if required, shall meet all state and local design requirements for Water Quality, Volume and Rate reduction as deemed appropriate for the site.

### 4.1.9 Dust Control

Seller shall apply dust control materials, at Seller's expense, to minimize raising dust from construction operations and traffic, including but not limited to haul routes, using only dust control mixtures approved by the local jurisdictions and Buyer. Dust control shall be maintained in accordance with state and local requirements until Final Acceptance is achieved.

### 4.1.10 Equipment Pads

All equipment pads shall be located such that adequate personnel access is provided to such equipment. A minimum of 4.0 feet (or 1.5 meters) horizontal clearance from obstructions that would otherwise limit access to the equipment on the pad shall be provided around all equipment pads. The pads shall be sized sufficiently to allow safety and adequate working space around the equipment. The inverter stations, switchgear, substation (if applicable), and other buildings shall be elevated 12 inches above the 100-year flood and the 24-hour design basis rainfall inundation level. The slope of the earthwork around the inverter stations and other equipment shall allow safe and ergonomic access to the equipment and provide for adequate drainage and maintenance. Above ground electrical equipment, including transformers, inverters, and BESS building or enclosures will be protected with bollards painted yellow.

Seller shall provide reinforced concrete, helical piles, or pile-driven foundations for all BESS equipment, including but not limited to:

- BESS enclosures
- PCS
- MV Transformers
- MV switchgear
- Auxiliary Transformers
- LV distribution panels
- Emergency Response Panel

All equipment shall be on foundations twelve-inch (12”) freeboard above the 100-year, 24-hour rainfall event.

BESS site shall be lime or Geotech stabilized with minimum 4-inch-deep rock.

### 4.1.11 Site Finish Grade

Seller shall leave the Site in clean condition upon completion of the work. Seller shall remove all trash, debris, and stockpiles. The Site access roads shall be returned to a condition that meets the original specification by repairing road damage such as ruts, gouges, and weather damage that may have occurred during construction.

The Site finish grade within the equipment footprint and in areas required for operation and maintenance of the Project shall be fully stabilized and gravel covered to prevent vegetation growth.

Provisions of the SWPPP for final storm water drainage shall be implemented.

Seller shall seed and mulch all areas of the Project Site that have been disturbed beyond the permanent portion of the Site and access road, per the SWPPP.

### 4.1.12 Construction Signage

Seller shall provide temporary signage for local traffic control in accordance with state department of transportation and/or local city requirements.

### 4.1.13 Personnel Access

Seller shall make access to all equipment safe and reasonably ergonomic for maintenance staff. For example, if an inverter pad is elevated, the earthwork surrounding the concrete pad shall have a safe approach slope (25% maximum).

### 4.1.14 Construction Access

Seller shall abide by all load limits established by the applicable state department of transportation.

Seller shall be responsible for providing, operating, and maintaining equipment, services, and personnel with traffic control and protective devices, meeting the requirements of the local municipal traffic laws as required, allowing traffic flow on haul routes and onsite access roads in a safe manner.

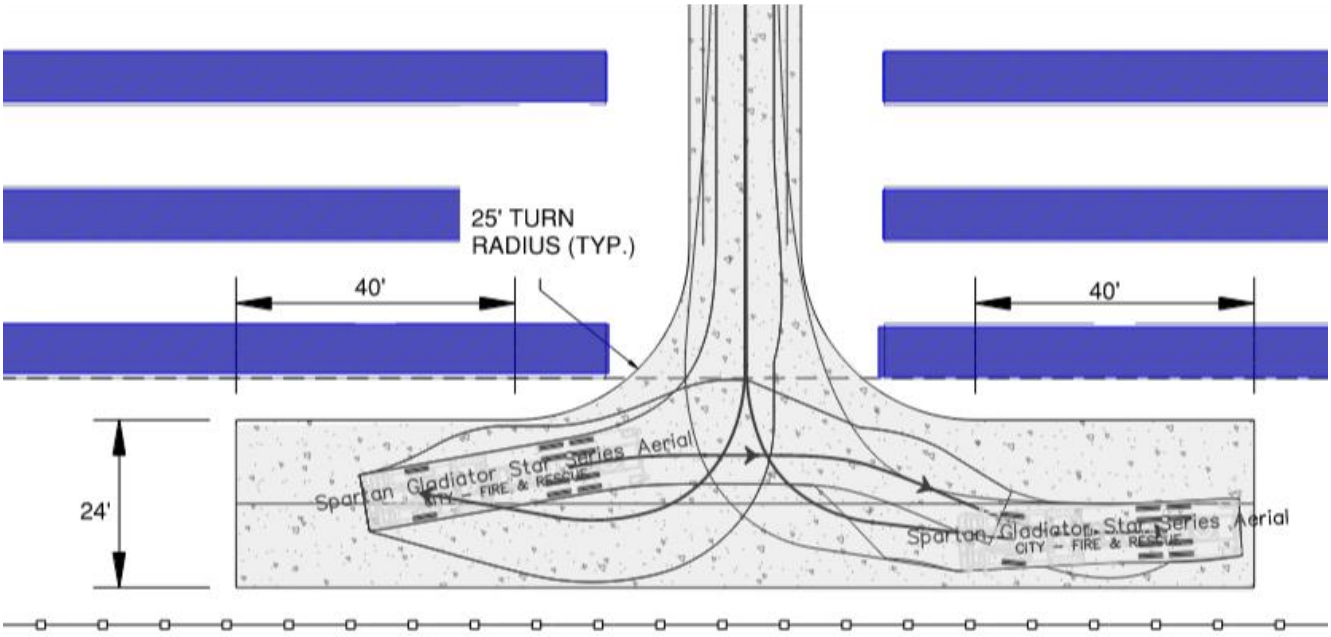
Seller is responsible for construction of temporary access around areas of excavation and other construction activity, if necessary and as required.

### 4.1.15 Roads

Roads shall be constructed using minimum construction requirements as shown in Table 3.

The Project design shall provide for, and the completed Project shall allow a 35-foot class 8 truck access with the ability to turn around at intersections for all roads. Road Design shall also allow for Delivery truck/trailer and 100-ton crane for the non-standard event of a PCS skid or PCS major component replacement to those equipment areas. An AutoTURN feature shall be used in AutoCAD to show final design accommodations.

Figure 3: AutoTURN example of a fire truck turn-around pad using a three-point turn




The road conditions must meet IFC Section 503 as well as all the requirements detailed below. Figure 3 above depicts the completed AutoTURN with the mentioned turn and turnaround requirements given the listed minimums.

- Road width: minimum 12 ft (with 2 ft shoulders)
- Turn radius: minimum 25 ft inside diameter
- Turnaround requirements: Required, through road available preferred
- Turn around pad dimensions: 24 ft x 40 ft

Roads and bridges shall be designed in accordance with the requirements of codes, including the International Fire Code, law, and applicable permits. A geotechnical engineering report shall include recommendations for site roads to accommodate planned vehicle access for construction and operations, including a class 8 vehicle. Adjustments to road width from minimum detailed below will further update the turn radius to ensure drive path can meet vehicle requirements.

Table 3: Road Construction Requirements

| Road Description | Lane Width Requirements | Turn Requirements | Construction details |
|---|---|---|---|
| Main Entrance Road to Project Site | Road Width – 20 ft<br>Shoulders – 2 ft<br>Total Width – 24 ft | Must support largest vehicle accessing the site through this entrance. | • Road base must be stabilized and compacted<br>• Must meet recommendations from |

| | | | |
|---|---|---|---|
| Road to Collector Substation | Road Width – 20 ft<br>Shoulders – 2 ft<br>Total Width – 24 ft | Must support a minimum inside turn radius of 50 ft or required minimum of largest vehicle accessing the substation. | geotechnical engineering report; however, at a minimum, two lifts of four inches each of aggregate with compaction on each lift (for a total of eight inches of aggregate) shall be used |
| Access Roads to Each PCS | Road Width – 12 ft<br>Shoulders – 2 ft<br>Total Width – 14 ft | Tractor trailer and/or crane to enter and exit (backing up acceptable) once project is constructed. | • Must meet recommendations from geotechnical engineering report; however, at a minimum, road base must be stabilized and compacted and two lifts of three inches each of aggregate with compaction on each lift (for a total of six inches of aggregate) shall be used |

Where a new road meets an existing road, the width of the new road shall smoothly transition back to the width of the existing road.

Vertical clearances above roadways for transmission lines shall be at least 20 feet unless additional clearances are required for special equipment access or other design requirements.

The existing grade of any road shall be compacted to a level specified by the engineer of record or replaced and compacted with suitable material, if necessary, and the sub-base, base, and pavement layers selected to provide sufficient bearing capacity to withstand the intended traffic and use. Roads shall comply with American Association of State Highway and Transportation Officials (***AASHTO***) requirements. Road surfaces for the Project Site shall be designed based on the recommendations from the final geotechnical report and the engineer of record.

Seller shall be responsible for checking any possible limitations on the transportation of sensitive material, heavy equipment, or other items to be delivered to the Project Site or use of vehicles or other modes of transportation due to the loading capacities and clearances of existing bridges and roads linking the roads, waterways, or other places to the Project Site.

Seller shall ensure that project has access for emergency response vehicles as determined by the local AHJ.

### 4.1.16 Bollards

Seller shall install bollards and gravel around all sectionalizing cabinets, fibers splice boxes, and other equipment which may be damaged by mowing equipment.

## 4.2 Electrical Requirements

Areas of the BESS enclosures subject to explosive concentrations of gases due to faulty systems, failure of ventilation, etc., shall be classified as hazardous locations in accordance with the latest NFPA criteria. Accordingly, electrical equipment in those areas shall be provided with the appropriate enclosures.

Electrical system design shall be performed under the supervision of a professional engineer licensed in the state of the project. Specifications and drawings shall be sealed if required for submittal to regulatory agencies.

Electrical systems shall be equipped with protective relaying to trip circuit breakers for de-energizing and isolation of equipment in the event of electrical faults. Seller supplied relaying protection will include primary and back-up relaying and overlapping zones of protection. Seller protection relaying is to be coordinated with Buyer's existing relaying. Areas of Seller supplied relaying will include, but not be limited to, MPTs, MV system, and DC/UPS systems. Protection relaying shall comply with Buyer's requirements.

### 4.2.1 MV Switchgear

Seller shall provide and install Outdoor Switchgear if required by Seller's detailed design to provide a means of disconnect between the PCS and the POI interface. Outdoor switchgear shall be in a National Electrical Manufacturers Association (NEMA) 4 lockable enclosure.

The switchgear shall be designed, manufactured, and tested in accordance with the latest IEC, ANSI, and NEMA standards. The MV and LV switchgear shall be of a design that has passed testing for arc-flash resistance according to Standard IEEE C.37.20.7 or shall be provided with arc-flash mitigation if required. Switchgear shall include an auxiliary compartment containing all instrument transformers associated with the protective relays and metering. The protective relay system shall be specified, designed, and installed in accordance with standards, codes, and Industry practice. Switchgear monitoring and communication hardware shall be included to meet the requirements of BESS SCADA system, and the metering requirements of Buyer. Relay current transformers shall be C400 accuracy class at a minimum unless a higher class is required due to saturation current per IEEE C37.110.

The switchgear shall be adequately rated per Appendix 5.

Medium-voltage protective device selection and relaying should be based on the use of Schweitzer Electric Laboratories (SEL) relays or approved other.

### 4.2.2 Protection and Control Relaying

A complete protective relaying system shall be provided by the Seller for the PCS and transformer(s) as stated below:

- Inverters equipped with internal relays with 27, 59, 81U/O and voltage-controlled overcurrent 51C functions shall be provided with one utility grade relay with 27, 59, 81 U/O and 51C functions as secondary protection. Otherwise, two utility grade relays and one Buyer-designated interrupting device shall be installed to meet the protection requirements.
- Protective relays shall be hardwired to the device they are tripping.

Interconnection interrupting devices shall have DC trip coils and tripping energy shall be derived from Seller supplied battery separate from the BESS main batteries.

Buyer will review Seller's relay settings and their calibration and test results of those relays to satisfy Transmission Provider's protection practices.

- Seller shall provide phase and neutral overcurrent protection for the PCS transformer(s).
- Protective relays shall have backup power of 125 VDC system supplied by station batteries.

- Relay settings files are to be included following the completion of the IFC design package.

Seller shall use microprocessor type protection equipment.

The protective relaying and metering shall be integrated with the BESS SCADA system. However, integration into the BESS SCADA system shall not circumvent normal protective relaying functions nor shall any protective relay or revenue metering values be used for control within the project control system.

Based on the finalized and approved relay settings and relay configuration for the project, the relay programming shall be performed. The Seller shall inspect and test each protective relay in accordance with ANSI/NETA-ATS section 7.9. Seller shall program each device with the recommended relay settings provided by the engineer.

After energization, Seller shall perform all relay phase in verifications on all relays. This includes calculating expected magnitude and phase angles to compare to actual values. Phase in documentation shall be submitted upon successful verification.

### 4.2.3 Auxiliary Power

The electrical auxiliary power system shall be sized so that in no case it limits unit output power relative to the specified nominal capacities detailed in Appendix 5. Any revisions to the existing electrical power system installation (e.g., protective relaying) shall be designed for Buyer coordination, safe operation, and maintenance.

Primary AC station service shall be provided from the low voltage side of the Project PCS transformer bus of a dedicated auxiliary transformer. If required, back-up station service shall be provided. All facilities required to provide primary and back-up station service to the Project and building, including auxiliary power transformers, transfer switches, protection and distribution panels shall be Seller's responsibility.

In the event of a loss of the Auxiliary Power connections to Project, primary and/or backup station service may or may not be available. Back-up UPS to power Project controls, and auxiliaries in the event of a total failure of the primary and back-up station service feeds shall be provided for orderly shutdown. The UPS shall be separate from the BESS main battery system and sized for an orderly shutdown of the Project for a loss of station service with the UPS at 80% rated capacity. The UPS shall be housed in a separate location from the BESS main battery to facilitate ease of maintenance.

All auxiliary DC station service requirements for the BESS shall be designed, engineered, furnished, and installed by Seller. 125 $V_{DC}$ shall be used for protective relay power.

As described in detail throughout this document, Seller shall engineer, furnish, and install to the Site all material required for a complete auxiliary power system to complete the Project, including but not limited to, the following material:

- Electrical Medium Voltage switchgear
- Auxiliary/backup power including emergency generator, DC, UPS etc.
- Low voltage switchboard, auxiliary transformers
- Remotely accessible data acquisition system
- AC and DC Cables
- All electrical conduit, cable trays and junction boxes

- Grounding and Lightning protection system
- Protective devices for switchgears, transformers etc.
- Lighting system including emergency lighting
- Concrete equipment pads, or driven piles.
- Fencing, gates, security cameras, and security camera recording equipment
- Communications infrastructure, I&C systems
- All materials related to drainage and access roads required by the civil engineering plan
- Miscellaneous steel
- Components (nuts, bolts, clamps, etc.)

Each item supplied by Seller shall be subject to inspection and testing during and upon completion of its fabrication and installation as described in Section 7.

Installed equipment and materials shall be new, of a suitable grade for the intended purpose, and not a lower grade or quality than specified in the design and engineering plans or in manufacturers' recommendations. Utility-grade equipment shall be used. Commercial- or residential-grade equipment shall not be acceptable. No equipment shall utilize polychlorinated biphenyls (PCBs).

Seller shall provide detailed calculations and drawings for the auxiliary power system.

### 4.2.4 Grounding

A suitable equipment grounding system shall be designed and installed for the Project. Seller will be responsible for providing an effective grounding mechanism. Seller shall provide detailed information (such as ground-grid drawings and calculations) for the project grounding. Seller is responsible for designing and providing the Project system grounding and equipment grounding. The Project grounding system shall provide personnel protection for step and touch potential in accordance with IEEE 80. Equipment and systems not covered by IEEE 80 shall comply with grounding requirements of NEC. The system shall be capable of detecting and clearing ground faults. The Project grounding system shall be reviewed and approved by Buyer.

All exposed non-current carrying metal parts shall be solidly grounded. Particular attention shall be given to prevention of galvanic corrosion at the connection of dissimilar material such as aluminum and steel.

All ground conductors shall be stranded copper or copper weld and may be bare if exposed. Ground conductors in conduits shall be green insulated. Ground lugs shall be mechanical and rated aluminum to copper. All below grade connections shall be exothermic welds. Mounting structures shall be grounded in a manner that is sized for maximum available short-circuit current and lightning current (if required). All the equipment shall be grounded as per OEM's instructions and recommendations.

Seller shall submit to Buyer grounding and lightning calculations for assurance of safe step and touch potentials on the Site, in accordance with Buyer's standards. Seller shall conduct a ground resistivity test to verify that the grounding system meets minimum requirements for the overall grounding scheme.

#### 4.2.4.1 Fence Grounding

Fencing around the perimeter of the overall Project Site shall be grounded in accordance with IEEE 80, NEC, and local codes.

A perimeter ground shall be located 3 feet outside of the project fence. Every fourth fence post shall be bonded to the ground grid. Fence fabric and barbwire strands do not require grounding. Fence posts shall be tied to the grid using a welded or bolted ground clamp attached to the inside web. Corner posts shall be bonded to the ground grid using a welded or bolted connection.

Fences may be grounded using one of the below approved methods:

- Tie the fence to the project ground grid
- Place horizontal ground wires for gradient control inside, under, or outside the fence.

If the fence is not tied to the project ground grid, it shall be tightly bonded to its own grounding system, (i.e., loop conductor and ground rods). Fence shall be completely metallically isolated. The following factors shall be considered:

- Accidental energizing through a fallen conductor.
- Induced potentials during other types of faults (coupling through the soil).

#### 4.2.4.2 Swing Gate Grounding

All swing gates, including vehicle drive through and personnel walk through gates, shall be bonded to the gate post using an insulated 4/0 AWG flexible cable such as CADWELD FJ2G24 or FJ2Q24. If the gate post and gate frame is schedule 40 or larger steel pipe, direct exothermic connections to the steel shall be used.

All gate posts shall be bonded to the grid using an exothermic connection per the ground grid design.

All gate areas shall contain 4/0 AWG copper ground mesh that extends 3 feet past the maximum gate swing area.

#### 4.2.4.3 Horizontal Slide Gates Grounding

Sliding gate panels shall be grounded. Vanquish Sliding Gate kit or Festoon Systems are acceptable, for Festoon Systems, rail system shall be installed to prevent rotation. V-track for the sliding gate shall be grounded to the grid.

#### 4.2.4.4 Private Fences

Project fences shall not be closer than 10 feet to any metallic component of a privately owned fence. Where not possible to maintain 10 ft of distance Seller shall propose methodology for isolation of fence.

### 4.2.5 Lighting System

The Seller shall provide and install lighting. Both interior and exterior lighting shall be provided, and at the entrances to all interior spaces and main entry gates.

All lighting in all spaces shall be per IESNA (Illuminating Engineering Society of North America) recommendations; and shall meet those recommendations.

Emergency egress lighting shall be supplied at all exits, inside and outside the control enclosure.

Lighting controls shall be provided around the PCS equipment area; however, these lights should be controlled and not full-time running lights.

### 4.2.6 Cables and Cabling System

Cables shall be designed in accordance with the proposed voltage levels of the Project. All cables shall be halogen-free, fire-retardant, and self-extinguishing, with Cross Linked Polyethylene (XLPE) isolation where required. All cable (regardless of voltage level and use) shall have a fire-retardant jacket and shall have successfully passed the appropriate (IEEE, ASTM, or UL) flame spread and smoke generated test for the class, voltage rating, and size of the specific cable.

AC cables shall be rated for the correct maximum voltage and sized according to the operating and short-circuit currents.

Seller shall provide raceways for all below grade cable in conduits or duct banks (use of direct buried cabling is prohibited). All cabling, which may be exposed to mechanical damage shall be placed in conduits, wireways, overhead trays, or other enclosures suitable to Buyer. AC and DC circuits shall be installed in separate conduits. Wires shall have identifying labels or markings on both ends. The labels shall identify the opposite end destination.

All cabling shall be new and continuous for each run; splices are not acceptable unless reviewed and approved by Buyer on a case-by-case basis. If the POI (if Distribution interconnected) or Collector Substation (if Transmission interconnected) is more than thousand (1,000) feet from the closest aspect of the BESS facility, then aluminum is acceptable as a conductor for the MV cables. If not, the MV cables and all other cables shall utilize copper conductors.

Wiring to terminal blocks shall be arranged as marked on wiring diagrams. Terminal groupings shall be in accordance with external circuit requirements.

Raceway and cable systems shall not block access to equipment by personnel.

All conduit and raceway systems shall comply with NEC and NESC requirements. The conduit and raceway system design shall accommodate power and control cables, communication circuits, underground feeders, and optical fiber cables.

Low voltage cables used for protection and control, or station power shall be placed in conduit wherever they connect to oil immersed equipment to reduce the risk of burning oil flowing in raceways and causing severe damage to cables. All conduit systems including wiring size shall be detailed on drawings.

Seller shall provide for all external cable and wiring of all BESS equipment, including but not limited to:

- DC cable and connections
- Auxiliary Power cable and connections
- Fiber Optic communications cable and connections
- Fire protection devices (if required)
- Grounding connections

### 4.2.7 Surge Protection

A staged, comprehensive surge protection system, inclusive of Types 1, 2, and 3 surge protective devices (SPDs), shall be incorporated as determined by the lightning risk assessment or as required by the PCS manufacturers in all relevant pieces of electrical equipment. Protection shall be provided within the inverter on both the DC and AC sides as required by inverter manufacturer. Additionally, surge protection shall be provided in combiner boxes, and measurement control and communication systems as determined by the lightning risk assessment study. Type 3 surge protection installed within that equipment shall be mounted on DIN rails and must have finger safe replaceable modules that can be exchanged without the use of tools. SPDs shall be applied on all power circuits (AC and DC) and all communications and control circuits in a coordinated, staged manner. The operating status of the power SPDs shall include visual indication and shall be able to be remotely monitored by a set of integral contacts.

In addition to the performance requirements indicated above, all SPDs shall be compliant with the respective domestic or international standards, including, but not limited to, the following standards and guidelines:

- UL Standard 1449 3rd edition.
- IEEE Guideline C62.41.1-2002
- IEEE Guideline C62.41.2-2002
- IEEE Standard C62.42-2005
- IEEE Standard C62.45-2002
- IEEE Standard 1100-2005

### 4.2.8 Surge Protection Devices Applied on AC Power Circuits

Surge Protection Devices (SPD's) applied on AC systems must meet all the requirements of Section 4.2.7 and must be specifically designed for and compliant to UL 1449 3$^{rd}$ edition. SPDs must be selected for the system voltage where they are to be applied. SPDs are to have a short-circuit current rating (SCCR) higher than the short circuit availability where they are installed, therefore not requiring external fusing.

### 4.2.9 Surge Protection Devices on Critical Non-Power Circuits

All critical non-power circuits are to be protected with appropriate DIN rail-mounted pluggable surge protection for the system they are applied. Surge protection bases are to permit signal continuity even if the SPD module is removed from the base.

### 4.2.10 External Lightning Protection System (LPS)

Based on the findings of the lightning risk assessment, an external LPS may be required to be installed. If so, Seller shall provide an LPS to protect the overall Project from direct lightning strikes to any portion of it. The LPS shall consist of air terminals of proper height and spacing (using the rolling sphere method), properly rated and properly designed and placed down-conductors to assure safety of personnel during discharges, and a properly designed and installed ground system.

The systems shall be designed in accordance with the latest globally recognized standards for such designs, which are IEC 62305-1-4, or NFPA 780.

Grounding systems shall comply with IEEE 142-2007.

Designs are to be provided by a recognized expert LPS design firm, supplier, or professional engineer licensed in the state of the project and are to be submitted to Buyer. All components of the LPS shall be in compliance with the system design standard.

### 4.2.11 Control Enclosure

Control enclosure shall have suitable space and racking for all Buyer equipment, Protection panels, Communications, SCADA, and reactive power controls. Spare space for future expansion shall be provided.

Control enclosure shall be a free-standing building, complete with framing, or self-framing panels, roofing, siding, doors, windows, hardware, fasteners, flashing, weather-stripping, HVAC, and other components as required.

Control enclosure shall have ample room for all equipment required including the control and protection panels and a workspace.

The control enclosure shall have exterior access stairs and railings installed to code.

All steel shall be galvanized and be bonded to the ground grid by two separate connectors.

The building will be bonded to the ground mat by at least two separate connections.

Control enclosure must meet all electrical clearances per NEC and OSHA regulations.

The control enclosure shall be designed using the applicable code as required by the Authority Having Jurisdiction (AHJ).

### 4.2.12 Control and Instrumentation Cabling

All cabling shall be new and continuous for each run; splices are not acceptable unless reviewed and approved by Buyer on a case-by-case basis.

All cabling, which may be exposed to mechanical damage, shall be placed in conduits, wireways, overhead trays, or other enclosures suitable to Buyer. All below grade runs shall be in buried conduit unless proximity to a roadway requires concrete duct bank. Alternating Current (AC) and DC circuits shall be installed in separate conduits. Wires shall have identifying labels or markings on both ends. The labels shall identify the opposite end destination.

Control and instrumentation wiring shall be separated from power and high voltage wiring by use of separate compartments or enclosures or by use of separate wireways and appropriate barrier strips within a common enclosure according to the National Electric Code (NEC) or governing standard.

BESS control and instrumentation system wiring shall be bundled, laced, and otherwise laid in an orderly manner. Wires shall be of sufficient length to preclude mechanical stress on terminals. Wiring around hinged panels or doors shall be Type W or DLC stranding or equivalent and shall include loops to prevent mechanical stress or fatigue on the wires.

The instrumentation and control cable shields, within the BESS Yard, shall be multi-point grounded.

Wiring to terminal blocks shall be arranged as marked on wiring diagrams. Terminal groupings shall be in accordance with external circuit requirements.

Raceway and cable systems shall not block access to equipment by personnel.

## 4.3 Mechanical Requirements

Seller shall provide heating, ventilation and/or space conditioning for the BESS components, as required, to meet the equipment manufacturers' recommendations over the range of site conditions and over the full operating range. Seller shall provide documentation and design calculations supporting the adequacy of the BESS heating, ventilation and/or space conditioning.

Ventilation and space conditioning equipment controls shall be interlocked with fire protection and suppression systems to operate appropriately in the event of fire.

Ventilation system fans shall be provided with non-return, motor operated dampers. Forced ventilation air streams shall not impinge directly on electrical equipment. Inlet and outlet enclosure dampers shall be of a design that prevents wind driven water and dust intrusion. If required, ventilation systems shall be provided with an interlocked and automatic temperature control system, including appropriate alarming, for each Project building or enclosure.

Space site ambient temperature conditioning as required for the Project enclosure equipment provided shall be provided as complete systems with all accessory items required for proper operation. Consideration shall be given primarily to requirements for efficient conditioning of the installed BESS equipment except in normally occupied areas such as the control room. Normally occupied areas or areas requiring access for local operation shall consider operator comfort in addition to requirements for equipment conditioning. Space air conditioning equipment shall be designed for the loss of one unit without derating of the Project. Where heating or cooling is provided, the equipment shall have a minimum EER, IEER, SEER rating in accordance with the Energy Codes. Space air conditioning shall be provided with an automatic temperature control system, including appropriate alarming, for each Project operational enclosure.

The BESS components shall be fully contained in weatherproof, environmentally conditioned enclosures or building. The BESS shall have complete and failsafe battery and PCS thermal management systems.

## 4.4 Fire Protection and Project Security

### 4.4.1 Fire Protection and Suppression

Seller shall provide Fire detection and Suppression System, for property preservation. Fire detection and suppression system shall comply with applicable code. The Project shall incorporate results from UL9540A testing into the Fire Protection and Suppression System design. Details of the fire detection/suppression system to be provided to the Buyer prior to construction.

Seller shall develop posted instructions for tasks that site staff and local fire department may need to perform, such as system shutdown during an emergency.

The BESS Fire Protection and Suppression System shall include:

- Protective relays.
- Circuit breakers which self-protect the BESS in the case of internal electrical faults. Set and adjust circuit protection devices according to a short circuit and coordination study.
- Battery cell thermal runaway detection including testing performed and mitigation methods used in the BESS will be included in the submittal process.

- A visible and lockable via padlock disconnect will be installed that isolates BESS in accordance with utility interconnection requirements.

Special Built Enclosures and Building Enclosures provided by the Seller shall adhere to the concepts outlined in FM (Factory Mutual Insurance Company) Property Loss Prevention Data Sheets 5-33, “Lithium-Ion Battery Energy Storage Systems.”

If applicable, Seller shall provide and install water-based fire protection system including fire protection standpipes. Valves and control panels shall be located such that manual suppression operability is maintained during incident.

## 4.5 Other Facility Requirements

### 4.5.1 Hydrogen Mitigation

Seller shall be responsible for providing and installing Hydrogen Detection systems and ventilation systems to mitigate Hydrogen generation. Hydrogen detection and ventilation system shall comply with Battery OEM requirements. The Project shall incorporate results from UL9540A testing into the Gas Detection systems and ventilation systems design.

Hydrogen detection and ventilation system shall be designed to provide sufficient ventilation under all operating conditions for the battery (including thermal runaway). Seller shall provide Buyer with copy of the calculations including safety factors. Seller shall provide and install UL approved hydrogen detectors and configure their control logic such that the hydrogen detection system alarms at one percent hydrogen concentration (25% of Lower Flammable Limit for hydrogen in compliance with NFPA 1 Chapter 52.3.2.8). Additional alarms and logic shall be provided to electrically isolate the battery if the hydrogen concentration exceeds a safe level.

Any enclosures into which flammable gas may propagate during normal or abnormal operations shall be protected against accumulation of a flammable/explosive mixture and ignition by an external spark of any such mixture.

If flooded electrolyte cells are used, Seller shall install flame-arrested vent caps on the cells.

### 4.5.2 Toxic Materials

If there is a risk of a toxic substance emitting from the equipment, system shall be equipped with an alarm system to alert personnel. MSDS for the toxic substance shall be included in the Operation and Maintenance (O&M) manual (section 9.4.3) and emergency response plan (section 6.4).

### 4.5.3 Signage and Labeling

All necessary safety signs and warnings described in ANSI Z535-2002 (entire series from Z535.1 through Z535.6) shall be included on Project Site fencing and each enclosure and any other buildings at the Project Site. All necessary signs and warnings for identification of hazardous substances as described in NFPA 704 shall be included on the fencing, each building, and any other enclosure at the Project Site. Warning signs on perimeter fencing shall be placed no further than 50-foot intervals, communicating electrical hazard and NO TRESSPASS. Each entry gate sign shall have a unique identification name and physical 911 address with contact information for emergency access.

Permanent naming placards should be placed on all equipment, including BESS, inverters, transformers Switchgears etc. Naming on placards and/or tags shall match drawing naming convention following current Industry and local standards. Instruction plates, nameplates and labels shall be provided for all items of the Plant giving particulars about rating, duty, size, model number, serial number and full information for identification and operation. Labels shall be of sufficient size to carry a full description of the Plant item and its complete identifier. The Seller shall provide all required Labels to all BESS equipment, including ARC flash labels.

For all outdoor equipment labels, Seller shall provide 1/16" UV stabilized Acrylic Polypropylene labels printed in UV resistant ink with UV resistant laminate affixed with hot melt adhesive or epoxy suitable for the atmospheric conditions. All placards used to convey warnings, or critical information shall be 1/16'' thick, 2 ply, matte non-glare, 0.005" minimum engraving depth, micro surfaced impact acrylic suitable for all weather use and UV stable, similar to Rowmark's Ultra Grave product line.

Onsite roadway signage shall be posted at intersections where necessary to indicate exit routes and dead-end corridors.

All cables shall be labelled to meet applicable codes and standards. All cables shall have a label affixed to the outer jacket with a Brady or equivalent cable marker at each termination of a type accepted by Buyer before installation. Labelling will match the point-to-point drawings. Seller is required to place arc flash labels on all inverters, combiner boxes, and other equipment requiring such. A method for ensuring labeling is complete must be included in Seller's QC Inspection Point Program.

Labeling that lists arc flash incident energy exposure levels, including instructions on disconnecting devices required for the replacement of battery modules, shall be provided.

All electrical equipment, enclosures, disconnects, and overcurrent devices shall be clearly marked and identified according to the international/local standards and regulations. Markings shall refer to the same designations called out in the final design drawings.

Any object within the mowable pathway 24 inches in height or less shall have a warning sign with metal pole at least 48 inches high warning of the obstruction.

#### 4.5.3.1 Nameplates and Tagging

Nameplates shall be furnished and installed on the exterior of all equipment provided by Seller.

Equipment designation nameplates shall be furnished and installed on the front and back interior of all cabinets and panels.

Internal nameplates shall also be furnished and installed for all cabinet and panel internal components including, but not limited to, internal devices, modules, and terminal blocks (identification scheme to be finalized during detailed design).

All nameplates shall have white background with black engraved letters and shall be firmly and positively fastened to panels or walls by means of screws.

Unless utilization of screws would affect the NEMA and/or UL rating, in which case nameplate attachment via two-part epoxy shall be permitted.

Holes for attaching nameplates with screws shall be provided regardless of the attachment method (screws or two-part epoxy).

Nameplates shall be legible from ground level.

Seller shall provide nameplate lettering charts, which shall show engraving information for all nameplates.

### 4.5.4 Audible Noise

The maximum sound level generated from the BESS and any associated equipment supplied by Seller under any output level within the Project operating range, shall be limited to the level specified in Appendix 5 in any direction from the facility fence or building exterior. Seller shall comply with all ordinances and regulations that may apply to the BESS installation as determined by the local building codes. Results of noise studies shall be provided for major equipment such as HVAC and PCS units.

Noise produced by the Project and any associated subsystems shall be designed and furnished such that the ambient noise level in the BESS control room, or any typically occupied area with applicable standards in a building shall not exceed the level specified in Appendix 5.

### 4.5.5 Electromagnetic Interference

Seller shall take necessary precautionary measures to ensure that there will be no interruption, damage, or danger to any equipment or system due to broadband, radiofrequency, or comparable interference. Seller shall ensure that there are no discharge sources from the Project that could cause interference with radio and television reception, wireless communication, telecommunication, or microwave communication systems. The Work shall include any mitigation necessary to ensure that such communication systems are not adversely affected.

No aspect of the operation of the Project shall produce electromagnetic interference (EMI) that will cause faulty operation of instrumentation, communication, or similar electronic equipment within the Project or elsewhere on the Transmission System. The Project shall be designed to suppress EMI effects and must meet the specifications of the latest revision of IEEE 519 and its referenced standards, as applicable.

Interference to any radio service that requires a license, FCC licensees, military radio frequencies or medical devices is prohibited.

Seller shall ensure that the Project and related equipment does not generate any discharge sources that could degrade broadband, radio, television, wireless, or microwave communication. Seller shall take all necessary action to ensure that television reception is not adversely affected.

Seller should provide testing if required to validate project doesn’t critically interfere with broadband, radio, television, wireless, and microwave interference.

### 4.5.6 Painting / Logos

Seller shall paint the entire exterior of the building or enclosure with a finish coat in a color approved by Buyer. The paint shall be suitable for application to the exterior material of the building or enclosure and the environmental conditions applicable to the site. Buyer may supply image(s) of company logo for display on buildings or enclosures, after painting. Upon completion of painting, remove surplus material, rubbish, and debris resulting from this work and leave the building and enclosures and Site in a neat, clean and acceptable condition.

All builders’ hardware shall be suitable for the required functions. Hardware shall be of a durable grade consistent with the life expectancy of the facility and appropriate Federal specifications. Exit and fire door hardware shall conform to UL specifications. Installation of exits shall conform to NFPA No. 80.

# 5 FACILITY REQUIREMENTS

## 5.1 Electrical Systems

Seller's scope of supply will end at the POI as defined in the Interconnection Agreement and as defined in the Points List. The Project electrical systems and equipment shall be designed in conformance with the Project requirement.

Electrical systems shall not inhibit the BESS from complying with Frequency Ride Through (FRT)/ Voltage Ride Through (VRT) requirements per Buyer's requirements listed in the Technical Specification.

## 5.2 Physical Security Installations

The physical security of the site shall comply with Buyer and regulatory requirements. Seller is responsible to implement as described in the Table 4 and the sections 5.2.1-5.2.4.

Table 4: Physical Security Scope of Work

| LOCATION | DESCRIPTION | FACILITIES AND EQUIPMENT BY SELLER | EQUIPMENT BY BUYER |
|---|---|---|---|
| Collector Substation (if applicable) | Minimum two cameras located at opposite corners of substation area | Two 1" PVC conduits with pull cables for power and communication wiring, between BESS SCADA and camera masts, and required hardware supports and 15 ft camera masts capable of supporting pan, tilt, zoom cameras. | Cameras |
| | Electrically operated slide gate with keycard reader | Keypad, slide gate, gate operator, wiring (power and communications), grounding loop, and hardware for mounting keycard reader. In addition, two 1" PVC conduits with pull cables for power and communication wiring between BESS SCADA and keycard reader. | Keycard reader |
| Control House (if applicable) | Keycard reader for lock on control house personnel door | Keypad, wiring (power and communications), and required hardware supports for mounting keycard reader. | Keycard reader |
| Site Main Gate | Electrically operated slide gate with keycard reader | Keypad, slide gate, gate operator, wiring (power and communications), grounding loop, and hardware for mounting keycard reader. In addition, two 1" PVC conduits with pull cables for power and communication wiring between BESS SCADA and keycard reader. | Keycard reader |

### 5.2.1 Project Security (including Fencing)

Seller shall provide a security system for the Project. The security system around the perimeter shall include a 7-foot-high chain link fence with 1-foot top guard (total 8-foot high) of three strands of nine-gage barbed wire and designed to meet NESC and IEEE standards.

The Seller shall ensure there are no gaps greater than two inches between the ground and bottom of fence fabric, and the fence is secure.

Barbed wire shall be on arms oriented at 45 degrees facing up and outward. Fence posts shall be spaced no more than 8 ft apart, set in concrete finished no more than 2 inches above finished grade, and shall be grounded to meet NESC and IEEE standards. If any portions of the fence are located under transmission lines, they shall be isolated and grounded according to Utility requirements and NESC standards

The perimeter fence shall include at least two locked gate pairs to restrict access: one with a width of 24 feet with a keypad or access card operated electrically driven slide gate for vehicles and one pedestrian entrance with a width of four feet.

Perimeter signage shall be provided by Buyer and installed by Seller in accordance with Buyer standards. Signage shall be installed at a maximum distance between signs of 100 feet along the perimeter fence and on all gates. Signage indicating electrical hazard and NO TRESSPASS shall be installed five feet above ground level and comply with ANSI Z535 for size and font. Sign lettering shall be no less than 0.2” stroke width.

Seller shall be responsible for security during construction.

This equipment shall include:

- LED Spot or LED flood lights.
- Security cameras must be low-light capable located such that they are capable of adequate identification of intruders or animals covering the perimeter of the Site. Cameras shall be placed at a height that permits line-of-sight access to the property.
- Cameras with a control and detection system that assists in the detection and identification of intruders or animals.
- Network - Digital Video Recorders used to record video that could be used for evidence in the event of theft or vandalism.
- Seller shall negotiate with third party vendor to identify the scope of work that will be performed by Seller, to ensure that a complete and operational security system as described by third party vendor is provided. Third party vendor shall provide to Seller the security system design, which will indicate the location of cameras, DVRs, security lighting and any security communications equipment, based on third party vendor’s overall System design. The work that may be provided by third party may include the furnishing and installation of wiring, cabling, labor, tools, equipment, and ancillary materials required for a complete and operational security system. At minimum, it is expected the Security Sub-Seller will provide the following equipment: cameras, network DVRs, and any specialized security communications equipment.
- Seller shall be responsible for the furnishing and installation of all necessary conduits, 120-$V_{ac}$ power extensions for all Security related equipment.

- Seller shall provide a free-standing weather-proof enclosure with adequate space required for Security Control Equipment as specified by the third party.
- Installation of telephone lines, and/or cellular modem(s), and/or local area network for the interconnectivity of all related Security System Equipment.
- Seller shall provide fiber optic cable for Security System Communications. Fiber optic cable shall consist of a minimum of six fiber strands between each required camera location.
- The system shall be complete, tested, and fully operational. Prior to construction, Seller shall provide the following:
    - Descriptive statement and single-line block diagram to show how all related equipment will interface and operate as a complete system.
    - Product data: manufacturer's technical data sheets on each product to be used.
    - Drawings, including plans, elevations, equipment mounting heights, and dimensions required to show devices' locations and demonstrate accessibility compliance in accordance with referenced documents.
    - Detailed schematic wiring diagrams for all system devices; wiring information shall include cable type, conductor routings, quantities, and connection details at devices.
    - Manufacturer's user's manuals for operations, administration, installation, and maintenance.

### 5.2.2 Locks

The site will be a mix of Buyers access control system for control houses and battery storage. All equipment shall be lockable per NERC/CIP requirements. Seller responsible for project until COD. Buyer will supply its own locks at COD.

All egress and ingress doors on buildings, and access control system shall utilize approved locking hardware and release features that shall not delay egress per NFPA 101.

All minimum NEMA 3R rated equipment enclosures shall utilize a high security padlock or a clasp lock for the following use equipment types:

- IT
- Telecom
- Inverter

Seller shall coordinate with Buyer's Security to intake and begin management of CyberLock equipment using the CyberLock system managed by Buyer.

### 5.2.3 High Security Chain

Seller shall provide high security chains on appropriate gates or other site access points. The chain will be 0.375-inch minimum, heavy-duty construction rated either "high security" or grade 100 or higher with a through-tempered alloy and square-sided construction to minimize cutting ability.

### 5.2.4 Lock Forms

The acceptable types of locks Seller shall provide at the Project Site are:

- High Security Padlock – A padlock that meets certain levels, a minimum grade of F5/S6/K5/C4 per ASTM F883-13
- High Security Puck Lock – A padlock in the form of a hockey puck with the shackle hidden in a recess on the back side. This type of lock provides its high security by protecting the shackle itself from access, uses the same high security key as the padlock, and includes a special hasp that has a surround shield protecting the hasp tab and hole from cutting where the shackle enters the padlock
- Clasp Lock or Cam lock that fits the minimum NEMA 3R rated cabinets as required.

## 5.3 Control System and Communication Requirements

### 5.3.1 Cyber Security[4]

Seller shall design, build, and deliver a cyber security system and plan for the Project that conforms to the requirements specified in Appendix 7.

### 5.3.2 Network Devices

#### 5.3.2.1 Network Servers

The BESS SCADA System shall include a networked GPS synchronized clock capable of providing time synchronization signal to other devices in the BESS SCADA System using IRIG-B via coaxial cable.

All hardware and software shall support and implement standard, open protocols and datasets such as MODBUS and DNP3. No proprietary protocols shall be utilized. The BESS SCADA System shall retrieve data from all capable devices within the BESS and interconnect substation. The BESS SCADA System shall be capable of interfacing with Buyer's external historian database protocol systems.

All servers and functionality shall be implemented with redundant hardware and software in a hot standby architecture. Virtualized systems may be utilized to provide redundancy.

All hardware shall support redundant hot-swappable power supplies, hot-swappable solid-state drives, and RAID. All software shall be installed on a commercially available operating system with regularly provided security and reliability updates.

#### 5.3.2.2 Routers, Switches, and Modems

Seller shall supply network hardware as necessary to connect all servers, relays, meters, and other equipment capable of communicating with the BESS SCADA System and Buyer's corporate SCADA via external networks. All hardware shall be implemented using ruggedized industrial models unless housed in climate-controlled cabinets.

Seller shall supply redundant network switches as necessary to the BESS SCADA System network. Switches shall meet or exceed IEEE 1613 (Class 2). Switches shall support modern security functionality,

[4] The Cyber Security Plan set forth in this Appendix 7 was designed for a solar facility, is preliminary, indicative only, and subject to updating and modification (including expansion).

including VLAN, SNMPv3, RSTP, MAC-based port security, traffic prioritization, port mirroring, PTP time synchronization and pass through, user-based accounts, and dual power supplies.

Seller shall supply redundant network routers as necessary to connect the BESS SCADA System network to Buyer's existing SCADA system via external networks. Router shall meet or exceed IEEE 1613 (Class 2). Router shall support stateful firewall with NAT, IPSec Virtual Private Networking, AES256, RADIUS centralized password management, multi-level passwords, SSH/SSL encryption, MAC-based port security, VLAN and SNMPv3, external user access logging for auditing purposes.

Seller shall supply modems as necessary to support the requirements of Buyer and/or telecom utility to connect Buyer's external network. Seller shall work with Buyer to determine the number of internet connections needed and minimum bandwidth requirements. Seller shall work with Buyer to determine a list of acceptable internet providers.

#### 5.3.2.3 Operator Workstations

Seller shall supply one operator workstation. The workstation shall consist of one monitor, keyboard, mouse, and PC for display of the operator interface. All components of the workstation shall be utility grade off the shelf components and capable of operating in the BESS environment. Each workstation shall include all software necessary to access the BESS SCADA System and all functionality of the installed equipment with licensing for a minimum of five years.

Remote operation workstation shall be included for the remote operations of the BESS site. This can be achieved via remote access VPN tunneling or SSL.

### 5.3.3 Control and Monitoring Network

#### 5.3.3.1 Supervisory Control

Seller shall supply BESS controllers compliant with the communication methods, protocols and datasets provided in the MODBUS and DNP3 standards. Any operational function of the BESS shall be capable of being controlled through the BESS SCADA System HMI via either local or remote operator workstations. Function parameters of any operating function shall be capable of being modified remotely or locally.

The control system shall be configurable and capable of hardware, firmware or software upgrades to provide additional operating functions in the future, if needed. Seller shall provide 10 percent additional or spare hardware capacity to add to or reconfigure the modes of operation via software applications, replacement firmware, expansion of the operating system memory or additional input/output and/or logic.

The control system shall have the necessary hardware and software such that it is compliant with the latest Buyer standards and NERC CIP reliability standards for control system security requirements.

#### 5.3.3.2 SCADA Panels

Seller shall supply one or more SCADA panels within the BESS to install the PLCs, RTUs and other devices necessary to provide the required functionality of the BESS SCADA System. Each SCADA panel shall match the design of other panels as specified in this document, including power source, fuses, terminal blocks and other equipment necessary to the function of the BESS SCADA System. In the event that there is loss of Auxiliary power, UPS shall be included in the design and installation inside the panels containing essential control and network hardware.

The SCADA panel shall allow operators to connect to the facility network via standard Ethernet port for control or diagnostic purposes.

#### 5.3.3.3 Interoperability

The BESS System shall communicate with Buyer's corporate SCADA system via the communication methods, protocols and datasets provided in the MODBUS and DNP3 standard. Parameters to be communicated to Buyer will include, but not be limited to: SOC, actual and contractual Up Reserve and Down Reserve capability when the BESS is responding under its frequency response, status of frequency response, power output in MW, energy output in MWh, available energy capacity in MWH, circuit breaker status, physical availability in percentage, voltage at Revenue Metering Point, and other telemetered information that Buyer may require for system operations.

In the event of loss of communication between Buyer and the BESS SCADA System, a provision must be made for the BESS systems to institute Buyer's desired behavior in such circumstance, including but not limited to maintaining the previously communicated operating behavior, accepting a curtailment command from a local terminal, or a safe and linear shutdown.

### 5.3.4 HMI Color Coding

- Colors shall be used consistently throughout all software (HMI screens, etc.). Red shall indicate energized, closed, and live.
- Green shall indicate de-energized, open, tripped.
- Yellow shall indicate loss of communication with a device.

### 5.3.5 Local Control

The BESS local controls and indication requirements shall be designed in close coordination and with approval from Buyer. The BESS shall include a local control panel or console within the BESS control room. The local control panel may consist of manual control switches, with redundant control actions initiated by digital signals through a local control console. Emergency trip push buttons shall be manually operated and not require action from the digital control. As a minimum, the following operator controls shall be located on the local control panel:

- Trip/reset for the MV circuit breakers connected to the main step-up transformer.
- Trip/reset for the PCS circuit breaker.
- Trip/reset for the DC circuit breaker/contactor.
- PCS on/off.
- BMS on/off
- Reset toggle or push-button. When reset is initiated, the control system shall resume control and proceed to the appropriate operating mode.
- Reset cut-out selector switch to disable remote or local reset signals.
- A selector switch to manually set the operating state (i.e., shutdown, disconnect and operate).
- A selector switch to manually set the operating mode (i.e., VAR control, discharge and charge).
- An emergency trip push-button shall be located near the control panel and be suitably protected to prevent accidental operation.

#### 5.3.5.1 Remote Control

All functionality available through the Local Control Units shall be available via the BESS SCADA System for remote operation via Buyer's SCADA connection and remote operations center.

#### 5.3.5.2 Application-Specific Control Panels

Where appropriate, additional control panels shall be provided to control specific functionality and applications of BESS equipment. All functionality available at these panels shall be available remotely via the BESS SCADA System.

### 5.3.6 Integrated Automation Controls

The BESS SCADA System shall consist of established manufacturers' components such as balance of plant instruments, equipment and integral controls, process input/output equipment and companion PID "loop" controllers, equipment specific controllers, communication processors and various other necessary devices. The integrated BESS SCADA System electronic components taken together shall form the interconnecting means and functions required to; control, monitor, alarm protect, interlock, diagnose, maintain, and safely operate BESS facilities installed under an assigned project scope of work.

The installed BESS SCADA System equipment shall perform the requirements of supervisory and discrete control, equipment protection and process interlocking, component diagnostic, upset analysis, maintenance guidance, and alarm/data logging or archiving functions. Seller selected BESS SCADA System hardware and software provided shall meet all desired modes and conditions of operation, assuring a safe, environmentally compliant, and economic operation of distributed energy storage capabilities described in the scope of work.

BESS related systems startup, manual operation, shutdown, response to upsets, and other operating conditions shall be performed by: 1) intervention by an operator in any specific BESS local control point: or 2) remotely from a central or dispatch center via HMI operator positions with necessary software for that BESS facility. Once desired and stable functional BESS mode has been achieved, autonomous and selected supervisory modes shall automatically maintain, within tolerance, that selected mode until override, or manual intervention by the central or dispatch operators is enabled.

Supervisory, monitoring and mode management required BESS functions shall be gained by means of both local and/or remote operator HMI interface workstations. Functions and logic of control, protection, and interlock of BESS components and support systems shall be distributed to independent microprocessor-based controllers or unit programmable controllers as feasible to minimize a single point of failure.

Likewise, interface and networking equipment between the BESS SCADA System and the separate process control and instrumentation packages of individual equipment shall be redundant for both communication functions and control power source. The intent of the Project is that the BESS SCADA System as a Supervisory and Control System HMI be designed and implemented for intuitive and understandable human interactions, high reliability, including critical system redundant BESS control and sensing elements for specific BESS systems, to enable the desired degree of safe and automated operation.

HMI interaction and autonomous control of some independent auxiliary BESS systems may be as self-contained as practical. These independent systems may be controlled through integrated distributed controllers with local control panels incorporating a self-contained HMI. Alerts, alarms and process data along with auxiliary system diagnostic information shall be sent to the BESS System. Independent auxiliary BESS system controls shall be developed upon a common architecture, with data communications protocol

compatible with the BESS SCADA System. Simplicity of operator interaction and ease of maintenance should be the design criteria.

The fundamental BESS SCADA System control logic and related functions shall be segregated to the extent that failure of one or more modes of operation does not result in the failure of other functions. The BESS SCADA System controller shall be designed with regard for redundancy in critical “control loop” functions so that no single component fault will cause the failure of process-controlled equipment in any one system or cause the BESS diagnostics and protection systems to malfunction.

BESS SCADA System indication, control and alarm element redundancy shall be provided for all events or upsets in critical “control loop” functions that may directly cause a self-protection system to activate. Redundancy in the BESS SCADA System controller architecture shall be configured such that selected standby process equipment shall alarm and start automatically upon failure of the primary system. Specific standby components shall have self-initiated automatic start capability field wired to function in parallel with fundamental BESS SCADA System control logic.

#### 5.3.6.1 Control of Fire-Suppression Systems (if applicable)

Fire panel shall communicate with Buyer’s SCADA via a standard protocol as described in Section 5.3.3.1. The minimum remote monitoring requirements shall be as follows:

- System State
- Fire/Smoke Detector Status
- Fire System Trouble
- Countdown to discharge
- Discharge Completed
- Manual Release Request
- Abort
- Alarms/Warnings

The BESS / SCADA shall have a system including current/history of data and alarms. System shall include:

- System and alarm status, unit voltages, temperatures, and other necessary system details
    - Trouble notification when preventive maintenance is needed.
    - System level alerts shall be provided by the manufacturer over customer interface.
    - Remote Shutdown capability that shall include:
        - Strobe lights and audible alarm – at least one for each of the following:
            - Fire Alarm
            - High Gas Alarm
        - Physical panel that is located outside of the fence line at the gate entry that is accessible to emergency responders. Panel shall include contact information for remote operations facility.
        - Fire alarm control panel
        - Electrical remote shutdown for associated equipment on site to be safely shutdown during emergency situations.

### 5.3.6.2 Control of HVAC Systems

HVAC system shall communicate with Buyer's SCADA via a standard protocol as described in Section 5.3.3.1. The minimum remote monitoring requirements shall be as follows:

- System State
- Battery cell and module temperature
- Humidity Levels
- Area Temperatures (air-cooled systems)
- Fresh air operation status (air-cooled systems)
- Coolant temperature (liquid-cooled systems)
- Ambient temperature (liquid-cooled systems)
- Coolant Flow Rate (liquid-cooled systems)
- Pump Pressure (liquid-cooled systems)
- Manual Control
- Alarms/Warnings

### 5.3.6.3 Control of Electrical Systems

BESS auxiliary electrical power shall communicate with Buyer's SCADA via a standard protocol as described in Section 5.3.3.1. The minimum remote monitoring requirements shall be as follows:

- Availability of normal and backup power sources.

## 5.4 Instrumentation Requirements

All metering, sensors, transducers and test points in the BESS shall be easily and safely accessible for calibration, maintenance and troubleshooting by Buyer. Seller shall provide and install current and voltage test switches for each protective relay and for each set of metering within a CT circuit.

Seller shall provide a complete metering system for the BESS, including any required current and voltage transformers, to measure all required parameters at the Revenue Metering Point. The metering system shall be utility grade, revenue class accuracy in all components. The metering system shall be capable of measuring all required quantities, including but not limited to, BESS MVA in/out, BESS MW in/out, MWh in/out, MVAR in/out, MVARh in/out, voltage, frequency and harmonic content. Bi-directional quantities shall be measured and recorded independently. Metering of net quantities is not acceptable.

Seller shall furnish and install a complete metering system, including any required current and voltage transformers, for the AC station service. The metering system shall be utility grade, revenue class accuracy in all components. The metering system shall measure all BESS AC auxiliary station service loads, whether served from the primary or back-up AC station service system.

As a minimum, the BESS shall include instrumentation to measure and report locally and to Buyer's SCADA, as applicable to the system proposed, the following:

- Battery voltage and current at sufficient points to monitor the SOH of the battery.
- Cell temperature at sufficient points recommended by the seller to represent the battery temperature.

- Charging system trouble alarms.
- Battery ground faults, including fault location.
- Temperatures in PCS, battery rooms or other critical cabinetry.
- Hydrogen detectors.
- Smoke detection.
- Fire suppression equipment status (if provided).
- Ventilation system status (if provided).
- Battery leakage current-to-ground.

Other sensors and equipment, as needed to provide for monitoring and alarms as determined by Seller. As a minimum, the following meters shall be installed on the BESS local control panel and/or be displayed on the local control console. Meters shall be digital displays and shall be no less than 1.0-inch high. These metering signals shall also be supplied to Buyer's SCADA system.

- Battery voltage overall and in each string
- Battery current overall and in each string
- PCS DC power overall and from each PCS
- PCS AC power (real, MW) overall and from each PCS
- BESS net AC power (real, MW)
- BESS net AC power (apparent, MVA)
- BESS net AC power (reactive, megaVARs)
- PCS Transformer High Side Voltage (each phase)
- BESS net AC Amperes (each phase)

As a minimum, the following indicator lights or similar displays shall be installed on the local control panel or console.

- PCS breakers status
- Status of all contactors and motor-operated disconnect switches (if applicable)

At a minimum, the following alarm functions shall have indicator lights or similar displays on the local control panel or console, as applicable:

- PCS breaker trouble alarms (to be determined)
- Grid voltage present
- Battery, PCS or other equipment over temperature
- Battery ground fault (DC ground current exceeds trip level)
- Smoke/Fire detection
- Fire Suppression Activation
- Excess hydrogen level detected
- Synchronization Error Shutdown
- Control logic trouble
- Blown fuse
- Building door(s) and/or gate open
- Battery under voltage

- Module under voltage
- String under voltage

At a minimum, alarms from the battery monitoring/alarm system, if automatic, shall be displayed locally at the control panel or console and Buyer's SCADA system.

The BESS control and instrumentation systems shall include provisions for determining and storing in non-volatile memory, the sequence of abnormal events, trips and/or alarms that cause the BESS to go to a disconnect or shut down state. In addition, the BESS shall include a dynamic system monitor or fault recorder to record the BESS output and waveform, and other Seller and specified parameters, for all events where the BESS is required to operate. Waveform recording shall be triggered automatically by Seller and Buyer specified means and shall record a sufficient amount of pre-event data to analyze the event.

The BESS shall transmit all the above meter quantities and alarm/status indicators to Buyer's SCADA system as described in Section 5.3. Seller shall provide all transducers, interposing relays, or other equipment required to interface to Buyer's SCADA system. Seller shall design, supply, and install wiring from the BESS equipment to the interface enclosure located in the control room. Such wiring shall be placed in conduits or wireway and shall be designed for ease of installation of future wiring by Buyer.

# 6 ENGINEERING SERVICES AND STUDIES

## 6.1 Design Package

### 6.1.1 Engineering Design Package

Based on the review of the Project Site and infrastructure, Seller shall design a Project that will meet the required performance and that is capable of being operated in a safe, normal, reliable, and continuous manner at all operating conditions and modes. The system design shall comply with all applicable laws and regulations and applicable permits. Studies prepared by Seller's third-party consultants shall be provided to Buyer for review.

The Engineering Design Package shall include at a minimum item listed below:

- As applicable, studies related to the Project, such as the geotechnical engineering report and the lightning protection study.
- Schematic and preliminary designs.
- Design calculations.
- All drawings including mechanical, fire protection, HVAC, electrical, structural, civil, and construction drawings, site plans, schematic single lines, index, and detail drawings.
- Project schedule.
- Product and manufacturer description information.
- Bill of Materials.
- Equipment details, descriptions, and specifications.
- Instrumentation and electrical lists, including preliminary circuit schedules.
- Layout and arrangement of equipment.

The Engineering Design Package shall be provided prior to commencement of construction.

Buyer shall be provided an opportunity to review, comment, and approve or reject all equipment and engineering provided by the Seller. The requirements are as follows:

Electronic copies approval drawings depicting the physical and operational characteristics of the equipment and installation must be delivered to Buyer. These drawings must clearly indicate arrangement, size, function, pertinent dimensions, interface with other equipment or material type(s) or components(s), operational limitations, and job name.

Seller shall provide for a minimum of ten (10) working days for Buyer review of any drawings submitted for approval. The 10-day period will commence upon electronic receipt of drawings and end upon transmittal to the Seller.

Seller shall identify revisions by alpha characters, date, and subject in a revision block on the face of the submittal for each drawing during permitting and design phase.

Following return of approved drawings, Seller, shall make corrections or revisions as required and re-submit all drawings in final form. Seller shall not proceed with purchase or fabrication until Seller has made all revisions to technical submittals that are required by the Buyer. Each revision shall be identified by number, date, and subject in a revision block on the face of the submittal.

Buyer review and approval does not constitute an approved deviation or exemption from any Project specifications, standards, or codes. Any requests for deviations or exemptions must be formally requested and approved by Buyer. Any contradictory specifications in the Project documents should be formally submitted to Buyer for clarification and resolution. Buyer's review of technical submittals shall not be construed as a complete check but only as a check that the general method of construction and detailing is satisfactory. Review by Buyer shall not relieve Seller of responsibility to perform the scope of Work correctly. It shall be the Seller's responsibility to make and verify all measurements required for the fabrication and installation of equipment for the Project.

All mechanical design shall be in accordance with the International Mechanical Code and the International Fire Code, the additional documents incorporated by reference and the additional requirements herein. All mechanical design shall be performed by or done under the direction of a Professional Engineer licensed in the state. All Life Safety requirements shall meet all national, state, and local codes, as well as agree with the local Authority Having Jurisdiction.

In accordance with State and Local Laws, all final (Issued for Construction) drawings, specifications, and calculations shall be wet stamped by a Licensed Mechanical Engineer in the state where the project is located.

### 6.1.2 Design for Maintainability

Maintenance features shall be incorporated into Seller's design to optimize maintenance work. This shall include adequate space inside Project enclosures, adequate space around and inside DC racks, removable panels in electromechanical enclosures, and positioning of equipment access to allow removal of equipment, and other features that facilitate material handling. Required maintenance activities during normal operations and how it impacts system SOC and performance must be appropriately considered.

### 6.1.3 Operability and Safety

The Project shall be designed for primary operation via its own autonomous control. The secondary operation shall be via remote dispatch centers and the Project shall also have the capability to operate via local panels for normal startup, operation, shutdown, and emergency shutdown capability for all BESS

related equipment. BESS, balance of plant equipment, power conversion, instrumentation, controls, and monitoring devices shall be designed for ease of operation and maintenance. Attention shall be given to adequate lighting, access, and ventilation of operational spaces.

The BESS and supporting equipment shall be operable from remote dispatch centers under all normal conditions including automatic startup and shutdowns as a load following mode of operation.

Where redundant equipment is supplied, the idle device shall be capable of immediately backing up the operating device. The switchover shall be accomplished automatically through a system local panel, or the BESS SCADA system.

“Single point of failure contingency” shall be incorporated into the Project design such that the loss of any single IT switch, server, or control system shall not interrupt BESS availability to the grid.

The standby power of the BESS should be compliant with NFPA 855.

The BESS shall be designed to have high reliability, Design Life as listed in Appendix 5 and designed for unattended operation with 24-hour remote monitoring and control by Operator in addition to Buyer’s SCADA system.

The BESS shall be “Utility Grade.” This means that all equipment shall be expected to last through the Design Life with only typical routine maintenance and planned consumable goods.

### 6.1.4 Fire Suppression Philosophy

Seller shall provide a Fire Protection narrative which shall be stamped by fire protection engineer. Narrative shall include at a minimum the following items:

- Fire suppression drawings
- Sequence of operations
- Suppression system sizing basis

Suppression system sizing shall be designed in accordance with test results from UL 9540a testing.

## 6.2 Electrical System Studies

Load flow, dynamic stability, harmonic interaction, short circuit, voltage droop, coordination, grounding system safety and other studies shall be performed to properly determine equipment capacity, performance, withstand requirements, transformer impedances, etc. Seller shall submit design criteria, harmonic profile, short circuit characteristics, and calculations associated with these studies to Buyer for review. Buyer will provide data on existing Buyer equipment and electric grid as necessary and will be available to facilitate Seller’s performance of these studies.

Seller shall prepare electrical system studies as required to configure the Project and to determine control response and settings. The short circuit and arc flash models and reports shall be made in SKM and be made available for Buyer’s use. Seller shall provide the PSSE/PSCAD models related to the electrical studies. These studies, at a minimum, shall address and solve the following concerns:

- Harmonic analysis of the proposed system
- Minimum system requirements and configuration for proper operation of the BESS (i.e., requirements to stabilize a self-commutated power conversion system (PCS))

- Minimum spacing requirements between equipment to maintain safe energization and maintenance conditions
- Battery degradation and expected power output at end of life of the BESS
- Charge and discharge curves of the project for potential tie into other renewable systems
- Requirements for Volt-Ampere Reactive (VAR) support, peak shaving, battery charging and other support services as described in this Technical Specification.
- Safety requirements for operation compliance with applicable codes and standards

### 6.2.1 Grounding System Study

Seller shall perform studies to determine the parameters for the Project's grounding system in WinIGS, CDEGS or equivalent.

### 6.2.2 Required Dynamic Models

#### 6.2.2.1 Frequency Models

- Seller shall prepare individual models of the fundamental positive sequence behavior of the BESS.
- Seller shall provide PSSE (Power System Simulator for Engineering) models in the version required by the interconnection authority that accurately represent the control characteristics and dynamic behavior of the BESS in response to balanced voltage and frequency disturbances. This model shall be updated once the 60% design is complete and refined to reflect the final design configuration at IFC.
- Fully detailed equivalent models are required; generic models from the WECC(Western Electricity Coordinating Council) approved model library are acceptable if they can accurately model the BESS behavior in response to voltage disturbances and system frequency disturbances.
- The PSSE models shall be validated for accurate representation of disturbances that are within the model's appropriate range of application, using a validated electromagnetic transient model or full-scale testing.
- The PSSE models shall be fully documented.
- The PSSE models must be non-proprietary and shall be accessible to other utilities, system operators, asset Buyers, and other entities associated with the interconnection.
- The PSSE models shall be updated by Seller prior to any change to the inverter controls or control parameters that affect the dynamic performance.
- Seller shall ensure compatibility of the provided PSSE models with the version of PSSE that Buyer utilizes at the start of commercial operation. Upgrades and modification of the models to maintain compatibility with ongoing PSSE versions shall be the responsibility of Seller over the lifetime of system performance.

#### 6.2.2.2 Model Inputs

The PSSE model should reflect the current design of the power plant and a general network equivalent or detailed network, depending upon interconnection study requirements.

For design purposes, the power system characteristics at the Project location and for which the BESS will be required to provide rated output, shall be considered as follows:

- Maintain frequency and voltage within the utility set limits.
- Supply required real and reactive power at a power factor range of -1 to +1.

### 6.2.3 Lightning Protection Study

Seller shall provide a lightning risk assessment performed to Industry Standards by a certified lightning protection professional, as outlined in Section 4.2.10External Lightning Protection System (LPS). The results of this assessment shall be the basis for determining the requirements and extent of the facility LPS and a surge protection system that provides protection of the batteries, DC power circuit, PCS, measurement control and communications systems, and other major electrical equipment including transformers.

### 6.2.4 Interference and Harmonic Suppression Study

Seller shall perform studies and analysis to determine required AC harmonic filter types and ratings if filters are required to meet the harmonic specifications. In addition, these studies shall be used to demonstrate that the AC filters do not cause any resonance with Buyer's power system and that the harmonic distortion limits can be met by the filters designed by Seller.

Seller shall perform studies to determine required AC harmonic filter types and ratings if filters are required to meet the harmonic specifications. In addition, these studies shall be used to demonstrate that the AC filters do not cause any resonance with Buyer's power system and that the harmonic distortion limits can be met by the filters designed by Seller.

## 6.3 Hazard Mitigation Analysis

A Hazard Mitigation Analysis (HMA) shall be conducted by a qualified engineer or consultant, appointed by Seller, in accordance with NFPA 855 and IFC requirements and provided to Buyer for review and approval. The HMA shall be provided for the initial design and, at a minimum, shall be updated for the 60% design and final design. This analysis is an evaluation of potential BESS failure modes and the safety-related consequences attributed to the failures. At a minimum, the analysis shall evaluate the consequences of:

- Thermal runaway conditions
- Failure of the BMS
- Failure of the required systems (fire, gas, smoke, exhaust or ventilation, and deflagration)

The HMA shall also include a design basis that describes all the mitigations to these events (including all active and passive systems described in this specification) as well as any associated assumptions and/or calculations.

## 6.4 Emergency Response Plan (ERP)

Seller shall provide an Emergency Response Plan (ERP). The ERP shall establish procedures in place to prepare for and respond to an emergency at the BESS Project. The Plan delineates emergency response responsibilities of personnel and identifies mutual aid resources available by off-site responders. The plan identifies training provided to site personnel in responding to emergencies and identifies drill procedures and incident investigation procedures. Coordination and approval of an emergency response plan

consistent with the guidance of NFPA-855 for the local fire protection agency is required prior to acceptance by Buyer. ERP shall include egress/access plan.

### 6.5 Decommissioning Plan

Seller shall provide a Decommissioning Plan to provide a description and strategy for the de-commissioning of the Project at End-of-Life (EOL). The plan must comply with NFPA 855, obtain Authority Having Jurisdiction (AHJ) approval, and include a safe shutdown of safety systems, an orderly removal process, and a plan for intact and damaged ESS units. A recycling plan for the battery packs shall be included.

Refer to Energy Storage Integration Council (ESIC) Energy Storage Implementation Guide (3002030029) Section 7.0 for guidance.

# 7 TESTING, COMMISSIONING AND START-UP

## 7.1 General

Seller shall furnish a commissioning plan. The commissioning plan shall outline the tasks, processes, procedures, and deliverables necessary to commission the Project, conduct the Project Performance Tests, and prove the function and performance of the Project, including its components. Commissioning plan shall include the 12 items listed in IFC 1207.2.1.

The plan will specify the tests and processes required to be completed and performed before Mechanical and Substantial Completion, including all quality assurance and quality control (QA/QC) tests and all Project Performance Tests.

Seller shall provide the Commissioning Plan to Buyer reasonably prior to the commencement of Seller's commissioning activities.

Buyer and Representatives shall be always permitted access to the Project Site and shall be permitted to visit factories during the manufacturing of equipment, materials, and components for the Project and to witness factory tests and inspections. Buyer may contract with one or more third parties to conduct individual inspections and tests at any time to confirm test results and to verify that the Project has been installed and constructed in accordance with the requirements of the Agreement, and this Scope Book.

Seller shall furnish all supervision, technical personnel, labor, normal and special test instruments, tools, equipment, spare parts and consumables and materials required to perform the electrical, instrumentation and mechanical checkout and testing of components and equipment to verify the initial operation of the systems and equipment in Seller's scope.

Seller shall perform and successfully complete Site Acceptance Testing (SAT) following Commissioning Tests on systems and equipment to demonstrate the safety, operability and reliability of the systems and equipment within specified design limits according to the contract, engineering drawings, documents, and specifications. All normal and necessary tests shall be conducted using written test procedures signed and verified by Seller.

Overall administration of the commissioning and testing activities for OEM equipment shall be carried out by the Seller.

Seller shall coordinate with Buyer for all tests where the BESS is to be connected to Buyer's power system. No such tests shall be performed unless permission by Buyer has been granted.

## 7.2 Commissioning Tests

Seller shall perform Commissioning Tests per ESIC (Energy Storage Integration Council) Energy Storage Test Manual (3002021710).

The tests shall include, but are not limited to:

- Grounding System Testing
- Insulation Resistance Test
- High Potential Test (or VLF (Very Low Frequency) Test)
- Functional Tests of all Controls, Protection Relays, and Interlocks
- Functional Tests of all Safety Devices and Alarms
- AC/DC Motor Tests
- Battery and UPS Test
- PCS Test
- Switchgear Test
- Control Circuit Checkout
- Instrument and Loop Calibration
- Fire protection Test
- Functional Test of the Remote Shutdown Panel
- SCADA system
- All manufacturers recommended equipment tests
- Safety plan during startup and commissioning.
- Review of all QA/QC testing on the DC and AC sides of inverters.
- Detailed procedure for Project startup, including switching sequencing.
- Confirm testing and energizing inverters in conformance with manufacturer's recommended procedures; note operating voltages; and confirm inverter is performing as expected.
- Testing the communication system for offsite monitoring.
- Testing the Project metering and protective relaying to verify they meet utility requirements.
- Insulation check of auxiliary cables.
- Verification of operation of station auxiliary power distribution.
- DC distribution system, battery, and battery charger.
- Verification and tuning of cooling system (if required).
- Check of operation and indications of circuit breakers disconnect and earthing switches.
- Capacitance check of capacitor banks (if required).
- Verify proper operation of all pump fans and motors.
- Verify proper operation of heating, ventilation, and lighting systems.
- Check current and voltage transformers.
- Overall check of trip operations from protections to breaker.
- Check circuits through the local control interface and the remote interface.
- Detailed procedure for interface and initialization with the grid and completion of all Transmission Provider forms to be provided prior to construction.
- Documentation of successful startup and commissioning procedure.

- Written notification submitted by Seller to Buyer that the completion of Acceptance Testing and Commissioning has occurred.

Additional required procedures include, but are not limited to:

- Start-up Program Organizational Procedure
- Safety Tagging Procedure
- Confined Space Entry Procedure

## 7.3 Performance Verification

The total system performance verification plan shall be submitted to Buyer for review and approval sixty (60) days prior to initiation of BESS performance tests.

These tests shall demonstrate that the BESS capabilities, efficiencies, response, and features conform to Appendix 4.

## 7.4 Other Compliance Tests

Seller is responsible for obtaining before and after BESS installation measurements to ensure the Project complies with this Technical Specification in the following areas:

- Broadband frequency signal strength and noise voltage.
- Harmonic voltages and currents.
- Audible noise measurements.

## 7.5 Startup

Seller shall coordinate with Buyer to develop an acceptable startup plan that includes a checkout procedure, acceptance test, and punch lists. This plan shall ensure that systems are activated in a manner that is safe for personnel and equipment, that the BESS perform as required, and are ready to be turned over to Buyer. As the construction and installation of the systems nears completion, Seller and Buyer shall conduct system walk-downs, sub-system and system checkouts, startups, testing, and turnovers. The final approved Acceptance Test shall, at minimum, include the following:

- Safety plan.
- Review of all QA/QC testing on the DC and AC sides of inverters.
- Detailed procedure for Project startup, including switching sequencing.
- Confirm testing and energizing inverters in conformance with manufacturer's recommended procedures; note operating voltages; and confirm inverter is performing as expected.
- Testing the system control and monitoring system to verify that it is performing correctly.
- Testing the communication system for offsite monitoring.
- Testing the Project metering and protective relaying to verify they meet utility requirements.

- Detailed procedure for interface and initialization with the grid and completion of all Transmission Provider forms to be provided prior to construction.
- Documentation of successful startup and commissioning procedure.
- Written notification submitted by Seller to Buyer that the completion of Acceptance Testing and Commissioning has occurred.

Seller shall coordinate the interconnection and back feed power from the transmission system.

All proper protection systems shall be installed, including fusing, relaying and lightning protection, as applicable, to ensure the safe and reliable operation of the collection system. Collection system grounding shall meet all applicable codes, standards, and guidelines (including NEC) and shall ensure the safe and reliable operation of the collection system

## 7.6 Synchronization Procedures and Requirements

All testing shall be done in accordance with the GIA and all the requirements to achieve electrical and mechanical completion of the Project.

## 7.7 Mechanical Completion

Seller shall achieve Back feed and assure that the Project has been synchronized with the Buyer Interconnection Facility before conducting performance tests.

# 8 MAINTENANCE

## 8.1 General

Operations and Maintenance requirements shall comply with the O&M contract and Seller must meet the technical specifications and requirements of the equipment manufacturers. All equipment and construction documentation to be compiled into O&M manuals. Seller to provide O&M procedures to properly guide the Buyer for safe operations of the site.

Full Operations and Maintenance manuals for all equipment, the fully integrated facility and site tasks are required by the Seller.

## 8.2 Maintenance Procedures

O&M procedure periods shall be identified to be consistent with OEM specified intervals. Expected O&M intervals for all equipment shall be provided.

All equipment planned maintenance for the period of the LTSA shall be identified prior to Commercial Operations date and presented in an O&M Plan, in accordance with OEM maintenance requirements.

## 8.3 Spare Parts

Seller shall submit a complete spare parts list needed for initial operation (startup spares') and operation with prices.

The Seller shall provide the recommended priced spare parts list for the BESS Equipment a minimum of six (6) months prior to the Guaranteed Delivery Date of the BESS Equipment. The recommended spare parts list shall consist of a complete listing of the name of the part, part numbers, recommended quantities, and unit price. The basis for the recommended spare parts and quantities shall be made for five (5) years of operation.

Seller shall identify spare parts which should be stocked locally to ensure prompt repair due to any failure that can be reasonably expected.

All spare parts for equipment covered by this Technical Specification shall comply in all aspects with the requirements of this Technical Specification. This includes documentation identical in kind and format to that required for the original equipment or material. Each of the spare parts shall be fully identified by reference to the spares list, part number, cost, and manufacturer drawing number.

If Contractor, their suppliers, or sub suppliers cease manufacture of any of the spare parts, or if for any reason any spare part will become unavailable at any time during the Design Life of the facility, as specified in Table 1, Contractor shall notify Owner in writing at least 180 days prior to the unavailability of such spare parts. Contractor shall provide Owner the opportunity to purchase sufficient stock of spare parts to support the system for its expected life.

The initial complement of equipment shall include a supply of chemicals as may be needed to neutralize small electrolyte spills.

Seller shall provide, receive, store locally, distribute and restock spare parts, materials, test equipment, instruments, tools, and consumables required for start-up and operation of the systems and equipment within its scope until Substantial Completion.

## 8.4 BESS Long-Term Service Agreement (LTSA)

LTSA shall include 24-hour control and oversight. All equipment warranties shall be negotiated so that they can be assigned to Buyer upon project acceptance. LTSA shall provide the following guarantees:

- Energy
- Capacity
- Availability
- Round Trip Efficiency (RTE)

If part of the LTSA, a detailed annual report shall be provided by the Seller every year with the first one dated one year after the commercial date of operations including the degradation of the BESS for the commercial date prior. This report shall be used for commercial and warranty purposes during the operational phase.

## 8.5 Tools and Equipment

Seller shall provide all “special tools and equipment” for maintenance and operation which are not normally or readily available. Seller shall submit a complete list of tools and equipment needed for erection/installation and maintenance and a list of special tools and equipment that will be provided, including prices. Special tools and equipment shall become the property of Buyer at Final Acceptance. Buyer reserves the right to purchase additional quantities of tools if desired.

## 8.6 O&M Documentation

For any equipment provided by Seller, Seller shall supply Buyer with all manuals and/or handbooks (in printable electronic format) that provide, either in a single manual or handbook or collectively, complete operating and maintenance instructions (including inventories of spare parts and tools and parts lists with ordering instructions) for each major piece of equipment and system of the Project. O&M suggested schedule shall be coordinated among major equipment.

# 9 TRAINING AND TOOLS

## 9.1 General

Seller shall provide training for the Project as specified below. Seller shall determine the content and duration for each training session. The suggested class durations in this Technical Specification are meant to illustrate the level of training expected. Performance evaluation testing of all trainees (i.e., a written test) is required for all classes. Seller's minimum requirements for Training are:

- Submit training plan
- Plan shall be reviewed and approved by Buyer
- Lesson Plan for each topic shall be provided
    - Learning Objectives
    - Instructor Qualifications
    - Classroom training objectives w/safety
    - Field training objectives w/ safety
    - Evaluation: Either test learning or demonstration
- Record keeping
    - Program
    - Each participant
- Certification of Training Completion

Training schedule shall be agreed upon prior to Commercial Operational Date.

## 9.2 Operator Training

Seller shall provide the necessary training in proper operation of the Project and related equipment. This training shall be conducted after completion of the Project performance verification testing, but before system commissioning.

## 9.3 Maintenance Training

Seller shall provide necessary training in maintenance of the Project and related equipment. Seller will provide an outline and syllabus prior to the session. The maintenance training shall include, but not be limited to:

- Safety and grounding procedures
- Frequency of inspections and maintenance
- Normal maintenance methods
- Repairs and replacement

- Diagnostic procedures
- Equipment calibration
- Re-energization
- Special tests
- Spare parts
- Special tools

## 9.4 Turnover Documents Including O&M Manuals

For any equipment provided by Seller, Seller shall provide Buyer with three paper copies and one editable electronic copy of all manuals.

The electronic copy of the manuals shall be organized in folders consistent with tabs in the paper manuals. Electronic copies of installation, operation and maintenance manuals shall be organized from the most general information in the top directory to the most specific information in the lowest level folder. The top-level folders shall include a document containing a directory of the subfolders describing the contents of every subfolder. Electronic copies of Installation, Operation and Maintenance manuals shall be organized by project, system, subsystem, equipment, and components. Manufacturers or vendors' electronic manuals shall be delivered as individual files. Seller shall not merge or combine manufacturer and vendor provided files containing manuals.

The manuals to be provided shall include:

### 9.4.1 Design Manuals

Design manuals shall contain the following items:

- Drawing List, Drawing and Specification Identification System, Units of Measurement and Formats
- System List and Equipment Numbering System
- System design requirements
- System and equipment descriptions
- Equipment lists itemizing type, performance, and technical requirements.
- Overall performance data
- Equipment Data Sheets

### 9.4.2 Start Up, Operation, and Shutdown Manual

Seller shall provide a startup, operation, and shutdown manual for the BESS which shall include as a minimum the following items:

- BESS start-up and shutdown procedures
- Startup schedule
- Startup organization chart
- Administrative procedures
- Data sheets

- Test procedures for all tests required for Mechanical and Electrical Completion and Final Acceptance.
- Turnover sequences and procedures
- Safety clearance procedure
- Work responsibility matrix

### 9.4.3 Installation, Operation, and Maintenance Manuals

Seller shall provide installation, operation, and maintenance manuals for the Equipment, including information typically supplied for equipment and/or systems such as the following items:

- System or equipment startup and shutdown procedures
- Description / design criteria of each item of equipment
- Nameplate information and shop order numbers for each item of equipment and components thereof
- Operating procedures and instructions for commissioning, startup, normal operation, shut down, standby and emergency conditions and special safety precautions for individual items of equipment or systems
- List of any start-up prerequisites
- Normal range of system variables
- Operating limits and hazards for all equipment and systems including alarm and trip set points for all devices
- Testing and checking requirements
- Effect of loss of normal power
- Tolerance of electrical supply frequency variation
- Final performance and design data sheets, specifications and performance curves for all equipment including test data and test curves
- Preventive maintenance schedule and maintenance instructions for equipment including standard and special safety precautions and special conditions that trigger non-scheduled maintenance
- Dismantling and assembly procedures for equipment with associated tests and checks prior to returning equipment to service
- Detailed assembly drawings to complement assembly procedures mentioned above including parts lists and numbers for replacement ordering
- Cleaning procedures, including frequency, equipment, resources needed, water source, etc.
- Specifications for any gases, chemicals, solvents, or lubricants
- Drawing showing space provided for equipment maintenance for equipment and any fixed facilities for maintenance
- Methods for troubleshooting
- List of maintenance tools furnished with equipment
- Installation instructions, drawings, and details
- Vendor drawings as appropriate
- Installation, storage, and handling requirements.

The above requirements are a minimum; however, requirements which are clearly not applicable to specific items or components may be deleted, however, any additional information which is necessary for proper operation and care of the equipment shall be included.

### 9.5 Supplemental Appendix Information

For Appendix 3 and in accordance with the other terms of this Agreement, Seller shall update all applicable cells left blank as of the effective date in the Appendix with accurate data and content. Seller shall provide to Buyer periodic updates to each Appendix at the intervals specified in the Agreement for Seller's updates to the schedules. However, no cells may be updated within 90 days of closing without the prior written agreement of Buyer and Seller.

# 10 DOCUMENT SUBMITTALS

## 10.1 Documentation to be Submitted During Project Design (Documents IFC)

Seller shall prepare and submit to Buyer the following documents during the design and engineering phase of the Project.

Submission of all documents shall be in electronic format through a mutually agreed-upon document manager. Documents shall be submitted for 30% design, 60% design, 90% design, issued for construction, and as built. A preliminary list of documents and drawings to be submitted to the Buyer for review and approval is given below in the Submittals tab. The provided document list may not be inclusive of all documents that need to be submitted. The Seller shall be responsible for providing all documentation necessary to fully characterize the design, construction, and operation of the Project.

**Table 5: Submittals requirements during project design**

| Item | Description | Due |
|---|---|---|
| 10.1.1 | Monthly progress reports | Monthly |
| 10.1.2 | Weekly meetings beginning at FNTP that show weekly progress of project and the following week project schedule and production plans. | Weekly |
| 10.1.3 | Overall Project Schedule showing an approximate start date, major milestones, and durations for Seller's work. Schedule shall include design and engineering work, procurement, and delivery of major equipment, FAT of major equipment, site surveys and studies, site preparation, construction activities, SAT, commissioning activities, performance tests, substantial completion date, and mechanical completion date | 30 days after FNTP, then with each monthly report |
| 10.1.4 | Project Execution Plan (PEP document) | 30 days after FNTP |
| 10.1.5 | Drawings and documents provided with permit applications | TBD |
| 10.1.6 | Copies of all correspondence exchanged between or on behalf of Seller and any governmental authority with respect to the Project | TBD |

| Item | Description | Due |
|---|---|---|
| 10.1.7 | 30% Electrical Design Package | TBD |
| 10.1.8 | 60% Electrical Design Package | TBD |
| 10.1.9 | 90% Electrical Design Package | TBD |
| 10.1.10 | 30% Structural Design Package | TBD |
| 10.1.11 | 60% Structural Design Package | TBD |
| 10.1.12 | 90% Structural Design Package | TBD |
| 10.1.13 | 30% Civil Design Package | TBD |
| 10.1.14 | 60% Civil Design Package | TBD |
| 10.1.15 | 90% Civil Design Package | TBD |
| 10.1.16 | Stormwater Pollution Prevention Plan (SWPPP) | TBD |
| 10.1.17 | The initial, baseline Environmental Assessment (subject to the main body of the Agreement) | TBD |
| 10.1.18 | Project Plot Plan with landscaping notes | TBD |
| 10.1.19 | General arrangement drawings | TBD |
| 10.1.20 | Plans, sections, and details for each system | TBD |
| 10.1.21 | Underground arrangement drawings (mechanical, electrical, and civil) | TBD |
| 10.1.22 | Terminal point list | TBD |
| 10.1.23 | One-line diagrams | TBD |
| 10.1.24 | Three-line diagrams | TBD |
| 10.1.25 | Cable layouts | TBD |
| 10.1.26 | Electrical load flow studies | TBD |
| 10.1.27 | Electrical grounding calculations | TBD |
| 10.1.28 | Protective relaying settings and coordination study | TBD |

| Item | Description | Due |
|---|---|---|
| 10.1.29 | Electrical short circuit analysis | TBD |
| 10.1.30 | Grading and drainage drawings, including hydrology report | TBD |
| 10.1.31 | Geotechnical Investigation Report | TBD |
| 10.1.32 | Foundation and structural steel drawings sealed by a PE licensed in the state where the project is located | TBD |
| 10.1.33 | Structural calculations for BESS foundations | TBD |
| 10.1.34 | Structural calculations for PCS foundations | TBD |
| 10.1.35 | Structural calculations for substation structure and foundation calculations | TBD |
| 10.1.36 | Specifications and datasheets for Battery racks, modules, cells, PCS, combiner box, cables, wire management, and other equipment | TBD |
| 10.1.37 | (If applicable) Construction pile installation QA/QC procedure, including:<br>• *Pile installation tolerances*<br>• *Out of tolerance remediation plan*<br>• *Pile rejection criteria for damage to pile, extreme out of tolerance*<br>• *Pile testing campaign for sampling population and acceptance criteria, pile load test procedure* | 30 days prior to commencement of pile installation |
| 10.1.38 | System description of the main systems for the Project | TBD |
| 10.1.39 | Start-up and shutdown diagrams | TBD |
| 10.1.40 | Preliminary Commissioning Program with procedures for respective tests and activities | TBD |
| 10.1.41 | Draft project performance test procedures | TBD |
| 10.1.42 | Preliminary O&M philosophy | TBD |
| 10.1.43 | Property Protection Design Basis Document as described in Appendix 5 | TBD |
| 10.1.44 | Project Site Security Plan | 120 days prior to construction commencement date |
| 10.1.45 | Initial Point list for SCADA system | TBD |
| 10.1.46 | Project design basis (including design criteria) | At 30% design |
| 10.1.47 | Equipment receiving, handling, storage, and installation instructions and manuals | 120 days prior to construction commencement date |

| Item | Description | Due |
|---|---|---|
| 10.1.48 | Corrosion engineering report | At 30% design |
| 10.1.49 | Field touch-up procedures of painted equipment | 120 days prior to construction commencement date |
| 10.1.50 | Site finish grade | At 30% design |
| 10.1.51 | I&C drawings (instrument list, network diagram, control panel layout, architecture, alarm list)) | TBD |
| 10.1.52 | MSDS documentation | 120 days prior to construction commencement date |
| 10.1.53 | Visual weld inspection procedures | 120 days prior to construction commencement date |
| 10.1.54 | HVAC equipment | TBD |
| 10.1.55 | Electrical package including cable schedule | TBD |
| 10.1.56 | Transformer recommended assembly and filling procedure | TBD |

## 10.2 Document Submittals by Seller During Project Construction

Seller shall prepare and submit to Buyer the following documents from and after the construction commencement date through substantial completion. Refer to Table 6.

**Table 6: Document Submittals by Seller During Project Construction**

| Item | Description | Due |
|---|---|---|
| 10.2.1 | Monthly progress reports in accordance with Appendix 11 | Monthly |
| 10.2.2 | Weekly construction status report in accordance with Appendix 11 | No later than 5 PM Every Tuesday |
| 10.2.3 | Copy of all Project Work permits and Project operational permits when obtained | As obtained |
| 10.2.4 | Final Commissioning Program | 30 days prior to Mechanical Completion |
| 10.2.5 | Final performance test procedure | Substantial Completion |
| 10.2.6 | Final O&M philosophy | Substantial Completion |
| 10.2.7 | Construction Test Reports, including compaction test results and related documents for roads, substation pads, and at non-pile supported foundations and structures; in situ pile test results and related documents | Substantial Completion |
| 10.2.8 | System graphics | Substantial Completion |
| 10.2.9 | Certificate of achievement of mechanical completion | Substantial Completion |
| 10.2.10 | Final post-mechanical completion punch list | Substantial Completion |

| | | |
|---|---|---|
| 10.2.11 | OEM FAT and shop test reports for all equipment provided by Seller | Prior to initial energization |
| 10.2.12 | Environmental Assessment | No earlier than 180 days prior to closing |
| 10.2.13 | Environmental test reports, inspections, and records | Closing |
| 10.2.14 | Training manuals | Substantial Completion |
| 10.2.15 | Coating specifications | Substantial Completion |
| 10.2.16 | Paint color samples | Prior to Mechanical Completion |

## 10.3 Document Submittals by Seller at Substantial Completion

Seller shall prepare and submit to Buyer the following documents as shown in Table 7 prior to Substantial Completion.

**Table 7: Document Submittals by Seller at Substantial Completion**

| Item | Description | Due |
|---|---|---|
| 10.3.1 | Punchlist in accordance with the Agreement, including the agreed punch list holdback amount | Substantial Completion |
| 10.3.2 | Draft as-builts for all drawings and documents submitted during the engineering and design phase and during project construction | Substantial Completion |
| 10.3.3 | Power production estimates | Substantial Completion |
| 10.3.4 | OEM performance field test reports | Substantial Completion |
| 10.3.5 | Software licenses and Project intellectual property rights | Substantial Completion |
| 10.3.6 | Instrument calibration list and certificates | Substantial Completion |
| 10.3.7 | Protective relay settings list | Substantial Completion |
| 10.3.8 | Equipment list | Substantial Completion |
| 10.3.9 | Equipment O&M manuals | Substantial Completion |
| 10.3.10 | Construction turnover documentation | Substantial Completion |
| 10.3.11 | Commissioning turnover documentation | Substantial Completion |
| 10.3.12 | Input and output list | Substantial Completion |
| 10.3.13 | SCADA FAT results | Substantial Completion |
| 10.3.14 | Commissioning test results, bills of material, and drawings to demonstrate compliance with NERC standards (reference Appendix 10) | Substantial Completion |
| 10.3.15 | Project Site specific operating procedures | Substantial Completion |
| 10.3.16 | Arc flash study | Substantial Completion |
| 10.3.17 | NERC test reports and calibration records (reference Appendix 10) | Substantial Completion |
| 10.3.18 | All Project Performance Test analysis, reports, and results | Substantial Completion |
| 10.3.19 | All Project Functional Test analysis, reports, and results | Substantial Completion |
| 10.3.20 | All permits | Substantial Completion |
| 10.3.21 | All signed and approved design change requests | Substantial Completion |
| 10.3.22 | Invoices | Substantial Completion |

| | | |
|---|---|---|
| 10.3.23 | Spare parts and consumables list | 16 weeks prior to Substantial Completion |

Seller shall provide to Buyer 'Red-Lined' drawings with all 'as built' changes made by the Seller prior to Commissioning Team leaving site. A station copy shall remain in the Seller's trailer during the project phase and shall be stored in the control enclosure house once the Project is turned over to Buyer as an accurate set for operations personnel.

## 10.4 Document Submittals by Seller at Final Completion

Seller shall prepare and submit to Buyer the following documents as shown in Table 8 at Final Completion.

**Table 8: Document Submittals by Seller at Final Completion**

| Item | Description | Due |
|---|---|---|
| 10.4.1 | Final as-builts for all drawings and documents submitted during the engineering and design phase and during project construction | Final Completion |
| 10.4.2 | Red line drawings | Final Completion |
| 10.4.3 | Operator and maintenance personnel training records | Final Completion |
| 10.4.4 | Final equipment O&M manuals | Final Completion |
| 10.4.5 | Final system descriptions of as-built systems | Final Completion |

## 10.5 OEM Documents Provided by Seller During Project Design

Seller shall prepare and submit to Buyer the following documents during the design and engineering phase of the Project.

**Table 9: Document Requirements During Project Design and Engineering Phase of the Project**

| Item | Category | Description | Documentation Buyer | Notes | Submittal Date |
|---|---|---|---|---|---|
| 10.5.1 | Battery | NFPA 68 and/or NFPA 69 evaluation reports | Battery Supplier | | |
| 10.5.2 | Battery | UL9540A test results (cell, module, unit levels) | Battery Supplier | | |
| 10.5.3 | Battery | UL1973 certification | Battery Supplier | | |
| 10.5.4 | Battery | UL 9540 certification | Battery Supplier | | |
| 10.5.5 | Battery | Fire protection philosophy overview, component bill of material & datasheets | Battery Supplier | To evidence compliance with NFPA 855 and IFC | |
| 10.5.6 | Electrical Studies | Arc flash hazard study | Battery Supplier<br>PCS Supplier<br>MVT Supplier | Battery container, PCS, and MVT to be evaluated for arc flash per IEEE 1584 including recommendations for PPE. Units to be installed with proper arc flash signage | |
| 10.5.7 | Electrical Studies | Short circuit contribution | Battery Supplier<br>PCS Supplier<br>MVT Supplier | Components able to contribute a short circuit to the balance-of-plant shall provide such values to the Engineer of Record | |
| 10.5.8 | General/All | Detailed delivery schedule and shipping plan | Battery Supplier<br>PCS Supplier<br>MVT Supplier | To include any warehousing requirements, staging of deliveries, and shipment tracking information | |
| 10.5.9 | General/All | Decommissioning Plan | Battery Supplier<br>PCS Supplier<br>MVT Supplier | Guidance for decommissioning of system at end of life | |
| 10.5.10 | General/All | Points list and key set points | Battery Supplier | For BMS and EMS (Including details of alarm and control functions of BMS and response to fault events. ) | |
| 10.5.11 | General/All | Remote monitoring agreement (if | Battery Supplier | | |

| Item | Category | Description | Documentation Buyer | Notes | Submittal Date |
|---|---|---|---|---|---|
| | | applicable/offered by OEM) | | | |
| 10.5.12 | General/All | LTSA agreement (if applicable/offered by OEM) | Battery Supplier<br>PCS Supplier<br>MVT Supplier | To discuss remote monitoring requirements for maintaining equipment warranty (standard expectations) and remote monitoring supplemental options (for preventative maintenance LTSA, etc.) | |
| 10.5.13 | General/All | Non-site specific Hazard Mitigation Analysis inputs | Battery Supplier<br>PCS Supplier<br>MVT Supplier | Supplier to provide the Failure Modes and Effects Analysis of the product and other inputs for conducting the site-specific Hazard Mitigation Analysis (by Others) | |
| 10.5.14 | General/All | Emergency response / first responder training material | Battery Supplier<br>PCS Supplier<br>MVT Supplier | | |
| 10.5.15 | General/All | Seismic Qualification | Battery Supplier<br>PCS Supplier<br>MVT Supplier | Per IEEE 693 | |
| 10.5.16 | General/All | Factory Acceptance Test results | Battery Supplier<br>PCS Supplier<br>MVT Supplier | Battery unit, PCS unit, and MVT, as well as any tests pertinent to the skidded assemblies | |
| 10.5.17 | General/All | Product drawings | Battery Supplier<br>PCS Supplier<br>MVT Supplier | | |
| 10.5.18 | General/All | Technical specifications (including nameplate information, datasheet, etc.) | Battery Supplier<br>PCS Supplier<br>MVT Supplier | | |
| 10.5.19 | General/All | Warranty information and recommended spare parts | Battery Supplier<br>PCS Supplier<br>MVT Supplier | | |
| 10.5.20 | General/All | Operations & Maintenance Manual | Battery Supplier<br>PCS Supplier<br>MVT Supplier | Recommended preventative maintenance, LOTO procedure, etc. | |
| 10.5.21 | General/All | Installation & Commissioning Manual | Battery Supplier | Handling and storage guidance, lifting and | |

| Item | Category | Description | Documentation Buyer | Notes | Submittal Date |
|---|---|---|---|---|---|
| | | | PCS Supplier<br>MVT Supplier | rigging guidance, grounding and wiring guidance, etc. | |
| 10.5.22 | General/All | Site-Specific Commissioning Plan | Battery Supplier<br>PCS Supplier<br>MVT Supplier | To detail expectations before commissioning can commence, expected labor hours per task, isolation and energization needs/procedures, etc. | |
| 10.5.23 | General/All | Independent Engineer Due Diligence - Technology Items | Battery Supplier<br>PCS Supplier<br>MVT Supplier | "* Bankability Reports | |
| 10.5.24 | General/All | Equipment sourcing / country of origin information | Battery Supplier<br>PCS Supplier<br>MVT Supplier | * Deployment history of the battery and PCS technology, including discussion of fleet operational availability and resolution of any recurring issues | |
| 10.5.25 | General/All | IP Escrow Agreement | Battery Supplier<br>PCS Supplier<br>MVT Supplier | * Manufacturing Facility 3rd party audits | |
| 10.5.26 | General/All | Operator Training Material | Battery Supplier<br>PCS Supplier<br>MVT Supplier | * Equipment sourcing / manufacturing location | |
| 10.5.27 | PCS | NERC/FERC Compliance (reference Appendix 10) | Battery Supplier<br>PCS Supplier<br>MVT Supplier | * Independent Laboratory evaluation or testing (e.g., laboratory degradation assessment) | |
| 10.5.28 | PCS | Certificates and code/standard compliance | Battery Supplier<br>PCS Supplier<br>MVT Supplier | * Battery thermal management design overview, evidence of adequate heating/cooling capacity" | |
| 10.5.29 | PCS | PSSE/PSCAD Models | Battery Supplier<br>PCS Supplier<br>MVT Supplier | | |
| 10.5.30 | Use Case & Sizing | Degradation and round-trip efficiency lifetime performance schedule (indicative or guaranteed) | Battery Supplier | To provide Buyer with necessary information to operate equipment in event of failure of Supplier company | |

| Item | Category | Description | Documentation Buyer | Notes | Submittal Date |
|---|---|---|---|---|---|
| 10.5.31 | Use Case & Sizing | Aux Load Consumption details | Battery Supplier | | |
| 10.5.32 | Use Case & Sizing | Augmentation method/procedure guidance | Battery Supplier | Documentation evidencing NERC/FERC compliance (reference Appendix 10) | |
| 10.5.33 | Use Case & Sizing | AC and DC System losses [assumed based on typical values for the cable losses, PCS losses (inverter / MV transformer), battery losses (internal), MPT losses, gen-tie/transmission losses] and corresponding determination of quantity of units to meet POI nameplate | Battery Supplier<br>PCS Supplier<br>MVT Supplier | "* IEEE 1547 or 2800, as applicable | |

# BESS BOT Scope Book

# Appendix 1

# Collector Substation

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 9/14/2023 | All | Original Publication |
| 1 | 6/6/2024 | 5.3.14 | Updated GSU/MPT Transformer Configurations |
| 25-1 | 5/19/2025 | All | Editorial corrections, clarifications, formatting thorough out, added additional guidance for Generator Step-up transformers, Updated AVL/AML |
| 25-2 | 11/3/2025 | Cover | Added BESS Cover Page |
| | | | |
| | | | |

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# 1 INTRODUCTION

## 1.1 Purpose

This Appendix to the Scope Book provides design requirements and reference material for the design of renewable energy (solar, wind, battery storage) collector substations (the ***Collector Substations***) that will be built in or connected to the Project. This Appendix is intended to provide to Seller and others acting at Seller's request, requirements, recommendations, and guidance in the planning, design, construction, asset management, use, and operation of the Collector Substations.

## 1.2 Scope

Appendix applies to all new Collector Substations.

Appendix primarily describes technical requirements, both performance-based and prescriptive for the design and installation of Collector Substations.

Refer to the Scope Book and other parts of the Agreement for information regarding Project sequencing and milestones, the Project Execution Plan, Project Schedule and schedule management, Project controls reporting, health and safety information, factory acceptance tests, training, required submittals, design reviews, equipment records, specified deliverables, Project documentation, and other relevant matters not covered by this Appendix.

Appendix 1 addresses aspects of the Work relating to Collector Substations. It is not intended to be, and shall not be construed to be, a comprehensive list of each element or other requirement applicable to the Work and shall in no way limit Seller's obligations under the Agreement or any Ancillary Agreement. Seller shall comply with, and cause its Contractors and Subcontractors to comply with, the terms of this Appendix 1, the Scope Book, all Laws (including codes) and applicable Permits.

## 1.3 General Data

This Appendix provides the Minimum Functional Specification (***MFS***) for the Collector Substations, including scope and design requirements. In addition to the Requirements set forth in the Agreement (including the Scope Book), the Collector Substations shall comply with all requirements specified in the GIA or any other Required Deliverability Arrangement.

Article, Section, Table, Figure, and Attachment references in this Appendix are to this Appendix 1 unless otherwise provided or the context otherwise requires.

## 1.4 HV Collector Substation Work

The Work, with respect to the Collector Substations, includes the supply, assembly, and installation of the following components:

- High Voltage (***HV***) switchgear, if applicable
- Medium Voltage (***MV***) switchgear, if applicable
- MV/HV transformer(s)
- Switchyard buses
- Revenue metering

- Circuit breakers
- Disconnect switches
- Overhead line
- Normal Alternating Current (***AC***) and Direct Current (***DC***) power distribution
- Backup power supply/emergency generator
- Uninterruptable Power Supply (***UPS***), if applicable
- Heating Ventilation and Air Conditioning (***HVAC***)
- Grounding (grid and conductors)
- Lightning protection system, if applicable
- Conduits and cable trays
- Cables
- Relay protection
- Relay and control panels
- DC control power (including batteries, chargers, and motoring)
- Lighting systems (including emergency lighting)
- Instrumentation and Control (***I&C***) system (including fire alarm system), if applicable
- Earthwork
- Structures
- Control enclosure
- Fencing

## 1.5 Deviations

Any deviations from the MFS for the Collector Substations or the terms of this Appendix 1 shall require Buyer's prior written approval and will be subject to the terms of the Agreement.

# 2 DEFINITIONS, TERMINOLOGY AND ACRONYMS

Terms with initial capital letters used but not defined in this document shall have the meanings ascribed to such terms in the Agreement, unless the context manifestly requires otherwise. For the avoidance of doubt, the rules of interpretation set forth in the Main Body of the Agreement shall apply to this document. The following terms, when used in this Appendix 1 have the meanings set forth below:

***"Ampacity"*** means the current-carrying capacity, expressed in amperes, of an electric conductor under stated thermal conditions.

"***Base Flood***" or "***100-year flood***" means the flood level having a one percent chance of being equaled or exceeded in any given year. Note that a 100 year flood does not mean that such a flood occurs once every 100 years; instead, it means that there is a one in one-hundred (or 1%) chance of such a flood occurring in a given year. There is approximately a 63.4% chance of one or more 100-year floods occurring in any 100 year period.

"***Equipment support structures***" generally refers to all structures within the Collector Substation other than the control house.

***"Extra High Voltage" (EHV)*** means Nominal System Voltage 345 kV and above.

"***Finished Grade***" or "***Subgrade***" means design site elevation, after site grading.

"***High Voltage***" (***HV***) means Nominal System Voltages 69 kV and higher up to 230 kV. (Note that ANSI C84.1 defines high voltage as nominal system voltage between 100 kV and 230 kV). This term is also used as an adjective to designate the high voltage winding of a power transformer.

"***Low Voltage***" (***LV***) means Nominal System Voltage less than 1000 volts. This term is also used as an adjective to designate the low voltage winding of a power transformer.

***"Maximum System Voltage"*** means the highest system voltage that occurs under normal operating conditions, and the highest system voltage for which equipment and other components are designed for satisfactory continuous operation without derating of any kind. In defining maximum system voltage, voltage transients and temporary overvoltages caused by abnormal system conditions such as faults, load rejection, and the like are excluded. However, voltage transients and temporary overvoltages may affect equipment operating performance and are considered in equipment application. (ANSI C84.1)

"***Medium Voltage***" (***MV***) means Nominal System Voltage above 1 kV and up to 38 kV. (Note that ANSI C84.1 defines medium voltage as Nominal System Voltage above 1 kV and below 100 kV).

***"Nominal System Voltage"*** means the voltage by which a portion of the system is designated, and to which certain operating characteristics of the system are related. Each Nominal System Voltage pertains to a portion of the system bounded by transformers or utilization equipment. (ANSI C84.1)

"***Substation Designer***" means for the purposes of this Appendix 1, any person, regardless of business unit or contractor or employment status, who makes decisions pertaining to the equipment to be used in a substation, or the manner in which it will be used. Generally, the term "Substation Designer" includes substation layout and relay designers.

***"System Voltage"*** means the Root-mean-Square (***rms***) phase-to-phase voltage of a portion of an alternating-current electric system. Each System Voltage pertains to a portion of the system that is bounded by transformers or utilization equipment. (All voltages are rms phase to-phase or phase-to-neutral voltages.) (ANSI C84.1)

# 3 APPLICABLE CODES AND STANDARDS

The Collector Substation shall be designed and constructed in accordance with all applicable and up to date codes, ordinances and standard industry practices including, without limitation, ANSI, IEEE, NEMA, standards and FERC, NERC and OSHA regulations. This includes, without limitation, the standards and guidelines for substation design established by the following sources:

| Applicable Standards and Organizations | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ACI | American Concrete Institute |
| AISC | American Institute of Steel Construction |
| AISI | American Iron and Steel Institute |
| ANSI | American National Standards Institute |
| APLIC | Avian Power Line Interaction Committee |
| ASCE | American Society of Civil Engineers |
| ASHRAE | American Society of Heating Refrigerating and Air Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing Materials |
| AWS | American Welding Society |
| CRSI | Concrete Reinforcing Steel Institute |

## Appendix 1: Collector Substation

| Applicable Standards and Organizations | |
|---|---|
| IBC | International Building Code |
| ICE | Institution of Civil Engineers |
| ICEA | Insulated Cable Engineers Association |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| IESNA | Illuminating Engineering Society of North America |
| ISO | International Standardization Organization |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers Association |
| NERC | North America Electric Reliability Corporation |
| NESC | National Electrical Safety Code |
| NFPA | National Fire Protection Association |
| OSHA | Occupational Health & Safety Administration |
| SSPC | Steel Structures Painting Council |
| UL | Underwriters Laboratories |
| | ACI 318: Building Code Requirements for Structural Concrete |
| | AISC 360: Specification for Structural Steel Buildings |
| | ANSI/TIA-568-C.0-2009 Generic Telecommunications Cabling for Customer Premises |
| | ASCE 113: Design of Substation Structures |
| | ASCE 48: Design of Steel Transmission Pole Structures |
| | American Welding Society (AWS) D1.1 |
| | IEEE Std 605-2008: IEEE Guide for Bus Design in Air Insulated Substations |
| | IEEE Std 693-2018: IEEE Recommended Practice for Seismic Design of Substations |
| | IEEE Std 1527-2018: IEEE Recommended Practice for the Design of Buswork Located in Seismically Active Areas |
| | NECA/FOA 301-2009 Installing and Testing Fiber Optics |
| | RUS Bulletin 1724-200 Rural Utilities Service Design Manual for High Voltage Transmission Lines Electrical System Requirements |
| | RUS Bulletin 1724-300 Rural Utilities Service Design Guide for Rural Substations |

The latest issued Applicable Standards and Codes as of the Effective Date of the Agreement shall be used. Earlier editions are not allowed unless specifically identified in this Appendix 1.

If a revision to a standard or code is issued, it is not required to be implemented unless the authorities having jurisdiction have adopted it, in which case, Seller is obligated to abide by any increased compliance requirements above what was required by the standards and codes as of the Effective Date of the Agreement. This risk is borne by Seller.

# 4 SAFETY

The Substation Designer shall incorporate safe work practices into the design of the Collector Substation. The Collector Substation's design and construction shall allow safe operation and maintenance under all foreseeable operating conditions. The design shall ensure that maintenance can be carried out without a significant effect on the Collector Substations operation and will allow adequate working space to maintain minimum approach distances as specified in Section 5.2.3 (Clearances and Spacing), *Table 3*.

Other aspects such as fire hazard and fire suppression and environmental aspects, such as site drainage and oil containment, shall be considered and incorporated in the design. The Substation Designer is responsible for ensuring that the Collector Substations are designed in compliance with the NESC, OSHA, and other regulations. See Section 6 (EQUIPMENT SUPPORT STRUCTURE LOADING) for further details.

# 5 GENERAL REQUIREMENTS

## 5.1 Site Environmental Characteristics

Seller shall use the criteria and values set out in ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION) and any other criteria and values reasonably determined by Buyer to be necessary or appropriate in the design of the Collector Substation.

## 5.2 Substation Current, Voltages and Clearances

### 5.2.1 Current Ratings

The Collector Substation bus systems, jumpers and equipment which is part of the bus shall be designed to serve the maximum equipment ratings. Equipment attached to buses, but not a part of the bus system, shall be designed to service the equipment maximum capabilities.

Any current calculation performed shall take into consideration ambient temperature, temperature rise, conductor maximum operating temperature and coefficient of emissivity. Typical and acceptable ambient temperature value for continuous ampacity shall be 40°C.

Size, variety, and types of conductors used in the Collector Substation shall be kept as minimal as practical.

### 5.2.2 Voltage Ratings

Equipment and bus systems shall be designed for the voltage ratings in accordance with *Table 1*. Project-specific voltage requirements shall be considered, such as high voltage or contamination, and will dictate Basic Impulse Level (***BIL***) and Basic Switching Level (***BSL***) for a specific design. This shall be coordinated and agreed upon by Seller and Buyer during Project planning phases.

Table 1: Equipment Voltage Ratings

| Nominal Voltage (kV) | Rated Voltage (kV) | BIL (BSL) (kV) | Remarks |
|---|---|---|---|
| 13.8 | 15.5 | 110 | Bus, and disconnects shall be rated 34.5 kV, 200 kV BIL |
| 24 | 25.8 | 150 | Bus, and disconnects shall be rated 34.5 kV, 200 kV BIL |
| 34.5 | 38 | 200 | |
| 69 | 72.5 | 350 | |
| 115 | 121 | 550 | Circuit breakers and instrument current transformers shall be rated 145 kV and 650 kV BIL. |
| 138 | 145 | 650 | |
| 161 | 169 | 750 | |
| 230 | 242 | 900 | Instrument current transformers shall be rated 242 kV, and 1050 kV BIL |
| 345 | 362 | 1300 (825) | |
| 500 | 550 | 1800 (1175) | |

### 5.2.3 Clearances and Spacing

All equipment shall be designed to maintain minimum substation clearances and spacing as outlined in *Table 2*, *Table 3*, *Table 4*, *Table 5*, and Table *7*. The below clearances are the minimum allowable clearances for common collector substation HV and MV voltages. Values listed are for altitudes of 1000 meters (3300 feet) or less. See IEEE 1427 for altitude adjustments (if required).

Minimum electrical clearances between the conductors, and conductors to ground, shall be as tabulated below.

Table 2: Substation Minimum Clearances

| Nominal Voltage (kV) | BIL (BSL) (kV) | Minimum Clearance to Ground for Rigid Parts (inches) | Minimum Clearance Between Phases (or Live Parts) for Rigid Parts, Metal to Metal (inches) |
|---|---|---|---|
| 7.5 | 95 | 7 | 8 |
| 15 | 110 | 8 | 9 |
| 25 | 150 | 11 | 12 |
| 34.5 | 200 | 15 | 16 |
| 69 | 350 | 26 | 29 |
| 115 | 550 | 41 | 45 |
| 138 | 650 | 49 | 54 |
| 161 | 750 | 56 | 62 |
| 230 | 900 | 67 | 74 |
| 345 | 1300 (975) | 97 (100) | 105 (140) |
| 500 | 1800 (1300) | 135 (150) | 150 (215) |

## Appendix 1: Collector Substation

Minimum horizontal and vertical clearances to live parts for worker safety shall be as tabulated below. These clearances are intended to prevent unintentional encroachment by a worker into the guard zone.

Table 3: Substation Minimum Safety Clearances

| Nominal Voltage (kV) | BIL (BSL) (kV) | Vertical Clearance | Horizontal Clearance |
|---|---|---|---|
| 7.5 | 95 | 8 ft 10 in | 3 ft 4 in |
| 15 | 110 | 9 ft | 3 ft 6 in |
| 25 | 150 | 9 ft 3 in | 3 ft 9 in |
| 34.5 | 200 | 9 ft 6 in | 4 ft |
| 69 | 350 | 10 ft 5 in | 4 ft 11 in |
| 115 | 550 | 11 ft 7 in | 6 ft 1 in |
| 138 | 650 | 12 ft 2 in | 6 ft 8 in |
| 161 | 750 | 12 ft 10 in | 7 ft 4 in |
| 230 | 900 | 13 ft 9 in | 8 ft 3 in |
| 345 | 1300 (828) | 18 ft 11 in | 13 ft 5 in |
| 500 | 1800 (1167) | 27 ft | 21 ft 6 in |

Table 4: Substation Minimum Vertical Clearances above Ground

| Maximum System Voltage (kV) | Pedestrian Traffic | Roadways |
|---|---|---|
| 7.5 | 14 ft 6 in | 18 ft 6 in |
| 15 | 14 ft 6 in | 18 ft 6 in |
| 25 | 14 ft 6 in | 18 ft 6 in |
| 38 | 14 ft 6 in | 18 ft 6 in |
| 72.5 | 15 ft 2 in | 19 ft 2 in |
| 121 | 16 ft 1 in | 20 ft 1 in |
| 145 | 16 ft 7 in | 20 ft 7 in |
| 169 | 17 ft | 21 ft |
| 245 | 18 ft 6 in | 22 ft 6 in |
| 362 | 20 ft 9 in | 24 ft 9 in |
| 550 | 24 ft 4 in | 28 ft 4 in |

Note: These clearances shall be maintained under the maximum conductor operating temperatures.

Table 5: Substation Minimum Horizontal Clearance to Fence

| Nominal Voltage (kV) | BIL (kV) | Clearance to Fence |
|---|---|---|
| 7.5 | 95 | 10 ft |
| 15 | 110 | 10 ft 1 in |
| 25 | 150 | 10 ft 4 in |
| 34.5 | 200 | 10 ft 7 in |
| 69 | 350 | 11 ft 7 in |
| 115 | 550 | 13 ft |
| 138 | 650 | 13 ft 8 in |
| 161 | 750 | 14 ft 4 in |
| 230 | 900 | 15 ft 5 in |
| 345 | 1300 | 18 ft 4 in |
| 500 | 1800 | 21 ft 6 in |

## 5.3 Substation Equipment

### 5.3.1 Approved Manufacturers

A list of approved manufacturers is included in 0ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION). Seller shall procure items from manufacturers listed in accordance with the Agreement.

### 5.3.2 HV Cables

Seller shall comply with the requirements of the Generator Interconnection Agreement (***GIA***) for the design, manufacturing, installation, and testing of all HV cables.

### 5.3.3 Substation Bus/Conductors

Cable connections between the tube bus and equipment and between equipment shall be Aluminum Conductor Steel Reinforced (***ACSR***), All Aluminum Alloy Cable (***AAAC***) or All Aluminum Cable (***AAC***). Bus connectors shall be aluminum alloy for aluminum-to-aluminum connections and tinned bronze for aluminum-to-copper connections. Hardware connectors shall be welded onto the cable or tube. Aeolian cable shall be installed in the switchyard tubing to limit bus vibration.

### 5.3.4 Insulators

All insulators for the rigid bus system and disconnect switches shall be porcelain station post and shall be ANSI 70 gray in color. High strength or extra-high strength insulators may be required based on detailed analysis. Polymer station post insulators shall be used for jumper standoff support.

Insulators shall conform to ANSI C29 standards. Insulators shall be specified to satisfy mechanical and electrical requirements including creepage based on the Project contamination criteria. If contamination criteria is not available, medium (35mm/kV) shall be used.

### 5.3.5 Insulator Strength

The determination of the required cantilever strength of the insulator shall be performed in accordance with ANSI/IEEE Standard 605. The determination of the required effective bus span length due to insulator strength shall be determined for the insulator chosen and the external forces applied.

### 5.3.6 Load Combinations:

| | |
|---|---|
| Case 1 – Extreme Wind: | 2.5 D + 2.5 W IFW + 1.0 SC |
| Case 2 – Ice with Concurrent Wind: | 2.5 D + 2.5 IWIFI + 2.5 WIIFI + 1.0 SC |
| Case 3 – Seismic: | 2.5 D + 2.5 E (or EFS)IFE + 1.0 SC |

Refer to ASCE 113 for definitions of the load components within the load cases above. Design values for these load cases shall be as defined in Section 7.1 (Design Loads) herein.

IEEE 605-2008 recommends a safety factor of 0.4 be applied to insulator strengths for loads other than short circuit loading and 1.0 for short circuit loading. As detailed in IEEE 605-2008, Section 12.4.2, when different load types are combined, the loads must be calibrated by the appropriate safety factor. As such, the 2.5 load factors on loads other than short circuit loading shown above are used to account for the safety factor on the insulator strength.

### 5.3.7 Surge Arresters

The surge arresters shall be station class, metal-oxide type. Surge arresters shall be in accordance with ANSI C62.11. The arrester housing shall be made of polymeric silicone and shall be gray in color. Arresters up to a rated duty cycle voltage of 60 kV shall be of single unit construction, and not more than 2 pieces up through 120 kV.

Arresters shall not be used as rigid bus supports. Arresters shall be installed on all incoming line terminals and at transformer terminals. Arresters shall be installed as close as possible to the equipment being protected. Duty Cycle Ratings and Maximum Continuous Operating Voltage (***MCOV***) for surge arresters shall be as shown in *Table 6* and dimensions shall be as shown in *Table 7*.

Table 6: Station Class Surge Arrestor Ratings

| Nominal System Voltage (kV) | System Type | Rated Duty-Cycle Voltage (kV) | Rated MCOV (kV) |
|---|---|---|---|
| 2.4 | Effectively Grounded, wye connected system | 3 | 2.55 |
| | Ungrounded or Impedance Grounded, Delta connected system | 3 | 2.55 |
| | Distribution Networks (Note) | 3 | 2.55 |
| 4.16 | Effectively Grounded, wye connected system | 6 | 5.1 |
| | Ungrounded or Impedance Grounded, Delta connected system | 6 | 5.1 |
| | Distribution Networks (Note) | 9 | 7.65 |
| 12.47-14.4 | Effectively Grounded, wye connected system | 12 | 10.2 |
| | Ungrounded or Impedance Grounded, Delta connected system | 18 | 15.3 |
| | Distribution Networks (Note) | 21 | 17 |
| 23 | Effectively Grounded, wye connected system | 21 | 17 |
| | Ungrounded or Impedance Grounded, Delta connected system | 36 | 29 |
| | Distribution Networks (Note) | 36 | 29 |
| 34.5 | Effectively Grounded, wye connected system | 30 | 24.4 |
| | Ungrounded or Impedance Grounded, Delta connected system | 48 | 39 |
| | Distribution Networks (Note) | 48 | 39 |
| 69 | Effectively Grounded, wye connected system | 60 | 48 |
| 115 | Effectively Grounded, wye connected system | 96 | 76 |
| 138 | Effectively Grounded, wye connected system | 120 | 98 |
| 161 | Effectively Grounded, wye connected system | 132 | 106 |
| 230 | Effectively Grounded, wye connected system | 192 | 152 |
| 345 | Effectively Grounded, wye connected system | 276 | 220 |
| 500 | Effectively Grounded, wye connected system | 420 | 335 |

Note: Ungrounded Distribution Network and Systems where an accidental ground can exist for long periods of time.

Table 7: Arrestor Housing Dimensions by Rating

| Rated Duty-Cycle Voltage (kV) | Creepage Distance (inches) | Height (inches) |
|---|---|---|
| 3 | 15 | 8 |
| 6 | 20 | 10 |
| 12 | 25 | 13 |
| 18 | 34 | 14 |
| 21 | 38 | 16 |
| 30 | 45 | 19 |
| 36 | 55 | 23 |
| 48 | 55 | 23 |
| 60 | 69 | 25 |
| 96 | 115 | 45 |
| 120 | 138 | 50 |
| 132 | 161 | 65 |
| 192 | 230 | 92 |
| 276 | 345 | 110 |
| 420 | 500 | 175 |

### 5.3.8 Disconnect Switches

Generator Step-Up (***GSU***) high-side main disconnect switches are not required when there is only a single transformer configuration. The HV line disconnect shall provide isolation to HV circuit breaker and transformer without compromising safety or operations. When a dual transformer configuration is in place, the high side transformer circuit breaker shall include disconnect switches. The GSU shall include a low side disconnect switch to allow isolation of the entire transformer zone without the need of opening feeder circuit breaker hooksticks.

The disconnect switches shall be three-pole, group operated, single-throw complete with station post insulators, switch blades, contacts, operating mechanisms and include all necessary hardware for the assembly and mounting to steel structures. All disconnect switches shall conform to IEEE Standard C37.30.1 for HV switches. Ratings for disconnect switches shall be as shown in *Table 8* and *Table 9*.

Standard practice is to orient the vertical and side break switches so that the blade shall be dead when the switch is in the open position, i.e., the hinge shall be towards the closest circuit breaker.

All disconnect switches shall be provided with arcing horns which will interrupt charging or magnetizing currents to prevent any arcing at the main switch contacts. Grounding switches will be required for HV line disconnect switches. The line disconnect switch and associated ground switch shall be mechanically interlocked to avoid mis-operation, i.e. closing the line disconnect switch when the ground switch is closed and vice versa.

**Appendix 1: Collector Substation**

Table 8: HV Disconnect Switch Ratings

| **Nominal Operating Voltage (phase-to- phase)** | **230 kV** | **161 kV** | **138 kV** | **115 kV** | **69kV** | **34.5 kV** |
|---|---|---|---|---|---|---|
| Maximum Voltage (phase-to-phase) | See *Table 1* | | | | | |
| Basic Impulse Level | | | | | | |
| Maximum Continuous Current (amperes) | To be determined after study results | | | | | |
| Short Time Withstand (symmetrical) Current | To be determined after study results | | | | | |
| Preferred Configuration Type | Vertical Break/Double End Break/Center Break | | | | | Vertical Break/ Center Break/ Hookstick |

Table 9: EHV Disconnect Switch Ratings

| **Nominal Operating Voltage (phase-to- phase)** | **345 kV** | **500 kV** |
|---|---|---|
| Rated Voltage | 362 kV | 550 kV |
| Lightning Impulse Withstand Voltage | 1300 kV | 1800 kV |
| Switching Impulse Withstand Voltage | 885 kV to ground<br>1120 kV across open gap | 1150 kV to ground<br>1450 kV across open gap |
| Rated Continuous Current: | 2000 A, or 3000 A<br>(Note) | 2000 A, or 3000 A<br>(Note) |
| Rated Short Time Withstand | 63 kA rms, 164 kA peak | 63 kA rms, 164 kA peak |
| Short-time Current Withstand Duration | 3 seconds | 3 seconds |

Note: To be determined after study results

Line switches shall be monitored by the Remote Terminal unit (***RTU***) or Supervisory Control and Data Acquisition (***SCADA***) system.

All disconnect switches whether motorized or not will have auxiliary contacts for system monitoring. Auxiliary contacts on motorized switches will not be actuated by the motor cam but will be triggered based on the physical switch position.

Electrical interlocks shall be installed to prevent opening of motor operated disconnects and/or grounding switches when the station main breaker is in the closed position.

The complete switch assembly shall have a rated ice breaking ability to open and close with a ¾ inch thick coating of ice.

Gradient control rings shall be provided for switches at 230 kV and higher voltages on both the hinge end and the jaw end to fully shield the live mechanism parts including the terminal pads.

Flexible braids are not acceptable as by-pass shunts. Flexible laminated current carrying components are acceptable only when welded connections are made on each end. Bolted connections are not acceptable on laminated components. All moving contact surfaces for current transfer shall be silver or silver alloy. Aluminum or plated aluminum is not acceptable.

The switches shall be free of visible corona at 110% rated voltage. The Radio Influence Voltage (***RIV***) shall not exceed 300 microvolts.

All fastenings, nuts, bolts and washers utilized in the non-live parts area shall be of hot-dipped galvanized steel. Plated fastenings are not acceptable.

All bearings shall be heavy duty with stainless steel balls and races. Aluminum or its alloys are not acceptable as a material for bearing raceways or bushing surfaces.

Bearings shall be maintenance free and not located in the current carrying path. Switch bearings shall be lubricated and sealed and shall not require further field lubrication. Dry type, non-lubricated type bearings will be preferred. Lubricant shall be non-deteriorating with a projected shelf life in excess of ten years. All bearing assemblies shall be weatherproofed with corrosion-free seals.

All switches supplied with a manual operating mechanism shall be readily convertible to motor operation.

Maintenance ground studs shall be supplied on both hinge and jaw sides of the switch for attachment of portable ground cables. Design of the ground stud attachment shall be such that presence or absence of the ground studs will not change the switch height from its base to the top of the switch terminal pads. Ground studs shall be capable of being added to a switch in the field without undue switch dismantling. The ground studs shall be corona-free and shall be fully shielded where necessary. The ground stud material shall be the same as that of the switch contacts. The ground stud length shall be at least 6 inches for attaching the portable ground cable clamps and have sufficient strength to support a 50 feet length of a 4/0 copper portable ground cable.

### 5.3.9 Operating Mechanism

Hookstick operated switches may be used for equipment or circuit isolation, and regulator bypass applications up to 34.5 kV. Hookstick operated disconnect shall be located to provide switch operator space to allow 45-degree switch stick angle, for opening or closing, without operator or switch stick bumping into adjacent equipment, structures or foundations. Escape paths shall be considered in layout to deal with arcing or equipment failure that might occur during switching any switch or local breaker operation.

Switches shall be supplied with a manual three-phase group operated mechanism. The operating mechanism shall be designed such that the complete three-phase switch assembly can be operated to fully open and closed positions by one person with a force of not more than 35 pounds applied to the actuating handle.

The vertical operating pipe operation for switches up to and including 145 kV shall be torsion operated by a swing handle. The swing handle shall be galvanized steel pipe not less than 3 feet in length. The switch design, where operation with a swing handle would require a force greater than 35 pounds, shall utilize a worm gear operator.

The vertical operating pipe operation for 170 kV and 230 kV switches shall be torsional operated by a worm gear in lieu of swing handle.

For 363 kV and 550 kV switches, the switch shall be supplied preferably with a three-phase torsional gear drive mechanism with a gearbox for each pole. The operating mechanism shall be designed such that the complete three-phase switch assembly, can be operated to fully open and closed positions with a force of not more than 35 pounds. applied to a manual actuating handle. The worm gear operator, when supplied, shall be in a sealed housing, corrosion and maintenance free. The gear operator shall be self-locking and

prevent back driving of the crank handle during operation. The operating crank handle shall be no more than 15 inches in length.

Status indication of operator position is not required for manually operated switches but is required for motor operated switches.

### 5.3.10 EHV Switches (345 kV & 500 kV) Additional Requirements

The mounting location for the switch operating handle and/or the motor operator shall be the center pole support column.

The switch shall use porcelain station post insulators ANSI TR number 368, rated 1300 kV BIL for 362 kV switches and ANSI TR number 391, rated 1800 kV BIL for 550 kV switches.

### 5.3.11 Line Tuners

Communication using carrier equipment (line traps and tuners) shall not be used.

### 5.3.12 Metering Devices

#### 5.3.12.1 General

Metering systems for the Project shall be designed and installed to monitor and record all energy traveling to and from the Project and to permit the evaluation of the functionality and efficiency of the overall Project.

Shorting-type terminal blocks shall be provided for all current transformer circuits to allow meters to be removed without disrupting current transformer circuits.

A set of metering current transformers on the GSU secondary shall be provided. Potential transformers (***PT***s) shall be provided on the medium voltage buses for input to the meters. Shorting-type terminal blocks shall be provided to allow meters to be removed without disturbing current transformer circuits.

All permanently installed electrical metering instrumentation, or a combination of temporary test and permanently installed instrumentation, that will be used for the Project Performance Tests shall comply with maximum allowable measurement uncertainties per ASME PTC 22.

Except where more restrictive requirements apply, relaying class accuracy voltage and current transformers are acceptable for panel indication meter applications.

ABB FT-1 type test switches shall be provided for the voltage and current inputs to each meter.

#### 5.3.12.2 Revenue Metering

The revenue metering system shall be included in the Work except for installation of the revenue meters, which shall be performed by Buyer. Seller shall purchase the revenue meter(s) from [Entity] Transmission during the design phase of the Project. Notwithstanding anything herein to the contrary, all revenue meters, installation and purchases thereof, and revenue metering shall be in accordance with the GIA or other applicable Required Deliverability Arrangement (to the extent applicable).

All meters shall conform to ANSI Standards C12.20, C12.1, and C12.10.

Seller shall provide and install high accuracy 0.15 B 1.8 extended range Current Transformers (***CT***s) and 0.15 Z accuracy PTs for GSU high-side revenue metering.

Seller shall provide the revenue meter cabinet(s) to Buyer's specifications. Seller shall design and install all wiring needed for revenue metering. Buyer shall install the revenue meters and make the final connections to the meters. Seller's schedule for the Work shall allow a reasonable period of time for Buyer

to undertake, complete, and test such installation and final connections, and Seller shall use commercially reasonable efforts to cooperate with Buyer in connection with such installation and final connections.

#### 5.3.12.3 Metering Locations

Other than where included with standard equipment packages (e.g., inverters), indication metering shall be provided in the following locations:

- High side of each GSU (voltage, current, kW, and kVAR)
- Each medium voltage main breaker (voltage, current, kW, and kVAR)

### 5.3.13 Coupling Capacitor Voltage Transformers & Potential Transformers

Voltage transformers and/or Coupling Capacitor Voltage Transformers (***CCVT***s) are required to provide a low voltage supply to protective relays and metering equipment.

Voltage transformers, Capacitor Voltage Transformers (***CVT***s) and CCVTs are directly connected to the high voltage bus. Fuses shall not be used on the high side of the voltage transformer.

Auxiliary transformers are not permitted.

Refer to *Table 10* and *Table 11* for required CCVT and PT ratings, respectively.

Table 10: CCVT Ratings

| Nominal System Voltage (kV) | Maximum Line to Ground Voltage (kV) | BIL (kV) | Performance Reference Voltage (kV) | Nameplate Ratio | Nameplate Secondary Voltage (V) | Accuracy |
|---|---|---|---|---|---|---|
| 69 | 42 | 350 | 40.25 | 350 / 600:1 | 115 / 67.1 | 0.6 WXYZ |
| 115 | 70 | 550 | 69 | 600 / 1000:1 | 115 / 69 | 0.6 WXYZ |
| 138 | 84 | 650 | 80.5 | 700 / 1200:1 | 115 / 67.1 | 0.6 WXYZ |
| 161 | 98 | 750 | 92 | 800 / 1400:1 | 115 / 65.7 | 0.6 WXYZ |
| 230 | 140 | 1050 | 138 | 1200 / 2000:1 | 115 / 69 | 0.3 WXYZ, ZZ |
| 345 | 209 | 1550 | 209 | 1800 / 3000:1 | 115 / 69 | 0.3 WXYZ, ZZ |
| 500 | 318 | 1800 | 287.5 | 2500 / 4500:1 | 115 / 63.8 | 0.3 WXYZ, ZZ |

Table 11: PT Ratings

| System Voltage (kV) | BIL (kV) | Primary Voltage (kV) | Marked Ratio | Secondary Voltage (each winding) (V) | Accuracy / Burden | Minimum Thermal Burden (VA) |
|---|---|---|---|---|---|---|
| 15 | 110 | 7.2 / 12.47 Grd Y | 60:1 | 120 | 0.3 Z | 1000 |
| 15 | 110 | 8.4 / 14.4 Grd Y | 70:1 | 120 | 0.3 Z | 1000 |
| 25 | 150 | 14.4 / 24.9 Grd Y | 120 / 200:1:1 | 120 / 72 | 0.3 Z | 1000 |
| 34.5 | 200 | 20.125 / 34.5 Grd Y | 175 / 300:1:1 | 115 / 67.08 | 0.3 Z | 1000 |
| 69 | 350 | 40.25 / 69 Grd Y | 350 / 600:1:1 | 115 / 67.08 | 0.3 ZZ | 2000 |
| 115 | 550 | 69 / 115 Grd Y | 600 / 1000:1:1 | 115 / 69 | 0.3 ZZ | 2000 |
| 138 | 650 | 80.5 / 138 Grd Y | 700 / 1200:1:1 | 115 / 67.08 | 0.3 ZZ | 2000 |
| 161 | 750 | 92 / 161 Grd Y | 800 / 1400:1:1 | 115 / 65.71 | 0.3 ZZ | 2000 |
| 230 | 1050 | 138 / 230 Grd Y | 1200 / 2000:1:1 | 115 / 69 | 0.3 ZZ | 2000 |

### 5.3.13.1 Current Transformers

All current transformers shall be in accordance with ANSI-C57.13 and shall meet the following requirements.

Relaying: Bushing type, fully distributed winding, five lead multi-ratio, C800 or as specified. (X and Y positions on a breaker bushing 69 kV and higher; X position on a breaker bushing 34.5 kV only.)

Metering: Bushing type, fully distributed winding, single- or dual-ratio, 0.15% B-0.9 and 0.30% B-1.8 or as specified. To be installed at the Z position on a breaker bushing for 69kV and higher or on the Y position on a breaker bushing at 34.5kV. See Section 5.3.12.2 (Revenue Metering).

Free standing post type current transformers shall be designed to operate at an average ambient temperature of 30°C and with a winding temperature rise not to exceed 55°C. In Buyer's service area, the ambient temperature under full sun can reach as high as 45°C to 50°C.

The minimum thermal rating shall be 2.0.

If continuous load is going to be "X" amps, then the CT shall also be rated "X" amps. Before applying a lower rated CT to benefit from the rating factor the application shall be evaluated thoroughly, and it is generally acceptable only if the peak load is seldom expected and for a very short duration.

Generally, the current transformer rated primary current shall be 10% to 40% above maximum load current when peak load information is unknown. Consideration shall also be given to short circuit levels. The maximum CT ratio shall be selected so that the maximum fault current is less than 20 times the maximum current tap, and so that the maximum secondary CT current is less than 100 amps under maximum fault conditions. An additional rating margin of not less than 25% shall be provided to accommodate future increased fault levels.

Refer to *Table 12* and *Table 13* for required minimum CT ratios and CT accuracy, respectively.

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Table 12: CT Ratios

| Fault Current (kA) | Minimum CT Ratio |
|---|---|
| 48 – 64 | 4000/5 |
| 32 – 48 | 3000/5 |
| 20 – 32 | 2000/5 |
| 0 – 20 | 1200/5 |

Table 13: CT Accuracy

| | At RF *100% Rated Current | At 10% Rated Current | At 5% Rated Current | At ≤ 1% Rated Current |
|---|---|---|---|---|
| 0.3 | 0.3% | 0.6% | | |
| 0.3 S | 0.3% | | 0.3% | |
| 0.15 | 0.15% | 0.3% | | |
| 0.15 S | 0.15% | | 0.15% | 0.15% |

The CT shall have the following primary current and minimum short-time thermal current ratings, rms for one second. For bushing and slip-over CTs these ratings apply to the secondary winding only.

Table 14: CT Short-Time Thermal Current

| Maximum System Voltage (kV) | Primary Current (A) | Short – time Thermal Current (kA) |
|---|---|---|
| 15.5 | 1200 | 25 |
| | 2000 | 31.5 |
| | 3000 | 40 |
| 25.5 | 1200 | 25 |
| | 2000 | 31.5 |
| 36.5 | 1200 | 25 |
| | 2000 | 31.5 |
| | 3000 | 40 |
| 72.5 | 2000 | 40 |
| | 3000 | 63 |
| 123 | 2000 | 40 |
| | 3000 | 63 |
| 145 | 2000 | 40 |
| | 3000 | 63 |
| 170 | 2000, 3000 | 40 |
| 245 | 2000 | 40 |
| | 3000 | 63, 80 |
| 362 | 2000 | 40 |
| 550 | 3000 | 40 |

### 5.3.13.2 CT/PT Combo Units

CT/PT combo units are not allowed. Exceptions must be approved by Buyer in writing.

## 5.3.14 Circuit Breakers

Circuit breakers shall be three phase dead tank design with current transformers on each bushing. A sufficient number of CTs shall be supplied to support the system protection and metering requirements. Circuit breakers shall use SF6 or vacuum interrupters.

DC power for the circuit breaker operation and protection will be 125 VDC.

Bushings shall comply with the requirements of IEEE Std C37.017. Voltage class and the current rating of the bushings and insulators shall not be less than that of the circuit breaker.

Continuous current rating factor (***RF***) shall be 2.0 in accordance with IEEE Std. C57.13.

HV and MV breakers shall not have internal 43 Local/Remote switches. If the breakers do come with a 43 device, the device shall be jumpered out. The only 43 Local/Remote switch shall be in the relay panel in the control house, near the 52 CS. The relay panel 43 switch associated with each breaker shall be a three-position switch, with “Local”, “Remote”, and “Maintenance” positions only (i.e., no “Off” position).

HV and MV breakers shall permit local tripping (i.e., tripping via the control switch in the breaker cabinet OR the 52 CS in the relay panel) regardless of the position of the relay panel 43 switch associated with that breaker. HV and MV breakers shall permit local closing ONLY when the relay panel 43 switch associated with that breaker is in the “Local” position. HV and MV breakers shall permit remote closing ONLY when the relay panel 43 switch associated with that breaker is in the “Remote” position. The “Maintenance” position will be used when working on the circuit and shall initiate a different set of relay settings.

All circuit breakers shall have dual trip coils. Trip coil 1 and the close coil shall be on the same 125 VDC circuit. Trip coil 2 shall be on a separate 125 VDC circuit. Trip circuits shall be in separate cables.

A platform shall be installed for maintenance access if operators will not or would not reasonably be expected to be able to reach all breaker equipment while standing at grade (cabinet access 60” or higher). Seller shall perform a detailed review of breaker manufacturer drawings to ensure that operability concerns, such as proper cabinet heights or the need for a platform, are addressed.

### 5.3.14.1 High Voltage Circuit Breaker:

HV power circuit breakers shall be SF6 gas insulated, dead-tank, “puffer” type design with a spring-spring type operating mechanism. Auxiliary contacts for breaker internal control functions shall be provided plus additional form “a” and form “b” field convertible contacts per *Table 15*. Circuit breakers shall conform to IEEE C37. Circuit breaker ratings shall be as shown in *Table 15*.

Table 15: HV Circuit Breaker Ratings

| Rated Maximum Voltage | | 72.5 kV | 123 kV | 145 kV | 170 kV | 242 kV |
|---|---|---|---|---|---|---|
| Rated Continuous Current (as specified) | | 1200 A<br>2000 A | 2000 A<br>3000 A | 2000 A<br>3000 A | 2000 A<br>3000 A | 2000 A<br>3000 A |
| Rated Short Circuit Current (to be determined after study results) | | 40 kA | 40 kA<br>63 kA | 40 kA<br>63 kA | 40 kA | 40 kA<br>63 kA |
| Lightning Impulse Withstand Voltage | | 350 kV | 650 kV | 650 kV | 750 kV | 900 kV |
| Rated Interrupting Time | | 5 cycles | 3 cycles | 3 cycles | 3 cycles | 3 cycles |
| Rated shunt Capacitor Switching current | | 630 A | 315 A | 315 A | 400 A | 400 A |
| Additional Auxiliary Contacts | Form “a” | 12 | | | | |
| | Form “b” | 12 | | | | |

The alarm for SF6 gas breakers shall be annunciated at the operations control center. SF6 meter/monitor shall be suitable for the loss of SF6 emissions. All of the available alarms for HV breakers shall be inputs into the substation RTU and made available to the Electric Reliability Coordinating Council (***ERCC***) via the communications network.

All HV circuit breakers shall have low SF6 pressure alarms and emergency operations for:

Stage 1: Low gas pressure

Stage 2: Auto-trip of the trip coil 1 and trip coil 2 circuits and block close of the close coil circuit.

Stage 3: Block-trip of the trip coil 1 and trip coil 2 circuits and block close of the close coil circuit.

### 5.3.14.2 EHV Circuit Breakers (345 kV & 500 kV)

Additional specific requirements pertaining to 345 kV & 500 kV circuit breakers will be provided under separate cover where applicable.

### 5.3.14.3 Medium Voltage: Collector Feeders and Reactive Breakers:

MV circuit breakers shall be rated for outdoor, three-poles, gang operated, dead tank, frame mounted vacuum type with motor charged operating mechanism in conform to IEEE C37. MV circuit breaker ratings shall be as shown in *Table 16*.

Table 16: MV Circuit Breaker Ratings

| | |
|---|---|
| Nominal Operating Voltage (phase-to-phase) | 34.5 kV |
| Maximum Voltage (phase-to-phase) | See *Table 2* |
| Basic Impulse Level | See *Table 2* |
| Maximum Continuous Current (amperes) | To be determined after study results |
| Short Circuit Interrupting Current (kA) | 40kA with full back-to-back switching capability; tested and proven* |
| Interrupting Time (cycles) | 3 |
| Independent Pole (Phase) Operators | N/A |
| Duty Cycle | O-0.3 sec – CO -3 min - CO |
| Spring Motor Voltage | 125VDC |
| AC Heaters and Receptacle Voltage | 120/240VAC |
| Additional Auxiliary Contacts | Forms “a” and “b” |

*40kA analysis - use conservative design/results. The results of final short circuit model shall dictate the final rating.

### 5.3.15 Generator Step-Up / Main Power Transformer

This Section describes requirements for the Main Power Transformer (***MPT***) within the Collector Substation. This item is also referred to as the Generator Step-up (***GSU***) transformer. The GSU connects the medium voltage collector system to the high voltage interconnecting transmission system.

The GSU shall be built to ANSI/IEEE C57. The GSU shall be an outdoor, oil-filled power transformer and designed in accordance with the Project Site climactic conditions listed in Section 5.3.15.3).Unless otherwise specified, winding connections for the transformer shall be a wye-g/wye-g/delta (internally buried) configuration with a neutral grounding bushing on the high and low sides. The low-side winding shall be appropriately insulated when specified for use with impedance grounding applications.

The GSU ratings shall be based on the Project’s expected total generation at all operating power factors, including all applicable derating factors and confirmed through software simulations. A minimum 10% design margin shall be included.

The GSU shall be purchased complete with bushings, current transformers, tap changers, surge arresters, cooling equipment (such as radiators & fans), and control/monitoring system equipment.

Ancillary equipment such as bushings, tap changer, winding leads, etc., shall not restrict the transformer loading to levels below those permitted by the winding conductor. The transformer shall be capable of carrying loads above its nameplate rating in accordance with IEEE C57.91. All internal parts of the transformer shall be designed to withstand the accelerations encountered on the US and other railroads enroute to the point of delivery. The design criteria for rail shipment shall be 5g longitudinal, 3g transverse, and 3g vertical.

*Table 17* below provides some recommended transformer specifications to consider. Project specific engineering requirements may differ from the recommended specification listed in this table.

Table 17: Transformer Recommended Specifications

| **Project MW** | | **260** | **240** | **195** | **150** | **100** | **20** |
|---|---|---|---|---|---|---|---|
| Transformer MVA | ONAN | 180 | 168 | 135 | 105 | 69 | 18 |
| | ONAF1 | 240 | 224 | 180 | 140 | 92 | 24 |
| | ONAF2 | 300 | 280 | 225 | 175 | 115 | |
| %Z (H-X, Positive Sequence) | | 9.0% | 9.0% | 8.5% | 8.5% | 8.0% | 8.0% |
| $X_0$ Neutral Reactor | | Yes | Yes | Yes | Yes | No | No |

Assumptions:

1. Power factor range required at point of interconnect is +/- 0.95
2. Inverters are capable of +/- 0.8 power factor
3. Substation is not close to synchronous generation switchyard
4. Transformers over 300 MVA not recommended due to 34.5 kV fault current. ONAF2 Rating should be 115% of the Project MW rating.
5. Based on transformer winding configuration: HV (wye-gnd); XV (wye-gnd); XV (delta-buried)

### 5.3.15.1 Loss Evaluation

The test system accuracy for measuring losses shall be as specified in IEEE C57.12.00. The calibration and the accuracy of the test equipment shall be traceable to the National Institute of Standards and Technology.

The manufacturer shall guarantee the following losses for each transformer:

- No-load loss in kilowatts at rated voltage and rated frequency
- Total losses (sum of no-load loss and load loss) in kilowatts at ONAN rated output, rated voltage and rated frequency
- Auxiliary losses (all cooling in operation)

Load losses shall be evaluated on the ONAN 65°C rating for each transformer.

Transformer losses determined under tests shall be corrected to 85°C. No-load loss shall not be corrected to 20°C.

### 5.3.15.2 Non-Conformance

Entergy reserves the right to reject a transformer that exceeds the specified temperature rise limits. If a transformer exceeds the 65 °C temperature rise limit during tests at rated loads, and / or exceeds the 80 °C hottest spot winding temperature rise (measured or calculated) resulting in a de-rating of capacity, then a price penalty of 2.0% of the transformer purchase price for each °C by which the temperature rise is exceeded shall apply. No credit shall apply if the actual test temperatures are lower than rated.

### 5.3.15.3 Service Conditions

The power transformer fully assembled with accessories and auxiliary equipment shall be suitable for installation and operation in an ambient temperature range of – 20 °C to + 40 °C, withstand hurricane winds up to 150 mph, or a one-inch-thick coating of ice with wind up to 40 mph. The transformer shall be designed according to the requirements of IEEE Std 693 Annex D. The transformer assembly shall be designed to withstand seismic loading as specified in IEEE 693.

All control components shall be capable of operating in a temperature range of minus 20°C to plus 70°C in the control cabinet(s). The control cabinet design shall ensure that all control components will operate satisfactory when the transformer is loaded at 120% of its nameplate rating in a 40°C ambient temperature, 90% relative humidity, in full sun with no wind. The control cabinet design shall ensure that damage from condensation inside the cabinet is prevented.

### 5.3.15.4 Winding Insulation

The BIL of the transformer windings and bushings shall be as listed below for the specified nominal system voltage.

Table 18: Transformer Winding BIL

| Nominal System Voltage (kV) | Winding Lightning Impulse Level (kV) |
|---|---|
| 500 | 1550 |
| 345 | 1175 |
| 230 | 825 |
| 161 | 650 |
| 138 | 550 |
| 115 | 450 |
| 69 | 350 |
| 34.5 | 200 |
| 24 | 150 |
| 13.8 | 150 |

The inter-winding insulation system between windings, phases and to ground shall be designed for maximum voltage stress and with a safety margin of 20% for the oil space stresses. Weidmann de-gassed oil gap curves shall be used to determine the field stresses. Design insulation level (***DIL***) factors shall be as follows:

- Lightning impulse: 2.5
- Switching impulse: 1.8
- Induced test (enhanced): 0.8

The use of Metal Oxide Varistor (***MOV***) or other internal devices to control voltage transients is not allowed without prior approval from the buyer. If used, the location shall be shown on the nameplate winding schematic and must be accessible form the top of the transformer without draining of the oil.

### 5.3.15.5 Impedance

The transformer percent impedance at the self-cooled (ONAN) rating, with and without a Load Tap Changer (***LTC***) shall be as specified in *Table 19* below (for 345 kV and 500 kV, requirements will be provided under separate cover);

Table 19: Impedance

| HV Winding Voltage (kV) | Impedance % | |
|---|---|---|
| | Without LTC | With LTC |
| 230 | 10.0 | 10.5 |
| 161 | 9.5 | 10.0 |
| 138 | 9.0 | 9.5 |
| 115 | 8.5 | 9.0 |
| 69 | 8.0 | 8.5 |
| 34.5 | 7.25 | 7.5 |
| 24 | 6.75 | 7.0 |
| 13.8 | 6.75 | 7.0 |

### 5.3.15.6 Winding Temperature

The maximum average winding temperature rise shall be 65°C. The maximum hottest-spot temperature rise of the winding shall not exceed 80°C. The maximum hottest-spot temperature rise of any metal components in the transformer core and tank whether in contact or not in contact with the paper insulation, shall not exceed 80°C at an ambient temperature of 40°C.

The calculated maximum temperature rise of any lead or connection shall not exceed the calculated maximum winding hottest spot temperature rise.

The temperature of any serviceable metal parts, gauges, switch handles, etc., located in the control cabinet that may be touched by an operator under normal operation shall not be affected by the transformer and shall not exceed the ambient temperature by more than 10°C at maximum rated load.

Winding hottest-spot calculations shall be made for each winding using the maximum localized losses including the eddy current losses, the insulation thickness at the points of maximum localized losses, and the oil rise in the winding. If Seller is unable to measure the oil rise in the windings, an allowance will be made for the added rise at the design review. These results shall be used in calibrating the hot-spot temperature indicator.

### 5.3.15.7 Audible Sound Level

The audible sound level shall not exceed levels specified in the NEMA TR-1.

### 5.3.15.8 Short Circuit Capability

The transformer shall be designed and constructed to withstand, without damage, the effects of both three-phase and line-to-ground through-faults at either of the transformer HV, LV, or Tertiary Voltage (***TV***) terminals. The windings shall not exceed the IEEE thermal limits for the duration of 2 seconds. The pre-fault operating voltage on the non-faulted terminals shall be 1.05 per unit rated voltage.

All windings shall be designed for an infinite bus condition i.e. system impedance shall not be used in the calculation of the fault currents. The inner windings shall be designed to withstand maximum short circuit forces in an unsupported buckling mode (free buckling), assuming no radial mechanical support from the core. The windings shall also be designed for forced or supported buckling.

For shell form transformers, the maximum allowable tolerance for the support members between the core and the tank walls shall not exceed 1 mm.

### 5.3.15.9 Laminated Iron Core

The iron core shall have grain-oriented steel, and all core joints shall be the mitered step-lap design. No core through-bolts are allowed in the design.

The transformer core shall not be saturated when operating at 115% of rated voltage

The cooling ducts in the core shall be either ceramic, high temperature fiberglass, or buyer approved equivalent.

High temperature fiberglass or Nomex insulation or other Buyer approved high temperature material shall be used for the insulation between the tie plates and the core.

The iron core shall be designed such that at full load and with 105% rated secondary voltage, the maximum core temperature (hotspot) shall not exceed 120°C (80°C rise at 40°C ambient), and the maximum tie plate or core surface temperature rise shall also not exceed 120°C (80°C rise at an ambient of 40°C).

The top and bottom T beams in Shell Form transformers shall be insulated from the core and tank. Separate grounds shall be brought from the various sections of the core to terminals in a weatherproof enclosure. Separate grounds shall be brought to separate terminals from the T- beams.

### 5.3.15.10 Windings:

All windings shall be circular. All winding conductor material shall be copper, and all other current-carrying parts shall be copper or silver, or alloy(s) of copper and/or silver.

The current density in the winding conductor under maximum rated power at 65°C temperature rise shall not exceed 4 A / mm2 (2580 amps per square inch).

The winding conductor insulation shall be thermally upgraded paper meeting the life criteria as defined and verified in IEEE C57.100. The minimum nitrogen content of the upgraded paper when tested by ASTM standards shall not be less than 2%.

When more than one high-side or low-side voltage rating is specified, series multiple connections shall be made using an external switch or (preferably) brought to a terminal board readily accessible through a hand hole(s) in the cover. Changing of connections shall be designed to avoid disturbing the insulated leads. Terminal boards shall be accessible without lowering the oil and shall employ captive hardware.

### 5.3.15.11 Tank Construction, Physical Features & Finish

All welding shall be in accordance with ANSI/AWS D1.1 / D1.1M, American Welding Society Steel Structural Welding Code.

The transformer tank shall be of welded sheet steel construction, free from distortion and provided with a steel base to permit rolling and skidding of the transformer in any direction. The transformer “footprint” shall have a maximum pressure of 5000 pounds per square foot.

The transformer tank cover shall be welded to the tank using flanges to facilitate removal. All tank joints and penetrations (except cover) shall be welded both on the inside and the outside.

The main tank, radiators, conservator, and LTC compartment(s) as applicable shall be designed to withstand full vacuum and at least 10 psig positive pressure without leakage or distortion.

There shall be two (2) or more round manholes in the main tank cover. Manhole covers shall be round with 2 lift-handles. The minimum inside diameter of manholes shall be 20 inches.

The tank cover shall be peaked or sloped to prevent rainwater accumulation. All oil and gas seal designs shall have grooves for gasket retention and shall have groove-depth controlled compression for maximum seal life.

Fall protection system consisting of FALLSOFT GM 135 fall arrest anchor plates for rescue purposes be supplied. One anchor plate shall be welded at each manhole location and one anchor plate shall be welded at the least congested corner of the transformer tank. All gaskets shall be one-piece, oil-resistant nitrile elastomer or Fluoro elastomer, such as Viton, compatible with the transformer operating temperature. All gasket materials shall be verified in accordance with ASTM D3455 to be compatible for the intended use with transformer oil. The gasket material shall also be fully compatible with the fluids used in the bushings. Gaskets shall not be exposed to the weather. The gasket material shall also be fully compatible with the fluids used in the bushings.

The transformer tank and all oil-filled accessories shall be labeled with a “NON PCB” permanent tag.

The location of the “shipping” and “dressed” center of gravity shall be marked with raised letters and symbols on the transformer tank.

A minimum of four stainless steel ground pads shall be provided welded to the tank wall on each corner near the base and shall be as specified in IEEE Std C57 12.10. Support brackets shall be welded to the tank wall to support the neutral and surge arrester ground leads. Support brackets and the copper bus bar down leads with necessary connectors from the neutral terminal and the surge arresters ground terminals to the grounding pads near the bottom of the transformer case shall be provided by the transformer manufacturer. Ground conductors for the neutral and arrester grounds shall be ¼ inch x 2 inch (minimum) rigid copper bar. The HV & LV side ground busbars shall run along the top and down the tank sidewalls on both ends of the transformer. The busbars shall be attached to supports welded to the tank sidewalls and shall be grounded to the NEMA 2-hole ground pads near the tank base.

Insulating oil shall be inhibited, type II, 0.3 percent DBPC, or DBP. Insulating oil shall be non-corrosive when tested in accordance with a modified ASTM D-1275 Part B requiring a minimum duration of 48 hours at a minimum temperature of 150 °C. Insulating oil shall not contain any detectable PCB's. Purchaser shall be contacted for oil shipping instructions.

### 5.3.15.12 Oil Preservation System

The oil preservation system shall be a sealed-tank system with a constant pressure inert gas-pressure or conservator/diaphragm system.

### 5.3.15.13 Conservator Tank System

The tank (or conservator) shall have sufficient capacity to ensure that oil will not be below low-oil trip level at an ambient temperature of –20 °C with transformer de-energized and will not overflow at an ambient temperature of +40 °C when the transformer is loaded at 125% of its nameplate rating in accordance with IEEE Std C57.91.

The conservator shall include a diaphragm that completely separates the insulating oil from the atmosphere. The conservator shall be supplied with a maintenance free dehydrating breather.

A gas collector system shall be mounted on the transformer main tank cover and shall tap the tank cover at adequate intervals (bushing pockets if used) to allow all gases that are generated in the tank to freely enter the gas collector system. The gas collector system shall be equipped with a valve, located a maximum of five (5) feet above the transformer base, for gas sample collection and the release of excess gasses from the system. The valve opening shall be capable of accepting ¼ inch plastic tubing for collecting gas samples. The collecting system shall be designed to shed water off the top of the transformer to prevent standing water.

The conservator and the piping shall be provided with valves and fittings for complete oil filling of the main tank, turrets, radiators, and the conservator under vacuum.

The diaphragm in the conservator shall be made of a flexible oil- and fungus resistant nitrile elastomer. The diaphragm manufacturer shall determine the leakage rate through the rubber preferably using helium gas. The gas permeation rate through the rubber shall be such that the oil will not become saturated for a minimum of twenty years. The bags shall be Pronal, Musthane or buyer approved. Drawings of the diaphragm shall be included in the instruction manual.

### 5.3.15.14 Inert-Gas Pressure System

The tanks of transformer with inert-gas pressure system shall have sufficient capacity to ensure that the oil will not be below the low-oil trip level at an ambient temperature of -20 °C with the transformer de-energized. The internal gas pressure in the transformer tank shall not exceed 8 psig at an ambient temperature of + 40 °C with the transformer loaded at 125% of its nameplate rating.

Inlet and outlet fittings for Nitrogen connections in the transformer shall be located on diametrically opposite sides of the transformer tank wall. Shut off valves to isolate the Nitrogen system shall be mounted at a height less than six feet from the base of the transformer.

The nitrogen gas bottle shall be located on a shelf 3 inches from bottom of transformer tank and secured to transformer tank by a strapping design with shield above valve, in compliance with OSHA safety regulations. There shall be at least two stages of pressure reduction regulation in the inert gas system from the bottle pressure to the pressure in the transformer (settable down to 1.5 psig). The regulation equipment (not the Nitrogen bottles) shall be in a self-contained, weatherproof, steel cabinet. Removal and replacement of the regulator shall be readily accomplished. A pressure gauge (3000 psig) for monitoring the pressure in the gas cylinder shall be provided. The gauge shall be equipped with a contact to indicate 200 psig. A contact shall be wired to the terminals in the control.

The inert gas monitoring system shall be provided with the following gauges and alarms inside the cabinet. All alarm contacts shall be wired to an independent terminal block in the gas cabinet and brought to the alarm terminal block in the main control cabinet.

- Pressure gauge for monitoring the transformer tank pressure.
- A ball valve between the transformer tank and the gauge to allow calibration of gauge at site.
- A self-resetting low-pressure switch for monitoring the transformer tank pressure. The alarm contacts shall be set to close at 4 ounces per square inch of decreasing pressure in the main transformer tank and reopen at 6 ounces per square inch increasing pressure.
- A transformer high-pressure alarm switch for monitoring the transformer tank pressure.
- The alarm contacts shall be set to close at least 1.0 psig below the maximum rated tank operating pressure.

### 5.3.15.15 Valves, Pipes and Hardware

All valves shall be flange mounted. All valves shall have provision for padlocking. The transformer shall be provided with the following valves and fittings for oil filling and processing:

- Oil drain valve. (with ¼ inch oil sampling valve)
- Vacuum pump connection.
- Oil filling connection with oil deflectors inside the tank.

An “oil supply valve” and an “oil return valve” – shall be provided on the transformer tank for connection to a “Dissolved Gas in Oil” monitoring system. The valves shall be 1-1/2 inch NPT gate valves with a plug. The oil supply valve shall be located near the radiator top header and the oil return valve shall be located near the transformer tank base. Distance between these two valves shall be not less than three feet. Both valves shall be located as close to the control cabinet as practical.

### 5.3.15.16 Bushings and Terminals

All bushings shall be in accordance with IEEE Std C57.19.01 with the rated voltage and minimum BIL as tabulated below.

Table 20: BIL and Voltage Ratings for GSU Bushings and Terminals

| Nominal System Voltage (kV) | Rated Voltage of Bushing (kV) | Rated BIL of Bushing (kV) |
|---|---|---|
| 500 | 318 | 1675 |
| 345 | 220 | 1175 |
| 230 | 146 | 900 |
| 161 | 146 | 750 |
| 138 | 102 | 650 |
| 115 | 88 | 550 |
| 69 | 44 | 350 |
| 34.5 | 22 | 200 |
| 24 | 16 | 150 |
| 13.8 | 10 | 150 |

The rated current of the bushing shall be as specified in IEEE Std C57.19.01 but not less than 1.2 times the transformer load current corresponding to its maximum MVA rating with full cooling in operation.

All bushings including the neutral bushing shall be provided with test taps.

All bushings shall be power factor tested. Values of “C1” and” C2” shall be stamped on the bushing nameplates.

The oil sight gauges or sight glass on cover-mounted bushings shall face “outward” so that the oil level sight glass in the bushing can be seen from ground level. All bushing nameplates are to face outward to allow reading of nameplates with spotting scope.

All bushings shall be paper-oil condenser type. Minimum clearance between the live parts of bushings and surge arresters to the components of the transformer that may be serviced (e.g. gas detector relay, valves, gauges, etc.) shall be in accordance with OSHA requirements. Bottom of the bushings shall be minimum 8.5 feet above ground including six-inch foundation pad. Vertical clearance between the bushing terminal and the ground shall be in accordance with National Electrical Safety Code IEEE Std C2 requirements.

Bushings shall have the creepage distance set forth in Table 21.

Table 21: GSU Bushing Creepage Distance

| System Voltage (kV) | Creepage Distance (inches) |
|---|---|
| 15 | 15 |
| 25 | 25 |
| 35 | 35 |
| 69 | 69 |
| 115 | 115 |
| 138 | 138 |
| 161 | 161 |
| 230 | 230 |
| 345 | 345 |
| 500 | 415 |

All bushings shall be supplied with NEMA standard 4-hole, four-inch square stud connector terminal pads, machine-finished and tin plated on both sides. The H2 and X2 bushings shall be located on the same centerline, and where practicable shall be on the main tank centerline.

Minimum metal to metal clearance between the live parts of bushings in the air shall be as tabulated below in *Table 22*.

Table 22: GSU Bushing Minimum Clearance Between Live Parts

| System Voltage (kV) | Clearance (phase to phase) (inches) | Clearance (phase to ground) (inches) |
|---|---|---|
| Up to 34.5 | 24 | 15 |
| 69 | 32 | 26 |
| 115 | 48 | 41 |
| 138 | 60 | 49 |
| 161 | 72 | 56 |
| 230 | 90 | 67 |
| 345 | 120 | 100 |
| 500 | 160 | 150 |

### 5.3.15.17 Bushing Current Transformers

Internal, multi-ratio, bushing-type current transformers shall be provided with all secondary terminals wired to shorting terminal blocks using ring type lugs without intermediary splices.

CT ratios shall be based upon full load current through the bushing(s). Typical CT ratios are listed below in Table 23. Actual ratios to be confirmed as required to support protection relaying scheme requirements and shall be submitted for Buyer's written Buyer approval. For 345 kV and 500 kV voltages, requirements will be provided under separate cover.

Table 23: GSU Bushing Typical CT Ratios

| BUSHING VOLTAGE (kV L–L) | kV | 600:5 | 1200:5 | 2000:5 | 3000:5 | 5000:5 | XFMR WINDING MVA RATING: 3Ph @65C |
|---|---|---|---|---|---|---|---|
| | 13.8 | 12-14 MVA | 19-28 MVA | 28-47 MVA | 47-71 MVA | 71-100 MVA | |
| | 14.4 | 12-14 MVA | 19-29 MVA | 29-49 MVA | 49-74 MVA | 74-100 MVA | |
| | 24 | 12-24 MVA | 33-49 MVA | 49-83 MVA | 83-100 MVA | | |
| | 34.5 | 12-35 MVA | 48-71 MVA | 71-100 MVA | | | |
| | 69 | 12-71 MVA | 95-100 MVA | | | | |
| | 115* | 12-100 MVA | | | | | |
| | 138* | 12-100 MVA | | | | | |
| | 161* | 12-100 MVA | | | | | |
| | 230* | 12-100 MVA | | | | | |

Note: CT ratio should be appropriate such that CT saturation is taken into consideration for project specific fault currents.

The continuous thermal current-rating factor for the bushing current transformers shall be 2.0 based on temperature rise in accordance with IEEE Std C57.13 unless specified otherwise in this Appendix.

All current transformers shall be multi-ratio with ratios in accordance with IEEE Std C57.13. All secondary leads shall be brought to the control cabinet. All secondary leads for each CT shall be terminated and individually identified, at individual short circuiting terminal blocks, equipped with a shorting bar that permits each terminal to be shorted to the other when a set screw is inserted. CTs that are spare and do not have any connected secondary load shall be short circuited with temporary yellow shorting wire jumpers on Customer side of terminal block, in addition to the set screw. Sole use of shorting set screw is not acceptable. exterior CT leads shall be protected in schedule 40 aluminum, or hot-dipped galvanized steel conduit. This conduit shall not be shared for other wiring.

Provision shall be made to remove and replace the CTs without removing the tank cover.

### 5.3.15.18 Surge Arresters

Surge arresters shall be station class silicone polymer. Energy class of surge arresters for application up to system voltage 245 kV shall be class “F”, and for application at 362 kV and 500 kV shall be class “G” in accordance with IEEE Std. C62.11.

Table 24: GSU Arrester Ratings for an Effectively Grounded, wye connected system

| System Voltage (kV) | Surge Arrester Rated Voltage (kV) | Surge Arrester MCOV (kV) |
|---|---|---|
| 500 | 420 kV | 335 kV |
| 345 | 276 | 220 |
| 230 | 192 | 152 |
| 161 | 132 | 106 |
| 138 | 120 | 98 |
| 115 | 96 | 76 |
| 69 | 60 | 48 |
| 34.5 | 30 | 24.4 |
| 24 | 21 | 17 |
| 12.47-14.4 | 12 | 10.2 |
| 4.16 | 6 | 5.1 |
| 2.4 | 3 | 2.55 |

Arrester ratings for an Ungrounded or Impedance Grounded, Delta connected system shall be provided on a project basis and require approval by the Buyer.

The height, from base to the terminal, of the arresters up to 34.5 kV shall be the same as that of the associated LV bushing to reduce probability of flash cause by wildlife. Spacers should be added at the base of the arresters if necessary.

Each arrester shall be individually grounded.

### 5.3.15.19 Cooling System

The transformer shall be provided with two stages of cooling using forced air circulation ONAN/ONAF/ONAF).

Connection provisions shall be made in the cooling equipment controls circuit to allow external interlocking with the transformer protective relaying scheme, such that operation of normally closed contacts of the transformer protection lockout relay (86T) will shut down the cooling equipment in the event of an internal transformer fault.

### 5.3.15.20 Fans

The fans shall have a one-piece, heavy duty, dynamically balanced metal blade. Sheet metal or plastic blades are not acceptable.

Fan motors shall be NEMA type, totally enclosed, outdoor weatherproof with sealed ball bearings.

Unless specified otherwise in the purchase requisition the motor voltage shall be 230 Vac, single-phase, 60Hz. Plugs for all unused fan motor weep holes shall be provided.

Fans shall not be located on top of the radiators nor directly mounted on radiator fins. Separate, removable mounting support for fans shall be supplied and bolted to the transformer tank.

Fan guards shall be hot-dipped galvanized, totally enclose the fan blades, and meet OSHA safety requirements.

### 5.3.15.21 Radiators

Radiators shall be detachable from the main tank and preferably shall be interchangeable. The radiators shall be equipped with bolted flanges and valves to permit the removal of any radiator without draining the oil from the transformer or any other radiator and without the loss of cooling from other radiator banks. Lifting eyes shall be provided on each radiator/cooler group.

Studs welded to the tank or headers for mounting of the radiators are not acceptable.

Radiator shut-off valves (butterfly type) shall be provided for each detachable radiator or header, at both top and bottom openings to the main transformer tank. It shall be possible to remove individual radiators for maintenance without the loss of cooling from other radiator banks. The open and closed positions on the radiator shut-off valves shall be clearly and marked.

Radiators shall be heavy hot-dip galvanized in accordance with ASTM A123. As measured in accordance with ASTM A386, minimum zinc-coating thickness shall be 3 mils or 1.8 oz/ft2. If any repair of the galvanizing coating is necessary, Seller shall make such repairs in accordance with ASTM 780. Radiators shall be located about the main tank such that access to drain and fill valves, gauges, thermowells, manholes, etc., is not blocked.

### 5.3.15.22 Cooling Equipment Control

All protective devices, control switches and contactors, etc., required for the control of fans shall be located in the transformer control cabinet.

Winding temperature indicators/sensors shall be calibrated to simulate the winding(s) actual hottest spot temperature and shall actuate automatic control of the fans.

An alarm relay shall be provided for each stage for cooling failure.

A two-position "Fan Transfer Switch" shall be provided to allow selection of either bank of cooling equipment to operate on either stage of cooling.

A three-position switch shall be provided to allow manual or automatic operation of cooling equipment. Switch positions shall be marked "Auto-Off-Manual".

Each bank of cooling equipment shall be fed separately from and protected by a two-pole breaker of adequate rating, 20 kA interrupting capacity minimum.

Means shall be provided to turn off the cooling system with a remote contact.

### 5.3.15.23 Control Cabinets

Control cabinet(s) shall comply with the requirements of IEEE Std C57.148 except were modified by this specification.

All cabinets shall be of sheet metal, minimum 12-gauge thickness, weatherproof and sufficiently rigid to prevent warping of doors to ensure positive operation of doors and latches. The top of the cabinet shall be sloped to prevent water accumulation. A drip shield shall be provided above the cabinet door(s). Doors shall be hinged and shall have a heavy duty, handle-type three-point latch. All hinges, latches, etc. shall be made of stainless steel. Cabinets wider than four (4) feet shall have two approximately equal sized doors.

The inside pocket on the door shall contain one copy of the instruction manual and OEM drawing set.

All devices for the transformer control, indication, and terminal blocks for external cable connections shall be located in a weatherproof control cabinet. All control, power, CT, cooling system and alarm wiring shall be terminated in the control cabinet.

The bottom of the cabinet shall be approximately 24 inches above the foundation or the base of the mounting structure. Sufficient space and clearances shall be provided at the bottom of the cabinet to facilitate cable entry and termination.

All devices, switches, and pushbuttons that require routine access by Entergy shall be located not more than 60 inches above the foundation. Gauges in the cabinet shall be clearly readable from the ground.

All control cabinets shall be provided with heaters for anti-condensation. The heaters shall be rated to operate at 120 V ac and each heater shall be on its own circuit, protected by an appropriate 20 kA interrupting capacity circuit breaker. The heaters shall be Positive Temperature Coefficient (***PTC***) for temperature limiting heater(s) of sufficient size to prevent moisture condensation. Fan-less PTC heaters, where used, shall be oriented to facilitate convective air flow over their fins to maximize heat transfer.

A 120-volt, 15 Amp weatherproof convenience duplex receptacle with ground fault protection shall be provided on the exterior of the control cabinet. A circuit breaker for this receptacle shall be provided inside the cabinet.

The cabinet interior shall have a switched convenience light. Large cabinets shall have two switched convenience lights.

The cabinet shall be provided with a grounding bar for individually grounding current transformers, control cable shields, etc.

### 5.3.15.24 Auxiliary Equipment and Control Wiring

Exterior wiring shall be enclosed in schedule 40, hot-dipped galvanized steel conduit. PVC is not acceptable. Flexible water-tight metallic shielded conduit or oil-resistant rubber-jacketed cords may be used for short runs to permanently mounted devices

Control wiring terminal blocks shall be barrier type rated 600 Volts, 30 amperes for 10 AWG control wire. Screws, with locking device, shall be non-ferrous and corrosion resistant Philips fillister-head metal type. An additional 20% spare or extra terminations shall be installed within the control cabinet. All metal parts of the terminal block shall be nonferrous and corrosion resistant. All terminal blocks with voltage above 120V shall be fitted with insulating covers to prevent accidental contact.

Wires shall be terminated using solder-less, compression type insulated ferule, ring terminals. Double lugging (two wires in one connector) is not permitted. Connectors shall be rated for the wire size used. The use of shims to allow use of larger connectors is not acceptable.

All current transformer wiring shall be minimum number 12 AWG stranded copper and all other wiring except for instrumentation shall be a minimum number 14 AWG stranded copper. All wiring shall be insulated for 600 volts with 150 °C insulation.

All wiring and components, including relay coils, motor controls, etc., shall be minimum 600 Volts AC insulation class, where applicable. Circuit breakers shall be thermal-magnetic, and rated a minimum of 240 Volts ac.

Oil stops shall be provided where wiring enters a chamber exposed to oil vapor.

All devices shall be identified by suitable nameplates in English. Polarity, phase and tap identification

shall be provided where applicable. Terminal blocks and all other devices shall be numbered in accordance with IEEE Std C37.2.

### 5.3.15.25 De-Energized Tap-Changer

A tap changer for de-energized operation is required for the transformer unless specifically requested otherwise. When supplied, the taps shall be full capacity with two plus and two minus 2½% steps in the

high voltage winding. The internal mechanism shall be readily accessible for inspection and repair without untanking from the top of the transformer.

The tap changer-operating handle shall be mounted on the side of the tank not more than five feet above the base and shall have provisions for padlocking in each tap position. Each tap position, as marked on the transformer nameplate, shall be clearly and permanently marked on the operating handle in either raised or recessed letters in metal.

The tap changer shall have heavy stationary and movable contacts with silver plating. There shall be no requirement for moving the contacts to prevent coking unless the position is changed. The instruction book shall contain instructions for movement of the tap changer to wipe the contracts if the position is changed.

### 5.3.15.26 Load Tap-Changer

When specified, a motor operated, vacuum-type load tap changer (***LTC***) shall be supplied. The LTC shall comply with the requirements of IEEE Std C57.131.

Unless specified otherwise the LTC shall have a range of plus-or-minus 10% in 32 - 5/8% steps with full MVA capacity on all taps above neutral position, and reduced MVA capacity on taps below neutral position.

The LTC rated current for power transformers shall be not less than the maximum winding current at its rated maximum load (2 stages of supplemental cooling).

The tap position indicator shall be located where it can be readable and re-settable from the ground level. LTC position indicator shall be visible when manually operating the LTC. The position indicator shall have markings to signify the normal and range extremes and be in accordance with IEEE Std. C57.12.10.

Each contact of the load tap changing equipment shall be capable of 500,000 electrical and mechanical operations at the top MVA rating of the transformer before requiring contact replacement. The contacts shall be easily accessible.

The load tap changing equipment shall be contained in a compartment separate from the core and coils to prevent mixing of oil. The following shall be provided in this compartment:

a) LTC drain valve.
b) Oil filter connection, top.
c) Oil filter connection, bottom.
d) Provision for a common connection between main tank and load tap changing compartment including selector compartment if separate from LTC compartment for pressure equalizing during vacuum filling process. External pipe nipples with caps are acceptable.

The hand crank for manual operation of the drive mechanism shall be operable while standing at the base of the transformer. The automatic or manual operation of the LTC shall be blocked if the vacuum interrupter fails to interrupt and transfer the load current during a tap change operation.

LTC control devices shall be housed in the transformer control cabinet. The following shall be provided for the LTC controls:

a) Switch for Manual-Off-Auto control functions. A contact CLOSED when the selector switch is in either the “OFF” or “MANUAL” position shall be provided for the Purchaser's supervisory indication.
b) Switch for Local-Remote control.
c) Tap Position Indicator with Drag Hands.
d) Tap position indication sending unit
e) Operations Counter.
f) Raise/Lower Switch.
g) Automatic voltage control equipment.
h) Terminal blocks for Purchaser’s cable connection.

i) Heaters for anti-condensation

Each tap position indication sending unit shall be operated by the LTC drive mechanism and provide a digital or analog output for indication in the substation control room and for SCADA indication. A tap changer auxiliary contact, closed during tap changer travel, shall be wired to terminals in control cabinet for "tap change-in-progress" indication.

Test terminals shall be provided for adjustment of the voltage relay, reading of output voltage and for testing and calibration from an external power source.

Protective devices shall include an oil level indicator in the tap changer compartment with "high" and "low" oil alarm contacts.

The LTC motor and control circuit shall have a factory installed jumper on Purchaser's side of terminal block with a note on drawing stating: "Remove jumper before connecting the power supply for out-of-service testing of LTC".

LTC control panel shall be equipped with a white indicator light to be illuminated on neutral position only and to be labeled "neutral position".

The load tap changer compartment cover shall be suitably hinged and bolted to the compartment flange. The gasket material shall be one-piece nitrile rubber. Galvanized nuts, to prevent galling, shall be used to bolt the door.

Design of the diverter switch shall be such that it shall not stop in between steps if the motor supply is interrupted before the step is completed. The tap-changer mechanism shall cause the tap-changer to move one step only per operation. The equipment shall be wired to prevent stopping on an off-normal position due to inching.

LTC drive motor shall have thermal overload protection and means shall be provided for isolating the motor from the supply.

### 5.3.15.27 Nameplates

Nameplates shall be made of stainless steel, and permanently attached to the transformer tank(s) with appropriate hardware. Transformers shipped without nameplates attached to them will not be accepted by Entergy. Nameplates shall include permanently engraved data per IEEE Std C57.12.00. A schematic representation of main winding and current transformers connections shall be shown. Ratios and polarities shall be indicated for all CTs. Rated currents shall be shown for all windings. A table showing the rated current at the various tap voltages shall be provided for the ONAN and ONAF ratings of the transformer.

Location and rating of all internal voltage, and current limiting devices shall be shown.

### 5.3.15.28 Transformer Monitoring

The transformer shall be provided with an on-line monitoring system to continuously monitor the condition of LV and HV bushings, transformer dissolved gases and temperatures and other transformer parameters, including loss of insulation life. The on-line monitoring system shall be capable of controlling the coolers'/radiators' operation in parallel with the conventional cooler controls.

Buyer currently uses Dynamic Ratings Monitoring Control Communication (***DRMCC***) on-line monitoring with a bushing monitoring system. The latest DRMCC monitoring system or a better system approved by Buyer in writing shall be provided with the transformer.

The type and model of the on-line monitoring system and multi-gas monitoring for the transformer shall be specified in the bid proposal. The on-line monitoring system shall have communications protocols built in to monitor all parameters in Buyer's Distributed Control System (***DCS***) and PI data server. The transformer shall be provided with the latest model of a Vaisala multi-gas monitor (or better), to be specified by Seller and approved by Buyer in writing, for continuously monitoring and detecting fault gasses in the transformer

oil. The system shall be complete with necessary hardware, software, and interfaces. This gas monitor shall perform the following functions or as specified by Buyer: detect, analyze, and correlate quantity of all dissolved fault gasses, including hydrogen ($H_2$), carbon monoxide (CO), carbon dioxide ($CO_2$), methane ($CH_4$), ethylene ($C_2H_4$), ethane ($C_2H_6$), acetylene ($C_2H_2$) moisture-in-oil, and oil temperature.

The transformer shall include an annunciator/data logger panel in the transformer control cabinet. The type of annunciator/data logger shall be Rochester Instrument Systems Inc. (***RIS***) or equivalent approved by Buyer in writing. The annunciator shall monitor the system's health and indicate occurrences of alarms, trips, and other general signaling messages.

The annunciator shall be mounted on a hinged weather-tight panel, for easy access to rear wiring, in a cabinet of dead-front construction arranged so that water cannot enter the wiring area of the cabinet when resetting the annunciator in rainy or inclement weather. A plexiglass panel shall be provided for external viewing of the annunciator. The panel door shall be equipped with a handle mechanism to allow easy access to the annunciator.

The following is a typical list of alarms generated by the monitoring devices that the annunciator system shall be required to monitor and display. All alarms will be discussed and approved in writing during the design review meeting with Buyer.

- Power Supply Auto Transfer
- Loss of AC Control Power for each circuit.
- Fan bank motor current excessive
- Fan bank fail
- Cooling system breaker fail
- Low Oil Level
- Low-Low Oil Level
- Sudden Pressure Seal-in Relay
- High Top Oil Temp.100° C
- High-High Top Oil Temp.110° C
- High Winding Temp. 110° C
- High-High Winding Temp. 120° C
- Gas Detector Relay
- Monitoring Devices Fail
- Control Cabinet Temp. High
- Low Nitrogen Cylinder Pressure

Alarm contacts shall be Form C type and shall be wired independently to terminal blocks in the control cabinet to make possible any grouping of alarms by Buyer for remote indications. The contacts shall be rated 125 volts DC, 5 amps continuous and 0.2 amps DC non-inductive tripping.

Protection and Monitoring Devices:

The transformers shall be equipped with the following devices for monitoring, control, and protection of the transformer (all of which shall have independent alarm contacts wired to the terminal blocks in the control cabinet):

Oil Level Gauge:

A magnetic oil level gauge, Qualitrol or Buyer-approved equivalent, with a 6-inch dial, visible from the ground level shall be provided on the transformer tank and conservator.

The oil level gauge shall be a two-stage oil level monitor. Each stage shall be provided with two normally open contacts for alarm and trip functions. Contacts of the second stage shall close when the oil level in the transformer tank falls to a critical level and will result in an internal flashover of the unit.

Top Oil Temperature Gauge:

A conventional oil temperature indicator, Qualitrol or Buyer-approved equivalent, with a minimum six (6)-inch dial, with drag hands, shall be supplied to indicate the temperature of the top oil. The instrument shall be mounted at eye level. The indicator shall be vibration-insulated from the transformer. The temperature indicator shall have two adjustable normally open contacts. Top oil alarm contacts shall be set at 105ºC and used to turn on all of the cooling equipment.

Pressure Relief Devices:

A spring-loaded diaphragm-type pressure relief device, Qualitrol Type XRPD or Buyer-approved equivalent, complete with animal intrusion screen P/N SCN-600-1 and a DPDT alarm contact shall be mounted on the transformer tank cover or the tank wall near the top. Transformer tanks containing more than 10,000 gallons of oil shall be provided with two pressure relief devices mounted on diagonally opposite corners of the transformer tank. The device(s) shall be located remote from the control cabinet(s) and equipped with directional shield to direct oil flow downward. Pressure relief value shall be stamped on the device.

Sudden Pressure Rise Relays:

A transformer with conservator tank shall be equipped with two sudden pressure rise relays, Qualitrol Type 900-014-02, to detect rapid pressure increase in the transformer tank. The relays shall be located on diagonally opposite corners of the transformer and shall be flange-mounted with gate-type shut-off valves located between three (3) and six (6) feet above the base of the transformer.

Sealed tank transformers shall be supplied with two sudden pressure rise relays, Qualitrol Type 910, to detect rapid pressure increase in the transformer tank. The relays shall be flange-mounted with gate-type shut-off valves in the gas space on the tank wall.

The sudden pressure relays shall be provided with Qualitrol type 909-300-01 seal-in relays set up for 125 volts DC and reset feature. A target relay shall be provided to give visual indication of sudden pressure relay operation. The target relay shall also have a reset feature. The alarm and trip contacts of the relays shall be wired to the terminal blocks in the control cabinet.

Actuation of each relay will result in an alarm. Actuation of both relays will result in a unit trip.

Gas Accumulation Detecting Relay:

The transformers with a conservator tank shall be equipped with a gas accumulation detection device for detecting the presence of combustible gas within the tank and auxiliary oil-filled compartments. The device shall be Qualitrol type 038-003-01 complete with a sampling valve and alarm contacts. Sample test valves shall be located a maximum of five (5) feet above the transformer base.

The design of the gas detecting system, showing the location of the gas detection device and the gas accumulation system, shall be submitted for Buyer's written approval before manufacture. Seller shall also submit a complete written description of operation as applied to the particular transformer with above submittal that will later become part of the Instruction Book.

A Buchholz gas monitor relay shall be installed based on the transformer design with the Constant Oil Preservation system (***COPs***) tank.

Dehydrating Breather(s):

The oil preservation system of transformer with a conservator shall be equipped with a Waukesha/HVS, or Reinhausen or other Buyer-approved, automatically self-regenerating, maintenance-free dehydrating breather containing an oil bath to prevent outside air from having direct contact with the desiccant.

Top of the breathers shall be within approximately five feet of the transformer base.

Temperature Monitoring System:

Transformer shall be provided with an Electronic Temperature Monitoring System (***ETMS***) in which the temperature rise of the winding hottest spot over the top oil temperature is added digitally by calculation.

The traditional simulated winding hotspot measuring system consisting of winding temperature CTs, heater circuit, and analog dial type thermometers is to be supplied only when specifically requested in the purchase order.

The transformer shall be provided with sufficient number of winding temperature CTs, thermo wells, sensors, dual element RTDs (Pt100Ω or Cu10Ω), probes, etc., to monitor the transformer oil and winding temperatures using a digital temperature monitoring system. The transformer shall be equipped with an APT TTC-1000 from Advanced Power Technologies or Buyer-approved temperature monitoring system with digital displays easily readable in daylight.

The sensors, probes, thermowells, etc., shall be located on the transformer tank sidewall (not the tank cover), and capable of being installed or replaced without de-energizing the transformer, opening the transformer, or lowering the oil in the transformer.

The ETMS shall have the digital displays for the following:

- HV winding hottest spot temperature, each phase
- LV winding hottest spot temperature, each phase
- Transformer tank top oil
- Transformer tank bottom oil
- Ambient temperature
- Control cabinet temperature

The temperature monitor shall have large Light-Emitting Diode (***LED***) displays for easy readability in any lighting condition. The monitor shall operate with a solid-state LED light source that will under normal operating conditions last for the life of the transformer without the need to replace the light source.

The monitor shall cover a temperature range from -30 °C to +150 °C, and shall have a display resolution of ± 1 °C and a 0.7% accuracy at full scale. The device should display the future temperature gradient projection and the load current. The monitor shall be complete with 4–20 mA analog outputs for oil temperature and winding temperature and have contacts to control cooling, for alarms, and for trips.

The monitoring system with digital display gauges shall be mounted in the control cabinet five (5) feet above the base of the transformer. The temperature monitor shall be installed in a manner such that all controls are visible and adjustable from the front, and such that adjustments may be made without interference to other devices. The monitor shall be labeled as ETMS.

The transformer shall be provided with sufficient number of windings embedded fiber optic sensors at least three (3) fibers per phase per winding (HV & LV) for winding temperature monitoring and three fibers for top oil temperature monitoring. The fiber shall be terminated into Luma Sense digital temperature monitor or Buyer-approved equivalent located inside the control cabinet. The temperature monitor shall have outputs to connect to other plant devices, DCS, and monitors, including the transformer on-line monitoring system.

### 5.3.15.29 Tests

The Manufacturer shall notify the Purchaser at least four weeks in advance when planned specified tests are to be conducted and at least two weeks in advance when the tests dates are firm. The Purchaser reserves the right to inspect and witness these tests at the factory.

The insulating oil used to fill the transformer for the purpose of performing the electrical tests shall not be lowered, replaced, or otherwise altered, nor shall the access cover be removed at any time throughout the duration of the testing. All tests shall be performed on the fully assembled transformer including cooling and conservator equipment. The bushings that will be furnished with the transformer shall be installed on the transformer during the factory tests. Substitute bushings for testing shall not be allowed.

Resistance, polarity, ratio, phase relationship, impedance, load loss and temperature rise test shall precede the dielectric tests. No-Load loss and excitation current tests shall be performed after impulse tests. A final Dissolved gas-in-oil analysis (DGA) shall be performed before and after the temperature tests and before and after the dielectric tests.

All transformers shall be tested in accordance with IEEE Std C57.12.00.

- Resistance measurements shall be taken at all DETC tap positions. For three phase windings phase to phase and per phase values shall be recorded and reported.
- Lightning impulse tests shall be performed on all transformers. All terminals including neutral shall be tested.
- The temperature monitoring equipment shall be operational during temperature rise tests and demonstrated during these tests. For the transformers equipped with fiber optic temperature sensor probes, the hottest probes for each phase shall be identified. Temperature data for all probes shall be recorded and reported in the test report. If the Manufacturer's calculated values for the top oil and hot spot temperature fall below the fiber optic thermometer measurements the Manufacturer shall determine the cause and may be required to repeat the temperature rise test. Temperature rise test results shall include steady-state (prior to hot-resistance takeoff) readings of top-oil and winding hot-spot temperatures from gauges and electronic temperature monitors. The reported hot-spot reading may be after any calculated adjustment for the tested versus calculated average winding rise.
- A temperature rise test in accordance with IEEE Std C57.12.90 shall be performed on the first unit of a design. The test shall be conducted at the base ONAN rating and at the maximum ONAF ratings. The temperature rise test shall be performed prior to the dielectric testing. Ambient temperature, top and bottom oil temperature rise, average winding temperature rise and winding hot-spot temperature rise shall be stated on the test reports. Test report shall include oil and winding temperature readings from the electronic temperature monitor and infrared images of transformer sides and cover for the maximum ONAF test.
- Dissolved gas-in-oil analysis tests shall be performed before, during, and after each temperature rise test. Oil samples shall be taken at the start, and at the completion of the tests, within one hour of the final shutdown. The rate of generation of the gases shall not exceed the limits proposed in IEEE Std. C57.130.
- Bottom oil temperature rise shall be included in the test report.
- Partial discharge measurements using the apparent charge method for power transformers rated 69 kV and above, shall be recorded. The partial discharge shall not exceed 200 pC. The increase in the partial discharge during the one-hour test shall not be more than 30% of the reading taken ten minutes after the enhancement tests. The partial discharge level during the enhancement period shall be recorded and included in the test report. All units shall be tested.
- Transformer turns ratio test shall be performed at each HV tap to neutral and from rated HV tap to all LTC positions (as applicable).
- When specified, audible sound level tests shall be conducted.
- Excitation current and no-load losses shall be measured at 90, 100, 105, 110 and 115 percent of rated voltage.
- Impedance and load loss measurements shall be made at the normal tap and the tap extremes, at the self-cooled ONAN rating of the transformer using three wattmeter method and corrected to 85 °C.
- Insulation power factor measured prior to starting the tests shall be 0.4% or less when converted to 20 °C. The measurements shall be made using DOBLE or other Entergy approved equivalent test equipment. The test form shall be submitted before, or to coincide with, the transformer shipment.
- All bushings shall be tested in accordance with IEEE Std C57.19.00. The partial discharge shall not exceed 10 pC or 10 µV in accordance with IEEE Std C57.19.01. Power factor tests shall be performed on all bushings with resulting power factor and values of C1 and C2 recorded in the test

report. Copies of the certified test report form the bushing manufacturer shall be included in the transformer certified test report. The Manufacturer shall verify that all bushings have also been tested utilizing Doble or approved testing equipment.

- Pressure test on the tank and the cooling system shall be made by filling the transformer with hot oil and maintaining 10 psig pressure maintained for 10 hours. If any leaks appear they shall be repaired, and the test shall be repeated.
- A vacuum test shall be performed on the transformer tank and cooling system designed for vacuum filling.
- Current transformers shall be tested as required by IEEE Std C57.13. Polarity applied potential tests and saturation tests shall be repeated after installation of the CTs in the power transformer from their terminals in the control cabinet. The following tests are required:
    - Applied Potential Test.
    - Induced Potential Test.
    - Polarity Test.
    - Saturation Curve.
    - DC Resistance.
- The results of calibration tests on the winding temperature devices (hot spot indicators) shall be included in the test report. The test report shall include the tap setting of the correcting transformer, if used, when calibrated.
- Zero sequence impedance tests shall be performed. For three winding transformers the impedance between each pair of windings shall be measured, i.e., HV-LV, HV-TV, LV-TV. Zero sequence test is not applicable to single phase units.
- Core to Frame insulation tests shall be made, with minimum 1000-volt insulation tester, and recorded on the completed core and coil assembly prior to the tanking of the assembly. Core insulation tests shall be repeated after the transformer is loaded on the carrier immediately prior to shipping. The measured resistance and voltage of the tester shall be shown in the test report.
- The correctness of the control wiring shall be checked by electrical operation of all devices and individual circuit continuity checks by electrical circuit testers. The control wiring and current transformer wiring insulation shall be tested as required by IEEE Std C57.12.00, and IEEE Std C57.148.
- Doble SFRA tests shall be performed on all transformers in the oil-filled fully assembled condition. For transformers that are shipped by ocean vessel or rail, additional SFRA tests shall be performed in the as-shipped condition using spark-plug type bushings on the bushing shipping covers. These test bushings shall be protected during shipment.
- All certified test reports shall require approval by Entergy prior to shipment. The test reports shall include a brief statement of any test failures or abnormalities that required repair and retesting of the transformers.
- The manufacturer shall provide Doble power factor and SFRA files for both factory and field (install) testing.
- Nameplate data for all bushings tested and scheduled to be shipped with the transformer shall be supplied in the certified test report.

### 5.3.15.30 Approval Drawings

All drawings for approval shall be sent under a cover letter which lists drawing numbers and title of all drawings forwarded, destination of the transformer, and Customer purchase order number.

The following drawings shall be submitted for approval; within 6 to 8 weeks after receipt of a purchase order from the Purchaser.

- Outline and General Assembly - this drawing shall show details such as dimensions, weight, location of accessories, handholds, manholes, center of gravity, lifting and moving details, etc.
- Bill of Material - this shall include but not be limited to the following:

  - Manufacturer, rating, type and creepage distance of bushings
  - Type and catalogue number of connectors when supplied Manufacturer, type, and catalogue number of accessories, e.g., gauges, pressure relief devices, indicators, breathers, etc.
  - Manufacturer, type, catalogue number, size and material of valves, pipes, and fittings
  - Manufacturer, quantity, rating, and capacity of fans
  - Type, catalogue number and manufacturer of all components including control switches, terminal blocks, fuses, instruments, and relays in the control cabinet
- Nameplate Diagram – the nameplate drawing shall show the transformer serial number.
- Schematic diagrams
- Wiring Diagrams – shall be point to point drawings. Line-less, wire list and coordinate type drawings are not acceptable.

#### 5.3.15.31 Generator Step-Up Transformer Warranty

The GSU transformer(s) shall be provided with an original equipment manufacturer's warranty that the GSU transformer(s) shall be free from defects in material, manufacture, workmanship, and design for a minimum period of five (5) years from the date of such GSU transformer's energization; provided that, if such GSU transformer has not been energized within six (6) months after delivery thereof to the Project Site, the warranty period shall be at least five (5) years commencing twelve (12) months after the date of delivery to the Project Site. The GSU transformer manufacturer shall be required to repair or replace at its cost any GSU transformer (or component thereof) in breach of such warranty. The warranty shall cover the cost of removal from the Project Site, transportation to and from the repair facility, reinstallation after repairs, and any and all other "in and out" work.

Seller shall notify Buyer of any procedure, activity, or other Work that may void a manufacturer warranty or violate any law or applicable permit reasonably in advance of the performance of such procedure, activity, or Work. Seller shall provide to Buyer all original equipment manufacturer warranty documents.

## 5.4 Neutral Grounding Reactor

The Neutral Grounding Reactor (*NGR*) shall be used to limit the fault current magnitude on the 34.5kV.

The rating of the NGR shall be based on underground collection design, short circuit analysis and ampacity calculation design criteria. *Table 17* shows typical MPT MVA where the X0 Neutral Grounding Reactor is required. The requirement of the NGR shall be evaluated during planning phases.

## 5.5 Station Service Transformer (Auxiliary Loads)

All HV substations, and other major and strategic substations, shall be provided with two independent AC station service sources with automatic transfer from one source to the other for redundancy.

Recommended station service AC voltage ratings are as follows:

- 240/120 V AC 60Hz, single phase, 3 wire.

The AC station service capacity shall be sufficient to supply all loads for the following, as applicable:

- Control house lighting, heating, and air conditioning,
- Power transformer cooling fans, pumps, LTC and control cabinet space heaters,
- Circuit breaker control cabinet heaters, and operating mechanism charging motors,
- Substation lighting,
- Battery chargers
- Maintenance equipment, including gas cart, and oil filter truck if feasible

- Future loads

Approved sources of AC station service include the following:

- Distribution line(s) area feeder
- Distribution transformer connected to a substation bus
- Station Service Voltage Transformers (***SSVT***s) up to 230 kV (suitably rated for this service, but not less than 50 kVA)

SSVTs are used as the primary station service source in critical substations or in substations up to 230 kV without a MV source. The backup station service in such substations shall be from a nearby area distribution feeder based on economics and station importance. If a distribution feeder is not available, then a second SSVT shall be used as a backup. The SSVTs shall have sufficient kVA rating to be able to supply all substation loads including maintenance equipment.

SSVTs are typically connected to the substation bus or a transmission line and are within the associated primary protection zones. Surge protection shall be required on the HV side of the SSVT unless arresters protecting other equipment are close enough to protect the SSVT.

Alternate sources of AC station service, including but not limited to the following, are to be used only in special circumstances and require Buyer's approval:

- Inverter system
- Solar panels
- Autotransformer tertiary
- SSVTs above 230kV

An engine generator shall not be acceptable for providing AC station service source.

See IEEE Std. 1818 -IEEE Guide for the Design of Low-Voltage Auxiliary Systems for Electric Power Substations for additional guidance.

# 5.6 Reactive Equipment

Reactive equipment used to provide power quality and reliability to the electrical system (where required) shall be done through capacitor banks and reactors at the 34.5 kV level. To protect and control the reactive equipment, a circuit/reactor switcher shall be used. The MV circuit breaker (See Section 5.3.14.3 (Medium Voltage: Collector Feeders and Reactive Breakers:)) shall be used to protect for external faults of the reactive zone of protection (bus differential, etc.)

## 5.6.1 Circuit Switcher

Fully rated dead tank circuit breakers shall be used for the switching of power transformers and shunt capacitor banks; however, circuit switchers may be used with Buyer's prior written approval. For switching of the shunt capacitor banks rated up to and including 170 kV, the circuit switchers shall be equipped with pre-insertion resistors for suppression of transients.

For each application where a fully rated dead tank circuit breaker is not justifiable and circuit switcher with a desired fault interrupting rating is not available, a live tank circuit breaker without post type instrument current transformers may be considered in lieu of circuit switcher with Buyer's prior written approval.

Circuit switchers are typically rated to interrupt lower fault currents than circuit breakers. As the circuit switchers are normally installed to protect shunt capacitor banks, they are designed to be rated to the expected capacitive switching current as mentioned in the IEEE standards. The circuit switcher application shall ensure that these ratings are not exceeded.

### 5.6.2 Shunt Reactors

Air core reactors present unique design and safety considerations because they produce very high magnetic fields during normal operation. The distance from adjacent iron and steel structures and apparatuses must be sufficient to prevent induction heating. Safety fencing with reactor safety signage shall be provided as needed to prevent personnel from getting too close to a set of reactors. A worker approaching too close could experience overheating of ferrous items he is carrying. There is a danger that implanted medical electronic devices such as pacemakers, insulin pumps, or hearing aids will malfunction or fail, causing injury or death. The manufacturer's documentation shall include minimum phase spacing and magnetic clearance requirements for perimeter fencing and these requirements shall be adhered to in the design of the substation.

The Substation Designer shall consult with the manufacturer of the reactors with any additional questions including clear instructions for reactor grounding. To protect personnel working near the reactors the Substation Designer shall also request the manufacturer to supply magnetic field plots, needed to determine the perimeter fence spacing.

The ratings of the shunt reactors shall be provided during detail analysis (Project specific not required in all projects).

### 5.6.3 Shunt Capacitor Banks

Shunt capacitor banks may be installed in ungrounded wye configuration up to 115 kV and shall be grounded wye for 138 kV and above. Fuseless capacitor units shall be installed in capacitor banks. Seller must obtain Buyer's approval in writing for any exception.

The ratings of the shunt capacitor banks shall be provided during detail analysis (project specific not required in all projects).

## 5.7 Control House

### 5.7.1 General

There shall be no wood framing or trim. Eave height is to be manufacturer's standard to accommodate a clear interior height of 10 feet (minimum) including specified insulation.

See Section 8 (FOUNDATIONS) for control house structural design information.

### 5.7.2 Roof

All roof panels in all locations shall have a U.L. wind uplift classification of class 90 (minimum).

### 5.7.3 Ceiling

Insulation shall be R-19 minimum and shall have a U.L. Flame Spread Rating of 25 (minimum).

### 5.7.4 Walls

For metal buildings, the exterior building walls shall be constructed with a minimum of 16-gauge aluminized steel (or a zinc-aluminum finish), flat or corrugated surface, with a factory baked on light reflecting finish including a minimum ten-year guarantee.

For concrete buildings, the exterior building walls shall be solid concrete design with 6-inch walls and steel rebar reinforced high strength concrete.

The building walls shall be insulated with a non-combustible blanket type insulator with a glued-on vapor barrier facing material rated at R-11 (minimum) and a U.L. Flame Spread Rating of 25 (minimum).

### 5.7.5 Doors

Substation control house doors shall be level 3 full flush doors (Level 3 - 16 gauge per ANSI/SDI A250.8-2003) with weather stripping. All doors are to be equipped with metal, weather-tight thresholds.

The main room (relay room) exit door shall be 6 feet wide (double leaves, 3 feet each). The battery room entrance and exit doors shall be 3 feet wide.

All doors shall be 8 feet in height. All exit doors shall open outwards and be equipped with panic bars and lighted or photo luminescent exit signs.

The battery room outside exit door shall have no outside handle and shall only be capable of being opened from the inside. All battery room doors (entrance and exit) shall have an emergency push bar. In the battery room, the floor and all interior wall panels shall be acid resistant.

### 5.7.6 Paint

For steel buildings, steel shall be coated with either aluminum or aluminum-zinc mix (containing at least 4% aluminum) and shall conform to the proper thickness as specified by ASTM. All structural steel is to have two shop coats of red oxide paint which meets or exceeds Federal Specification TT-P686.

#### 5.7.6.1 Color Schedule

| | |
|---|---|
| Exterior wall panels: | Light gray unless specified otherwise by Entergy |
| All trim: | As specified by Entergy (specified during planning phases) |
| Interior wall panels: | White |
| Ceiling panels: | White |
| Partition door: | White |
| Exit doors: | to match exterior trim |
| Interior partition wall: | White |

### 5.7.7 Cable Tray

The tray shall be aluminum, ladder type, two side rails, with six inch rung spacing.

All cable tray entrances into the house shall be 36 inches wide and reducers shall be utilized to connect to 24-inch cable tray inside of the control house when required. A minimum of four (4) cable tray entrances is required.

A solid flanged aluminum tray cover (0.040 inches thick) with heavy duty cover clamps and stainless-steel mounting hardware shall be installed over all cable trays located on the outside wall of the control house.

Separate cable tray for communication cables shall be provided.

### 5.7.8 Lighting

Interior lighting shall be LED light fixtures that provide 40 foot-candles of light at a level of three feet above the floor.

External lighting shall be supplied above the exterior doors using weatherproof fixtures.

Exit lighting (OSHA-approved) shall be an LED illumination or self-illuminating device.

### 5.7.9 Air Handling

The battery room exhaust fan shall be rated for 90 cfm. Battery room exhaust fan(s) shall be equipped with animal deterrent and mounted 8 feet above the floor for security purposes. Exhaust fan(s) shall be controlled and operated with an electro-mechanical timer. Operation intervals of exhaust fan shall be a minimum of four twenty-minute cycles every twenty-four hours.

The air conditioner shall be controlled by a remote low voltage heating/cooling control thermostat, such as Accustat Energy Guard or equivalent, with design set points of 78°F for cooling and 68°F for heating.

### 5.7.10 Warranty

Building finish: minimum twenty (20) year non-prorated warranty.

The walls, including all wall openings for doors and louvered openings, are to be warranted weather-tight for a period of five years from the date of completion of the building.

Ceiling: minimum ten (10) year warranty.

Roof: minimum twenty (20) year non-prorated warranty.

A full five-year warranty on the control house including equipment with parts and service is to be included.

## 5.8 Substation Civil/Structural Design Criteria

Seller shall complete all civil works to furnish a Collector Substation site design, access road(s), and any other outdoor civil works required inside the Project Site or as needed for interconnection of the Project to the ELL Transmission System. The design shall meet all applicable federal, state, and local Laws and regulations and requirements of the Agreement, including the Scope Book and this Appendix 1, and provide a relatively maintenance-free design (e.g., provide adequately sized culverts to limit the possibly of clogging, provide erosion control means on slopes to eliminate maintenance re-grading, design access road cross-section to minimize rutting, etc.).

### 5.8.1 Siting and Civil

#### 5.8.1.1 Flood Risk Evaluation

Flood risk shall be evaluated, and an Elevation Basis selected. This includes evaluation of the flood risk to the substation from rain, river elevation, storm surge, or other causes. It also includes the placement of structures within known Federal Emergency Management Agency (***FEMA***) Special Flood Hazard Areas (***SFHA*s**) or other flood prone areas.

The substation location flood evaluation and decisions made with respect to site and equipment elevations shall be documented on the applicable substation site and foundation drawings.

The process to establish the Elevation Basis shall be as follows:

1. Determine if the site location is located within or near a FEMA SFHA.
2. If published information is available, determine the Base Flood Elevation (***BFE***) of the proposed site and if the location is within or adjacent to a mapped floodplain.
3. Evaluate the FEMA Flood Insurance Rate Map (***FIRM***) to determine the most recent revision to the map (including Letters of Map Revision).
4. Determine the date of the underlying Flood Insurance Study (***FIS***), if the FIS is available, and if the FIS method can be determined.

5. Evaluate local development and the potential impacts to flooding since the publication of the FIS.
6. Obtain written documentation about local ordinances regarding development in a SFHA, including any local requirements for development.

For locations outside of a mapped SFHA, but that are suspected to be at an elevated flood risk, document the known information and attempt to quantify the risk in relation to the site. An example of this type of risk evaluation is floodway extents or floodplain extents ending in a straight line in the vicinity of the site. This occurrence might indicate a road or railway embankment but may be indicative of an arbitrary study limit.

Determine planned access routes to the site for construction, operation, and maintenance and if such routes could be adversely affected by surface water flooding. The evaluation should consider the probability of surface water flooding at critical elevation points such as control houses, equipment cabinets, and access roads for the expected life cycle of the facility.

If the site is located within a FEMA SFHA, the underlying FIS was conducted within the previous 10 years, and the 100-year BFE is available, the 100-year BFE shall be used as the Elevation Basis.

If the site location is not located in a FEMA SFHA, the FIS was conducted more than 10 years ago, or the BFE is not otherwise available, engineering judgement and input from the Project Team shall be utilized to determine if local knowledge will be used as a basis for the site and equipment elevations or if a hydrologic and hydraulic study by a suitably experienced individual or company would need to be performed to determine an Elevation Basis. If it is deemed a study is needed to determine a proper Elevation Basis, a study should be ordered along with a site topographic survey. If applicable, the study shall be used to determine the Elevation Basis.

### 5.8.1.2 Flood Design Requirements

The Finished Grade of the site shall be at or above the Elevation Basis. Equipment foundation Top of Concrete (***TOC***) elevations shall be a minimum of one (1) foot above the Elevation Basis and a minimum of six (6) inches above the Finished Grade. The final TOC elevations shall be chosen to keep all equipment control cabinets a minimum two (2) feet and if possible four (4) feet above the Elevation Basis. The Project Team will determine the Elevation Basis, make the final TOC elevation determination, and document those determinations. The TOC elevations shall be recorded on the station foundation plan and foundation details.

When establishing the TOC elevation for the control house foundation, the relative elevations of the control house and equipment control cabinets shall be evaluated. In all stations the control house floor shall be a minimum of six (6) inches above the Finished Grade to prevent rainwater from entering the house. If the control house has trenches in the floor, then the bottom of the trenches shall be a minimum of six (6) inches above Finished Grade. In stations within a FEMA SFHA or otherwise determined to be prone to flooding, the control house floor should be at or above the elevation of the bottom of the lowest equipment control cabinet. A higher control house elevation may be selected to allow for easy maintenance access under the house. In existing substations where the control house is raised due to flooding concerns, the ability to raise equipment cabinets to the same elevation as the control house floor should be evaluated for feasibility.

### 5.8.1.3 Earthwork

The existing site shall be cleared, grubbed/stripped to a depth sufficient to remove organic material, leveled, filled, compacted, and sloped to drain. The substation yard shall be graded to accommodate drainage. The preferred substation site shall be graded with a slope of no less than 0.5% - 1.5% to facilitate water drainage from the site, storm sewers, catch basins, and/or manholes may be used if required for proper drainage.

A soil drainage analysis may be performed at the same time as soil boring investigation to determine the site's characteristics for water infiltration and retention for sites with aggregate implications larger than 1 acre where Governmental Authorities may require additional site Permitting.

The drawings shall note the control points on the site, and which coordinate system is to be used.

### 5.8.1.4 Erosion Control

The design shall comply with the Storm Water Pollution Prevention Plan (***SWPPP***) and Environmental Management Plan (***EMP***).

### 5.8.1.5 Wetland Delineation and Mitigation

Seller shall comply with all wetland requirements specified by Laws and applicable Permits. Wetlands shall be confirmed by a qualified third party.

### 5.8.1.6 Stormwater Management

Seller shall design the Project Site stormwater management plan. Seller shall complete and submit all necessary Permitting applications, including stormwater discharge National Pollutant Discharge Elimination System (***NPDES***) Permit applications, to the appropriate Governmental Authorities. The design shall provide for quality control of stormwater prior to discharge.

Seller's design for stormwater management on the Project Site shall meet stormwater quality and quantity requirements of local, state, and, if applicable, federal Governmental Authorities. The design shall consist of the following, as a minimum:

- Size and design details of stormwater, oil containment, run-off basin, and outfall
- Location and size of stormwater piping, inlets and manholes as needed
- Location and size of stormwater ditches or channels
- Project Site relative grades and slope including the drainage area to each stormwater feature

### 5.8.1.7 Site Surfacing

Thickness: The Project Site shall be graded to drain and then be surfaced with a minimum of six inches of compacted crushed stone.

Aggregate shall meet the following:

If the Collector Substation is not in Arkansas or Louisiana: Material designation - #610- Crushed limestone, primarily used in the Entergy system.

If the Collector Substation is in Arkansas: Material designation - Arkansas Department of Transportation Class 7 Base - Crushed granite or limestone, primarily used in Arkansas. Class 7 Base is a new designation that replaces the old designation (SB2). The materials in Class 7 and SB2 have the same gradation.

If the Collector Substation is in Louisiana: Material designation - Grade D Base (DGA) Dense Grade Aggregate m-crushed limestone.

Compaction: The crushed stone shall be compacted to a minimum density equal to 95% of the maximum density obtained by a Modified Proctor Test (ASTM D-1557). Do not grade ruts down; fill with additional aggregate and compact.

Sterilant: After sub grade preparation and prior to applying the crushed rock, a non-toxic vegetation eradicator (sterilant) shall be applied. Sterilant shall be applied from a minimum of five feet to a maximum of ten feet outside the fence.

#### 5.8.1.8 Drive Access and Road Design

Substation ingress/egress points are to be compliant with all State and local Permitting requirements. A permanent all-weather twenty (20) feet wide roadway shall be provided for access and egress to the substation site directly from a public street or road. Such access road shall be adequate for construction and maintenance activities, including hauling heavy equipment such as the Collector Substation GSU. The access road shall have no less than 50 ft. centerline turn radii.

Roadways within the substation shall be provided, along the fence, if possible, for personnel and equipment movement. All roadways within the substation shall be at least twenty (20) feet wide with at least a fifty (50) feet centerline minimum turn radius. A reduced turn radius inside the substation is acceptable provided that an 18-wheeled low-bed vehicle loaded with equipment can easily negotiate all roads and turns within the substation fence enclosure. Road crossings over cable trenches, and culverts, shall be designed to withstand heavy traffic. Substation shall have only two points of entry in and out of the yard. The yard shall allow for vehicles to turn around or back out of the yard.

Note that new substations designated as Critical or Deemed Essential (***CODE***) (see Section 12 (PHYSICAL AND ELECTRONIC SECURITY) shall include a vehicle access corridor around the exterior of the perimeter to allow drive-around access by security or law enforcement personnel.

### 5.8.2 Oil Containment

#### 5.8.2.1 Federal Regulatory Requirements

Design and construction shall conform to 40 CFR, Parts 110 and 112.

Oil spill containment shall be provided for the main transformer. Oil spill containment shall be provided for other equipment when required by Governmental Authorities.

#### 5.8.2.2 State and Local Regulatory Requirements

Oil containment shall comply with state and local requirements which are contained in 40 CFR Part 109. State and local governments have generally adopted the existing federal regulations prohibiting discharges of oil.

#### 5.8.2.3 Containment System

Secondary oil containment type shall be an above grade containment pit.

Minimum containment volume is to be 100% of oil contained within protected equipment in addition to the volume of rainwater retained during a 24-hour 25-year recurrent interval storm event.

All designed water removal systems shall incorporate a method of monitoring discharged water quality. Monitors shall be connected to alarm systems.

In designing (sizing) a stone filled collection pit, the final oil level elevation shall be situated approximately 12 inches below the top elevation of the stone. This provides a fire extinguishing capability designed to quench flames if a piece of oil filled equipment catches fire. The use of 1.5 inch or larger stone (washed and uniformly sized) is recommended to permit quicker penetration to avoid a pool fire. Void Volume Ratio for stone filled devices shall be between 30 to 40 percent.

Pits using drainpipes shall assure that the drainpipe material shall be capable of withstanding the higher temperatures associated with an oil fire.

#### 5.8.2.4 Oil Filled Equipment Separation

Oil-filled equipment shall be separated from other equipment and buildings to prevent potential fire hazards that may impede restoring or maintaining electric service. The following minimum separations from NFPA 850 Section 5.1.4 are suggested:

- Power transformers containing between 500 and 5,000 gallons of oil shall be located a minimum of 25 feet from any building unless the exposed walls consist of or are protected by a wall or barrier having a two-hour fire rating. The barrier shall extend horizontally and vertically such that any exposed part of the building is a minimum of 25 feet from the transformer. Transformers shall also be spaced an adequate distance from a fire-rated building wall to ensure that this 25-foot minimum is maintained to any other parts of the building that do not have a two-hour fire rating.
- For outdoor transformers with an oil capacity of greater than 5,000 gallons, maintain clear separation of 50 feet from other structures or provide a 2-hour fire rated barrier.
- A minimum distance of 8 feet shall exist between the transformer and any building or wall to ensure there is adequate space for normal operating and maintenance work. Cable trenches shall not be routed adjacent to oil immersed equipment.

Barriers that are required due to inadequate separation to equipment or buildings shall be constructed of non-combustible, heat-resistant, fire-rated material. The barrier height shall extend a minimum of 1 foot above the top of any oil filled equipment and any of their components. Barriers shall also extend horizontally a minimum of 2 feet beyond the line of sight of the subject building or equipment.

For transformers with less than 500 gallons of oil and where a firewall is not provided, the edge of the postulated oil spill (i.e., containment basin, if provided) should be separated by a minimum of 5 feet from the exposed structure to prevent direct flame impingement on the structure.

Any transformer for the Project using a listed “less flammable” insulating oil (e.g., Envirotemp FR3) shall be installed with and maintain a separation distance and barriers as provided above. If Seller seeks a modification of a separation distance or a barrier requirement for a transformer on the basis that the transformer will use a listed less flammable insulating oil, Seller shall perform and provide to Buyer a detailed hazard evaluation of such transformer with the proposed less flammable insulating oil. Buyer will consider such evaluation in its review of the modification request.

# 6 EQUIPMENT SUPPORT STRUCTURE LOADING

## 6.1 Load Cases

The load cases specified shall include the following environmental requirements:

Dead Load: The weight of equipment and support structures shall be included with appropriate increases for all equipment accessories and structure connections.

NESC District Loading (Rule 250B) - NESC District Loading shall be selected from *Table 25*, *Table 26*, *Table 27*, or *Table 28* based on Project location (Note that these districts may not match the district depicted in NESC for a given county). The ambient air temperature shall be taken as 0°F. Note that the load factors specified in NESC Table 253-1 shall only be used for this condition.

Extreme Wind: An Extreme Wind speed shall be selected from *Table 25*, *Table 26*, *Table 27*, or *Table 28* based on Project location (Note that the values in the tables may not match the maps depicted in NESC or ASCE 113 for a given county). Wind pressure shall be developed using ASCE 113. The Importance Factor

for Extreme Wind (***IFW***) loading shall be 1.0 corresponding to a 50 year mean recurrence interval per ASCE 113, Table 3-3. The ambient air temperature shall be taken as 60°F.

Concurrent Ice and Wind: A wind speed of 30 mph from any direction and a radial ice thickness shall be selected from *Table 25*, *Table 26*, *Table 27*, or *Table 28* based on project location applied on the equipment or structure. The Importance Factor for Concurrent Ice and Wind (***IFI***) loads shall be 1.0 corresponding to a 50 year mean recurrence interval per ASCE 113, Table 3-11. The ambient air temperature shall be taken as 15°F.

Short Circuit Loading: Determined in accordance with ASCE 113 and IEEE 605-2008 using electrical parameters determined from a site-specific analysis.

Seismic: Seismic design parameters (accelerations, site class, etc.) will be provided in the Geotechnical Report for each site. The seismic loads shall be calculated in accordance with ASCE MOP 113. Unless larger values are provided in the Geotechnical Report, the following minimum values shall be used for the mapped ground motion spectral response accelerations: Ss = 0.140 and S1 = 0.051. The ambient air temperature shall be taken as 60°F.

Other: For equipment mounted on structures, the same design weather conditions shall apply. Loads associated with operation of the equipment shall be added to applicable load combinations.

Table 25: Load Districts by County - Arkansas and Missouri

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| AR | Arkansas | 100 | | M | | 1 |
| AR | Ashley | 100 | | M | | 1 |
| AR | Baxter | 100 | | | H | 1 |
| AR | Benton | 100 | | | H | 1 |
| AR | Boone | 100 | | | H | 1 |
| AR | Bradley | 100 | | M | | 1 |
| AR | Calhoun | 100 | | M | | 1 |
| AR | Carroll | 100 | | | H | 1 |
| AR | Chicot | 100 | | M | | 1 |
| AR | Clark | 100 | | | H | 1 |
| AR | Clay | 100 | | | H | 1 |
| AR | Cleburne | 100 | | | H | 1 |
| AR | Cleveland | 100 | | M | | 1 |
| AR | Columbia | 100 | | M | | 1 |
| AR | Conway | 100 | | | H | 1 |
| AR | Craighead | 100 | | M | | 1 |
| AR | Crawford | 100 | | | H | 1 |
| AR | Crittenden | 100 | | M | | 1 |
| AR | Cross | 100 | | M | | 1 |
| AR | Dallas | 100 | | M | | 1 |
| AR | Desha | 100 | | M | | 1 |
| AR | Drew | 100 | | M | | 1 |

## Appendix 1: Collector Substation

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| AR | Faulkner | 100 | | | H | 1 |
| AR | Franklin | 100 | | | H | 1 |
| AR | Fulton | 100 | | | H | 1 |
| AR | Garland | 100 | | | H | 1 |
| AR | Grant | 100 | | M | | 1 |
| AR | Greene | 100 | | | H | 1 |
| AR | Hempstead | 100 | | | H | 1 |
| AR | Hot Spring | 100 | | | H | 1 |
| AR | Howard | 100 | | | H | 1 |
| AR | Independence | 100 | | | H | 1 |
| AR | Izard | 100 | | | H | 1 |
| AR | Jackson | 100 | | | H | 1 |
| AR | Jefferson | 100 | | M | | 1 |
| AR | Johnson | 100 | | | H | 1 |
| AR | Lafayette | 100 | | M | | 1 |
| AR | Lawrence | 100 | | | H | 1 |
| AR | Lee | 100 | | M | | 1 |
| AR | Lincoln | 100 | | M | | 1 |
| AR | Little River | 100 | | | H | 1 |
| AR | Logan | 100 | | | H | 1 |
| AR | Lonoke | 100 | | M | | 1 |
| AR | Madison | 100 | | | H | 1 |
| AR | Marion | 100 | | | H | 1 |
| AR | Miller | 100 | | M | | 1 |
| AR | Mississippi | 100 | | M | | 1 |
| AR | Monroe | 100 | | M | | 1 |
| AR | Montgomery | 100 | | | H | 1 |
| AR | Nevada | 100 | | M | | 1 |
| AR | Newton | 100 | | | H | 1 |
| AR | Ouachita | 100 | | M | | 1 |
| AR | Perry | 100 | | | H | 1 |
| AR | Phillips | 100 | | M | | 1 |
| AR | Pike | 100 | | | H | 1 |
| AR | Poinsett | 100 | | M | | 1 |
| AR | Polk | 100 | | | H | 1 |
| AR | Pope | 100 | | | H | 1 |
| AR | Prairie | 100 | | M | | 1 |
| AR | Pulaski | 100 | | | H | 1 |
| AR | Randolph | 100 | | | H | 1 |
| AR | St. Francis | 100 | | M | | 1 |
| AR | Saline | 100 | | | H | 1 |

**Appendix 1: Collector Substation**

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| AR | Scott | 100 | | | H | 1 |
| AR | Searcy | 100 | | | H | 1 |
| AR | Sebastian | 100 | | | H | 1 |
| AR | Sevier | 100 | | | H | 1 |
| AR | Sharp | 100 | | | H | 1 |
| AR | Stone | 100 | | | H | 1 |
| AR | Union | 100 | | M | | 1 |
| AR | Van Buren | 100 | | | H | 1 |
| AR | Washington | 100 | | | H | 1 |
| AR | White | 100 | | | H | 1 |
| AR | Woodruff | 100 | | M | | 1 |
| AR | Yell | 100 | | | H | 1 |
| MO | Dunklin | 100 | | | H | 1 |
| MO | New Madrid | 100 | | | H | 1 |
| MO | Oregon | 100 | | | H | 1 |
| MO | Pemiscot | 100 | | | H | 1 |
| MO | Stoddard | 100 | | | H | 1 |
| MO | Taney | 100 | | | H | 1 |

Table 26: Load Districts by Parish - Louisiana

| State | Parish | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| LA | Acadia | 150 | L | | | 0.5 |
| LA | Allen | 125 | L | | | 0.5 |
| LA | Ascension | 150 | L | | | 0.5 |
| LA | Assumption | 150 | L | | | 0.5 |
| LA | Avoyelles | 110 | L | | | 0.5 |
| LA | Beauregard | 125 | L | | | 0.5 |
| LA | Bienville | 100 | | M | | 0.75 |
| LA | Bossier | 100 | | M | | 0.75 |
| LA | Calcasieu | 150 | L | | | 0.5 |
| LA | Caldwell | 100 | | M | | 0.75 |
| LA | Cameron | 150 | L | | | 0.5 |
| LA | Catahoula | 100 | L | | | 0.5 |
| LA | Claiborne | 100 | | M | | 0.75 |
| LA | Concordia | 100 | L | | | 0.5 |
| LA | Desoto | 100 | | M | | 0.75 |

**Appendix 1: Collector Substation**

| State | Parish | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| LA | East Baton Rouge | 150 | L | | | 0.5 |
| LA | East Carrol | 100 | | M | | 0.75 |
| LA | East Feliciana | 125 | L | | | 0.5 |
| LA | Evangeline | 125 | L | | | 0.5 |
| LA | Franklin | 100 | | M | | 0.75 |
| LA | Grant | 100 | L | | | 0.75 |
| LA | Iberia | 150 | L | | | 0.5 |
| LA | Iberville | 150 | L | | | 0.5 |
| LA | Jackson | 100 | | M | | 0.75 |
| LA | Jefferson | 150 | L | | | 0.5 |
| LA | Jefferson Davis | 150 | L | | | 0.5 |
| LA | Lafayette | 150 | L | | | 0.5 |
| LA | Lafourche | 150 | L | | | 0.5 |
| LA | Lasalle | 100 | L | | | 0.75 |
| LA | Lincoln | 100 | | M | | 0.75 |
| LA | Livingston | 150 | L | | | 0.5 |
| LA | Madison | 100 | L | | | 0.75 |
| LA | Morehouse | 100 | | M | | 0.75 |
| LA | Natchitoches | 100 | | M | | 0.75 |
| LA | Orleans | 150 | L | | | 0.5 |
| LA | Ouachita | 100 | | M | | 0.75 |
| LA | Plaquemines | 150 | L | | | 0.5 |
| LA | Point Coupee | 125 | L | | | 0.5 |
| LA | Rapides | 100 | L | | | 0.5 |
| LA | Red River | 100 | | M | | 0.75 |
| LA | Richland | 100 | | M | | 0.75 |
| LA | Sabine | 100 | | M | | 0.75 |
| LA | St. Bernard | 150 | L | | | 0.5 |
| LA | St. Charles | 150 | L | | | 0.5 |
| LA | St. Helena | 125 | L | | | 0.5 |
| LA | St. James | 150 | L | | | 0. 5 |
| LA | St. John the Baptist | 150 | L | | | 0.5 |
| LA | St. Landry | 125 | L | | | 0.5 |
| LA | St. Martin, North | 150 | L | | | 0.5 |

| State | Parish | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| LA | St. Martin, South | 150 | L | | | 0.5 |
| LA | St. Mary | 150 | L | | | 0.5 |
| LA | St. Tammany | 150 | L | | | 0.5 |
| LA | Tangipahoa | 150 | L | | | 0.5 |
| LA | Tensas | 100 | L | | | 0.5 |
| LA | Terrebonne | 150 | L | | | 0.5 |
| LA | Union | 100 | | M | | 0.75 |
| LA | Vermillion | 150 | L | | | 0.5 |
| LA | Vernon | 100 | L | | | 0.5 |
| LA | Washington | 125 | L | | | 0.5 |
| LA | Webster | 100 | | M | | 0.75 |
| LA | West Baton Rouge | 150 | L | | | 0.5 |
| LA | West Carrol | 100 | | M | | 0.75 |
| LA | West Feliciana | 125 | L | | | 0.5 |
| LA | Winn | 100 | | M | | 0.75 |

Table 27: Load Districts by County - Mississippi

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| MS | Adams | 100 | L | | | 0.5 |
| MS | Amite | 110 | L | | | 0.5 |
| MS | Attala | 100 | L | | | 0.5 |
| MS | Benton | 100 | | M | | 1 |
| MS | Bolivar | 100 | | M | | 1 |
| MS | Calhoun | 100 | | M | | 1 |
| MS | Carrol | 100 | | M | | 1 |
| MS | Chickasaw | 100 | | M | | 1 |
| MS | Choctaw | 100 | | M | | 1 |
| MS | Claiborne | 100 | L | | | 0.5 |
| MS | Clay | 100 | | M | | 1 |
| MS | Coahoma | 100 | | M | | 1 |
| MS | Copiah | 100 | L | | | 0.5 |
| MS | Covington | 110 | L | | | 0.5 |
| MS | Desoto | 100 | | M | | 1 |
| MS | Franklin | 100 | L | | | 0.5 |

**Appendix 1: Collector Substation**

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| MS | Grenada | 100 | | M | | 1 |
| MS | Hinds | 100 | L | | | 0.5 |
| MS | Holmes | 100 | | M | | 1 |
| MS | Humphreys | 100 | | M | | 1 |
| MS | Issaquena | 100 | L | | | 1 |
| MS | Jefferson | 100 | L | | | 0.5 |
| MS | Jefferson Davis | 110 | L | | | 0.5 |
| MS | Lafayette | 100 | | M | | 1 |
| MS | Lawrence | 110 | L | | | 0.5 |
| MS | Leake | 100 | L | | | 0.5 |
| MS | Leflore | 100 | | M | | 1 |
| MS | Lincoln | 110 | L | | | 0.5 |
| MS | Madison | 100 | L | | | 0.5 |
| MS | Marion | 110 | L | | | 0.5 |
| MS | Marshall | 100 | | M | | 1 |
| MS | Montgomery | 100 | | M | | 1 |
| MS | Neshoba | 100 | L | | | 0.5 |
| MS | Newton | 100 | L | | | 0.5 |
| MS | Panola | 100 | | M | | 1 |
| MS | Pike | 110 | L | | | 0.5 |
| MS | Ponotoc | 100 | | M | | 1 |
| MS | Quitman | 100 | | M | | 1 |
| MS | Rankin | 100 | L | | | 0.5 |
| MS | Scott | 100 | L | | | 0.5 |
| MS | Sharkey | 100 | L | | | 0.75 |
| MS | Simpson | 100 | L | | | 0.5 |
| MS | Smith | 110 | L | | | 0.5 |
| MS | Sunflower | 100 | | M | | 1 |
| MS | Tallahatchie | 100 | | M | | 1 |
| MS | Tate | 100 | | M | | 1 |
| MS | Tippah | 100 | | M | | 1 |
| MS | Tunica | 100 | | M | | 1 |
| MS | Union | 100 | | M | | 1 |
| MS | Walthall | 110 | L | | | 0.5 |
| MS | Warren | 100 | L | | | 0.5 |
| MS | Washington | 100 | | M | | 1 |
| MS | Webster | 100 | | M | | 1 |
| MS | Wilkinson | 110 | L | | | 0.5 |
| MS | Winston | 100 | L | | | 0.5 |
| MS | Yalobusha | 100 | | M | | 1 |

**Appendix 1: Collector Substation**

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| MS | Yazoo | 100 | L | | | 0.75 |

Table 28: Load Districts by County - Texas

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| TX | Angelina | 100 | | M | | 0.75 |
| TX | Brazos | 100 | | M | | 0.75 |
| TX | Burleson | 100 | | M | | 0.5 |
| TX | Chambers | 150 | L | | | 0.5 |
| TX | Galveston | 150 | L | | | 0.5 |
| TX | Grimes | 100 | | M | | 0.75 |
| TX | Hardin | 125 | L | | | 0.5 |
| TX | Harris | 125 | L | | | 0.5 |
| TX | Houston | 100 | | M | | 0.75 |
| TX | Jasper | 125 | | M | | 0.5 |
| TX | Jefferson | 150 | L | | | 0.5 |
| TX | Leon | 100 | | M | | 0.75 |
| TX | Liberty | 125 | L | | | 0.5 |
| TX | Limestone | 100 | | M | | 0.75 |
| TX | Madison | 100 | | M | | 0.75 |
| TX | Montgomery | 110 | | M | | 0.5 |
| TX | Nacoqdoches | 100 | | M | | 0.75 |
| TX | Newton | 125 | | M | | 0.5 |
| TX | Orange | 150 | L | | | 0.5 |
| TX | Polk | 110 | | M | | 0.75 |
| TX | Robertson | 100 | | M | | 0.75 |
| TX | Sabine | 100 | | M | | 0.75 |
| TX | San Augustine | 100 | | M | | 0.75 |
| TX | San Jacinto | 100 | | M | | 0.75 |
| TX | Trinity | 100 | | M | | 0.75 |
| TX | Tyler | 110 | | M | | 0.75 |
| TX | Walker | 100 | | M | | 0.75 |
| TX | Waller | 110 | L | | | 0.5 |
| TX | Washington | 100 | L | | | 0.5 |

## 6.2 Load Combinations

All substation equipment support structures shall be designed using the load cases in Section 7 and using the provisions and load combinations of ASCE 113. Additionally, wire-supporting structures shall be designed per NESC construction “Grade B”.

## 6.3 Structural Analysis

Computer aided analysis and design shall include secondary moments from non-linear effects (p-delta) for structure stresses. Analysis procedures shall be based on the applicable design document (AISC 360 for steel structural shapes, ASCE 48 for tubular steel structures, ACI 318 for concrete structures, ASCE 10 for lattice structures, the Aluminum Design Manual for aluminum structures, etc.).

## 6.4 Equipment Support Structure Design

Transmission line dead ends shall be located outside the substation, with a slack span inside the substation.

Structural supports for bus work, switches, and all other equipment shall be designed in compliance with ASCE MOP 113, and IEEE 605.

All substation structures, except dead-end structures, shall be designed and constructed using hot-rolled, structural steel square, rectangular, or tapered polygonal tubes. The dead-end structures shall be designed using tapered tubular polygonal shapes.

Per ASCE 113, polygonal tube structures shall be designed in accordance with ASCE 48. Per ASCE 113, structures designed with other structural shapes shall be designed in accordance with AISC 360.

## 6.5 Structure Deflection

For deflection load combinations, the deflection extreme wind shall not be determined by using a reduced return period per ASCE 113, Table 3-14. For the ice with wind load combination, the deflection ice thickness shall not be determined by reducing the ice thickness per ASCE 113, Table 3-15.

Structure deflections shall be checked for loading combinations with all load factors equal to 1.1.

The calculated deflections shall not exceed the values listed below.

- Wire-Supporting Structures and Shield Poles
  - Horizontal deflection of vertical members: 1/100 of height
  - Horizontal deflection of horizontal members: 1/200 of span
  - Vertical deflection of horizontal members: 1/200 of span
- All other Equipment Support Structures
  - Horizontal deflection of vertical members: 1/200 of height
  - Horizontal deflection of horizontal members: 1/300 of span
  - Vertical deflection of horizontal members: 1/300 of span

# 7 CONTROL HOUSE STRUCTURAL DESIGN

The control house shall be designed using the applicable building code as required by the authority having jurisdiction. If no oversight from the authority having jurisdiction is required, the International Building Code 2015 edition shall be used for design.

Design, fabrication, and erection of structural steel shall meet the requirements of the IBC, AISC Steel Construction Manual (AISC specification and AISC code of standard practice). Structural design shall comply with seismic design and detailing requirements of the IBC, ASCE 7, and AISC 341. It is preferred to have an Engineered/prefabricated and delivered to site precast concrete building. Steel, concrete, and Concrete Masonry Unit (***CMU***) buildings are all acceptable options.

## 7.1 Design Loads

Design loads shall be determined in accordance with IBC assuming a "Risk Category III".

Roof dead load: Weight of built-up roof, roof joists, insulation, structural members, permanent equipment, cable tray fully loaded with cables, lighting, and any other items supported by the roof.

Floor dead load: Weight of AC/DC panels, control/relay panels, batteries, cable termination cabinets, and other electrical equipment supported on the floor.

Roof live load: 40 psf (minimum).

Snow load: Per the applicable building code. 10 psf ground snow load minimum.

Floor live load: 250 psf or a 1,300-pound load concentrated in any 2½ square foot area.

Wind load: Per the applicable building code. 120 mph (minimum).

Seismic: Per the applicable building code.

## 7.2 Fall Protection

Buildings shall be constructed to include permanent anchorage points to accommodate personal fall protection systems capable of supporting 5,000 pounds per worker (OSHA defined impact load). For elevated houses, permanent anchorage points shall additionally be included on the walls of the control house adjacent to each exterior door to accommodate personal fall protection systems for use when working on the platform. All anchorage points shall be shown on roof drawings and marked on control house if not easily visible.

## 7.3 Roof

The roof shall have a minimum slope of ¼ inch in 12 inches; designed and constructed as specified by the IBC. The control house shall have a freestanding roof with no interior vertical supports to support the roof ridge beam.

## 7.4 Cable Tray

The cable tray and other suspended items shall be adequately supported to resist applied loads including, but not limited to, dead loads, cable pulling loads, and seismic loads.

The cable tray shall be capable of carrying a uniformly distributed load of 75 pounds/ft in addition to the weight of the cable tray with a safety factor of 2.0 when supported as a simple span.

# 8 FOUNDATIONS

Foundation design will incorporate the soil capacity determined from the Geotechnical Report. Foundation design shall conform to ACI 318 and county and state codes.

Drilled pier/shaft and slab-type foundations shall be used. Alternative foundation systems may be considered if agreed upon between Buyer and Seller.

Ground supported pieces of equipment, such as circuit breakers and transformers, shall be supported by cast-in-place reinforced concrete slabs unless otherwise indicated by the Geotechnical Report.

Transformers shall be positively anchored to supporting foundations.

Foundations for the equipment support structures (bus supports, switches, etc.) and transmission line dead end structures shall be cast-in-place reinforced concrete drilled piers or spread footings, whichever is appropriate based on the subsurface soil information, unless otherwise indicated by the Geotechnical Report. Anchor bolts for all structures shall be of sufficient length to allow for the use of leveling nuts. The use of grout between the structure base plate and the top of the structure foundation is not required.

The control house foundation shall be piers or concrete slab. A cable routing and pulling area will be designed to facilitate connection with the conduit or pre-cast concrete cable trench entry from the substation and shall be located beneath the termination cabinet(s).

Foundation designs shall be in accordance with the following general minimum criteria:

a) Concrete strength fc = 4,500 psi at 28 days
b) Grout auger cast piling fc = 5,000 psi at 28 days
c) Reinforcing steel (ASTM A615 Gr 60) fy = 60,000 psi
d) Foundation loads

Structures From structure design calculations

Equipment From original equipment manufacturer shop drawings or product literature

Importance Factor

Structures/Foundations - 1.0 for non-essential facilities

Safety factors (foundation reactions shall be service loads)

Shallow Foundations – Bearing Capacity 3.0

Shallow Foundations – Stability (Overturning, Sliding, and Uplift) 1.5

Drilled Piers Not less than 1.5, preferably 2.0

In general, foundations shall extend below the Finished Grade as required by local or state code and the recommendations in the Geotechnical Report. The Geotechnical Report shall clearly state the safety factors needed for each site.

## 8.1 Foundation Deflection and Rotation

Deflection and rotation of drilled pier foundations shall be limited to 0.5 inch of deflection (vertical and horizontal) and 0.5 degrees of rotation due to unfactored (service) loads.

## 8.2 Materials

Structural steel shapes, plates, and appurtenances for general use shall conform to ASTM A992 or ASTM A572 grade 50 (wide-flange shape and ASTM A36 (other shapes)). Steel pipes shall conform to ASTM A53 grade B. Structural tubing shall conform to ASTM A500 grade B. Primary connection bolts shall conform to ASTM A325, type 1 or ASTM A490, type 1 with ASTM A194 grade 2H heavy hex nuts and steel washers conforming to ASTM F436 or Compressible-Washer-Type Direct Tension Indicators conforming to ASTM F959. Connection plates shall be ASTM A36 or ASTM A572 grade 50 steel. Steel components

for metal wall panels, roof decking, and cold-formed girts and purlins shall conform to the North American specification for design of cold-formed steel structural members (AISI-S100).

Welded connections shall be made with welding electrodes with a minimum tensile strength of 70 ksi. Bolted connections shall be made with minimum 5/8-inch diameter ASTM F3125 Grade A325 high strength bolts, and shall typically be fully pre-tensioned Type N connections with threads included in the shear plane, unless noted otherwise. Connections subject to significant stress reversals or as otherwise required by the AISC shall be designed as slip-critical connections.

Welding procedures and qualifications for welders shall be in accordance with AWS D1.1 structural steel welding code and AWS D1.3 sheet steel welding code. Welding electrodes shall be as specified by AWS.

Preparation of metal surfaces for coating systems shall follow the specifications and standard practices of the SSPC, NACE, and the specific instructions of the coatings manufacturer. All structural steel for exterior use shall be hot dip galvanized steel per ASTM A123 and ASTM 153, unless noted otherwise. All structural bolts shall be galvanized, unless noted otherwise. Steel assemblies shall be safeguarded against embrittlement and warping during hot dip galvanizing per ASTM A143 and ASTM A384. Repair of damaged and uncoated areas of hot-dip galvanized steel shall be per ASTM A780.

## 8.3 Record Documents

Seller shall provide Buyer with structure and foundation detail drawings and supporting calculations. The drawings shall note all loading criteria used in the design. Foundation details shall note the structure base reactions used in the design. Drawings shall contain appropriate information (e.g. dimensions, materials, weld data, etc.) to allow reanalysis of the structure under future loading conditions.

# 9 FENCE & SIGNAGE

All substations shall have a fence at least eight feet high (seven feet of fabric and one foot of barbed wire). Fences shall consist of chain link fabric, with 3 strands of barbed wire on 45-degree extension arms, with no ground gaps greater than two (2) inches and secure. All steel, including pipe, roll-formed sections, and fittings to be first quality, full weight, “hot-dipped galvanized” as per ASTM-F1234 or ASTM-F1083. The fence fabric shall be aluminum coated steel according to ASTM-A491. Safe step and touch potential of the perimeter fence shall be verified by an IEEE 80 compliant grounding study.

## 9.1 Gates

Drive gates shall be equipped with heavy duty drop bars, drop bar keepers, stops, and flip-over latches (as required) to be locked by standard Entergy lock(s). Hinges shall be heavy duty and shall allow gates to swing either in, or out, or in and out of all gate leaves.

Gates shall be operational from both sides of the gate. Gates shall clear Finished Grade by not more than 3”. Gate locking mechanism shall be installed with 3/8” diameter case hardened bolts. The nuts on the bolts shall be incapable of being removed, either by using lock nuts, splitting the end of the bolts or by welding the nuts on the bolts.

The Collector Substation shall have one motor operated sliding gate and an additional non-motor operated sliding gate or one main gate.

Features of the motor operated sliding gate(s) shall include the following:

- Sliding gate shall be four feet (4) greater than width of entrance road
- An electric gate operator (Lift Master Elite or newer equivalent or better), including associated items
- A hard-wired continuous power connection (if available)

- A hard-wired keypad gate opener (not wireless) located at the gated entrance (exterior side of the Project Site fence)
- A pedestal mount, conduits, and wiring at the gated entrance
- A hard-wired push-button gate opener located at the gated exit (interior side of the Project Site fence); exit ground loop not required
- A pedestal mount, conduits, and wiring for the gated exit
- Sliding gate shall be grounded
- Additional security requirements are found in Section 12 (PHYSICAL AND ELECTRONIC SECURITY).

## 9.2 Signage

A "Danger – High Voltage – Keep Away" sign shall be placed on the exterior of the fence at a maximum spacing of 50 ft. The sign shall be visible and readable from any angle the substation fence can be approached.

# 10SUBSTATION PHYSICAL DESIGN CRITERIA

## 10.1 Substation Bus System

### 10.1.1 Bus Systems

The bus system consists of the bus conductor, bus insulators and supporting structures, and jumper conductors to equipment and lines. The bus system shall be designed to meet the voltage and continuous current rating requirement, as well as the mechanical requirements for bus design strength and deflection for all cases and conditions.

Rigid bus structures shall be designed per IEEE Std. 605, IEEE Std. 1427 and in compliance with the NESC. The bus work must be designed to withstand all required weather conditions appropriate for the location of the station and withstand all forces due to maximum fault current.

Bus dampening shall be accounted for during detailed design and be between 10% and 33% of the bus conductor weight.

### 10.1.2 Bus Configuration

The layout of the bus design shall minimize the crossing of bus sections and equipment by lines and other station buses. This is to reduce or eliminate possible common mode failures and to permit service work to be performed without having to take additional busses or equipment out of service.

The design shall be of the low-profile type using rigid bus in a horizontal (flat) configuration on vertically mounted station post insulators.

Hookstick-operated disconnect switches shall be provided on both sides of all feeder breakers.

If so directed, the bus configurations of the substation facilities shall take into account future expansion. The physical layout shall be made so that expansion can be accomplished with the least amount of outage time when required.

### 10.1.3 Bus Fittings

Bus fittings used for rigid bus connections shall consist of welded connectors.

Fittings used for stranded conductor shall consist of either bolted, compression or welded types. For incoming lines to the substation Dead End (***DE***) structure, the use of quadrant clamps is acceptable. In applications where connection to a line surge arrester is required, the use of bolted connectors is preferred to compression connectors due to the potential chance of incorrect installation and bird caging effect on the incoming conductor. If using compression fittings for the incoming transmission line span, the compression tee and dead-end fittings shall have NEMA 4-hole or 6-hole terminal pads for connection of conductor jumpers.

Fittings used for conductor jumpers shall be of the bolted, compression, or welded type to a bolted pad. Jumpers shall be designed so that they can be unbolted and removed from equipment for maintenance, repair, or replacement.

## 10.2 Station Layout

The collection system shall be identified and marked. This includes all the phases on pad mount transformers, as well as any time the system transitions from underground to over ground or vice versa. An acceptable method of identification is stickers.

## 10.3 Phase Orientation

The phasing orientation of the substation shall be A-B-C when facing the low side transformer bushing left to right. If the phasing is different for the interconnecting utility, notation shall be added to the drawings detailing the phase rotation. Additionally, all equipment and busses shall be labeled.

## 10.4 Grounding System

High voltage structures will be connected to a ground grid. All metallic equipment, structures, and fencing will be bonded to the ground grid utilizing properly rated conductors and ground rods, as required for personnel safety.

## 10.5 Grounding Design Criteria

The grounding system shall be designed using field resistivity values obtained from geotechnical studies. Substation ground grid design shall be based upon IEEE Std. 80 and NESC. Parameters to be used in the design, such as fault current magnitude and duration, will come from various studies, such as the Facility Study and other interconnection studies, and relay and protection system evaluation. Seller shall use fault current split factor calculations that consider OHGW, OPGW and feeder neutral grounding, in order to lower the effective ground fault current. The substation ground grid shall be connected to the overheard transmission line shield wires unless specifically isolated due to other engineering considerations. Clearing time for grounding analysis shall not be shorter than the total time for backup relay operation plus breaker time.

The ground grid analysis shall seek to optimize the cost and complexity of the installation. Multiple design iterations shall be developed, considering varying depths of substation rock, grounding conductor size, grid spacing, ground rod depth, etc., until an optimized, lowest-cost design is achieved.

Grounding analysis shall address seasonal conditions as appropriate, such as seasonally dry soil conditions or frozen earth conditions. The ground grid shall be designed to account for the most-restrictive weather conditions.

The grounding system shall be modeled using grounding analysis software. SES CDEGS, WinIGS, or equivalent.

# 10.6 Grounding System Components

## 10.6.1 Soil Structure:

Grounding analysis software shall be used to determine the number of soil layers present based on field test results input. The soil model results are considered usable if the resultant soil model accurately reflects the measured data.

The original soil model shall be adjusted to minimize the rms error.

## 10.6.2 Ground Grid:

Ground grid conductors shall be optimized for cost, considering the fault current magnitude and other parameters. Copper clad steel should be considered where appropriate, but soil corrosivity shall be considered when evaluating the use of copper clad steel.

The ground grid shall be installed at a minimum depth of eighteen (18) inches below Finished Grade (i.e. grade not including any rock cover).

Ground grid shall extend to cover the swing access for all man and vehicle gate access points as well as any pad mount transformers and other medium or low voltage station service equipment located close to the substation fence. Recommended to go three (3) feet beyond the fence or overall equipment/gate offset.

## 10.6.3 Grounding Rods

The standard ground rod shall be 10-feet-long and made of 5/8-inch diameter copper-clad steel rod. It is acceptable for longer lengths to be made by joining multiple rods together with ground rod couplers. Longer ground rods shall be considered before more costly methods (such as ground wells) are implemented.

Ground rods shall be installed at applicable ground grid locations or at locations dictated by design. Applicable locations include substation perimeter, dead-end structures, lightning masts, surge arrestors, control house corners, etc.

## 10.6.4 Grounding Connections

All underground ground grid cable-to-cable and cable-to-ground rod connections shall be made with exothermic connections (Cadweld or equivalent). All above ground grounding connections shall be made with mechanical, bolted, or compression connections.

## 10.6.5 Above Grade Grounding Provisions

The perimeter fence shall be connected to the substation ground grid at each gate post, every corner and along the fence at intervals dictated by design. Grounding of the fence shall also include grounding provisions for the fence fabric and barbed wire.

All four corners of the control house shall be connected to the substation ground grid.

Two grounding conductors shall be installed the entire length of all pre-cast concrete cable trench greater than 36 inches wide. For pre-cast concrete cable trench less than 36 inches wide a single grounding conductor shall be installed. These conductors shall provide a convenient access to the substation ground and shall provide some shielding of control cables from electrostatic interference. They shall be connected to the ground grid at all main grid crossings and sized to match the ground grid conductor size.

Personnel safety mats (galvanized steel grating) shall be installed on top of the crushed rock surfacing at each disconnect switch operator, manual or motor-operated gang switches, and each personnel entrance

to the control enclosure if metal steps are used. Safety mats shall be bonded to the station ground system in accordance with IEEE 80.

Equipment and structure grounds, or "stingers," consisting of bare conductors shall connect each piece of the substation equipment and steel structure to the ground grid. The minimum conductor size shall be calculated but never be smaller than the ground grid conductor size. There will be two (2) ground connections to each structure and piece of equipment.

Ground studs shall be installed on every breaker bushing pad. Provisions for portable safety ground installations, either bus ≤ 3-inch diameter, ground studs, or grounding stirrups, shall be included at both sides of all disconnect switches. Grounding studs shall be placed such that there is no interference from other equipment (for example, disconnect switch blades).

### 10.6.6 Crushed Rock

The site will be covered with a layer of crushed rock as defined in Section 5.8.1.7 (Site Surfacing). The crushed rock shall be installed throughout the entire substation area and extend 5 feet beyond the fence and swing radius of the gates.

Resistivity tests shall be performed on potential material sources early in the design phase, and those results shall be integrated into the overall grounding system design. The IFC grounding design shall use material with a known, tested resistivity; no assumptions should be made as to the availability of rock of a certain resistivity.

### 10.6.7 Grounding Drawings

The design input from the grounding calculation shall be recorded on the grounding drawing in a concise table. The table shall include all pertinent information, including, but not limited to, final design grid resistivity, depth of crushed rock, rock resistivity, length of ground rods, size of grounding conductor, soil parameters, design fault current, and fault duration. Additionally, it shall be included a field on the grounding drawing for the contractor to record the final fall of potential test results.

## 10.7 Conduit System

All conduit and raceway systems shall comply with NEC and NESC requirements. The conduit and raceway system design shall accommodate power and control cables, communication circuits, underground feeders, and optical fiber cables.

### 10.7.1 Conduits

Low voltage cables used for protection and control, or station power shall be placed in conduit wherever they connect to oil immersed equipment to reduce the risk of burning oil flowing in raceways and causing severe damage to cables. All conduit systems including wiring size shall be detailed on drawings.

Conduit shall be schedule 40 or greater PVC for below grade or above grade applications. Flexible conduit may be used for transitions where necessary. Galvanized steel conduits shall not be used in below-grade applications. Conduits shall be sized in accordance with the NEC (NFPA-70). Where applicable, 2 inch and 4-inch conduits shall be used.

Designs shall incorporate one spare conduit per transformer (main GSU) and circuit breakers 138 kV and above.

All below-grade conduits shall be buried to a minimum depth of twenty-four (24) inches below the Finished Grade (approximately six inches below the ground grid). The conduit system for the 34.5 kV collector cables

shall extend 10 feet beyond the fence and shall be concrete-encased. Additional coordination shall be made with the collector system designer.

### 10.7.2 Cable Trench

For substations and collector facilities that have more than one main GSU transformer, precast concrete trench systems shall be installed. It shall be identified early in detailed design if the current Project will ever be expanded with a second or third phase. If additional phases are planned, the initial layout shall be designed such that adding new cable trench can be implemented while minimizing the impact to existing facilities.

Precast concrete trench with a pedestrian strength rating shall be specified for the substation yard raceway system. HS-20 rated road crossing cable trench shall be used for all vehicle crossing locations. Each vehicle crossing location will be marked with high visibility bollards extending at minimum three (3) feet above the ground and visible during winter snow conditions. Applications for the use of a barrier internal to the cable trench or multiple trench systems may be utilized where required.

Conduits shall be provided between the concrete trench system and yard mounted equipment

On two transformer stations or an integrated ring bus switchyard, a partial cable trench system is normally required, and provisions shall be provided in detailed design.

### 10.7.3 Pullboxes

Cables entering the control house from the substation yard shall be routed through a pre-cast cable vault and pulling area into the control house termination cabinet.

### 10.7.4 Cable Entry and Trays

All conduit and cable entry openings into the control house shall be tightly sealed as a barrier to animals to keep out moisture and to minimize heat loss. Cables entering the control house shall be terminated at the appropriate termination cabinet or AC or DC panel board.

Inside the control house overhead cable tray suspended from the ceiling shall be used to route cables between the termination cabinet, control and relay panels, and other equipment.

## 10.8 Lightning System

The substation direct lightning stroke shielding design shall be performed in accordance with IEEE Std 998-2012 “IEEE Guide for Direct Lightning Stroke Shielding of Substations” using the “electro-geometrical model” or the “rolling sphere technique”. For small stations it is acceptable to use the fixed angle method as a means for determining proper shield protection locations.

After the substation layout is completed, the direct stroke shielding shall be analyzed to verify that the equipment within the substation fence is adequately protected. The transmission line static wires shall be connected to the substation ground grid.

The following criteria shall be used for the lightning shielding design:

- Station BIL, *Table 2*.
- Lightning stroke density shall be that for the Project area as reported by the Fault Analysis and Lightning Location System
- A design failure rate of less than one shielding failure in one hundred (100) years.

The shielding design shall utilize a combination of shield wires, shielding masts and/or mast poles. Shield wires over substation buses shall be arranged such that there is no more than a single bus between shield wire supporting structures.

All static wires from the transmission lines shall terminate into the station lightning shielding system.

### 10.8.1 Lighting System

The primary purpose of substation lighting is to provide sufficient illumination for personnel safety and emergency equipment maintenance. The substation shall be provided sufficient illumination during the night for safe passage of the maintenance crew who might be performing equipment inspection or maintenance. Outdoor lighting is often also intended to deter vandalism; however excessive illumination may attract vandals or result in complaints from the surrounding community. Lighting is also used in certain areas to deter birds from roosting and/or nesting. Yellow color lighting such as sodium vapor does not attract as many bugs, flying bats and birds that in turn attract snakes and climbing animals.

Proper placement of lighting is important. Placement of lighting shall consider the collection of insects on adjacent energized equipment. Large quantities of these bugs can attract animals and increase risk of animal outage.

At least minimum illumination levels recommended by National Electrical Safety Code C2 shall be provided in generating stations and substations. Illumination levels relevant to substations are as follows:

a) Emergency exit path: 1 foot-candle (11 lux)
b) Control house (occupied): 15 foot-candles (165 lux)
c) Control house (unoccupied): 5 foot-candles (55 lux)
d) Front of switchboards and panels: 15 to 25 foot-candles (165 to 275 lux)
e) Fence: 0.2 foot-candles (2.2 lux)
f) Substation general horizontal: 2 foot-candles (22 lux)
g) Substation vertical (on disconnects etc.) 2 foot-candles (22 lux)
h) Roadway: 0.5 foot-candles (5.5 lux)
i) Open yard: 0.2 foot-candles (2.2 lux)

The need for detailed lighting design for each substation shall be individually evaluated depending upon the substation's location, site area, type of buswork structures, and the equipment installed in it. LED light fixtures shall be installed for all new installations. The following is required as a minimum for typical substation lighting:

a) The entrance gate into the substation shall be provided with a motion-activated photocell-controlled light.
b) The substation control house entry doors shall be provided with motion-activated photocell-controlled lights.
c) The substation shall have switched, photocell-controlled lights, preferably with a timer, for safe passage. The control switch shall be in the control house.
d) A sufficient number of Ground Fault Circuit Interrupter (***GFCI***) outlets shall be provided in the substation near the equipment e.g. circuit breakers and power transformers for portable light hookup for nighttime repairs and maintenance. GFCI outlets provided in the equipment control cabinets shall be used for this function.

## 10.9 Substation Security/Safety

Substation Security shall not apply for substations below 161 kV. However, depending on the Project interconnection area, additional requirements may exist due to other evolving cyber security concerns. Check with Buyer - Transmission Planning for site specific concerns.

# 10.10 Animal Deterrents

Means for animal deterrent and mitigation shall be provided in all medium voltage substations, and the MV section of all high voltage substations.

IEEE Std 1264 provides guidance on methods and designs to mitigate animal intrusion and resulting interruptions and equipment damage.

Animal mitigation shall be achieved by applying substation insulators that have a large enough flashover distance to prevent bridging by animals, such as snakes and squirrels, by increasing phase spacing and by providing guards and covers for insulators or adding barriers between phases to prevent phase to phase bridging by birds. Guards and covers shall be installed on all MV equipment bushings listed below regardless of the spacing.

Insulating covers shall be installed on all medium voltage equipment bushings as follows:

a) Power transformers
b) Station service transformers
c) Voltage regulators
d) Circuit breakers and reclosers
e) Surge arresters
f) Capacitors
g) Instrument current and voltage transformers
h) UG cable terminations
i) MV switches and jumpers

Insulators in substations where higher BIL bus and disconnect insulators cannot be applied shall be protected by suitable guards and covers.

MV substation equipment including 34.5 kV equipment shall be provided with guards and covers and each phase shall be covered for a distance of three (3) feet, unless otherwise specified during the constructability review. The center phase shall be fully covered. Depending upon location and known animal intrusion problems, additional mitigation may be required.

# 10.11 Substation Protection & Control Design Criteria

## 10.11.1 Protection and Control Requirements

The protective relaying shall:

a) Preserve the integrity of the ELL Transmission System by being dependable and secure to the appropriate level of required reliability as specified by Entergy Transmission Planning.
b) Properly coordinate and function with other Entergy relay schemes, and neighboring utilities.
c) All Collector Substation protection relays, both primary and backup, shall be SEL as stated in ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION).

## 10.11.2 Backup and Transfer Trip

Breaker failure backup and/or transfer trip circuits to interface with other stations shall always be provided.

## 10.11.3 Transmission Line Protection

Transmission line protective relay equipment at the Collector Substation shall be provided to meet the requirements of Buyer - Transmission (as the host utility).

HV transmission lines shall have a dual primary line protection scheme comprising of dual primary communication assisted tripping relaying scheme. Each primary protection scheme shall utilize separate instrument current transformers, or separate current transformer cores of a free-standing current transformer, separate CVT or PT secondary windings, and separated DC and AC supplies from a common distribution panel. Breaker control is typically on the same line panel.

### 10.11.4 Bus Protection

HV and MV bus shall use single low or high impedance protection scheme. Low impedance is preferred. If using high impedance protection, all of the current transformers in the circuit shall have the same ratio and must be tapped at the full ratio.

### 10.11.5 Transformer Protection

Each power transformer shall be protected by a minimum of one and, preferably, two differential relaying schemes. The transformer differential relay shall be connected to the transformer high side bushing current transformers. Low-side circuit breaker or transformer bushing current transformers shall be positioned to provide a sufficient area of overlap between adjacent protective zones. Protection zones shall be created to prevent through-bus interruption for transformer differential operation.

Back up time overcurrent transformer overload relaying shall be provided.

GSU transformers shall be purchased and supplied with the following integral monitoring devices:

a) Oil level gauge on tank wall or conservator.

b) Pressure relief device(s). The pressure relief device is used for alarms. Transformer tanks containing more than 10,000 gallons of oil shall be provided with two pressure relief devices mounted on diagonally opposite corners of the transformer tank. The device(s) shall be located remote from the control cabinet(s). The pressure relief value shall be stamped on the device(s).

c) Sudden pressure rise relays. Transformers are specified to have two sudden pressure relays used to trip the transformer when both relays have operated. A sudden pressure or Bucholtz relay (Device 63) shall be provided, including seal-in contacts in an enclosure with a threaded conduit hub and “loss of DC indication”.

d) Gas accumulation detecting relay (conservator tank units). Contacts of the gas accumulation detecting relay are used for alarm.

e) Temperature monitoring system to indicate top oil and winding temperatures.

Seller shall design the system so as not to trip and isolate transformers due to the operation of pressure relief devices, high oil temperature, and high winding temperatures. Main power transformers shall be tripped and isolated when the oil level in the transformer tank falls below the critical level to prevent internal flashovers. GSUs or main power transformers shall have critical oil level as an alarming feature only and no tripping.

### 10.11.6 Capacitor Bank Protection

See IEEE Std C37.99 – IEEE Guide for the Protection of Shunt Capacitor Banks for detailed guidance on the capacitor bank protection schemes. Seller shall employ the Unbalance Detection scheme for the protection of the capacitor bank. The aim of this scheme is to trip the capacitor bank if there are unbalances in the phases that result in voltages 110% or more across the individual capacitor unit.

### 10.11.7 Shunt Reactor Protection

See IEEE Std C37.109 for guidance on the protection of shunt reactors. Studies shall be conducted to determine if snubbers are required for reactor switching. Surge arresters are recommended for all reactor applications.

### 10.11.8 HV Breaker Control

Gas insulated circuit breakers are specified to be equipped with two or more stages of gas pressure/density monitoring contacts.

a) Contact of the first stage closes on falling pressure at approximately 10% loss of pressure, and

b) Contact of the second stage closes on falling pressure at a further 10% reduction of gas pressure.

Most manufacturers comply with these requirements except that the first stage and second stage contacts may not necessarily close at 10% loss of pressure for all makes and models of the circuit breakers.

A circuit breaker retains its full electrical and mechanical rating at this second stage pressure/density of gas in the circuit breaker. However, the circuit breaker manufacturer will not guarantee any rating below this pressure and, accordingly, the circuit breaker operation shall be disabled below this pressure.

The manufacturers of circuit breakers generally do not offer any specific recommendations for the circuit breaker's continued operation when the second stage contacts of the gas density monitor close. It will be the responsibility of Buyer to determine whether a circuit breaker should be tripped (if it was already closed) or block any close/open operation under these conditions.

Since the system security, substation importance, and the circuit breaker applications within the substation vary throughout the system, a common system wide approach on whether to trip or block operation of all circuit breakers cannot be specified.

The following is a recommended plan of action, keeping in mind that the circuit breaker retains full rated values at the second alarm stage, and it is capable of withstanding normal system voltage with the gas in the interrupters at atmospheric pressure. Under ideal conditions and with a standard 0.5% gas leakage rate it would take more than five years for any alarm stage to be generated for most breakers. A second stage alarm usually signifies a rapid loss of gas.

The circuit breaker control scheme shall address the loss of gas alarms as follows:

1. First stage alarm: Effort shall be made to investigate the cause within eight hours (or the next day at the latest).
2. Second stage alarm received within one day of receiving the first stage alarm: In locations where the system continuity can be maintained (ring bus, or breaker and half bus substations) the circuit breaker shall be tripped immediately. If the system continuity cannot be maintained, then the circuit breaker operation shall be blocked. In substations with a single bus the circuit breaker operation shall be blocked. It may be necessary to include timers in the relay scheme to achieve this requirement. This should be evaluated during detail design.
3. Second stage alarm received more than one day after receiving the first stage alarm: Block circuit breaker operation.

All HV breaker control relays shall include Lockout Relays (***LOR***s).

### 10.11.9 HV Motor Operated Switch Control

When HV Motor Operated Switches (***MOS***s) are used, if a control building is used, it is preferred that the MOS controls be located on the applicable line protection, transformer protection, or breaker control panel.

If no control house is required, the panel design must be modified to fit in a suitable NEMA type 4X stainless steel outdoor enclosure.

### 10.11.10 MV Collection Feeder Protection

Primary feeder protection will be provided by an SEL-351S or similar relay at each feeder breaker. Instantaneous and time overcurrent phase and residual ground are typical elements to protect the feeder section. Additional voltage and frequency elements will be enabled to ensure compliance with NERC reliability requirements (e.g., PRC-019, -024, and -026, if applicable).

Breaker failure initiate will be enabled to ensure coordination with MV bus and transformer differential if a breaker fail occurs.

## 10.12 Relay Calculations and Setting Requirements

For relay settings, refer to TE-SD-AD-007 (Relay Settings Procedure) and PM1804 (Transmission Line Relay Setting Criteria, Design and Operation Guide) for guidance. Relay settings shall meet the requirements of NERC reliability standards PRC-019, -023, -024, -025, and -026, as applicable.

Typical Relay Engineering Calculations:

- Battery Bank Sizing & Design: IEEE-485 & NEC – Article 480.
- Battery Charger Sizing: EPRI Stationary Battery Guide (Design, Application, and Maintenance)
- DC Load Center Sizing: Requires building DC loading table (Watts / Amps) for yard and enclosure (panel) equipment – Nameplate information and/or equipment manuals required.
- AC Load Center Sizing: Requires building AC loading table (Watts / Amps) for yard and enclosure (panel) equipment – Nameplate information and/or equipment manuals required.
- Station service sizing
- Voltage Drop Calculations (use as guide only): NEC: 215.2(A)(4)
- Conductor Ampacity Calculations (use as guide only): NEC Table(s) 310.15 (Engineer to select correct table for use)
- Grounding Methods for Electrical Supply: NESC Sec. 9
- Size of Equipment Grounding Conductors (use as a guide only): NEC Sec. 250.122 and Table 250.122.
- Cable in Conduit Fill Calculations: NEC Tables 310.15(B)(2)(a) & 310.15(B)(3)(a), Chapter 9, Table 1, Table 4
- Cable Tray Fill Calculations: NEC 392.22, Table 392.22(A).

# 11CONTROL HOUSE

The control house shall be designed to comply with the latest version of the IBC, and with local building code requirements. See Section 5.7 (Control House). It is preferred to have an engineered/prefabricated and delivered to site precast concrete building. Steel, concrete and CMU buildings are all acceptable options.

The control enclosure shall contain Vendor-provided station services such as primary and backup AC supply disconnects, an automatic AC transfer switch, AC load centers, DC power system and storage battery, and air conditioning units.

The Vendor shall be capable of meeting any state-specific certification and/or inspection requirements.

The control enclosure shall be suitable for placement upon both concrete slab and concrete pier foundation types. An indication of design loads for both foundation types shall be supplied with the Vendor's engineering documentation.

All Vendor-supplied equipment within the control enclosure shall use equipment enclosures conformant to at least the NEMA 1 specification. External equipment shall be appropriately rated and weatherproofed for exterior installation.

The control enclosure shall contain space for equipment including:

a) Control enclosure shall be sized to account for all necessary equipment in the station ultimate configuration. No more than sixteen 27-inch, free-standing relaying and control panels in a single row. All cable access to the panels will be from a cable tray system above the panels.

b) One wall-mounted termination cabinet having dimensions of up to 72 inches x 90 inches x 24 inches.

c) Communications equipment including fiber-optic, telecommunications, and related interfacing gear.

d) Separated control room is required for all projects.

e) The control enclosure shall have a minimum internal ceiling height of 10 feet to allow for adequate equipment clearance below the cable tray.

Wall space shall be left open to the greatest extent practical. Conduits and raceways provided by Vendor for building services and included equipment shall be placed at or near the ceiling with vertical service drops. Horizontal raceways and conduits between adjacent equipment such as load centers are acceptable.

The control enclosure shall include one eye-wash system with two saline cartridges when there isn't water brought to the site.

# 11.1 DC System

One (1) VLA 125 VDC battery system shall be provided along with (2) 130 VDC battery chargers. The batteries and chargers shall be sized in accordance with IEEE 485 and considering substation ultimate configuration (if any). The calculation shall consider worst case tripping scenario along with dual trip coil operation. A single charger shall be able to fully charge a completed battery within eight to twelve hours while supplying normal loads.

Dual DC load centers shall be provided within the control house. DC load centers shall be designed with enough circuit positions for the substation's ultimate configuration. Each DC load center shall be rated 125 VDC and shall have a main circuit breaker. The DC load centers breaker position and total circuits requirement shall be dictated by final approved DC Calculation considering ultimate substation configuration. DC load centers shall be dead-front design, installed on the control enclosure wall, and provided with conduit access to the cable tray.

Battery chargers shall not have an alarm "on/off" switch. Each battery charger installed in the station shall alarm on zero current output. Dual charger setups shall be wired for parallel operation. When properly set up each charger shall share half of the battery bank charging current.

Battery banks shall be located in a separate room of the control house. There shall be enough space so field personnel can reach each cell and battery terminals for testing and maintenance. A minimum of 24 inches height separation between battery racks is needed to accomplish this.

Battery DC grounds shall be monitored via indicating lights on the front panel of the battery charger and indication of a DC ground shall be an input to the station RTU. Battery voltage shall be an input to the station RTU.

## 11.2 AC System

The substation will be equipped with normal and backup AC station service sources supplying 120/240 VAC, 3 wire, single phase power. Station service is preferred to be provided by low- side SSVT, local distribution, or on-site generator in that order. The design shall include two (2) fused disconnect switches for the incoming feeds (secondary feed of the SSVT and emergency feed). The system neutral must be bonded to ground in one and only one of the fused disconnects. These two disconnects shall both be in the control building. The normal station power source also needs to have a fused disconnect switch below the station service transformer. The fuses shall be Type LPN.

Also, the unprotected conductors between the normal or backup station service transformers and the first disconnect cannot be routed in the same conduit with feeders or branch circuits.

There shall be specified an Automatic Transfer Switch (***ATS***) with microprocessor control. The ATS shall be equipped with alarms for loss of normal service and loss of backup service. The ATS shall be capable of managing a standby generator on the backup source. The ATS shall have neutral bonding provisions.

There shall be specified AC load centers with enough circuit positions for the substation's ultimate configuration. Each AC load center shall be 120/240 VAC, three-wire, single phase, having a 100% rated, main breaker. The final AC load center breaker position and total circuits shall be dictated by the final approved AC Calculation, considering ultimate substation configuration. AC load centers shall be dead-front design, installed on the control building wall, and provided with conduit or wireway access to the cable tray for use by others. The load centers shall use a commonly available circuit breaker type.

## 11.3 Metering Requirements

The metering panel shall be designed and constructed as specified in the GIA or Project planning phases.

Multi-conductor cables no smaller than #10 AWG shall be used to connect the instrument transformer secondary windings to the meter location. Under no circumstances shall CT cables contain splices. Larger conductor size may be required depending on the location of instrument transformers in relation to the meters. Seller shall perform burden calculations to determine appropriate conductor size.

Conductor used for grounding the metering instrument transformer tank shall be the same size as that used for the ground grid and in no case be smaller than #40 AWG.

Metering CTs and PTs shall be 0.15B1.8 sized so that tapping down is not required and 3% extended range TR=2 respectively.

All meters shall conform to ANSI Standards C12.20, C12.1, and C12.10. Acceptable meters are Landis and Gyr E850 MAXsys Elite, SEL-734 or SEL-735.

## 11.4 SCADA

A Remote Terminal Unit ("***RTU***") and/or gateway device shall be specified, and installed to provide supervisory control, status indication, alarm monitoring, and to gather accumulated and instantaneous data to be telemetered to Entergy Distribution Operations Center (***DOC***), Transmission Control Center (***TCC***) and Entergy Local Balancing Authority (***LBA***). The RTU shall comply with all GIA requirements.

While all substations require a TCC / DOC RTU to be present, some existing substations host a "dual port" RTU design in which data is provided to a TCC and LBA SCADA host. Confirmation of existing substation RTU-SCADA host configuration shall be done by contacting the IT-OT EMCS SCADA teams and/or IT-OT Substation Services. Substations that serve as a generation interconnection or system tie boundary with another utility may also require a dual-port RTU-SCADA host configuration.

Relay Design Personnel shall perform the following activities per TMM TE-SD-AD-006; RTU/Communication Processor Configuration and Edit Sheet Procedure.

a) Obtain initial baseline TCC RTU edit sheet from IT OP- Tech Personnel of what the SCADA Host has programmed to date of the request, or latest revision if there are revisions being documented.

b) Provide SOC and/or GMS personnel needed information for them to provide new updated SOC and/or GMS edit sheets.

c) Issue final approved TCC, SOC, and/or GMS edit sheets with relay design package.

## 11.5 Communications

The communications media (pilot wire, fiber optic cable, power line carrier or digital microwave) required, and the communications system for supervisory control, telemetering and equipment status indication will generally be known at the Project initiation stage. Note that Entergy will usually consider digital microwave as adequate communication media. This will vary depending on the interconnection substation communication capabilities and GIA requirements.

Designers of communication circuits shall consider redundant, dual-purpose paths.

A telephone is required to facilitate voice receipt of switching orders, emergency services, and restoration of service during outages.

For fiber optic cable facilities, two conduits from the substation fence to the fiber optic cable terminal board in the control building shall be furnished and installed. The fiber optic cable between the fence and the terminal board shall be installed in conduit(s).

Multiplexers used for fiber-optic interface for digital relay communications schemes system protection shall be hardened per IEEE Std 1613 - IEEE Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations, and compatible with IEEE Std C37.94 - IEEE Standard for N times 64 kbps Optical Fiber Interfaces between Teleprotection and Multiplexer Equipment.

## 11.6 Digital Fault Recorder

If the Project requires a Digital Fault Recorder (*DFR*), TESLA 4000 or similar DFR may be used. This shall include enough current and voltage inputs as per Project design.

## 11.7 Low Voltage Cable (Wiring)

The following is a partial list of the requirements for station power, instrumentation and control cabling within the substation.

- The voltage drop for all control cables shall be verified not to exceed 10%.
- All current carrying control cables shall be sized based on the anticipated maximum load currents. Factors that shall be considered to determine the adequate cable size are conductor material, ambient conditions, cable insulation, cable stranding, proximity of parallel current carrying cables and whether the cables are in conduit, in a cable tray or suspended in the air.
- All low voltage power, instrumentation and control cables within the substation shall be insulated for a 600-volt rating.
- Coaxial and instrumentation cable shall be fully shielded both inside and outside the control house.
- All other control cables inside the control house are not required to be shielded.

- Shielded cables shall be required in 345 kV yards and above (CT, trip and control circuits) and in 69 kV and above capacitor banks (grounded and ungrounded). All control and low voltage power cables outside the control house shall have a longitudinally corrugated copper tape shield.
- Returns for power, currents, potentials, controls, analogs and others shall be within the same cable.
- Cable shields and unused conductors are not required to be terminated or grounded for cables within the control house. For shielded field cables, the shield shall be terminated at one end, preferably within the termination cabinet, and unused conductors shall be left ungrounded. The termination cabinet ground bar shall be sized to accommodate shield grounding.
- Analog connections shall be made with 2 pair #18 AWG instrumentation cable, communication connections shall use shielded 4/C #18 AWG control cable, and status point connections shall use shielded 8/C #18 AWG control cable when new cables are required.
- Power line carrier signals shall be shielded via a shielded coaxial type cable.
- Splicing of cables is not permitted.

# 12PHYSICAL AND ELECTRONIC SECURITY

Refer to IEEE Std. 1402 for guidance in providing physical and electronic security for the substation. Additional security design elements may be required by NERC Critical Infrastructure Protection ("***CIP***") standards.

The following NERC CIP standards provide mandatory security requirements:

a) CIP-002; Cyber Security – BES Cyber System Categorization

b) CIP-005; Cyber Security – Electronic Security Perimeter(s)

c) CIP-006; Cyber Security – Physical Security of BES Cyber Systems

d) CIP-014; Physical Security

Critical substations are designated as Critical or Deemed Essential (***CODE***). CODE substations include the Critical Asset and infrastructure but also the larger assets which if destroyed, damaged, degraded or otherwise rendered unavailable would have a significant impact on the Bulk Electric System (***BES***) affecting its stability or ability to transport large loads or would have a detrimental impact on the reliability or operability of the electric grid or would cause significant risk to the public health and safety.

NERC CIP-014-1 standard provides the following criteria for critical designation:

a) All 500 kV substations;

b) Substations operating at 200 kV to 499 kV with an aggregate weighted value exceeding 3000 per table the below; and

c) Substations operating at 200 kV and above and connected to three or more substations with an aggregate weighted value exceeding 3000 per the table below:

| Voltage of Line | Weight Value per Line |
|---|---|
| 200 kV to 299 KV | 700 |
| 300 kV to 499 kV | 1300 |

In general, all 500 kV substations, all substations with four 230 kV lines or all substations with three 230 kV and several 161 kV or lower transmission lines may be considered as CODE. The criteria noted above are the minimum threshold for CODE designation. A substation may also be designated CODE as necessary per the unique risks that justify such designation.

**Appendix 1: Collector Substation**

Substations that are designated as CODE assets require additional physical and electronic security from physical and electronic intrusion, vandalism as required by NERC CIP-002, -005, and -006.

Additional requirements may exist due to other evolving cyber security concerns. Check with Transmission Planning for site specific concerns.

Minimum security requirements are defined in *Table 29*

Table 29: Minimum Security Requirements

| Location | Description | Equipment by Seller | Equipment by Buyer |
|---|---|---|---|
| Collector Substation | Minimum two cameras located at opposite corners of substation area | Wiring (power and communications) and required hardware supports | Cameras |
| | Electrically operated slide gate with keycard reader | Keypad, slide gate, gate operator, wiring (power and communications), grounding loop, exit button and hardware for mounting keycard reader | Keycard reader |
| Collector Substation Control House | Keycard reader for lock on control house personnel door | Keypad, wiring (power and communications), and required hardware supports for mounting keycard reader | Keycard reader |

# 13DELIVERABLES

In addition to any submittals and deliverables defined in the Project Contracts, in accordance with NERC reliability standards, Seller shall provide the following documentation to Buyer thirty (30) days prior to initial synchronization of the Project, along with any other documentation reasonably requested by Buyer or required by NERC:

- BAL-005 – One-line diagram that displays the Electrical Interconnection Point (and includes unique line identifiers/names ensuring that the Project Site and Buyer - Transmission use the same naming convention when referring to the Plant (e.g., breakers, lines, etc.) by Seller)
- COM-002 – Network diagram of voice and data links by Seller
- FAC-008 – Identification of most limiting equipment factor based on application of Generator Buyers Facility Rating Methodology by Seller
- MOD-032 – Data for Power System Modeling and Analysis, as applicable, by Seller.
- VAR-002 - Transformer information, including the following, as applicable, by Seller and Buyer (or its Affiliate(s)), and as obtained by Seller from the Approved Vendor of the GSU:
- Tap settings
- Available fixed tap ranges
- Impedance data
- The + / - voltage range with step-change in % for load-tap changing transformers

# Appendix 1: Collector Substation

# Appendix 1: Collector Substation

## ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION

Attachment 1 to this Appendix (Collector Substation) provides an Approved Manufacturers List. The Approved Manufacturers List in this Attachment 1 is in addition to the Approved Manufacturers and EPC Contractor List in Appendix 9 (Approved Manufacturers and EPC Contractors List) of this Scope Book.

| Description | Preferred Manufacturer | Preferred Supplier | Other Approved Manufacturer(s) |
|---|---|---|---|
| Arrester, Surge | Cooper | Eaton Cooper | Siemens, Hitachi Energy |
| Battery Fiberglass Enclosure with A/C | Exponential | Exponential Power | |
| Battery – EC | Enersys | Exponential Power | |
| Battery – CC | Enersys | Exponential Power | |
| Battery Charger ATEVO | Hindle | Exponential Power | |
| Battery Rack | Enersys | Exponential Power | |
| Bolts Anchor | | | Valmont, Threaded Fasteners |
| Bolts Anchor cage for Substation Steel | | | Valmont, Threaded Fasteners (size limit) |
| Breaker, MV 15 kV- 27kV | ABB INC. - San Luis Potosi, Mexico | ABB Inc. | MEPPI - Warrendale, PA |
| Breaker, MV 34.5 kV | ABB INC. - San Luis Potosi, Mexico | ABB Inc. | MEPPI - Warrendale, PA |
| Breaker, HV 115kV - 40kA (Dead Tank) | Siemens - Richland, MS | Siemens | MEPPI - Warrendale, PA<br>Hitachi Energy - Mt. Pleasant, PA<br>ICO - Changwon, S. Korea |
| Breaker, HV 115kV - 63kA (Dead Tank) | Siemens - Richland, MS | Siemens | MEPPI - Warrendale, PA<br>Hitachi Energy - Mt. Pleasant, PA<br>HICO - Changwon, S. Korea |
| Breaker, HV 161kV - 40kA (Dead Tank) | Siemens - Richland, MS | Siemens | MEPPI - Warrendale, PA<br>Hitachi Energy - Mt. Pleasant, PA<br>HICO - Changwon, S. Korea |
| Breaker, HV 161kV - 63kA (Dead Tank) | Siemens - Richland, MS | Siemens | MEPPI - Warrendale, PA<br>Hitachi Energy - Mt. Pleasant, PA<br>HICO - Changwon, S. Korea |
| Breaker, HV 245kV-63ka (Dead Tank) | Siemens - Richland, MS | Siemens | MEPPI - Warrendale, PA<br>Hitachi Energy - Mt. Pleasant, PA<br>HICO - Changwon, S. Korea |
| Breaker, HV 69kv (Dead Tank) | Siemens - Richland, MS | Siemens | MEPPI - Warrendale, PA<br>Hitachi Energy - Mt. Pleasant, PA<br>HICO - Changwon, S. Korea |
| Breaker, HV 245KV, 80ka (Dead Tank) | Siemens - Richland, MS | Siemens | MEPPI - Warrendale, PA<br>Hitachi Energy - Mt. Pleasant, PA<br>HICO - Changwon, S. Korea |
| Breaker, HV 69-245 (Live Tank) | | | Hitachi - Ludvika, Sweden<br>Siemens - Jundiai, Brazil (245 kV only) |
| Breaker, EHV 345/500kV (Dead Tank) | MEPPI - Warrendale, PA | MEPPI | Hitachi Energy - Mt. Pleasant, PA<br>Siemens (345KV ONLY) - Richland, MS<br>HICO - Changwon, S. Korea |
| Breaker, EHV 345/500kV (Live Tank) | | | Hitachi Energy - Ludvika, Sweden<br>Siemens - Jundiai, Brazil |
| Bus, Aluminum Pipe | Three D Metals | Three D Metals | AFL |

# Appendix 1: Collector Substation

## ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION

| Description | Preferred Manufacturer | Preferred Supplier | Other Approved Manufacturer(s) |
|---|---|---|---|
| Control Cable -Shielded and Non-Shielded | Southwire | Southwire | Priority, Lake Cable, Service Wire, Prysmian |
| Capacitor Cans | | | Cooper, GE, Hitachi Energy |
| Capacitor Banks, Shunt | | | Cooper, GE, Hitachi Energy |
| Capacitor Banks, Series | | | Hitachi Energy, MEPPI, Siemens |
| Capswitcher 115kV and above | Southern States | Preferred Sales | |
| Capswitcher 245kV - 362kV | Southern States | Preferred Sales | |
| Capswitcher 34.5kV and below | Southern States | Preferred Sales | |
| Capswitcher 69kV | Southern States | Preferred Sales | |
| Power line Carrier UPLC | | Ametek | Pulsar |
| CCVT 69kV - 500kV | Ritz - Lavonia, GA | Aertker | GE - Charleroi, PA, Itajuba, Brazil<br>Trench - Toronto, Canada<br>Hitachi Energy - Crystal Springs, MS<br>Arteche - Tepeji Del Rio, Mexico |
| Chain Wall | Kenner Chain Wall | | |
| Circuit Switcher Mark V | S&C | Curtis Stout | Southern States |
| Circuit Switcher Vertical Standing | S&C (Series 2000) | Curtis Stout | Southern States |
| Cable, Aluminum ACSS, ACSR | Prysmian | Aertker co | Southwire |
| Cable, Copper (Not Control cable) | | Stuart Irby | Copperweld /Alcoa |
| Cable, Fiber ADSS | | Preferred Sales | AFL |
| Cable, Fiber OPT-GW | | Preferred Sales | AFL |
| Conduit & Accessories | | Stuart Irby | Cantex, Carlon |
| Connectors line ACSS | | Preferred Sales | AFL |
| Connectors line (Fiber, OPGW, ACSR) | | Preferred Sales | AFL |
| Connectors, Trans. Line - Insulator Assemblies | Maclean Power Sys | Preferred Sales | |
| Connectors/Fittings - Substation | | Stuart Irby | Any Approved Manufacturer |
| Control House | Modular Connections | Modular Connections | AZZ Inc. (Avail), Trachte, VFP |
| Control House Drop-In (turnkey) | VFP | VFP | |
| CT Slipover only | | ITEC | ITEC, ABB Inc., Meramec |
| CT 15kV - 34.5kV | | | ABB Inc, Ritz |
| CT 230kV | | | GE - Charleroi, PA, Itajuba, Brazil<br>Trench - Toronto, Canada<br>Ritz - Waynesboro, GA.<br>Arteche - Tepeji Del Rio, Mexico |

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## ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION

| Description | Preferred Manufacturer | Preferred Supplier | Other Approved Manufacturer(s) |
|---|---|---|---|
| CT<br>345kv - 500kV | | | GE - Charleroi, PA, Itajuba, Brazil<br>Trench - Toronto, Canada<br>Arteche - Tepeji Del Rio, Mexico |
| CT<br>69kv - 161kv | | | GE - Charleroi, PA, Itajuba, Brazil<br>Trench - Toronto, Canada<br>Hitachi Energy - Crystal Springs, MS<br>Ritz - Waynesboro, GA<br>Arteche - Tepeji Del Rio, Mexico |
| CT<br>High Accuracy Extended Range | | | GE - Charleroi, PA, Itajuba, Brazil<br>Trench - Toronto, Canada<br>Hitachi Energy - Crystal Springs, MS<br>Ritz - Waynesboro, GA<br>Arteche - Tepeji Del Rio, Mexico |
| DFR (Digital Fault Recorder) | | | MehtaTech - Louisiana, Mississippi, Arkansas only |
| DFR (Digital Fault Recorder) | | | Qualitrol - Texas only |
| Firewall | | | Durasystems, Modular, Oldcastle |
| Conductor Fittings Compression | | Stuart Irby | AFL, Sefcor, Anderson, Hubell |
| Below grade Grounding connectors - Weld | Cadweld | | Thermoweld |
| Below grade Grounding connectors - Swage | | | AFL |
| Ground Rods, Clamps, & Anodes | | Stuart Irby | Any Approved Manufacturer |
| Helical Foundation Piling | | | Hubbell, Cyntech |
| Insulator, Station Post, Porcelain<br>34.5kV and below | Vanguard | Preferred Sales | Victor, Lapp, NGK, Newell, PPC, Hubbell |
| Insulator, Station Post, Polymer<br>15kV - 230kV | Maclean Power Sys | Preferred Sales | |
| Insulator, Station Post, Porcelain<br>161kV | Hubbell | Hubbell Power Systems | Victor, Lapp, NGK, Newell, Vanguard, PPC |
| Insulator, Station Post, Porcelain<br>230kV STANDARD STRENGTH | Hubbell | Hubbell Power Systems | Victor, Lapp, NGK, Newell, Vanguard, PPC |
| Insulator, Station Post, Porcelain<br>230kV HI / EXTRA HIGH STRENGTH | | | Hubbell, Victor, Lapp,NGK, Newell, Vanguard, PPC |
| Insulator, Station Post, Porcelain<br>345/500kV HI / EXTRA HIGH STRENGTH | | | Hubbell, Victor, Lapp,NGK, Newell, Vanguard, PPC |
| Insulator, Station Post, Porcelain<br>69kV, 115kV | Hubbell | Hubbell Power Systems | Victor, Lapp, NGK, Newell, Vanguard, PPC |
| Insulator, Line, Polymer | Maclean Power Sys | Preferred Sales | |
| Insulator, Line, Polymer (Insulator Assembly) | Maclean Power Sys | Preferred Sales | |

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| Description | Preferred Manufacturer | Preferred Supplier | Other Approved Manufacturer(s) |
|---|---|---|---|
| Insulator, Line, Polymer (Insulator Only) | Maclean Power Sys | Preferred Sales | Newell |
| Insulator, Line, Polymer (Hardware Assembly Only) | Maclean Power Sys | Preferred Sales | |
| Interrupter | | Curtis Stout | S&C |
| Interrupter, Joslyn | | Ruffin | Joslyn |
| Interrupter Switches LLS I | Southern States | Preferred Sales | |
| Interrupter Switches LLS II | Southern States | Preferred Sales | |
| Interrupter Whip | Southern States | Preferred Sales | |
| Junction Boxes | | | MMR, Premier Control, SEL |
| Lighting - LED | Acuity | Ruffin & Associates | |
| Panel - Battery Switching | | | MMR, SEL, Premier Control |
| Panel - Breaker Line | | | MMR, SEL, Premier Control |
| Panel - Communication rack | | | MMR, SEL, Premier Control |
| Panel - Meter | | | MMR, SEL, Premier Control |
| Panel - AC & DC Cabinets | | | MMR, SEL, Premier Control, Peterson Panel |
| Panel - Bus Differential | | | MMR, SEL, Premier Control |
| Panel - Line Protection | | | MMR, SEL, Premier Control |
| Pole Caissons T-Line - after approval | Valmont | Preferred Sales | |
| Pole, Steel after approval | Valmont | Preferred Sales | |
| Pole, Concrete | Valmont | Preferred Sales | |
| PT 15kV - 34.5kV | | | ABB Inc, GE, Ritz |
| PT 69kv - 230kv | | | GE - Charleroi, PA, Itajuba, Brazil<br>Trench - Toronto, Canada<br>Hitachi Energy - Crystal Springs, MS<br>Arteche - Tepeji Del Rio, Mexico |
| Reactor, Limiting | | | Coil Innovations - Eferding, Austria<br>Trench - Toronto, Canada |
| Reactor, Dry Type Shunt Below 230kV | | | Coil Innovations - Eferding, Austria<br>Trench - Toronto, Canada |
| Reactor, Oil filled Shunt Through 500kV | | | Hitachi – Varennes, Canada; Guarulhos, Brazil<br>Mitsubishi – Ako, Japan<br>Prolec-GE Waukesha – Canoas, Brazil<br>Siemens – Jundiai, Brazil; Nuremburg, Germany; Weiz, Austria<br>SMIT – Nijmegen, Netherlands |

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| Description | Preferred Manufacturer | Preferred Supplier | Other Approved Manufacturer(s) |
|---|---|---|---|
| 3-ph station-class voltage regulators For replacement of existing 3-ph station-class regulators; For use with SN0102 Small Transformers in new installations (when approved) | | | Delta Star – Lynchburg, VA, USA<br>PTTI – Raeford, NC, USA<br>Virginia Transformer – Roanoke, VA, USA |
| SEL Relay cables Cable & Fiber | | Power Connection | SEL |
| SEL Relays | | Power Connection | SEL |
| ACS RTU Cables NTX | | Ruffin & Associates | ACS (Automated Control Systems) |
| ACS RTU – Peripherals NTX-U20 & Upgrades | | Ruffin & Associates | ACS (Automated Control Systems) |
| GE RTU Parts Accessories & Cables | | Perferred Sales | G.E. Grid Solutions |
| RTU IO cabinet standard RTU | | Perferred Sales | G.E. Grid Solutions |
| RTU - Kits & Parts D400, D20, DNPIO Kits & Parts | | Perferred Sales | G.E. Grid Solutions |
| Rupters/S&C ALDUTI 15 kV Vac | S&C | Curtis Stout | |
| Signs - General | | Stuart Irby | Stuart Irby |
| Signs - Entergy Substation Switchyard | | Impco | Impco |
| Structure, Tapered Tubular Fabrication and Design | Distran | Distran | Valmont |
| Structure, Standard Shape Fabrication only (existing details) | Distran | Distran | Industrial Steel, Valmont |
| Structure, Standard Shape Fabrication and Design | Distran | Distran | Industrial Steel, Valmont |
| Structure, Tapered Tubular Fabrication only (existing details) | Distran | Distran | Valmont |
| Switch, Fuse (SMD style) 15 kV | S&C | Curtis Stout | |
| Switch, T-Line group operated 245kV and below | | Southern Utility Sales Agency | SEECO |
| ASCO ATS (Automatic Transfer Switch) | | | Utility and Industrial Supply,LLC, WESCO |
| Switch, Disconnect 15kV - 34.5kV | Southern States | Preferred Sales | USCO |

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## ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION

| Description | Preferred Manufacturer | Preferred Supplier | Other Approved Manufacturer(s) |
|---|---|---|---|
| Switch, Disconnect, Hookstick<br>15kV - 34.5kV<br>PBO up to 2000A<br>XY-2A at 3000A | Southern States | Preferred Sales | USCO |
| Switch, Disconnect<br>115 & 230kV Air Break | Southern States | Preferred Sales | USCO, Pascor Atlantic |
| Switch, Disconnect<br>69kV - 230kV | Southern States | Preferred Sales | USCO, Pascor Atlantic |
| Switch, Disconnect<br>69kV Air Break | Southern States | Preferred Sales | USCO, Pascor Atlantic |
| Switch, Disconnect<br>345/500kV | Southern States | Preferred Sales | Pascor Atlantic |
| Switch, Motor Operator<br>S&C MO | S&C | Curtis Stout | |
| Switch, Motor Operator<br>Southern States MO | Southern States | Preferred Sales | |
| Gas Insulated Switchgear<br>69 kV- 500kV | | | MELCO - Itami, Japan<br>Hitachi Energy - Oerlikon, Switzerland<br>Siemens (345KV and below) - Berlin, Germany<br>HICO - Changwon, S. Korea |
| Metal-Clad Switchgear below 34.5kV | | | Powell – Confirm Approved Factory prior to bid selection<br>Eaton - Confirm Approved Factory prior to bid selection |
| Transformer HV 69kV and below//7.5 MVA (base) and below/non-LTC | Prolec-GE/Prolec-GE Waukesha - Goldsboro, NC USA | Aertker Co. | Delta Star - Lynchburg, VA USA<br>Prolec-GE/Prolec-GE Waukesha - Goldsboro, NC, USA; Waukesha, WI, USA<br>Hitachi Energy - Crystal Springs, MS USA<br>PTTI - Raeford, NC<br>Virginia Transformer - Roanoke, VA |
| SSVT; Station Service Voltage Transformer (Oil Filled)<br>230kV | | | Trench - Toronto, Canada<br>Hitachi Energy - Crystal Springs, MS<br>Arteche - Tepeji Del Rio, Mexico |
| SSVT; Station Service Voltage Transformer (Oil Filled)<br>46kV -161kV | | Hitachi 46 | Trench - Toronto, Canada<br>Hitachi Energy - Crystal Springs, MS<br>Arteche - Tepeji Del Rio, Mexico |
| SSVT; Station Service Voltage Transformer (SF6 Filled)<br>230 - 500kV | | | Trench - Bamberg, Germany<br>Hitachi Energy - Lodi, Italy |
| Transrupter II | S&C | Curtis Stout | |
| Trap, Line Carrier | | Curtis Stout | Trench ( No other supplier approved) |
| Trench | Concast | GHMR | Trenway, Old Castle |
| Tuner, Line Carrier | | Curtis Stout | Trench |

# Appendix 1: Collector Substation

## ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION

| Two – Winding GSU Transformers rated ≥ 100MVA (3-phase); HV ≥ 115 kV | | | | |
|---|---|---|---|---|
| OEM | Location | Qualified | Maximum deliverable ratings | |
| | | | MVA | kV |
| ABB | Varennes, Qubec, Canada;<br>Guarulhos, Brazil;<br>Cardoba, Spain | Yes;<br>No, India Manufacturer | | 500 |
| GE/Waukesha Electric (SPX) | Waukesha, WI, USA<br>Goldsboro, NC, USA | Yes;<br>No, Mexico Manufacturer | 400 | 345 |
| JST | Lyon, France | Yes | 1200 | 500 |
| Mitsubishi | Ako, Japan | Yes | 1500 | 1000 |
| Siemens | Linz & Weiz Austria;<br>Nuremberg, Germany;<br>Jundia, Brazil;<br>Bogata/Tenjo, Columbia | Yes;<br>No Mexico Manufacturer | | |
| SMIT | Nijmegen, Netherland | Yes | 500 | 500 |

| Two/Three – Winding Auxiliary, Reserve & Station-Service Transformers rated ≤ 100MVA (3-phase); HV ≤ 230 kV | | | | |
|---|---|---|---|---|
| OEM | Location | Qualified | Maximum deliverable ratings | |
| | | | MVA | kV |
| ABB/Kulman | Crystal Springs, MS, USA | Yes | 100 | 161 |
| ABB | Bland, VA, USA | Yes | 100 | 100 |
| Delta Star | Lynchburg, VA, USA | Yes | 60 | 230 |
| GE/Waukesha Electric (SPX) | Waukesha, WI, USA | Yes;<br>No Mexico Manufacturer | 100 | 230 |
| JST | Lyon, France | Yes | 100 | 230 |
| Mitsubishi | Ako, Japan | Yes | | |
| Siemens | Linz & Weiz Austria;<br>Nuremberg, Germany;<br>Jundia, Brazil;<br>Bogata/Tenjo, Columbia | Yes;<br>No Mexico Manufacturer | | |
| SMIT | Nijmegen, Netherland | Yes | | |

# Appendix 1: Collector Substation

## ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION

| ENTERGY APPROVED HV CIRCUIT BREAKER MODEL NUMBERS | | | | | | |
|---|---|---|---|---|---|---|
| **Voltage (kV)** | **Continuous Current (A)** | **Interrupting Rating (kA)** | **Siemens Breaker to be ordered** | **CT Ratio and Accuracy** | **CT Quantity (per bushing)** | |
| **230** | 3000 | 50 | SPS2-245-50-3000 | 3000:5 C800 | 3 | |
| | | 63 | SPS2-245-63-3000 (reference) | 3000:5 C1200 | 3 | non-standard |
| **161** | 3000 | 40 | SPS2-170-40-3000 | 3000:5 C800 | 3 | |
| | | 63 | SPS2-170-63-3000 (reference) | 3000:5 C1200 | 3 | non-standard |
| **138** | 3000 | 40 | SPS2-145-40-3000 | 3000:5 C800 | 2 | |
| | | 63 | SPS2-145-63-3000 (reference) | 3000:5 C1200 | 2 | non-standard |
| **115** | 3000 | 40 | SPS2-145-40-3000 | 3000:5 C800 | 2 | |
| | | 63 | SPS2-145-63-3000 (reference) | 3000:5 C1200 | 2 | non-standard |
| **69** | 3000 | 40 | SPS2-72.5-40-3000 | 3000:5 C800 | 2 | |
| | | 63 | SPS2-145-63-3000 (reference) | 3000:5 C1200 | 2 | non-standard |

# Appendix 1: Collector Substation

## ATTACHMENT 2: PROJECT SITE ENVIRONMENTAL CHARACTERISTICS

The Project Site environmental data that Seller shall use for the design of the Collector Substation shall have been determined prior to bid submission. The minimum required Project Site environmental data to be included is shown in Table 2-1 below. This Table 2-1 shall have been completed by Seller and included with the bid. Additional pertinent criteria shall be provided as needed.

**Table 2-1. Project Site Environmental Characteristics**

| Description | Data (Units) |
|---|---|
| Elevation (substation) | |
| Contamination Level (light, medium, heavy, extra heavy) * | |
| Average Annual Temperature | |
| Average High Temperature | |
| Extreme High Temperature | |
| Average Low Temperature | |
| Extreme Low Temperature | |
| Average Annual Precipitation | |
| Maximum 24-hour Rainfall | |
| Maximum 1-hour Rainfall | |
| Maximum 24-hour Snowfall | |
| Ground Snow Load | |
| Design Ice Load | |
| Design Wind Speed | |
| Isokeraunic Level | |
| Seismic Referenced Code | |
| Mapped Spectral Response Acceleration at Short Period (0.2- Second) $S_S$ | |
| Mapped Spectral Response Acceleration at 1-Second Period $S_1$ | |
| Site Class | |
| Seismic Design Category | |

*All equipment external bushing creepage distance shall be based on this criterion. If not available, medium contamination (35mm/kV) shall be used. This factor is applied to nominal line to ground voltage.

***** END OF APPENDIX 1*****

# BESS BOT Scope Book

# Appendix 2

# High Voltage Overhead Transmission

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 9/14/2023 | All | Initial Issue |
| 25-1 | 6/6/2024 | 9.3.8.1 | Updated maximum wind speed to 150 mph |
| 26-1 | 3/3/2026 | All | Editorial Corrections |
| | | | |
| | | | |
| | | | |

# Appendix 2: High Voltage Overhead Transmission

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# 1 INTRODUCTION

## 1.1 Purpose

This Appendix to the Scope Book provides design requirements and reference material for the design of the High Voltage (***HV***) (69 kV and above) overhead transmission lines that will be built and/or connected to the Entergy transmission system by or for Seller as part of the Project (Transmission Lines). This document pertains to the transmission line between the collector substation and the deadend structure delivered by the GIA. This document is intended to provide to Seller and others acting at Seller's request requirements, recommendations, and guidance in the planning, design, construction, asset management, use, and operation of the Transmission Lines.

## 1.2 Scope

This Appendix applies to all Transmission Lines.

This Appendix primarily describes technical requirements, both performance-based and prescriptive for the design and installation of the Transmission Lines. Refer to the Scope Book and other parts of the Agreement for information regarding project sequencing and milestones, the project execution plan, project schedule and schedule management, project controls reporting, health and safety information, factory acceptance tests, training, required submittals, design reviews, equipment records, specified deliverables, project documentation, and other relevant matters not covered by this Appendix.

## 1.3 General Data

This Appendix addresses aspects of the Work relating to the Transmission Lines. It is not intended to be, and shall not be construed to be, a comprehensive list of each and every element or other requirement applicable to the Work and shall in no way limit Seller's obligations under the Agreement or any Ancillary Agreement. Without limiting the other terms of the Agreement or any Ancillary Agreement, in performing the Work relating to the Transmission Lines, Seller shall comply with, and cause its Contractors and Subcontractors to comply with, the terms of this Appendix, all Laws (including codes) and applicable Permits.

This Appendix provides the minimum functional specification (***MFS***) for the Transmission Lines, including scope and design requirements. In addition to the requirements set forth in the Agreement (including the Scope Book), the Transmission Lines shall comply with all requirements specified in the GIA or any other Required Deliverability Arrangement.

Article, Section, Table, Figure, and Attachment references in this Appendix are to this Appendix unless otherwise provided or the context otherwise requires.

## 1.4 Deviations

Any deviations from the MFS for the Transmission Lines or the terms of this Appendix shall require Buyer's prior approval and will be subject to the terms of the Agreement.

# 2 DEFINITIONS

## 2.1 Definitions

BIL - Basic Lightning Impulse Insulation Level is a reference insulation level in terms of the crest voltage of a standard lightning impulse.

Conductor Displacement - With respect to clearances, conductor displacement is the conductor movement, including the effects of insulator swing and structure deflection, due to a prescribed ice, wind, or thermal load case. With respect to Right-Of-Way (***ROW***) determinations, conductor displacement is the maximum horizontal conductor displacement from its initial unloaded position, including the effects of insulator swing and structure deflection due to the extreme wind load case. See also (WCD) in Figure 6.3.4.1-3.

Conductor Movement Envelope - With respect to clearances, the conductor movement envelope is the full range of conductor positions in the prescribed ice, wind, or thermal load cases. With respect to ROW determinations, the conductor movement envelope is the full range of conductor movement, including the effects of insulator swing and structure deflection due to the extreme wind load case applied from both directions, and including the initial effective structure width. See also (WCME) in Figure 6.3.4.1-3.

Designer – Individual (in-house or contractor) responsible for analyzing and selecting transmission line components, structures, or foundations.

Effective Structure Width – the width between a structure's outboard conductors (e.g., for an H-frame configuration, it is twice the phase spacing, and for a vertical conductor configuration it is effectively zero). See also (wS) in Figure 6.3.4.1-3.

LIDAR (Light Detection and Ranging) – A method of detecting and determining the position, velocity, or other characteristics of distant objects by analysis of pulsed laser light reflected from the surfaces of such objects.

Meridian – Electronic document management system used to archive transmission standards and documents and track revisions.

PLS-CADD – A software package used during optimization of pole spotting, design analysis, and the development of material lists.

Vegetation Management Width – Right of way width outside of the conductor movement envelope, purchased solely for establishment of a vegetation management cycle. See (WVM) in Figure 6.3.4.1-1 and Figure 6.3.4.1-2.

## 2.2 Acronyms and Abbreviations

ACAR Aluminum Conductor Alloy Reinforced

ACCC Aluminum Conductor Composite Core

ACCR Aluminum Conductor Composite Reinforced

ACSR Aluminum Conductor Steel Reinforced

ACSS Aluminum conductor Steel Supported

BIL Basic Lightning Impulse Insulation Level

EPRI Electric Power Research Institute

FAA Federal Aviation Administration

FAD Foundation Analysis & Design

GFD Ground Flash Density
IEEE Institute of Electrical and Electronics Engineers
LIDAR Light Detection and Ranging
MFAD Moment Foundation Analysis & Design
MVATD Minimum Vegetation Action Threshold Distance
MVCD Minimum Vegetation Clearance Distance
NESC National Electrical Safety Code
OCF Overload Capacity Factor
ROW Right of Way
SRF Strength Reduction Factor
UBS Ultimate Breaking Strength

# 3 REFERENCES AND DOCUMENTS

## 3.1 Industry Standards

The following Industry Standards are referenced in this Appendix:

| | |
|---|---|
| ASCE MOP 91 | Design of Guyed Electrical Transmission Structures |
| ASCE MOP 123 | Prestressed Concrete Transmission Pole Structures |
| ASCE 48 | Design of Steel Transmission Pole Structures |
| ASCE 74 | Guidelines for Electrical Transmission Line Structural Loading |
| ANSI C2 | National Electric Safety Code (NESC) |
| IEEE Std 80 | IEEE Guide for Safety in AC Substation Grounding |
| IEEE Std 524 | Guide to the Installation of Overhead Transmission Line Conductors |
| IEEE Std 738 | Standard for Calculating the Current-Temperature of Bare Overhead Conductors |
| IEEE Std 1313.2 | Guide for the Application of Insulation Coordination |
| IEE Std 1542 | Guide for Installation, Maintenance, and Operation of Irrigation Equipment Located Near or Under Power Lines |
| APLIC 2012 | Reducing Avian Collisions with Power Lines – State of the Art– 2012 |
| APLIC 2006 | Suggested Practices for Avian Protection on Power Lines |
| NACE RP0177 | Mitigation of Alternating Current and Lightning Effects of Metallic Structures and Corrosion Control System |
| OSHA Std 2207, Part 1926 | Safety and Health Regulations for Construction |
| IEEE 738 | Standard for Calculating Current-Temperature Relationship of Bare Conductors |

| | |
|---|---|
| IEEE Std. 1243-1997 | Guide for Improving the Lightning Performance of Transmission Lines |
| EPRI | Handbook for Improving Overhead Transmission Line Lightning Performance |
| EPRI | AC Transmission Line Reference Book - 200kV and Above |
| EPRI | Guide for Transmission Line Grounding |
| EPRI | Outline of Guide for Application of Transmission Line Surge Arrestors – 42 to 765 kV |
| | Pre-stressed Concrete Institute Guide Specifications |
| | FAA Advisory Circular AC 70/7460-1K, Obstruction Marking and Lighting |

The latest issued Standards and Codes at the issuance of the effective date of the Agreement shall be used. Earlier editions are not allowed unless specifically identified in this Appendix.

If a revision to a standard or code is issued, it is not required to be implemented unless the Authority Have Jurisdiction (***AHJ***) has adopted it, in which case, Seller is obligated to any increased compliance above what is required by the Standards and Codes at the effective date of the Agreement. This risk is borne by Seller.

### 3.1.1 Materials

Seller shall use the descriptions of materials set out in the standard drawings provided in Attachment 1 along with the Approved Vendor List in Attachment 5 to procure the equipment, materials, systems, and other items required for the development, engineering, design, procurement, construction, testing, commissioning, use, and operation of the Transmission Lines in accordance with the terms of the Agreement.

# 4 SAFETY AND ENVIRONMENT

## 4.1 Safety

The safety of individuals, the Project, and other life or property in the development, engineering, design, procurement, construction, testing, commissioning, use, and operation shall be the Designer's highest priority.

## 4.2 Avian Design

The primary issues to consider for avian protection on transmission lines are clearances, marking, and nests. Transmission clearances for all voltages shall exceed the established minimums, shown in Where Entergy standard structure configurations, shown in Attachment 2, are used, the design will meet the guidelines. Marking of wires is addressed in Section 7.13.4 and is to be done only in areas where such marking is required by authorized wildlife agencies, Laws, or applicable Permits.

### 4.3 Future Impacts

Proper consideration shall be given to working space and access during siting to address direct impacts on both work safety and the need for environmental remediation. Similarly, proper consideration shall be given to the ability to re-conductor a line vs. rebuilding to address the potential considerable ecological benefits.

# 5 LOAD COMBINATIONS

## 5.1 Loading Combinations

This section covers the transmission line load cases and load case combinations to be used in the design of the Transmission Lines for the Project. It also includes the Overload Capacity Factors (***OCF***) and Strength Reduction Factors (***SRF***) used to calculate forces on the individual components of each structure within the Transmission Lines. The load combinations below are consistent with the loading requirements of NESC Rule 250; however, the boundaries for loading areas have been shifted from those in NESC Rule 250. All references to NESC 250B, 250C, and 250D refer to the District Loading, Extreme Wind, and Concurrent Ice and Wind as modified based on these shifts in loading areas.

### 5.1.1 District Maps

Based on the NESC figures, districts were established along county and parish boundaries which envelope the NESC requirements. These boundaries were further modified to address other commitments and past operating experience. Notably: several coastal parishes and counties have design wind speeds increased to 150 mph to address hardening study recommendations and other commitments; roughly the NW half of Arkansas has been treated as NESC Heavy rather than NESC Medium based upon past operating experience and design practice; and the 1 inch ice loading was extended throughout Arkansas and much of northern Mississippi based on extensive damage from past ice storms. They are collectively presented as Attachment 5 illustrating the enveloping districts as follows:

Transmission Line Designers shall use the most conservative loading requirements required along the entire line if the line crosses several counties or parishes requiring different loadings. Exception to this requirement may be taken where a containment structure is placed at the district boundary.

### 5.1.2 Load Cases - Summary

Table 5.1.2 summarizes the various load cases used to design and analyze structures.

**Table 5.1.2 – Structural Load Cases**

| Description | Wind Loading | Ice Loading | Temperature | NESC Ref. |
|---|---|---|---|---|
| NESC 250B District Loading | | | | |
| Heavy | 4 psf | 0.50 in. | 0°F (-20°C) | 250B, Table 250-1 |
| Medium | 4 psf | 0.25 in. | 15°F (-10°C) | 250B, Table 250-1 |
| Light | 9 psf | 0.00 in. | 30°F (-1°C) | 250B, Table 250-1 |
| NESC 250C Extreme Wind | | | | |
| 100 mph | 25.6 psf | 0.00 in. | 60°F (15°C) | 250C, Table 250-1 |
| 110 mph | 31.0 psf | 0.00 in. | 60°F (15°C) | 250C, Table 250-1 |
| 125 mph | 40.0 psf | 0.00 in. | 60°F (15°C) | 250C, Table 250-1 |
| 140 mph | 50.2 psf | 0.00 in. | 60°F (15°C) | 250C, Table 250-1 |
| 150 mph | 57.6 psf | 0.00 in. | 60°F (15°C) | 250C, Table 250-1 |

| Description | Wind Loading | Ice Loading | Temperature | NESC Ref. |
|---|---|---|---|---|
| NESC 250D Concurrent Ice and Wind | | | | |
| 0.5 in. | 2.3 psf | 0.50 in. | 15°F (-10°C) | 250D, Table 250-1 |
| 0.75 in. | 2.3 psf | 0.75 in. | 15°F (-10°C) | 250D, Table 250-1 |
| 1.0 in. | 2.3 psf | 1.00 in. | 15°F (-10°C) | 250D, Table 250-1 |
| Cold Case – Uplift | 0 psf | 0.00 in. | 0°F (-20°C) | |
| Every Day – Deflection | 0 psf | 0.00 in. | 60°F (15°C) | |
| Unbalanced | See Section 5.1.4 | See Section 5.1.4 | 60°F (15°C) | See Section 5.1.4 |

### 5.1.3 Loads – Structure Analysis

In addition to the cases in Table 5.1.2, the following load cases shall be used in the analysis and structure design of all Transmission Line structures.

### 5.1.4 Stringing Loads on Custom Davit and Cross Arms

For arms, the everyday load case shall include a vertical load of 5000 lbs. suspended from the ends of each arm (to address vertical construction loads). The described vertical load is an allowance for steep stringing angles and other construction loads.

### 5.1.5 NESC Load Cases with OCF = 1.0

In addition to the standard NESC Overload Capacity Factors, all concrete structures shall have loads applied for NESC Load Cases with OCF = 1.0.

### 5.1.6 Special Load Cases - Structure Analysis

The following load cases shall be used in the analysis and structure design of the following structure types.

### 5.1.7 Single Dead-End and Failure Containment (Dead-End Structures)

All wires up, One Side Only Loading, Initial or Final Condition using the Structural Load Cases in Table 5.1.2.

### 5.1.8 Stringing Longitudinal Unbalanced Load (Tangents & Run. Angles)

0 mph Wind & 0 inch Ice, 60°F (15°C), Initial (Everyday Loads) with 3000 lb. Longitudinal Force (1000 lb. per phase) or with 2000 lb. Longitudinal Force per conductor (H-Frames only).

### 5.1.9 Pole without Conductors (NESC 261A1c) (Guyed Poles)

Extreme Wind applied on pole in any direction.

### 5.1.10 Stringing loads on Dead-Ends

Everyday loads on one side only (0 mph wind, 0 inch ice, 60F (15C), Initial.

### 5.1.11 PLS Wind Direction for Structure Loading

Designers shall conservatively use wind applied normal to all spans simultaneously when selecting structures for new designs.

## 5.2 Load Cases – Clearance Verification

The following clearance load cases shall be included to check vertical and horizontal clearances. "Line Design Clearances" are shown in Attachment 2.

Table 5.2.1 – Clearance Load Cases

| Description | Wind Loading | Ice Loading | Temp. | NESC Ref. | Condition | Clearance Check |
|---|---|---|---|---|---|---|
| Max. Temp. (ACSR) | 0 psf | 0 in. | 212°F (100°C) | 232A | Final | Vertical Clearance |
| Max. Temp (ACSS & ACCC) | 0 psf | 0 in. | 347°F (175°C) | 232A | Final | Vertical Clearance |
| Max. Temp (ACAR) | 0 psf | 0 in. | 176°F (80°C) | 232A | Final | Vertical Clearance |
| NESC Zone | | | | | | |
| Heavy | 4 psf | 0.5 in. | 0°F (-20°C) | 230B, Table 230-1, Table 230-2 | Final | |
| Heavy Ice | 0 psf | 1.0in | 32°F (0°C) | 232A | Final | Vertical clearance to ground, other conductors, and structures |
| Medium Wind | 6 psf | 0 in. | 60°F (15°C) | 234A2 | Initial and Final | Horizontal clearance to ground, other conductors and structures. |
| High Wind (ROW) | Extreme Wind from Table 5.1.2 | 0.0 in. | 60°F (15°C) | | Final | Horizontal Clearance to Edge of Right-of-Way |
| High Wind (Horizontal. Clearance) | 100 mph | 0.0in. | 60°F (15°C) | | Final | Insulator swing and Conductor movement (See Section 6.3.3 for more information) |
| No Wind | 0 psf | 0.00 in. | 60°F (15°C) | | Initial and Final | Horizontal clearance to ground, other conductors and structures. |

## 5.3 Load Cases – Wire Stringing

The following load cases shall be used to calculate stringing tensions for conductors and shield wires.

Conductor & Shield Wire Stringing Tensions

0 mph Wind, 0" Ice, 60°F (15°C), Initial & Final Stringing Temperature – 10 to 120°F (-12 to 49°C)

## 5.4 Load Factor and Strength Reduction

Overload Capacity Factors (***OCF***) shall be coordinated with the appropriate Strength Reduction Factors (***SRF***) and confirm that material strengths are presented as ultimate or working material strengths.

**Table 5.4A – NESC & Entergy Design Overload Capacity Factors (OCF)**

| LOAD CASE | VERT (OCF) | WIND (OCF) | TENSION (OCF) | CODE REF. |
|---|---|---|---|---|
| **Structural Analysis** | | | | |
| NESC Zone Loading (Intact) | 1.5 | 2.5 | 1.65 | 253-1 |
| Extreme Wind - (Intact) | 1 | 1 | 1 | |
| Concurrent Ice & Wind – (Intact) | 1 | 1 | 1 | |
| Unbalanced – (Intact) | 1 | 1 | 1 | |
| Single DE NESC Failure Containment | 1.5 | 2.5 | 1.65 | |
| Single DE Extreme Wind & Heavy Ice | 1 | 1 | 1 | |
| Cold Case – for Uplift | 1 | 1 | 1 | |
| Every Day Loads – for Deflection | 1 | 1 | 1 | |
| **Clearance Calculations** | | | | |
| Clearance – Vertical – Heavy Ice (NESC) | 1 | 1 | 1 | 232A3 |
| Clearance – Vertical – Max. Temp. (NESC) | 1 | 1 | 1 | 232A2 |
| Clearance – Vertical – Static (NESC) | 1 | 1 | 1 | |
| Clearance – Horizontal Med. Wind – (NESC) | 1 | 1 | 1 | 234A2 |
| Clearance – Horizontal R/W – Entergy Max. Wind | 1 | 1 | 1 | |

**Table 5.4B - Strength Reduction Factors (SRF)**

| Structure Component | SRF NESC Loads (250B) | SRF Extreme Wind and Ice Loads (250C & 250D) | NESC Code Reference |
|---|---|---|---|
| Steel & Pre-stressed Concrete Structures | 1.0 | 1.0 | Rule 261-A, Table 261-1 |
| Foundation & Guy Anchors | 1.0 | 1.0 | Rule 261-B, Table 261-1 |
| Guys & Guy Insulator | 0.9 | 0.9 | Rule 261-C& 264, Tab. 261-1 |
| Steel Crossarms & Braces | 0.9 | 0.9 | Rule 261-D1, Table 261-1 |
| DE Fittings, Splices & Hardware(3) | 1.0 | 0.8 | Rule 261-H2C |
| Support Hardware(2) | 1.0 | 1.0 | Rule 261-D-1, Table 261-1 |
| Insulators – Suspension | 0.50 | 0.65 | Table 277-1(4) |
| Insulators – Post | 0.50 | 0.50 | Table 277-1(4) |
| Conductor & Shield Wire | (1) | (1) | Rule 261-H1 |

(1) Conductor and shield wire maximum wire tensions are taken from NESC Code Section 261- H1.

(2) Support hardware includes bolts and plates supporting davit arms, braced post and post insulators, brackets, suspension tees and other miscellaneous supports not supporting conductor or shield wire dead-

ends. The reduction factors shown are multiplied by the ultimate strength of the part as indicated by the manufacturer.

(3) Dead-end fittings include bolts and dead-end tees used to dead-end conductors and shield wires. The manufacturer generally gives the ultimate strength of the tees. This value is then reduced by the reduction factor shown. The “minimum tensile strength” shown for bolts by the Vendor is the allowable tensile load that shall be used on the bolt without the combined load of shear produced in a guyed structure. These loads are not reduced by the reduction factor; however, the shear values given shall be reduced depending on the actual tensile stress, in accordance with the interaction equation.

(4) NESC 2017

# 6 CLEARANCE AND RIGHT OF WAY REQUIREMENTS

This section covers vertical and horizontal clearance requirements for the Transmission Lines, which include NESC vertical and horizontal clearance requirements from Section 23 of the 2017 Code or counterpart for subsequent codes for HV transmission lines in Entergy’s Service Area plus an added safety buffer, as described below.

## 6.1 Vertical Clearance – Over Ground

NESC and Entergy vertical clearances over various ground surfaces are shown in Attachment 2. These clearances are based on the 2017 Code, Table 232-1, with the voltage adder defined in Rule 232C1a, using the sags calculated under Rules 232A2 and 232A3.

See Section 125.2 for Clearance Load Cases.

The actual clearance to ground shall be based on the measurement to ground at the low point in the line as determined when the line is at maximum sag. For purposes of determining the required clearance for the Transmission Lines,

NESC Clearance = Table 232-1 Clearance + Voltage Adder (.4”/kV in excess of 22kV)

Entergy-Required Minimum Clearance = NESC Clearance + Safety Buffer

NESC provides consideration for clearances over water surfaces, including floodwater. Footnotes 17-21 to Table 232-1 shall be carefully considered when determining necessary clearances. For flood-prone areas that do not typically have standing surface water and are not subject to USACE or other permits, the normal flood level (10-year flood level) shall be considered along with required clearances for areas not suitable for boating. For most spans over such areas, clearances that consider or are based on vehicle access with un-flooded ground surfaces will continue to apply. Lines leading into generating facilities, EHV interconnections, or other lines where increased reliability is desired shall consider less frequent flood events (e.g., 50-year floods or 100-year floods) to avoid potential service interruptions. Such lines shall be designed to higher flood levels where the incremental costs are justified and will generally be compared to NESC requirements for water surface not suitable for sailboats.

## 6.2 Other Vertical Clearances

### 6.2.1 Supply Conductors (69 kV and above)

NESC and Entergy vertical clearances between various electricity supply lines and non-current carrying wires are also shown in Attachment 2. These clearances are based on the 2017 Code, Table 233-1, with the voltage adder defined in Rule 233C2a, using the sags calculated under Rules 233A1a (3)(b) and 233A1a (3)(c).

The design clearance shall be measured as the distance between the field measured existing line and the design maximum sag.

The Entergy-Required Minimum Clearance: NESC Clearance + Safety Buffer

Attachment 2 shows the minimum vertical clearances over various ground surfaces and uses.

The line Designer shall establish “Prohibitive Zones” with the appropriate Design Clearances on the plan profiles within PLS-CADD in the areas where these considerations occur. Considerations could be but not limited to environmental, archaeological, landowner constraints, etc.

### 6.2.2 Substations

Transmission line vertical clearances inside substations shall meet the vertical clearance requirements shown in Attachment 2.

### 6.2.3 Miscellaneous

To every extent possible, ROW shall be selected, and ROW agreements written, to preclude structures, signage, and other miscellaneous items from being located beneath the transmission circuits. To the extent such items cannot be so precluded, the vertical clearances for the Transmission Line shall meet the basic NESC clearance requirements for each applicable clearance set forth in Attachment 2, plus an additional 4.5 feet.

## 6.3 Horizontal Clearance

All horizontal clearances shall include the deflection of the structure and the displacement of the conductor added to the clearance requirements defined below. Clearances per Section 6.3.1 and Section 6.3.2 shall be based on the development of the clearance envelopes shown in the NESC for each situation plus 4.5 feet at a minimum. Basic NESC clearances, including horizontal clearances, are summarized in Attachment 2.

### 6.3.1 Adjacent Supply Lines

Horizontal clearances to adjacent supply lines shall be calculated using loads described in Section 5.1.2. This clearance is based on an envelope as shown in NESC Figures 233-1, 2&3 and using the following loadings:

The horizontal movement shall be calculated using the medium wind defined under Rule 233A1a(1&2) using (1) a 6 lb/sf wind at 60°F (15°C) and no ice or (2) no wind at 60°F (15°C).

The maximum sag, Rule 233A1a(3), shall be calculated (a) using 120° F (49°C) with no wind; (b) using the max temperature; or (c) the Code Ice thickness with a temperature of 32°F (0°C) and no wind.

PLS-CADD shall be used to define the envelope vertices and check clearance to adjacent supply lines.

### 6.3.2 Adjacent Buildings and other Structures

The required clearance between conductors and buildings or other structures is covered in Rule 234 and varies between the various structure types. The loadings used for the clearance envelopes are given in Section 5.1.2. The Designer shall use PLS-CADD to check these clearances after specifying the required load cases and clearances.

### 6.3.3 Insulator/Conductor Swing Clearance

Clearances to the supporting structure resulting from insulator swing are addressed in Section 8.1. Additionally, air gap clearances between adjacent circuits on different structures are to be checked under

the high wind load case in Section 5.1.2. Minimum clearance shall be associated for the higher voltage for the 100-mph swing clearance given in Table 8.1.2.

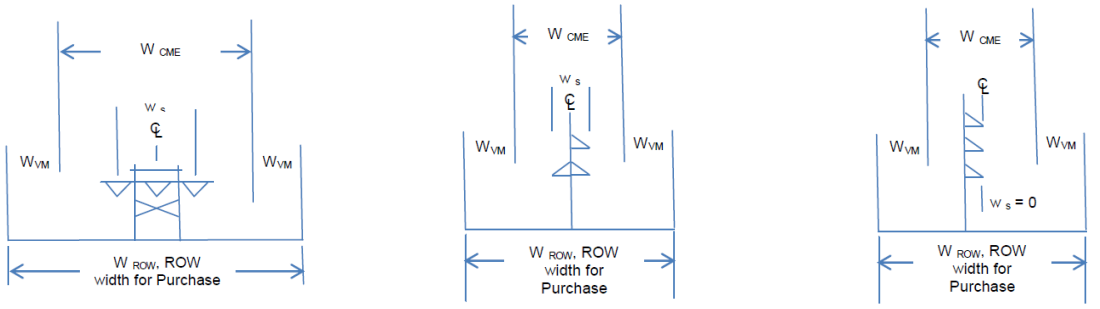
## 6.3.4 Right of Way Requirements

### 6.3.4.1 Rights of Way for New Lines

Rights of way (***ROW***) for new transmission lines must provide spacing sufficient to assure reliability and equipment accessibility for maintenance and construction.

Required ROW widths for new lines must be determined considering four primary parameters: (a) the effective structure width(s), taken as the outboard conductor spacing for the structure; (b) the minimum required spacing between adjacent circuits on separate structures; (c) the conductor displacement due to wind; and (d) a vegetation management width at the edges of the ROW to allow for a cyclical growth and periodic trimming schedules. The sum of the structure widths, any additional circuit spacing dimensions, and the conductor displacements (including the effects of structure deflection, insulator swing, and conductor movement) is called the conductor movement envelope ($W_{CME}$). Adding the appropriate vegetation management width on each side of $W_{CME}$ gives the minimum allowed ROW width for purchase. Note that total minimum allowed ROW widths for purchase will be rounded upward in whole 5 foot increments (e.g., 161 feet is rounded to 165 feet.) The four parameters described above are illustrated for typical ROW situations in Figure 6.3.4.1-1 and Figure 6.3.4.1-2. Additional figures are found in Attachment 4.

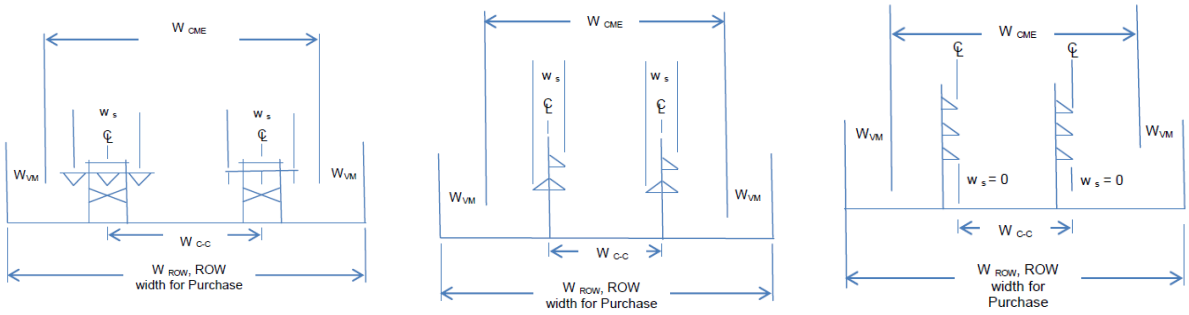
**Figure 6.3.4.1-1 – Typical Single Structure ROW**




(a) H-Frame (b) Monopole Delta (c) Monopole Vertical

Notes: $w_s$ = Effective Structure Width (Outboard Conductor Spacing) $W_{VM}$ = Vegetation Management Width; $W_{CME}$ = Width, Conductor Movement Envelope; Add Width = c/c Spacing

**Figure 6.3.4.1-2 – Typical Double Structure ROW**




(a) H-Frame (b) Monopole Delta (c) Monopole Vertical

Notes: $w_s$ = Effective Structure Width (Outboard Conductor Spacing) $W_{VM}$ = Vegetation Management Width; $W_{CME}$ = Width, Conductor Movement Envelope $W_{c-c}$ = Center to Center Structure Spacing

### 6.3.4.2 Effective Structure Width (ws) or Outboard Conductor Spacing

Except where special circumstances warrant use of larger values, the minimum allowed ROW widths for new construction shall be based on the effective structure widths (ws) for standard structure framings as set forth in Table 6.3.4.2-1.

**Table 6.3.4.2-1 – Typical Effective Structure Widths**

| | | Single Pole | |
|---|---|---|---|
| Voltage | H-frames (ft.) | Delta/ Vert. Double Circuit (ft.) | Single Circuit Vertical (ft.) |
| 500kV | 67.66 | 28.00 | 0.00 |
| 345kV | 51.00 | 24.00 | 0.00 |
| 230kV | 40.00 | 18.00 | 0.00 |
| 161/138/115 kV | 32.00 | 14.33 | 0.00 |
| 69kV | 24.00 | 12.00 | 0.00 |

Note that for vertical conductor configurations, the conductors fall on the centerline of the circuit/ROW and the monopole structure itself is offset by a function of the insulator length. In such configurations there are no outboard conductors, and the effective width of the structure is treated as zero.

When determining ROW requirements for constructing a new transmission line adjacent to an existing transmission line (discussed in more detail below), the actual effective widths of the existing structure shall be determined and used in the calculation.

Adjacent Circuit Separation (Wc-c)

Circuit center to center horizontal spacing for ROW determinations shall be as shown in Table 6.3.4.2-2 unless the Performance Standard requires use of a higher value.

**Table 6.3.4.2-2 – Minimum Spacing for Adjacent Circuits ($W_{c-c}$)**

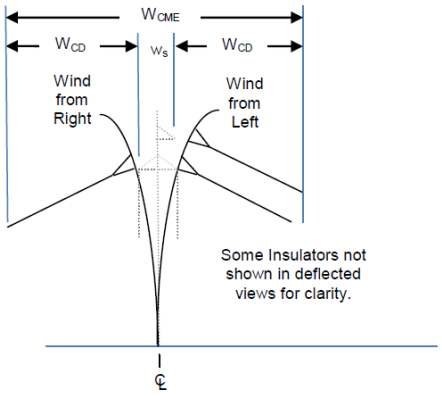
| | | Single Pole | |
|---|---|---|---|
| Voltage | H-frames (ft.) | Delta/ Vert. Double Circuit (ft.) | Single Circuit Vertical (ft.) |
| 500kV | 140 | 96 | 70 |
| 345kV | 120 | 65 | 45 |
| 230kV | 75 | 50 | 35 |
| 161/138/115 kV | 60 | 40 | 30 |
| 69kV | 45 | 30 | 20 |

For 345 kV and 500 kV Transmission Lines, the distances specified for adjacent single pole circuits reflect geometrical limits only. Electrical effects (audible noise, EMF, etc.) must be studied, and will require additional separation if indicated by the study. For two adjacent circuits of different voltage or framing, the larger of the two required separation distances shall be used.

### 6.3.4.3 Displaced Conductor Position (WCD)

During detailed line design, the displaced conductor positions are calculated including the effects of structure deflection and insulator/hardware swing; and using the load cases contained in Section 5. Wind loads are applied transversely in each direction to displace the conductor away from the centerline as illustrated below.

**Figure 6.3.4.3-1 – Displaced Conductor Position & Relationship to $W_{CME}$ and $w_s$**




Notes: $w_s$ = Effective Structure Width (Outboard Conductor Spacing) $W_{CME}$ = Width, Conductor Movement Envelope; $W_{CD}$ = Displaced Conductor Position Including Structure Deflection

In addition to checking required horizontal clearances per Sections 6.3.1 and 6.3.2, the displaced conductor position shall stay within the available conductor movement envelope under the extreme wind cases described in Table 5.1.2. As part of the line design, pole placements and span lengths must be adjusted if required to maintain required clearances and keep the conductor within the available width.

The available CME widths in Table 6.3.4.4-1 and Table 6.3.4.5-1 contemplate and accommodate standard framings, typical spans, the current list of typical conductors and their specified stringing limits, etc. Markedly atypical designs may require a more rigorous evaluation of the ROW requirements. Conversely, severe ROW restrictions will likely require atypical design such as shortened spans.

Note that all tabulated values consider the use of V-string assemblies, braced-post assemblies, suspension units with struts, or other configurations where insulator swing is confined.

### 6.3.4.4 Vegetation Management Width (WVM)

It is assumed that trees grow or someday will grow at the edge of the ROW, and that normal growth cycles will result in further encroachment into the Vegetation Management Width. Therefore, the conductor movement envelope (***CME***) alone is insufficient as a ROW. Vegetation management in the area adjacent to ROW edges is required to prevent grow-in and to comply with the Minimum Vegetation Clearance Distance (***MVCD*** see also definitions). Thus, additional width between the ROW edge and the outboard conductors is essential to allow planned, efficient vegetation management without violating the MVCD.

To accomplish this, apply a Minimum Vegetation Action Threshold Distance (***MVATD***) for prioritizing corrective maintenance. The Vegetation Management Width ($W_{VM}$) to be used when determining ROW width shall bound the MVATD and MVCD, and is tabulated below (values for MVATD and MVCD are provided for reference):

**Table 6.3.4.4-1 – Vegetation Management Widths**

| Voltage | $W_{VM}$ (ft.) | MVATD (ft.) | MVCD (ft.) |
|---|---|---|---|
| 500kV | 22.5 | 14.68 | 7.4 |
| 345kV | 15.0 | 9.44 | 4.5 |
| 230kV | 12.5 | 5.14 | 4.3 |
| 161/138/115 kV | 10 | 3.42 / 2.94 / 2.45 | 2.9 / 2.4 / 2.0 |
| 69kV | 7.5 | 2.45 | 1.2 |

Where a circuit is to be built at a given voltage but operated at a lower voltage, the $W_{VM}$ for the higher voltage shall be used to determine ROW width.

### 6.3.4.5 Calculation of Minimum Allowed ROW Width for Purchase - New Single Circuit Line or Double Circuit on the Same Structures

As illustrated in the preceding figures, at any given point, the minimum allowed ROW shall equal the applicable CME plus the applicable vegetation management width ($W_{VM}$) on each side of the ROW. Assuming multiple circuits are the same voltage, standard ROW widths are determined as:

ROW = WCME + 2(WVM), rounded up to the next whole 5’ increment

and are tabulated by voltage and framing type in Table 6.3.4.5-1 and Table 6.3.4.5-2.

**Table 6.3.4.5-1 – Minimum Required ROW Widths for Single Structures (Single Circuit or Multi-Circuit on Same Structure)**

| | | Typical ROW Width (ft.) for Purchase | | | Conductor Movement Envelope - CME (ft.) | | |
|---|---|---|---|---|---|---|---|
| Line Voltage (kV) | WVM (ft.) | H-Frame | Single Pole Delta/Vertical Double Circuit | Single Pole Vertical | H-Frame | Single Pole Delta/Vertical Double Circuit | Single Pole Vertical |
| 500 | 22.50 | 225 | 125 | 125 | 180 | 80 | 80 |
| 345 | 15.00 | 190 | 155 | 135 | 160 | 125 | 105 |
| 230 | 12.50 | 150 | 125 | 110 | 125 | 100 | 85 |
| 161 | 10.00 | 120 | 100 | 90 | 100 | 80 | 70 |
| 69 | 7.50 | 90 | 75 | 65 | 75 | 60 | 50 |

**Table 6.3.4.5-2 – Minimum Allowed ROW Widths for Multiple Structures and Circuits**

| | ROW Widths (ft.) assuming two identical lines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Line Voltage (kV) | ROW Width for Purchase (ft.) | | | Conductor Movement Envelope - CME (ft.) | | | Add. Width per line (ft.) | | |
| | H-Frame | Single Pole Delta/Vertical Double Circuit | Single Pole Vertical | H-Frame | Single Pole Delta/Vertical Double Circuit | Single Pole Vertical | H-Frame | Single Pole Delta/Vertical Double Circuit | Single Pole Vertical |
| 500 | 365 | 225 | 195 | 320 | 180 | 150 | 140 | 96 | 70 |
| 345 | 310 | 220 | 180 | 280 | 190 | 150 | 120 | 65 | 45 |
| 230 | 225 | 175 | 145 | 200 | 150 | 120 | 75 | 50 | 35 |
| 161 | 180 | 140 | 120 | 160 | 120 | 100 | 60 | 40 | 30 |
| 69 | 135 | 105 | 85 | 120 | 90 | 70 | 45 | 30 | 20 |

Notes regarding Tables 6.3.4.5-1 and 6.3.4.5-2:

1. Tabulated 500 kV single pole ROW reflect an atypical short span design intended to compact lines on narrower ROWs.

2. As noted in 6.3.4.1, tabulated values reflect Vee-String, Brace Post, Suspension/Strut or other insulator assemblies where conductor attachments are somewhat restrained. Where suspension I-String assemblies are used: at 230 kV and below the ROW widths given shall be increased by 5 feet; and at 345 kV they shall be increased by 10 feet. Only Vee-String assemblies are currently approved for 500 kV.

3. The ROW values presented are indicative of what would be required in straight sections of ROW containing tangent or light angle structures. Large angle changes using multi-pole structures or extensive guying patterns will require additional ROW in the vicinity of the angle structure.

# 7 CONDUCTOR AND SHIELD WIRE INFORMATION

This section includes design information about standard conductors, both in single and in bundled configurations, along with standard shield wires, including fiber optic wires. It includes tension and vibration control data for the NESC and Entergy design conditions. Conductors and shield wires shall be selected from these standards unless Buyer and Seller otherwise agree in a writing signed by authorized representatives of the Parties.

## 7.1 Entergy Standard Conductors

The required technical standards for conductors are set forth in this Section 7.1_(properties based on Southwire® data unless noted.):

**Table 7.1A – Standard Conductors – Mechanical Properties**

| Type | Size | Stranding | Code Word | Area ($in^2$) | Dia. (in.) | Weight (lb/ft) | Strength (lbs) |
|---|---|---|---|---|---|---|---|
| ACCC/TW (5) | 1949 | 56/1 | LAPWING (4) | 1.647 | 1.504 | 1.938 | 48,900 |
| | 1582 | 33/1 | BITTERN (4) | 1.336 | 1.345 | 1.566 | 39,400 |
| | 1428.5 | 33/1 | BEAUMONT (4) | 1.232 | 1.294 | 1.436 | 43,700 |
| | 1222 | 33/1 | CARDINAL (4) | 1.053 | 1.198 | 1.224 | 37,100 |
| | 821.2 | 18-1 | GROSBEAK (4) | 0.725 | 0.990 | 0.836 | 30,400 |
| ACSS | 1590 | 45/7 | LAPWING | 1.34 | 1.50 | 1.79 | 27,900 |
| | 1272 | 45/7 | BITTERN | 1.07 | 1.35 | 1.43 | 22,300 |
| | 954 | 54/7 | CARDINAL | 0.85 | 1.20 | 1.23 | 26,000 |
| | 666.6 | 24/7 | FLAMINGO | 0.59 | 1.00 | 0.86 | 18,200 |
| ACSR | 1780 | 84/19 | CHUKAR | 1.51 | 1.60 | 2.08 | 51,000 |
| | 1590 | 45/7 | LAPWING | 1.34 | 1.50 | 1.79 | 42,200 |
| | 1272 | 45/7 | BITTERN | 1.07 | 1.35 | 1.43 | 34,100 |
| | 1033.5 | 45/7 | ORTOLAN (1) | 0.87 | 1.21 | 1.163 | 27,700 |
| | 954 | 54/7 | CARDINAL | 0.85 | 1.20 | 1.23 | 33,800 |
| | 954 | 45/7 | RAIL (2) | 0.80 | 1.165 | 1.075 | 25,290 |
| | 666.6 | 24/7 | FLAMINGO | 0.59 | 1.00 | 0.86 | 23,700 |
| | 336.4 | 26/7 | LINNET | 0.31 | 0.72 | 0.46 | 14,100 |
| AC AR | 1024.5 | 34/13 | N/A (3) | 0.80 | 1.165 | 0.96 | 23,100 |

| Type | Size | Stranding | Code Word | Area ($in^2$) | Dia. (in.) | Weight (lb/ft) | Strength (lbs) |
|---|---|---|---|---|---|---|---|
| | 649.5 | 18/19 | N/A | 0.51 | 0.93 | 0.61 | 17,100 |
| | 395.2 | 15/7 | N/A | 0.31 | 0.72 | 0.37 | 10,100 |

(1) Not for New Construction, Capital Maintenance only

(2) 345 kV and 500 kV only – Use for new construction

(3) 500 kV only – for Capital Maintenance work only

(4) Source: General Cable/LAMIFIL Data

(5) It is generally preferential to develop a custom conductor solution using an ACCR conductor in lieu of the ACCC conductors. Use of the ACCC standards will generally be limited to extension of existing ACCC lines or other similar circumstances.

Ampacity ratings for the standard conductors are determined using the commercially available software SWRate, which is based on the methodology of IEEE 738. Ampacity was determined using design parameters specified in Entergy standards and the conductor properties contained in the SWRate program library. Line ratings are also expressed as conductance in MVA using the expression MVA = V * A * 0.001 * 3^0.5, where V is voltage in kV, and A is rated ampacity in amps. Ampacity and conductance ratings for the standard conductors are summarized below.

**Table 7.1B – Standard Conductors – Capacity**

| Type | Size / Code Word | Rated Amps (1) | MVA 69kV | MVA 115kV | MVA 138kV | MVA 161kV | MVA 230kV | MVA 345kV | MVA 500kV |
|---|---|---|---|---|---|---|---|---|---|
| ACCC/TW (3) | 1949 / LAPWING | 2490 | 298 | 496 | 595 | 694 | 992 | - | - |
| | 1582 / BITTERN | 2180 | 261 | 434 | 521 | 608 | 868 | - | - |
| | 1429 / BEAUMONT | 2050 | 245 | 408 | 490 | 572 | 817 | - | - |
| | 1222 / CARDINAL | 1857 | 222 | 370 | 444 | 518 | 740 | - | - |
| | 821.4 / GROSBEAK | 1439 | 172 | 287 | 344 | 401 | 573 | - | - |
| ACSS | 1590 / LAPWING | 2263 | 270 | 451 | 541 | 631 | 902 | - | - |
| | 1272 / BITTERN | 1957 | 234 | 390 | 468 | 546 | 780 | - | - |
| | 954 / CARDINAL | 1607 | 192 | 320 | 384 | 448 | 640 | - | - |
| | 666.6 / FLAMINGO | 1312 | 157 | 261 | 314 | 366 | 523 | - | - |
| ACSR | 1780 / CHUKAR | 1608 | 192 | 320 | 384 | 448 | 641 | - | - |
| | 1590 / LAPWING | 1494 | 179 | 298 | 357 | 417 | 595 | - | - |
| | 1272 / BITTERN | 1303 | 156 | 260 | 311 | 363 | 519 | - | - |
| | 1033.5/ ORTOLAN (2) | 1144 | 137 | 228 | 273 | 319 | 456 | - | - |
| | 954 / CARDINAL | 1088 | 130 | 217 | 260 | 303 | 433 | - | - |
| | 954 / RAIL | 1088 | 130 | 217 | 260 | 303 | 433 | 650 | 942 |
| | 666.6 / FLAMINGO | 882 | 105 | 176 | 211 | 246 | 351 | - | - |
| | 336.4 LINNET | 575 | 69 | 115 | 137 | 160 | 229 | - | - |
| ACAR | ACAR 1024.5 (2) | 878 | 105 | 175 | 210 | 245 | 350 | - | 760 |
| | ACAR 649.5 | 658 | 79 | 131 | 157 | 183 | 626 | - | - |
| | ACAR 395.2 | 483 | 58 | 96 | 115 | 135 | 192 | - | - |

(1) At normal operating temperatures, 212ºF (100ºC) for ACSR, 347ºF (175ºC) for ACSS and ACCC, and 176ºF (80ºC) for ACAR.

(2) Other historical limits may govern.

(3) It is generally preferential to develop a custom conductor solution using an ACCR conductor in lieu of the ACCC conductors. Use of the ACCC standards will generally be limited to extension of existing ACCC lines or other similar circumstances.

## 7.2 Standard Shield Wires

The required technical standards for shield wires are set forth in Table 7.2 below:

**Table 7.2 – Standard Shield Wires**

| Code Word | Class Type | Size | Strand-Ing | Area (in^2) | Dia. (in.) | Weight (lb/ft) | Strength (lbs) |
|---|---|---|---|---|---|---|---|
| 7 #7 | Alumoweld | 0.0 | 7 | 0.11 | 0.43 | 0.33 | 19,060 |

## 7.3 Standard Optical Ground Wires

The required technical standards for optical ground wires (OPGW) are set forth below:

**Table 7.3 – Standard OPGW Wires**

| Code Word | Class Type | Fibers | Strand-Ing | Area (in^2) | Dia. (in.) | Weight (lb/ft) | Strength (lbs) |
|---|---|---|---|---|---|---|---|
| DNO-5651 | AlumaCore | 24LT | 13 | 0.151 | 0.528 | 0.36 | 18,391 |
| DNO-6651 | AlumaCore | 48LT | 9/6 | 0.221 | 0.646 | 0.42 | 18,053 |
| DNO-3476 | AlumaCore | 24 | 13 | 0.151 | 0.528 | 0.36 | 18,433 |
| DNO-4596 | AlumaCore | 48 | 9/6 | 0.221 | 0.646 | 0.42 | 18,053 |
| DNO-6205 | CentraCore | 24 | 10 | 0.166 | 0.528 | 0.41 | 21,845 |
| DNO-6210 | CentraCore | 48 | 10 | 0.166 | 0.528 | 0.41 | 21,845 |
| DNO-8161 (1) | AlumaCore | 48 | 13 | 0.151 | 0.528 | 0.36 | 18,391 |
| DNO-9800 (2) | AlumaCore | 48 | 13 | 0.151 | 0.528 | 0.36 | 19,391 |

(1) DNO-8161, 48 fiber AlumaCore will be the default OPGW selection unless project specifics warrant a different selection.

(2) DNO-9800, 48 fiber AlumaCore will be the default OPGW selection for “backbone” applications where dispersion shifted fibers are required by the telecommunications department.

Alternative optical ground wires may be used, provided they meet the same specifications as the above-referenced wires. Similar hardware to that used for standard wires specified herein must be used so that nonstandard hardware does not have to be stocked for maintenance.

## 7.4 Bundled Conductors

### 7.4.1 Bundled Conductors (New Construction, excluding 500 kV)

The standard bundled configuration is a vertical bundle in which no spacers are required. If other configurations are used, the conductor supplier and/or manufacture of the spacers shall be consulted regarding spacers requirements.

The standard assembly for bundled dead-end structures shall be the “DEPY” dead-end assembly with a two-insulator attachment to the structure.

Bundled dead-end structures where the maximum tension (with OCF) in each sub-conductor is less than 9700 lbs. may use the “DEP- 2 wire” dead-end assemblies with a single insulator. This assembly shall mainly be used in reduced tension situations.

All bundled structures with angles less than 30 degrees shall be designed as running angle structures, including Structure Types “C”, “F” and “G”. Those with angles greater than 30 degrees shall be designed as dead-end structures.

### 7.4.2 Bundled Conductors (500 kV)

The standard 500 kV bundled conductor is a triple delta configuration with spacers at approximately 250 foot intervals.

## 7.5 Sag and Tension Limitations

### 7.5.1 NESC Tension Limits

Following are the maximum tension limits allowed in the determination of project sag and tension values. The "Zone Loading" tension limit is an NESC requirement for all load cases with an overload capacity factor of 1.65. The tension limits for extreme wind and heavy ice are Entergy requirements and have an overload capacity factor of 1.0. Load cases are shown in Section 5.4. The limit is a percent of the Ultimate Breaking Strength (UBS) of the wire. Limits are based on the Initial tension of the wire.

| Load | Tension Limits |
|---|---|
| • Zone loading (OCF=1.65) | 60% UBS - @ Initial Ten. (NESC 261H1) |
| • Extreme Wind (OCF=1.0) | 75% UBS - @ Initial Ten. |
| • Concurrent Ice & Wind (OCF=1.0) | 5% UBS - @ Initial Ten. |

Additionally, the NESC (Section 261 H1) requires that the tension at each of the applicable NESC Zone temperatures shown in Table 5.1.2, without external load, shall not exceed the following percent of their UBS:

Initial unloaded tension 35% UBS

Final unloaded tension 25% UBS

These tension limits apply at each of the applicable NESC Zone temperatures shown in Table 5.1.2, unless dampers are used, in which case this limitation is at a maximum of 60°F (15°C).

### 7.5.2 Tension Limits for Vibration Control

Except for ACCC and ACCR conductors, for vibration control, maximum catenaries (horizontal tension/weight), or "C" values, will be calculated at 0°F (-20°C), 0 mph wind, and 0 inches ice. Calculated values for "C final" shall be 4710 and for "C initial" shall be 6000. Lesser values of "C" will require approval by Buyer.

For ACCC conductors, vibration dampers shall be placed in accordance with the manufacturer's recommendations.

The following table," Vibration Control Values", provides Entergy's tension limits for the standard conductors. The table was developed considering 900 ft. ruling spans. However, these values may be used for other ruling spans with only slight variations. Other ruling spans will require approval by Buyer.

**Table 7.5.2 – Vibration Control Values**

| Type | Conductor Name | Load Case | Max Tension (pounds) | % of Ultimate Strength |
|---|---|---|---|---|
| ACSS | LAPWING | 0-0-0 (I) | 10740 | 38.5 |
| | LAPWING | 0-0-0 (F) | 8431 | 30.2 |

| Type | Conductor Name | Load Case | Max Tension (pounds) | % of Ultimate Strength |
|---|---|---|---|---|
| | BITTERN | 0-0-0 (I) | 8580 | 38.5 |
| | BITTERN | 0-0-0 (F) | 6735 | 30.2 |
| | CARDINAL | 0-0-0 (I) | 7380 | 28.4 |
| | CARDINAL | 0-0-0 (F) | 5793 | 22.3 |
| | FLAMINGO | 0-0-0 (I) | 5160 | 28.4 |
| | FLAMINGO | 0-0-0 (F) | 4051 | 22.3 |
| ACSR | CHUKAR | 0-0-0 (I) | 12480 | 24.5 |
| | CHUKAR | 0-0-0 (F) | 9796 | 19.2 |
| | LAPWING | 0-0-0 (I) | 10740 | 25.5 |
| | LAPWING | 0-0-0 (F) | 8431 | 20.0 |
| | BITTERN | 0-0-0 (I) | 8580 | 25.2 |
| | BITTERN | 0-0-0 (F) | 6735 | 19.8 |
| | ORTOLAN | 0-0-0 (I) | 6978 | 25.2 |
| | ORTOLAN | 0-0-0 (F) | 5478 | 19.8 |
| | CARDINAL | 0-0-0 (I) | 7380 | 21.8 |
| | CARDINAL | 0-0-0 (F) | 5793 | 17.1 |
| | RAIL | 0-0-0 (I) | 6450 | 24.9 |
| | RAIL | 0-0-0 (F) | 5063 | 19.5 |
| | FLAMINGO | 0-0-0 (I) | 5160 | 21.8 |
| | FLAMINGO | 0-0-0 (F) | 4051 | 17.1 |
| | LINNET | 0-0-0 (I) | 2760 | 19.6 |
| | LINNET | 0-0-0 (F) | 2167 | 15.4 |
| ACAR | 649.5 ACAR | 0-0-0 (I) | 3660 | 21.4 |
| | 649.5 ACAR | 0-0-0 (F) | 2873 | 16.8 |
| | 395.2 ACAR | 0-0-0 (I) | 2220 | 22.0 |
| | 395.2 ACAR | 0-0-0 (F) | 1743 | 17.3 |
| | 1024.5 ACAR | 0-0-0 (I) | 5760 | 24.9 |
| | 1024.5 ACAR | 0-0-0 (F) | 4522 | 19.6 |
| SW | 7#7 AW | 0-0-0 (I) | 1980 | 10.4 |
| | 7#7 AW | 0-0-0 (F) | 1554 | 8.2 |
| | 7/16” Steel | 0-0-0 (I) | 2400 | 11.5 |
| | 7/16” Steel | 0-0-0 (F) | 1884 | 9.1 |
| OPGW | * AlumaCore, DNO-8161 | 0-0-0 (I) | 2160 | 11.7 |
| | * AlumaCore, DNO-8161 | 0-0-0 (F) | 1696 | 9.2 |
| | * AlumaCore, DNO-9800 | 0-0-0 (I) | 2160 | 11.1 |
| | * AlumaCore, DNO-9800 | 0-0-0 (F) | 1696 | 8.7 |
| ADSS | ADSS-AE024HG611CA2 | 0-0-0 (I) | 546 | 18.2 |

| Type | Conductor Name | Load Case | Max Tension (pounds) | % of Ultimate Strength |
|---|---|---|---|---|
| | ADSS-AE024HG611CA2 | 0-0-0 (F) | 429 | 14.3 |

*AlumaCore, DNO-8161 is the default.
Note ADSS is not a transmission standard transmission conductor but is frequently used as an under-built non-transmission conductor. Typical ADSS span is on the order of 200 feet.
Also note that (F) load cases shall be controlled by both Creep RS and Load RS, and that bimetallic conductors shall consider the effects of compression at high temperatures

### 7.5.3 Vibration Control for Long Spans Exceeding the Ruling Span

For span lengths greater than the ruling span, the Designer shall take special care to compare the conductor and shield wire sags, to ensure that adequate clearances at mid-span are maintained under all conditions. The shield wire tension shall not exceed 16% of its ultimate strength at 60ºF (15ºC), final. To account for unusual circumstances (e.g., ravine crossings), it may be necessary to dead-end the shield wire to account for tension differentials and/or increase the tensions along with adding dampers per manufacturer's specifications.

## 7.6 Correction to Sag when Final Installation is Interrupted

Prolonged stringing durations can affect final sags due to creep beyond that considered in the sagging algorithm. Conductors and shield wires shall be clipped in within 72 hours of achieving the intended stringing tension. Where stringing operations are interrupted or extend beyond this 72-hour threshold, engineering evaluation/approval is required with final approval by Buyer, and the cable manufacturer shall be contacted to obtain technical instructions on the issue.

## 7.7 Galloping

Certain areas within the Entergy Service Area have been identified as areas prone to galloping and shall require the installation of vibration control devices. These areas are generally in north Arkansas along the Mississippi River in open, flat areas where it is possible for ice to form on the cables.

Phase spacing shall be set to avoid mid-span interference between phases through the required assumption that double ellipse galloping will occur on any span exceeding 400 feet. A galloping overlap of less than 10 percent between phases will be allowed in the design process. It is generally assumed that using span lengths between 400 and 900 feet would eliminate this overlap. The ruling span is set at 80% of the limiting span for this analysis.

## 7.8 Aeolian Vibration

Aeolian vibration fatigue damage typically occurs in flat, open areas. The most effective way to reduce this type of vibration is to reduce the line tension. Also, the installation of dampers may eliminate or reduce this vibration; however, the conductor and damper suppliers shall be consulted regarding these conditions.

The use of ACSS type conductors may also reduce this vibration after one year of operation because of the self-damping characteristics built into this type of conductor.

## 7.9 Conductor Corona

Two solutions to reduce conductor corona are larger conductors and/or bundled conductors.

For 161 kV, 115 kV, and 69 kV, 336 kcmil ACSR "Linnet" shall be the minimum conductor size.

At 230 kV, bundled 395 kcmil ACAR conductors or, for single conductor lines, a recommended standard wire size of 954 kcmil ACSR. The minimum wire size for 230 kV using industry standards is approximately one inch in diameter. The smallest standard wire size that meets the industry standard minimum wire size is “Flamingo” 666.6 kcmil ACSR.

For 500 kV transmission lines, 1024 kcmil ACAR and 954 kcmil ACSR “Rail” shall be the minimum conductor sizes to avoid corona effects. The standard for new construction is 954 kcmil “Rail”.

The selection of conductor size, considering corona losses, shall be estimated using the attached figure (obtained from the Westinghouse Transmission and Distribution Manual) entitled “Fig. 31 - Quick Estimating Corona-Loss Curves”. This figure is attached as Attachment **3**.

## 7.10 ACSS and ACSS/TW Conductor

### 7.10.1 ACSS Sags – Tensions - Stringing

ACSS suppliers have recommended that the ACSS & ACSS/TW conductors be pre-tensioned for approximately 10 to 15 minutes before final sagging of the line. This procedure inelastically stretches and elongates the aluminum wires and the steel core provides total support of the conductor in normal operation. Since little or no stress is left in the aluminum wires, initial and final sags and tensions are nearly the same. Pre-stressing is a means of reducing creep and enhancing self-damping capability. Recommendations for pre-stressing vary and range from the maximum tension. Consult with cable manufacturer for prestressing methodology and specifications.

## 7.11 Fiber Optic/Shield Wire Requirements

Fiber Optic Shield Wire (***OPGW***) is often the preferred shield wire. For structures with two shield wires, one shield wire will typically be OPGW and one shield wire will typically be 7#7. Project specific shield wire requirements is subject to approval by Buyer. Substation Relay Design, SCADA, Substation Networking and Corporate Telecommunications will need to determine the number of fibers that they will need. Standard Entergy shield wires are found in Section 7.

### 7.11.1 Fiber Optic Details

The fiber optic line may be dead-ended if the line angle is over 30°. For line angles between 30° and 50°, a heavy angle suspension assembly may be utilized. Fiber optic construction details are shown on the standard assembly drawings, shown in Attachment 1.

### 7.11.2 Splice Box Locations

Splice boxes shall be placed at existing or expected future laterals and substations. Additional boxes will be needed at intervals along the line, generally corresponding to reel wire length, line angles, and considering the nearest points of access.

## 7.12 SW Sagging Relative to Conductors

Every effort shall be made to ensure that the shield wire(s) have less sag than the conductor, so that any flashovers are encouraged to occur at a structure rather than at mid-span. It is suggested that the shield wire have a lesser amount of sag by approximately 0.33 percent of the span length, or approximately two (2) feet, under normal stringing loads, i.e., 60°F (15°C). Where this is not feasible, the tension limits to control vibration in Table 7.5.2 may be relaxed to pull the shield wire more tightly and achieve greater separation. Where the tension limits of Table 7.5.2 are relaxed, a conductor vibration study shall be performed, and vibration dampers shall be installed on the shield wire per the recommendations of the

vibration study. Alternately, the standard framing may be modified with approval from Buyer to provide greater separation between the shield wire and the conductor.

## 7.13 Conductor and Shield Wire Marking

### 7.13.1 Aerial Patrol Marking

Aerial patrol marking to provide early warning of the hazards due to crossing transmission lines shall be applied as described herein.

### 7.13.2 Marking for Federal Aviation Administration (FAA) regulations

Marking required to comply with Federal Aviation Administration (FAA) regulations shall not be confused with the aerial patrol marking described in paragraph 7.13.1. When routing new lines, it is generally better to avoid selecting routes that pass within close proximity of airports, landing strips, heliports and facilities such as hospitals that might have aircraft landing on improvised landing sites. Such facilities can be generally identified by examining aerial navigation maps available at pilot centers in most public airports, examination of quadrangle maps published by the U.S. Geological Commission, examination of aerial photographs acquired for the line project, and other sources. Where these facilities cannot be avoided and where it is determined that FAA rules apply, the requirements of FAA Advisory Circular AC 70/7460-1K shall apply.

### 7.13.3 Navigable Waterway Marking

Lines crossing navigable waterways shall be marked as delineated in the applicable permits.

### 7.13.4 Avian

Avian markers are to be installed where appropriate to make the line more visible to birds. Several forms of markers are commercially available and marketed to increase line visibility and reduce the possibility of avian mortality. Avian markers shall be required only where specified by wildlife agencies or by applicable permits.

### 7.13.5 Slow-Moving Vehicle Signs

Slow-moving vehicle signs shall be placed on the third and fourth adjacent structures on both sides of any crossover lines, with the signs facing the approach to the lines from either side of the crossover. It is very important that all crossings be marked on the same number of advance structures for safety reasons. One sign on each structure shall be used to indicate a single crossover ahead. If two crossovers in close proximity exist ahead, then two signs shall be installed on each structure, one sign over the other, if possible. Two-crossover situations shall also have single signs on both sides of structures between the crossovers. Details of the installation are covered in an attachment to this Appendix, but generally the signs shall be near the top of the poles or towers of the structures. When used on wooden poles, the signs shall be outside any woodpecker wire covering the pole.

### 7.13.6 Spiral Vibration Dampers (Yellow)

Spiral dampers in addition to slow-moving vehicle signs may be desirable in some cases with extraordinary visibility difficulty. When used, such dampers shall be installed with a minimum of one pair of dampers on both sides of centerline of the line being patrolled at a point just outside the conductor locations but not less than 15 feet between the pairs. If there are two shield wires on the crossover line, half of the dampers shall be installed on each shield wire.

### 7.13.7 QuikMark Devices

QuikMark devices, in addition to slow-moving vehicle signs, may be desirable in some cases with extraordinary visibility difficulty. When used, QuikMark devices shall be installed with a minimum of three QuikMark devices on each side of centerline of the line being patrolled at a point just outside the conductor locations but not less than 15 feet between each trio. If there are two shield wires on the crossover line, install half of the QuikMarks on each shield wire.

### 7.13.8 QuikMark Devices Combined with Spiral Vibration Dampers

QuikMark devices and spiral dampers may be combined to mark shield wires by keeping equal numbers of each on each side of the line being patrolled so the visual effects are balanced on the line. When the Transmission Line crosses under the line of another, the minimum requirement is for QuikMark devices or spiral dampers or both to be installed on the shield wires of the other line. This is for the safety of Entergy aerial patrollers and to protect Entergy and others from claims by the owner of the other line for property damage, lost revenues on the other line, and other claims.

# 8 OTHER ELECTRICAL CRITERIA

## 8.1 Electrical Insulation

All insulators shall be polymer (non-ceramic). Insulators that are procured from one of Entergy's approved vendors for insulators and adhere to Entergy's standards are assumed to meet this specification. Insulator types include dead-end, braced post, post, suspension and jumpers. All new HV (69 kV and above) Transmission Lines shall have insulators with corona rings installed. Details for these insulators are included in Attachment 1.

### 8.1.1 Insulator Swing

#### 8.1.1.1 Mechanical Clearance

Post and braced post assemblies have the potential for contact between their suspension shoe and their post insulator. The suspension shoe may swing towards the supporting post insulator without any wind due to line deflection angle and/or phase position changes between consecutive structures. With a 6 PSF wind (60 degrees Fahrenheit and final wire tension) further displacing the conductor hardware from its everyday displacement, contact with the sheds (or corona ring) is not allowed. With extreme wind specified in Table 5.1.2 of the design criteria (60 degrees Fahrenheit and final wire tension) further displacing the conductor hardware from its everyday displacement, contact with the rod's sheath is not allowed. A swing angle adapter shall be used to increase mechanical clearance. This adapter does not preclude mechanical conflict, so conductor position shall still be checked.

#### 8.1.1.2 Electrical Clearance

Table 8.1.1.2 specifies required certain clearances from the energized conductor shoe to non–energized portions of the structure under the prescribed conditions specified in the footnotes. These clearances were built into Entergy's standard framings shown in Attachment 1. Certain atypical conditions, such as short spans, structures in dips, transition between framings or phasing, deflection angles near the top of the range, and higher tensions, can warrant deviations from standard, such conditions will require Seller to acquire approval from Buyer. Conductor position shall be verified against Table 8.1.1.2 that the required minimum clearances are met, especially for suspension insulators. For posts and braced posts, the standard post lengths will ensure that these clearances are met, except for the no-wind clearance for

bundled conductors. For bundled posts and bundled braced posts, the conductor hardware shall not be allowed to swing more than 30 degrees toward the pole without wind (0 degrees F, initial). Note that the swing angle adapters mentioned in Section 8.1.1 do not improve electrical clearance.

**Table 8.1.1.2 – Minimum Insulator Swing Clearances**

| FRAMING VOLTAGE | CONDITION | CLEARANCE TO ARM OR STRUCTURE | CLEARANCE TO GUY |
|---|---|---|---|
| 500 kV | 6 psf wind (1) | 123 in | 11 ft. |
| 500 kV | 100 mph (2) | 60 in | 5 ft. |
| 500 kV | no wind (3) | 140 in | 12 ft. |
| 500 kV | no wind (4) | 140 in | 12 ft. |
| 345 kV | 6 psf wind (1) | 85 in | 8 ft. |
| 345 kV | 100 mph (2) | 41 in | 4 ft. |
| 345 kV | no wind (3) | 105 in | 9 ft. |
| 345 kV | no wind (4) | 105 in | 9 ft. |
| 230 kV | 6 psf wind (1) | 52 in | 6 ft. |
| 230 kV | 100 mph (2) | 27 in | 3 ft. |
| 230 kV | no wind (3) | 83 in | 8 ft. |
| 230 kV | no wind (4) | 88 in | 8 ft. |
| 161 kV | 6 psf wind (1) | 37 in | 5 ft. |
| 161 kV | 100 mph (2) | 19 in | 2 ft. |
| 161 kV | no wind (3) | 60 in | 7 ft. |
| 161 kV | no wind (4) | 71 in | 7 ft. |
| 138 kV | 6 psf wind (1) | 34 in | 5 ft. |
| 138 kV | 100 mph (2) | 16 in | 2 ft. |
| 138 kV | no wind (3) | 54 in | 7 ft. |
| 138 kV | no wind (4) | 65 in | 7 ft. |
| 115 kV | 6 psf wind (1) | 28 in | 5 ft. |
| 115 kV | 100 mph (2) | 13 in | 2 ft. |
| 115 kV | no wind (3) | 49 in | 7 ft. |
| 115 kV | no wind (4) | 60 in | 7 ft. |
| 69 kV | 6 psf wind (1) | 17 in | 3 ft. |
| 69 kV | 100 mph (2) | 8 in | 1 ft. |
| 69 kV | no wind (3) | 49 in (36 in) (5) | 6 ft. |
| 69 kV | no wind (4) | 60 in (49 in) (5) | 6 ft. |

(1) Max required value between switch surge and NESC air gap. Controlled by NESC with 10% Voltage Surge (1.1 x nom. Voltage).

(2) 60 Hz minimum flash over distance.

(3) No wind clearance for suspension insulator (Impulse Air Gap).

(4) No wind clearance for running angles (Impulse Air Gap).

(5) 69 kV framings use 115 kV no-wind air gaps for improved lightning performance. On existing structures where there isn't room for longer insulators and air gaps, the numbers in parentheses apply.

### 8.1.1.3 Typical Standard Davit Arms

For the purpose of determining clearances presented in Table 8.1.1.2 accounting for insulator swing; as well as for the purpose of evaluating shield angle and determining conductor coordinates, the following arm lengths and insulator lengths shall be used:

**Table 8.1.1.3 – Typical Davit Arm and Insulator Lengths for New Construction**

| INSULATOR LENGTH(2) | | | |
|---|---|---|---|
| VOLTAGE (kV) | TYPE | INSULATOR LENGTH (IN) | DESIGN LENGTH (IN.) |
| 69 | SUS | 59 | 66 |
| 161 | SUS | 73 | 78 |
| 230 | SUS | 89 | 96 |
| 69 | DE/RA | 62 | 80 |
| 161 | DE/RA | 92 | 98 |
| 230 | DE/RA | 104 | 110 |
| 69 | LP/BP | 60 | 60 |
| 161 | LP/BP | 76 | 78 |
| 230 | LP/BP | 94 | 94 |
| **DAVIT ARM LENGTH(1)** | | | |
| **VOLTAGE (kV)** | **TYPE** | **LENGTH** | **RISE (IN.)** |
| 69 | Tangent | 5'-6" | 13 |
| 161 | Tangent | 8'-6" | 25 |
| 230 | Tangent | 11'-0" | 24 |
| 69 | Swing | 3'-0" | N/A |
| 161 | Swing | 4'-0" | N/A |
| 230 | Swing | 5'-0" | N/A |
| 69 | DE | 5'-0" | 12 |
| 161 | DE | 6'-0" | 15 |
| 230 | DE | 8'-0" | 20 |

(1) Davit Arm Length is from pole face to conductor attachment

(2) Design length includes hardware.

### 8.1.1.4 Insulator Attachments – 69 kV, 161 kV, and 230 kV Structures

Braced post and line post insulators are limited to a line angle of 6 degrees based on the limited compression capacities of these insulators. Insulator capacities shall be obtained from manufacturer.

### 8.1.1.5 General

The same insulator type can be used for concrete and steel poles. Insulator attachments for post insulators are required to be provided by thru-bolting standard insulators to the pole structures.

Dead-end and suspension insulators are required to be attached to the poles via vangs on steel poles or pole-eye plates on concrete poles.

#### 8.1.1.6 Conductor and Shield Wire Vangs

Standard conductor and shield wire attachment vangs on all steel poles shall be ¾ inch plate with 1 1/8 inch diameter holes and 1 ½ inch radius and shall be the same on both ends.

Conductor attachment vangs on concrete poles will be 60,000 or 70,000 pound strength pole-eye plates mounted with 7/8 inch diameter all-thread rods, similar to those provided by Hughes Brothers in Lincoln, Nebraska.

#### 8.1.1.7 Guy Vangs

Standard guying vangs on all steel poles shall be ¾ inch plates with 1 1/8 inch diameter holes and11/2 inch radius and shall be the same on both ends. All guy attachment vangs on all concrete poles will be 60,000 or 70,000 pound strength pole-eye plates mounted with 7/8 inch diameter all-thread rods, similar to those provided by Hughes Brothers in Lincoln, Nebraska.

#### 8.1.1.8 Polymer Insulator Standard Drawing

Attachment 1 has detailed drawings of the Entergy Standard Insulator drawings for 115 kV, 138 kV, 161 kV and 230 kV voltages. Seller shall use the Entergy Standard Insulators and must verify they meet the requirements for the design. The drawing includes the following information:

Braced Post Insulators

Horizontal Line Post Insulators

Suspension Insulators

Dead-End Insulators

Minimum Flashover Characteristics

Minimum Leakage Distance

## 8.2 Transmission Line Lightning Protection Design

### 8.2.1 Reference Guides

| | |
|---|---|
| IEEE Std. 1243-1997 | Guide for Improving the Lightning Performance of Transmission Lines |
| EPRI | Handbook for Improving Overhead Transmission Line Lightning Performance |
| EPRI | AC Transmission Line Reference Book - 200kV and Above |
| EPRI | Guide for Transmission Line Grounding |
| EPRI | Outline of Guide for Application of Transmission Line Surge Arrestors – 42 to 765 kV |

Where applicable Seller shall apply the following parameters during the design process.

### 8.2.2 GFD

The GFD varies greatly throughout Entergy's transmission system and average from 2-7 flashes/$Km^2$/yr. However, the GFD for any area for a particular year can be more than 3X the historic average. Therefore, Entergy's design parameters do not consider the GFD for the specific line but assume the standard design

methods will ensure an adequate reliability throughout the system no matter the GFD of any particular location.

### 8.2.3 Structure BIL

Although local atmospheric conditions can affect the ability of air to insulate against a flashover the typical breakdown rate for a negative dry arc is 650 kV per meter. Therefore, the structure BIL is 650 kV X air gap in meters.

It is very difficult to maintain an acceptable BIL for distribution circuits on a transmission line structure. In order to maintain acceptable lightning performance when attached to tall shielded transmission structures, fiberglass arms and transmission class insulators are required.

Distribution underbuild is considered a last resort for new construction. It complicates maintenance for both organizations.

### 8.2.4 Shield Wire Installation

The installation of a shield wire is the required method of lightning protection.

### 8.2.5 Shield Wire Type and Size

The size and type of shield wire used will be determined by needs other than that required for lightning protection, such as fault current. Any of Entergy's standard shield wires conforming to the parameters set out in the referenced guideline will be adequate for the lightning protection of the line. Note: Supporting distribution phases on transmission structures exposes transmission shield wire to long duration distribution faults for which it was not designed. Therefore, a neutral conductor shall be bonded to each transmission structure.

### 8.2.6 Shielding Angle

The shielding angle, as measured at the structure from the vertical plane of the shield wire clamp to the conductor clamp, shall be no more than 25° for structures adjacent to spans averaging less than 150 feet above ground level. The required shielding angle on structures where the average conductor height is greater than 150 feet above ground level need to be designed on a case by case basis and shall be subject to approval from Buyer. The average height taken as the height at the structure minus 2/3 the sag.

On single pole structures with one shield wire, the shielding angle shall be checked to the top conductor as well as to the bottom conductor opposite the shield wire attachment.

On H-type structures, the shielding angle shall be checked for each shield wire to its corresponding outer conductor. Unless the distance between the shield wires exceeds 60 feet, the shielding angle to the middle conductor is not considered.

### 8.2.7 Maximum Grounding Resistance

The maximum allowable grounding resistance shall be obtained as specified in Section 8.3.

### 8.2.8 Lightning Arrestors

Lightning arrestors shall be used on transmission lines only in cases where a shield wire cannot be installed (e.g., clearance near an airport), the maximum allowable grounding resistance cannot be obtained, or adjacent to extremely long spans where the lightning protection software shows the shield wire is insufficient.

## 8.3 Grounding and Cathodic Protection

This section covers the design of the grounding and cathodic protection systems for concrete and steel structures for transmission lines.

### 8.3.1 Grounding

#### 8.3.1.1 Grounding Systems

Entergy's steel and concrete pole structures shall be "effectively grounded" as defined in Section 2 of the NESC. Shield wires are constructed, along with the associated grounding system, on all of Entergy's transmission lines for lightening protection. The use of proper structure grounding will reduce the ground resistance at the structures and will reduce line outages due to lightning strikes.

#### 8.3.1.2 Steel Structure Grounding System

Steel poles shall be bonded to the shield wire by a copperweld jumper. The pole then acts as a ground rod to the ground line. Because the coating at the bottom of direct embedded steel poles insulates the steel, direct embedded poles shall be grounded. This grounding shall be done with ground rods driven into the earth and bonded to the pole. The same grounding is used to ground a steel pole bolted to a concrete pier or set in a concrete pile. Steel poles socketed into steel piles shall be bonded to the steel pile.

#### 8.3.1.3 Concrete Structure Grounding System

Concrete poles shall be bonded to the shield wire through the grounding clip and a terminal lug at the pole top by a copperweld jumper. A copperweld wire shall then run down the pole to another terminal lug below ground. The wire may be internal or external. There are four options for grounding the direct buried pole: (1) connect the ground wire to the pancake at pole bottom; (2) extend the ground wire from the pancake to the ground rod; (3) connect the ground wire from the terminal directly to the ground rod; and (4) connect the ground to the substation ground grid using 4/0 copper. Ground wires shall be continuous (no splices). For concrete poles set in steel piles, the ground wire shall be extended from the bottom lug and bonded to the pile.

#### 8.3.1.4 Guy Wire Grounding System

In accordance with NESC requirements, guy wires shall be bonded directly to the steel structure or to the ground wire on a concrete structure using a copperweld wire bonded to the guy wire.

#### 8.3.1.5 Achieving Desired Structure Resistance

Tests to verify that the required footing resistance has been obtained using the standard methods shall be performed by Seller.

Seller shall test for grounding resistance, which shall not be greater than:

69 kV & 115kV 13 ohms

138 kV & 161 kV 10 ohms

230 kV 7 ohms

345 kV & 500 kV (H-frames) 18 ohms

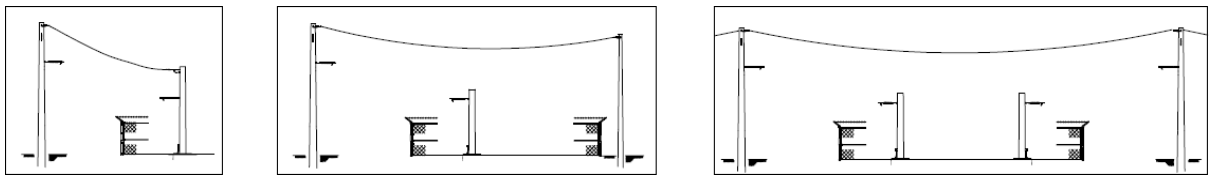
There are two acceptable methods to achieve these requirements: (1) driving additional rods and (2) installing a counterpoise that consists of 100 feet of conductor buried 18" deep parallel to the line.

#### 8.3.1.6 Grounding at Substations

Bonding of Transmission Line Shield Wire to Substation Ground Grid

Electrical currents can be introduced on shield wires from a variety of sources. To prevent these currents from arcing across mechanical connections to get to the substation ground grid, a bonding conductor shall be provided.

The following common shielding configurations and requirements shall be permitted are detailed below:



a b c

a. Shield wire attached to Substation pull-off structure

Generally, the transmission line will be dead-ended outside the substation and the shield wire slack span into the station will be positively grounded to the pull-off tower with a jumper and the pull-off tower will be connected to the substation ground grid. It is the responsibility of the substation to make these connections. The last transmission structure in the immediate vicinity of the station shall not be bonded to the substation ground grid unless a specific grounding analysis is performed.

b. Shield wire across station to dedicated shield wire pole

Since the shield wire pole is usually installed within close proximity to the substation; it shall be bonded to the substation ground grid. The last transmission structure in the immediate vicinity of the station shall not be bonded to the station grid unless a specific grounding analysis is performed.

c. Shield wire across station to exiting transmission line structure

One of the transmission structures on either side of the station shall be bonded to the substation ground grid. The structure selected for bonding shall be the one closest to the station or having the fewest physical obstacles between the structure and the station.

### 8.3.2 Cathodic Protection

The cathodic protection system is a method of protecting steel transmission line structures from corrosion, generally at the ground-line where moisture can mix with air to cause corrosion and thus deterioration and loss of strength of the structures. The protection system used is to attach either magnesium or zinc anodes to the structure.

These anodes provide sacrificial protection for the steel in the structures.

#### 8.3.2.1 Soil Investigations

The soil investigation shall include soil corrosion recommendations to determine the need for anodes and the number required for each structure.

#### 8.3.2.2 Anode Types

Magnesium anodes shall be used except that, in areas such as coastal marshes, zinc anodes may be used where recommended over magnesium anodes by the corrosion engineer based on in-situ conditions

### 8.3.3 Structure Protection

Steel poles, steel piles and steel guy anchors shall be protected as described below.

#### 8.3.3.1 Steel Dead-End and Guyed Structures

All buried steel (embed poles and piles) at dead-end and guyed steel structures shall be installed with anodes as shown on the Framing Drawings and provided Assembly Drawings. The number of anodes per structure shall be as recommended in the corrosion consultation report or as deemed necessary by the corrosion engineer based on in-situ conditions.

#### 8.3.3.2 Steel Tangent Structures

Steel tangent structures are generally not installed with anodes, anodes shall be installed on structures in areas of known corrosion problems, or when structures are to be installed adjacent to a pipeline or railroad. In these cases, installation shall be in accordance with provided Assembly Drawings in Attachment 1.

Guy Anchors for Steel and Concrete Structures

The steel helix type anchors for both steel and concrete poles shall be installed with anodes.

# 9 STRUCTURE DESIGN CRITERIA

## 9.1 Steel Poles

Entergy standard structure framings are shown in Attachment 1.

### 9.1.1 Tubular Steel Pole Purchase Specification

Details of structure design that shall be included in the purchase specification are:

ASCE Design Manual Requirements

Material Specifications

Pole Deflection Limitations

Fabrication Requirements

Protective Coating Requirements

Cathodic Protection

Grounding Requirements

Seller shall procure (or cause to be procured) tubular steel poles from tubular steel pole vendors on the Approved Vendor List (Attachment 5) for tubular steel pole vendors and direct the vendor to provide items in conformance with their applicable standard Energy specifications.

### 9.1.2 General Design Requirements

#### 9.1.2.1 General

All designs shall be in accordance with the provisions of the latest NESC, ASCE/SEI Standard 48, and the requirements stated in this document. All construction shall be Grade B, as defined in Section 24 of the NESC Code.

### 9.1.2.2 Foundation Rotation

In addition to the applied loadings, all self-supported monopole and un-braced H-frame structures shall be designed with a 3 degree foundation rotation. The point of rotation is assumed to be at the ground line. Smaller foundation rotations for braced H-frame structures shall be considered on a case-by-case basis.

### 9.1.2.3 Deflection Limitations

The following pole deflection limitations assume 0 degree foundation rotation and shall be adhered to in the design of all poles. The percentage listed is the percent of the pole height above ground.

**Table 9.1.2.3 – Deflection Limitations**

| Load Case / Wires | Tangent (Intact) | Running Angle (Intact) | Dead-end (Intact) | Dead-end (DE One Side) |
|---|---|---|---|---|
| NESC w/OLF See Loading District | 10% | 10% | 10% | NSL |
| NESC without/OLF See Loading District | NSL | NSL | NSL | NSL |
| High Wind See Loading District | 10% | 10% | 10% | NSL |
| Wind & Ice See Loading District | 10% | 10% | 10% | NSL |
| Everyday No Wind or Ice - 60°F | 3%(1) | 3%(1) | 3%(1) | NSL |
| Longitudinal Unbalance 1K at Each Phase Location | NSL | NSL | NA | NA |
| DE Stringing No Wind or Ice - 60°F | NA | NA | NA | 1%(2) |

NA - Not Applicable

NSL - No Specified Deflection Limit

(1) Camber if Deflection Exceeds 1%
(2) Only if Specifically Requested

### 9.1.2.4 Pole Raking

For new project construction, cambering the pole when deflection exceeds 1% of the pole height above ground is the required resolution to concerns arising from what might (aesthetically) appear to be excess pole deflection.

### 9.1.2.5 Guyed Structures – Pre-Designed

The Designer shall select a pre-designed light duty pole, such as an SW Class H-6 equivalent, to be used as the pole in guyed framings in the pole spotting procedure. This type of pole will make available the range of heights to complete the spotting process. PLS-CADD will select the optimal pole height.

#### 9.1.2.6 Selection of Pre-designed Poles – Optimizing Process

To use the line optimization features PLS-CADD, the Designer must select and input the pre-designed pole types and framings most suited for the Transmission Lines. This shall include the material, framings and pole heights, types and sizes.

#### 9.1.2.7 Pole Design and Verification Process

The purchase order for the structures selected by PLS-CADD during the optimization process is then forwarded to the pole vendor along with a calculated load tree for each pole. The vendor will then review the design of the selected poles before pricing and fabrication. In some cases the poles selected may have to be revised to meet the design criteria.

### 9.1.3 Procurement

To purchase the poles and associated materials, Seller shall use a type of purchase requisition known as a "White Requisition".

"White Requisition" – This type of order is used to purchase material from Entergy's preferred vendors including steel and concrete poles, insulators and conductors. The pole order will generally include the preferred item plus most of the assembly attachment material, such as nuts, bolts, vangs. It is the vendor's responsibility to verify the size and number of each item. "White Requisitions" are also used to order non-stock-coded items.

### 9.1.4 Structure Hardware

The Entergy "Standard Structure Framings" in Attachment 1 lists the standard assemblies required for each structure framing. Each assembly drawing lists the bill of materials required for that assembly. The standard hardware parts were designed to meet the maximum tensions and loads calculated for the pre-designed structures previously described but shall be verified by the designer. Unless Buyer grants an exception in writing, poles shall be ordered with sufficient step bolt mounting provisions.

### 9.1.5 Grounding and Cathodic Protection

See Section 8.3 for design information regarding the required grounding and cathodic protection for steel poles.

### 9.1.6 Hybrid Structures

Hybrid structures, a combination of a steel top section and a concrete bottom section, shall be used where ground water conditions may cause excessive corrosion of a steel pole. For such structures, the concrete bottom piece shall directly embedded using standard embedment details. Foundation and grounding details are discussed in Section 10 and Section 8.3, respectively.

## 9.2 Concrete Poles

This section covers the design and analysis of concrete pole structures for single and bundled conductor transmission lines. It covers single pole, two pole, and three pole structures with direct-embedded foundations, socket-type foundations and base-plated foundations all for use on tangent, running angle or dead-end structures. All standard structure framings applicable to this work are delineated in Attachment 1.

### 9.2.1 Spun Pre-stressed Concrete Pole Purchase Specification

Details of structure design that shall be included in the purchase specification include:

ASCE and PCI Design Guide Requirements

Material Specifications Pole Deflection Limitations

Fabrication Requirements

Testing Requirements.

Seller shall select a concrete pole vendor from the list of concrete pole vendors set forth in the Approved Vendor List (Attachment 5) and direct the concrete pole vendor to provide items in conformance with their applicable standard Entergy specifications.

## 9.2.2 General Design Requirements

### 9.2.2.1 General

All concrete pole and related designs shall be in accordance with the provisions of the latest NESC, the PCI and ASCE Guide Specifications, and the requirements stated in this document. All concrete pole construction shall be at least Grade B, as defined in Section 24 of the NESC Code.

### 9.2.2.2 Foundation Rotation

In addition to the applied loadings, all self-supporting structures shall be designed with a 3-degree foundation rotation. The point of rotation shall be assumed to be at the ground line.

### 9.2.2.3 Deflection Limitations

The following pole deflection limitations assume 0-degree foundation rotation and shall be adhered to in the design of all concrete poles. The percentage listed is the percentage of the pole height above ground.

| ***Load Case / Wires*** | *Concrete Structure Type* | | | |
|---|---|---|---|---|
| | Tangent (Intact) | Running Angle (Intact) | Dead-end (Intact) | Dead-end (DE One Side) |
| NESC w/OLF See Loading District | 10% | 10% | 10% | NSL |
| NESC without/OLF See Loading District | 2% | 2% | 2% | NSL |
| High Wind See Loading District | 10% | 10% | 10% | NSL |
| Wind & Ice See Loading District | 10% | 10% | 10% | NSL |
| Everyday No Wind or Ice - 60°F | 1% | 1% | 1% | NSL |
| Longitudinal Unbalance 1K at Each Phase Location | NSL | NSL | NA | NA |
| DE Stringing No Wind or Ice - 60°F | NA | NA | NA | 1% |

NA - Not Applicable

NSL - No Specified Deflection Limit

### 9.2.2.4 Pole Raking

Where deflections under the everyday load case exceed 1% of the above ground pole height as described in Section 9.2.2.3, but do not exceed 2% the pole shall be raked to improve aesthetic concerns and minimize

secondary moment effects. Where poles are to be raked, the Designer shall provide specific instructions identifying the degree to which the pole shall be raked to compensate for the calculated deflection under the everyday load case.

### 9.2.3 Procurement

To purchase the poles and associated materials, Seller shall use a type of purchase requisition known as a “White Requisition”.

“White Requisition” – This type of order is used to purchase material from Entergy’s preferred vendors, including steel and concrete poles, insulators and conductors. The pole order will generally include the poles plus most of the assembly attachment material, such as nuts, bolts, vangs. It is the vendor’s responsibility to verify the size and number of each item.

### 9.2.4 Structure Hardware

The applicable Entergy “Standard Structure Framings” included as Attachment 1 lists the standard assemblies required for each structure framing. Each assembly drawing lists the Bill of Materials required for that assembly. The standard hardware parts are designed to meet the maximum tensions and loads calculated for the pre-designed structures previously described. Unless a deviation is granted by Buyer, poles shall be ordered by Seller with sufficient mounting locations for attachment of climbing provisions.

## 9.3 H-Frame Design

This section covers the design of concrete and steel H-Frame structures to be used in construction of the Transmission Lines. These standard framings cover transmission structures for single and double circuit construction using standard suspension insulators. Clearance has been provided for the possible use of bundled conductors.

### 9.3.1 Structure Types

Standard framings are developed for single and double circuit “Light” and “Medium” (HA2) tangent (0° – 1.5°) structures and “Light” and “Medium” (HB2) small angle (1.5° – 6.0°) structures. Standard tubular steel cross arms have been pre-designed and detailed for use in “Light” and “Medium” structures.

The standard framings are based on the base assumption that steel structures will be X-braced and concrete structures will not be X-braced. The pole supplier shall determine if X-braces are required for each structure and shall detail and supply the X-braces and connection hardware if required.

Special “Uplift” framings are included for use in certain structures to address uplift forces in those structures. These structures use the “Light” cross arms with extra vangs to dead-end the conductors.

### 9.3.2 Cross Arm Design

The maximum allowable spans for the pre-designed standard cross arms are based on the maximum vertical load imposed on the arms. The load cases reviewed for each cross arm are NESC designated loadings with overload factors. Maximum arm deflections range from 1 inch to 2 inches.

The tubular steel cross arms are designed to support the vertical load of the various standard conductors used by Entergy on the standard H-Frame framings. The maximum loads for each of the Standard Framings are shown on the Framing Drawings.

The “Light” and “Medium” standard cross arm sizes are as follows:

Light Cross Arm – TS 6 x 6 x 3/16 inch

Medium Cross Arm – TS 8 x 8 x ¼ inch

Shield Wire Arm – TS 4 x 4 x 3/16 inch

The required use (loading) for the standard cross arms is as follows:

69 kV – Use the Light Cross Arm – for all conditions

161 kV – Use the Light Cross Arm – for ½ inch Ice loadings

Use the Medium Cross Arm – for 1 inch Ice loadings

230 kV – Use the Medium Cross Arm for all conditions

### 9.3.3 Cross Arm Assembly Details

The assembly drawings for attaching cross arms to poles are included in the voltage specific assemblies.

### 9.3.4 Rock Anchors

In rock formations, where screw type anchors will not penetrate the rock, rock anchors shall be used. There are two types of rock anchors available, to be selected based on in-situ conditions and engineering calculations.

### 9.3.5 Expanding Rock Anchors

Rods have a diameter of 1.0 inch and an ultimate strength of 36,000 lbs. The limitation of 36,000 lbs. can be overcome by using twin anchors. A more stringent limitation is that the rods are non-extendable. This prevents the expanding rock anchors from being used when the non-fractured bedrock is deeper than about four feet below the surface.

### 9.3.6 Grouted Rock Anchors

The anchors have a 1 ¼ inch diameter round shaft ending in a 4-inch diameter bell. The anchors can be extended with either 1 ¼" round shaft extensions or 1 ½" square shaft extensions. The anchor assembly has an ultimate strength of 70,000 lbs. The strength of the installed anchor (resistance to pullout) is dependent upon the rock type and the dimensions of the grout column. The characteristic of the rock that dominates the calculation for anchor depth is the equivalent cohesion. The installed anchor strength is calculated by multiplying the surface area of the grout column in each layer by the equivalent cohesion of the rock in that layer. For conservatism, any contribution from the overburden shall be ignored.

The High Wind and Heavy Ice Tensions shall be multiplied by 1.65 to provide a safety factor for the anchor installation. For the NESC Zone load case (NESC 250B) a safety factor of 1.0 shall be used as allowed by the code, since that load case already includes an Overload Factor of 1.65. The resulting worst case force shall be resisted by the friction between the grout column and the surrounding rock.

Anchor strength = (circumference) (column length per vertical foot) (constant of 0.9) [(layer 1 thickness)(layer 1 cohesion) + (layer 2 thickness)(layer 2 cohesion) + …]

Seller shall procure that the anchor manufacturer calculates the required anchor depth using their software, but the effective cohesion shall be the parameter that dominates the result. For simplicity, the formula above uses just the effective cohesion. The constant 0.9 is a factor to account for the possible effects of other rock characteristics

The dimension that is to be specified is the distance along the anchor shaft from the ground surface to the bottom of the anchor. The minimum anchor length engaging rock is five feet.

The grout shall be pumped into the hole to ensure that a solid column is produced.

## 9.3.7 Guying Hardware

Following are listed the strength values in Entergy's Standard Guying Assembly which limit line conductor tensions and are required for this Project.

### 9.3.7.1 Insulator Assembly

Entergy's Standard Polymer Dead-End Insulators have an ultimate tension capacity of 50,000 lbs. The NESC Strength Factor for insulators is 0.5, therefore the Routine Test Load (RTL or working load) of 25,000 lbs is used.

### 9.3.7.2 Steel Vangs (Steel Poles)

Steel Dead-End vangs are thru vangs and can be designed for any applied tensions. The NESC Strength Factor for the vangs is 1.0.

### 9.3.7.3 Pole Eye Plates for Conductor or Shield Wire (Concrete Poles)

The standard guying attachment is the "AS2720 Double Guying Tee" from Hughes Bros. The Ultimate Strength (maximum tension load) is 35,000 lbs per hole. The NESC Strength Factor is 1.0 for NESC Rule 250B Tensions (OLF=1.65) and 0.8 for Extreme Load Tensions (OLF=1.0) for Rule 250C.

### 9.3.7.4 Pole Eye Plates for Guy Wire (Concrete Poles)

The standard guying attachment is the "A2132 Heavy Dead End Tee" from Hughes Bros. The Ultimate Strength (maximum tension load) is 70,000 lbs. The Strength Factors are the same as for the above "Double Guying Tee". The maximum tension is along the guy slope, thus limiting the line tension depending on the actual guy slope.

### 9.3.7.5 Double Arming Bolts (Concrete Poles)

The standard bolt used in Entergy's Dead-End Assemblies is an ANSI C135.1, 7/8 inch "Double Arming Bolt". The maximum Tensile Strength is 25,400 lbs, the maximum shear strength through threads is 17,270 lbs. and the maximum shear strength through the shaft is 24,350 lbs. The shear strength through the threads is always used for the Dead-End Connection. The NESC Strength Factors are also the same as for the "Double Guying Tee". The allowable bolt strength for combination shear and tension loads, such as the guying assembly, is the calculated "interaction stress". These bolts are the limiting factor, depending on guy slope, of the line tension in the guying assembly.

### 9.3.7.6 Thimble Clevis

The thimble clevis used in the Dead-End Assembly has a 1 inch pin and is rated at 60,000 lbs. Ultimate Strength. The NESC Strength Factors are the same as the "Double Guying Tee".

### 9.3.7.7 Extension Link

The extension link is used in place of the thimble clevis when a double down-guy is used with two anchors. The link uses a 1 inch pin and is rated at 60,000 lbs. Ultimate Strength. The NESC Strength Factors are the same as the "Double Guying Tee".

### 9.3.7.8 Vari-Grip Dead-End

The vari-grip shall be rated for a 19#8 guy wire with an Ultimate Strength of 43,240 lbs. and 61,500 lbs. with a 19#6 guy wire. The NESC Strength Factor is 1.0.

#### 9.3.7.9 Turnbuckle

The turnbuckle shall be a 1" x 6" with jaw and eye ends with an Ultimate Strength of 50,000 lbs. The NESC Strength Factor is 1.0.

The following table gives the allowable line tension based on the guy assembly and guy wire slopes. All loads are in Kips.

**Table 9.3.7.9 – Allowable Line Tensions based on Hardware Limitations**

| Assembly Part | Ultimate Strength | NESC Strength Factor | Allowable Load | Line Tension Guy Slope 1.5:1 | Line Tension Guy Slope 1:1 |
|---|---|---|---|---|---|
| Dead-End Insulator | 50.0 | 0.5 | 25 | 25 | 25 |
| | | | | | |
| 19#8 Guys | 43.2 | 0.9 | 38.9 | 21.6 | 30.6 |
| | | | | | |
| 19#6 Guys | 61.7 | 0.9 | 55.5 | 30.8 | 39.4 |
| | | | | | |
| Double Guy Tee (NESC) | 35.0 | 1.0 | 35.0 | 19.4 | 24.8 |
| Extreme Loads | 35.0 | 0.8 | 28.0 | 15.5 | 19.9 |
| | | | | | |
| Dead-End Tee (NESC) | 70.0 | 1.0 | 70.0 | 38.9 | 49.6 |
| Extreme Loads | 70.0 | 0.8 | 56.0 | 31.1 | 39.7 |
| | | | | | |
| 7/8" D. A. Bolt (NESC) | T=25.4 | 1.0 | | 21.2 | 28.0 |
| Extreme Loads | V=17.3 | 0.8 | | 17.0 | 23.0 |
| | | | | | |
| 1-1/2" SS Screw Anchor | 70.0 | 1.0 | 70.0 | 38.9 | 49.6 |
| | | | | | |
| Thimble Clevis (NESC) | 60.0 | 1.0 | 60.0 | 33.3 | 42.5 |
| Extreme Loads | 60.0 | 0.8 | 48.0 | 26.7 | 34.0 |
| | | | | | |
| Vari-Grip (NESC) w/ 19#8 | 43.2 | 1.0 | 43.2 | 24.0 | 30.6 |
| Extreme Loads | 43.2 | 0.8 | 34.6 | 19.2 | 24.5 |
| | | | | | |
| Turnbuckle (NESC) | 50.0 | 1.0 | 50.0 | 27.8 | 35.5 |
| Extreme Loads | 50.0 | 0.8 | 40.0 | 22.2 | 28.4 |
| | | | | | |
| Extension Link (NESC) | | 1.0 | | | |
| Extreme Loads | | 0.8 | | | |

## 9.3.8 Guyed Structure Limitations

#### 9.3.8.1 Concrete Structures

The maximum line tension that can be applied on a guyed concrete structure is limited by the combined stress on the 7/8 inch D. A. Bolts, where the maximum guy tension is 18.0 kips on the 1.5:1 slope. The

governing design condition, which is considerably less than the ultimate applied tensions that shall be applied on the larger standard conductors for the Hurricane loads (150 mph wind speed.).

#### 9.3.8.2 Steel Structures

Welded steel thru vangs replace the tees and bolts on the concrete pole and these vangs shall be designed to support all of the possible applied loads. Therefore, as provided in the table, the 19#8 guys, the standard guy material, will govern the line tension limit when this guy wire is used. Where 19#6 guys are used, the anchor hardware will govern the line tension limit.

#### 9.3.8.3 Heavy Ice Zone

In the heavy ice zones (NESC 250D zones), standard through bolts, guy tees and single 19#8 guy wire may be inadequate for larger conductors or bundled configurations. Special design considerations shall be investigated under these conditions.

#### 9.3.8.4 Double Down-guy Assemblies

Double down-guy assemblies shall be used when it is determined that the soil is incapable of supporting the applied load with one anchor or where the loads exceed the allowable guy tension. The double down guy assembly shall consist of one attachment to the pole, a link with two rollers, and two guy wires and two anchors. Double Down-guy assemblies shall use 19#8 guy wires. The anchors shall be separated by at least five (5) feet.

#### 9.3.8.5 Guy Anchor Groups

All standard guyed structure framings reference a particular Guy/Anchor Group which defines the structure voltage, and in turn provides the required number and size of guys, type of anchor, guy configuration and structure type.

#### 9.3.8.6 Cathodic protection

Guy anchor assemblies shall be provided with cathodic protection by the installation of anodes.

Guy anchor assemblies shall be protected by anodes as shown on the “Guy Anchor Group” detail drawings. Refer to Section 8.3 for details.

## 9.4 Spacing of Dead-End Structures

Dead-end structures shall be required where necessary to carry eccentric loads developed due to conductor tensions. Such dead-end structures shall also be required where necessary as anti-cascading structures, or where they are necessary to facilitate construction. At a maximum spacing, dead-end structure shall be spaced such that no more than two reels of conductor and a single splice are needed between them. While the length of conductor contained on a reel can vary based on the conductor’s diameter and unit weight, for most commonly used conductors this will result in a maximum spacing of approximately 4 miles between dead-end structures.

## 9.5 Considerations at Major Crossings

The Transmission Lines shall be designed to provide additional reliability at major crossings, in particular along major highway crossings serving as evacuation routes from coastal area. Design and maintenance/replacement activities will apply the following:

1. All crossing structures are non-wood, for all voltages
2. If a wood crossing structure is to be replaced, it shall be replaced with non-wood structure

3. All highways are crossed at an angle as close to perpendicular as possible
4. No conductor or shield wire splices within two spans of the crossing span unless expressly approved in writing by Buyer
5. Where conductor/shield wire splices are unavoidable, or where they are installed during conductor maintenance, install implosive, full tension splices or shunt devices in conjunction with the conventional splice.
6. Install redundant insulator configurations on all crossings (e.g., braced post insulators, V-string insulators, semi-strain insulators, etc.)
7. Make shield wire connections more robust at the crossings (e.g., use shackles with nut, vs. shackles with pins, etc.)
8. No guys on crossing structures if possible, and where guys shall be installed, install double guys
9. Install highway crossing structures in locations difficult for vehicles to hit, e.g. behind ditches
10. Provide crash barriers on all highway crossing structures that are not installed in locations difficult for vehicles to hit

# 10 STRUCTURE FOUNDATIONS

This section covers the design of structure foundations.

Structure foundations shall be designed to meet the NESC District Loading and Everyday Load Cases, as discussed in Section 5.1; and considering the safety factors and deflection limitations discussed in Section 10.2. Note that loads shall generally be extracted from pole manufacturer calculations where the structure has been optimized for a high percentage of utilization. Where structures are designed in groups, the reaction used shall be that of the group (as opposed to loads derived from PLS or elsewhere for the specific location). Where manufacturer calculations are not available, foundations shall be designed for the published class/capacity of the pole used (to assure that future modifications on the line do not overestimate the foundation capacity based on the strength of the pole). Where this is not done, a notation shall be made on the plan and profile sheet stating that the foundation was determined considering actual loads in lieu of the structure's capacity.

## 10.1 Soil Information

The Designer shall obtain as much subsurface information as practicable. The basic sources of information are: (1) actual soil boring samples obtained from geotechnical investigations; (2) Geological maps; (3) data from existing U.S. Dept. of Agriculture maps; or (4) other Geotechnical sources (e. g., DOT files, customer soil records, etc.)

Actual soil data obtained from structure locations is preferable. Generally, soil borings are made at angle and dead-end structures and at intervals of approximately two miles within tangent runs depending on the terrain.

Soil information used in design shall be provided by Seller to Buyer.

## 10.2 Design Methodology – Lateral Load

### 10.2.1 Program Description

The Designer shall use the computer programs Moment Foundation Analysis and Design (***MFAD***), and Foundation Analysis and Design (***FAD***) to design for lateral loads.

### 10.2.2 General Acceptance Criteria

The Designer shall apply the following generally accepted factors of safety for the calculated lateral loads as related to the calculated ultimate capacity of the pile and the acceptable deflection and rotation of the pile:

| **Description** | **Normal Soil** |
|---|---|
| Total Ground Line Deflection (1) | 3.0 in. |
| Total Fnd. Rotation (1) | 1.5 deg. |
| Non Recoverable Deflection | 1.0 in. |
| Non Recoverable Rotation | 1.0 deg. |
| Safety Factor (Tangents) | 1.2 |
| Safety Factor (Angles/DEs) NESC 250B | 1.0 |
| Safety Factor (Angles/DEs) other load cases | 1.65 |

(1) Additionally, for DE Structures, total foundation rotation and ground-line deflection shall be limited to 0.5 degrees and 1 inch under Everyday load case with all conductors on one side only.

## 10.3 Foundation Types

### 10.3.1 Basic Foundation Types

The Designer shall select from the following six basic foundation types typically used by Entergy on steel and concrete pole structures: Direct Embedment Foundation, Steel Pile with Socket Foundation, Cap/Base Plate Foundation, Steel Pile with Anchor Bolt Foundation, Drilled Pier with Anchor Bolts Foundation, and Concrete Pile with Steel or Concrete Pole using Socket Foundation. Seller's foundation engineer shall determine suitable foundation types and dimensions. Alternative foundation types shall only be used if expressly approved in writing by Buyer.

Foundation elements shall be designed using applicable material design specifications (e.g. AISC 360 for steel elements, ACI 318 for concrete elements, etc.)

Reveal height for concrete or steel socket piles shall be between 4 feet and 5 feet to facilitate concrete placement and to minimize required excavation for the socketed pole. Foundation height for base-plated poles shall be at least 2 feet, to raise anchor bolts above the ground and the bulk of the wet underbrush. The Designer shall require taller reveals in floodplains, where requested for constructability purposes, or where otherwise needed. The Designer shall not all reveals outside these specifications on the foundation drawings and/or staking sheet.

### 10.3.2 Grounding and Cathodic Protection

The steel pile shall be designed to act as a ground for both steel and concrete structures. Socket connections and anchor bolt connections using steel piles shall be positively connected between the pole and pile using a #4 copperweld wire connected between the pole and the Two Hole NEMA Pad welded to the pile for a good ground. The cap/base plated connections shall be designed to provide a good grounded connection. Steel and concrete poles supported by concrete drilled piers shall be grounded to copperclad steel ground rods.

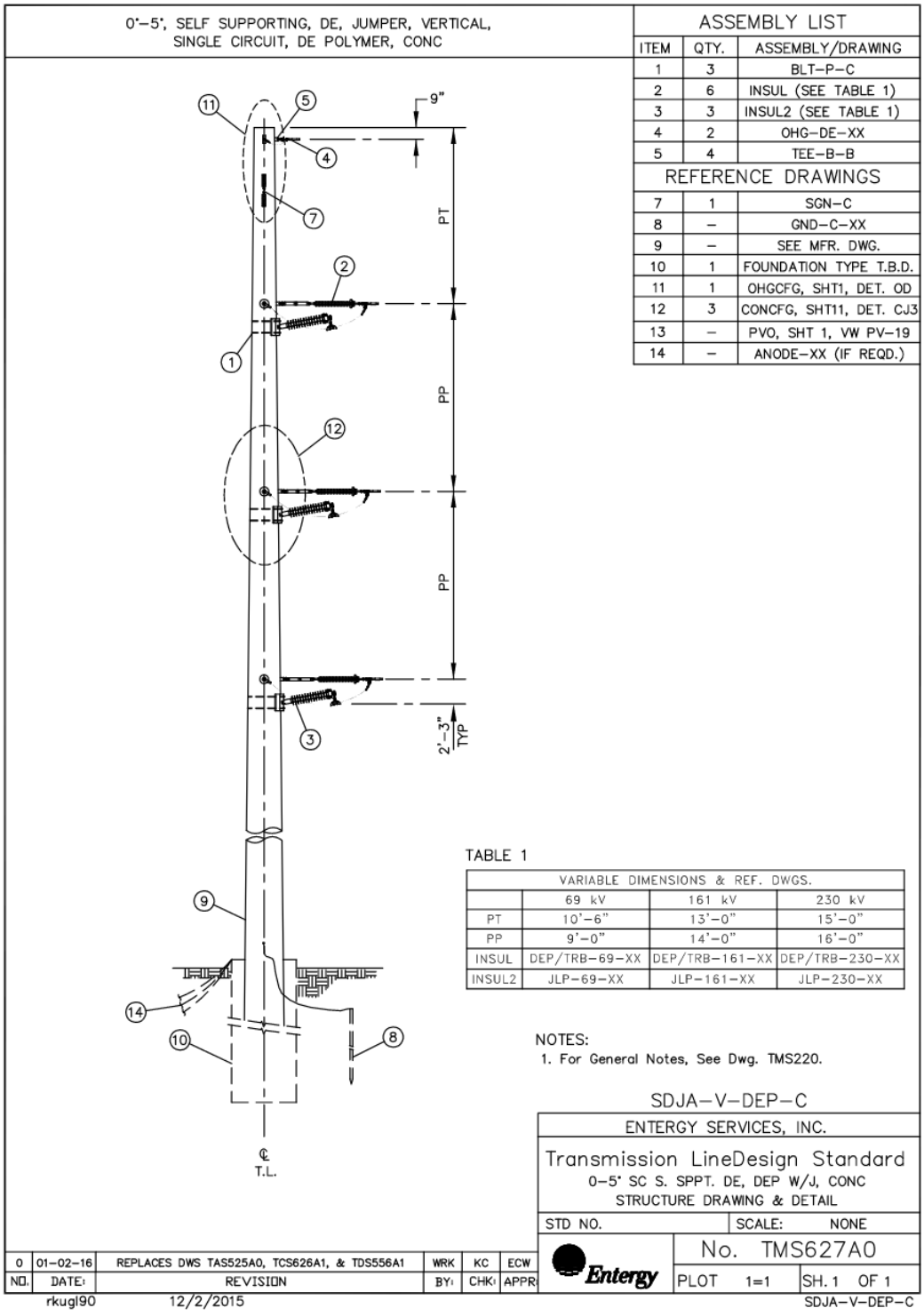
Where cathodic protection is required, the anodes shall be connected to the NEMA Pads as indicated on the cathodic protection detailed drawings. In general, unless an analysis for corrosion potential indicates otherwise or the structure is located in exposed bedrock, anodes will be required at all guy anchors, and dead-end or large angle structures supported on steel foundations or embedments. In general, unless local conditions warrant (brackish marsh, shared ROW with railroads or pipelines protected by impressed current cathodic protection, etc.) anodes are not usually required for tangent structures on structures supported on concrete foundations or embedments. Reference is made to Section 8.3 of this Appendix.

# 11 Attachments

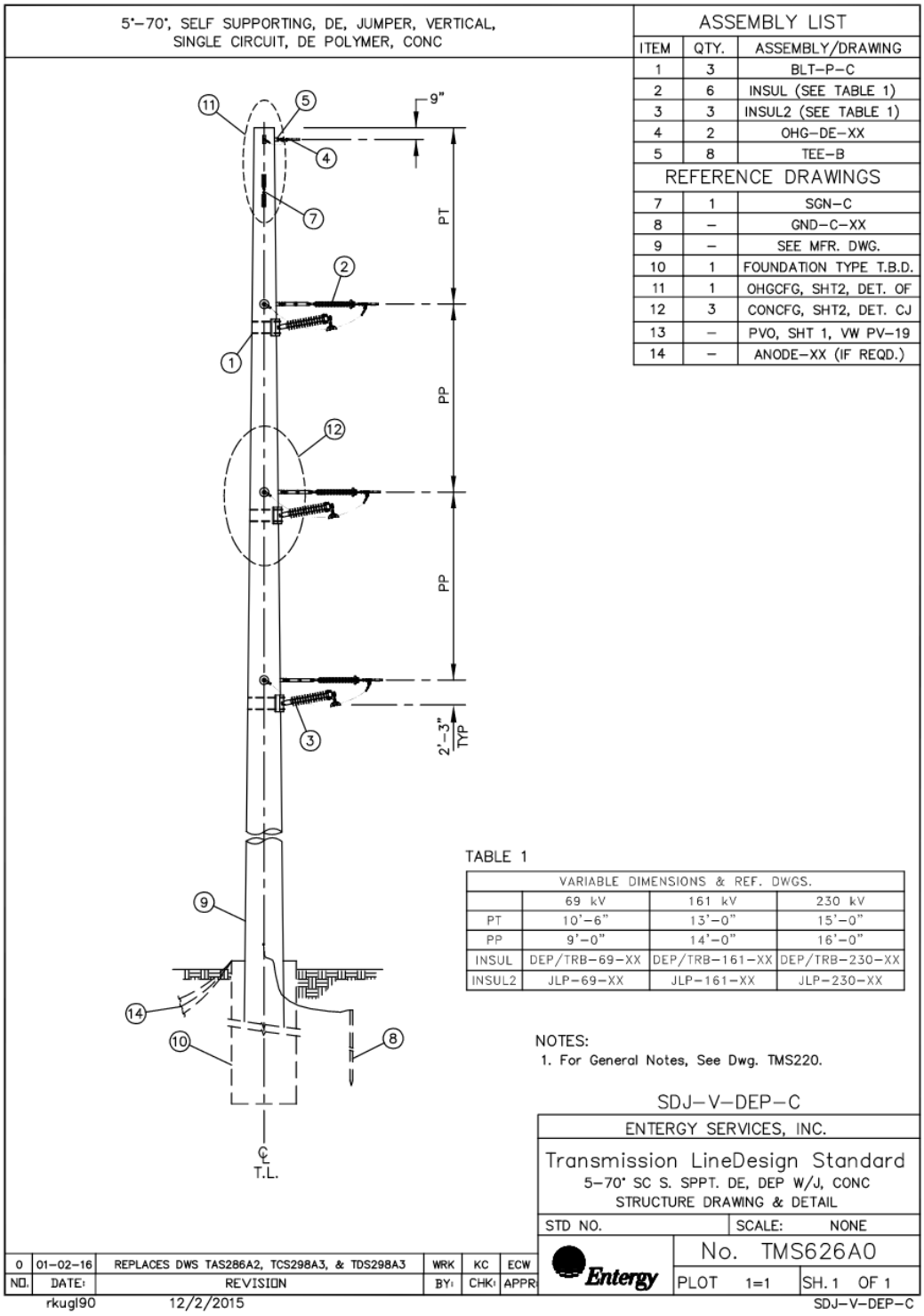
Attachment 1 – Applicable Standard Framing and Assembly Drawings
Attachment 2 – NESC and Entergy Clearance Requirements
Attachment 3 – Quick Estimating Corona Loss Curves
Attachment 4 – Example ROW
Attachment 5 – Approved Vendor List[1]
Attachment 6 – Entergy Loading Districts

[1] This Attachment provides an Approved Vendor List. This Approved Vendor List is in addition to that found in the Scope Book and is considered acceptable for use, and preferred.

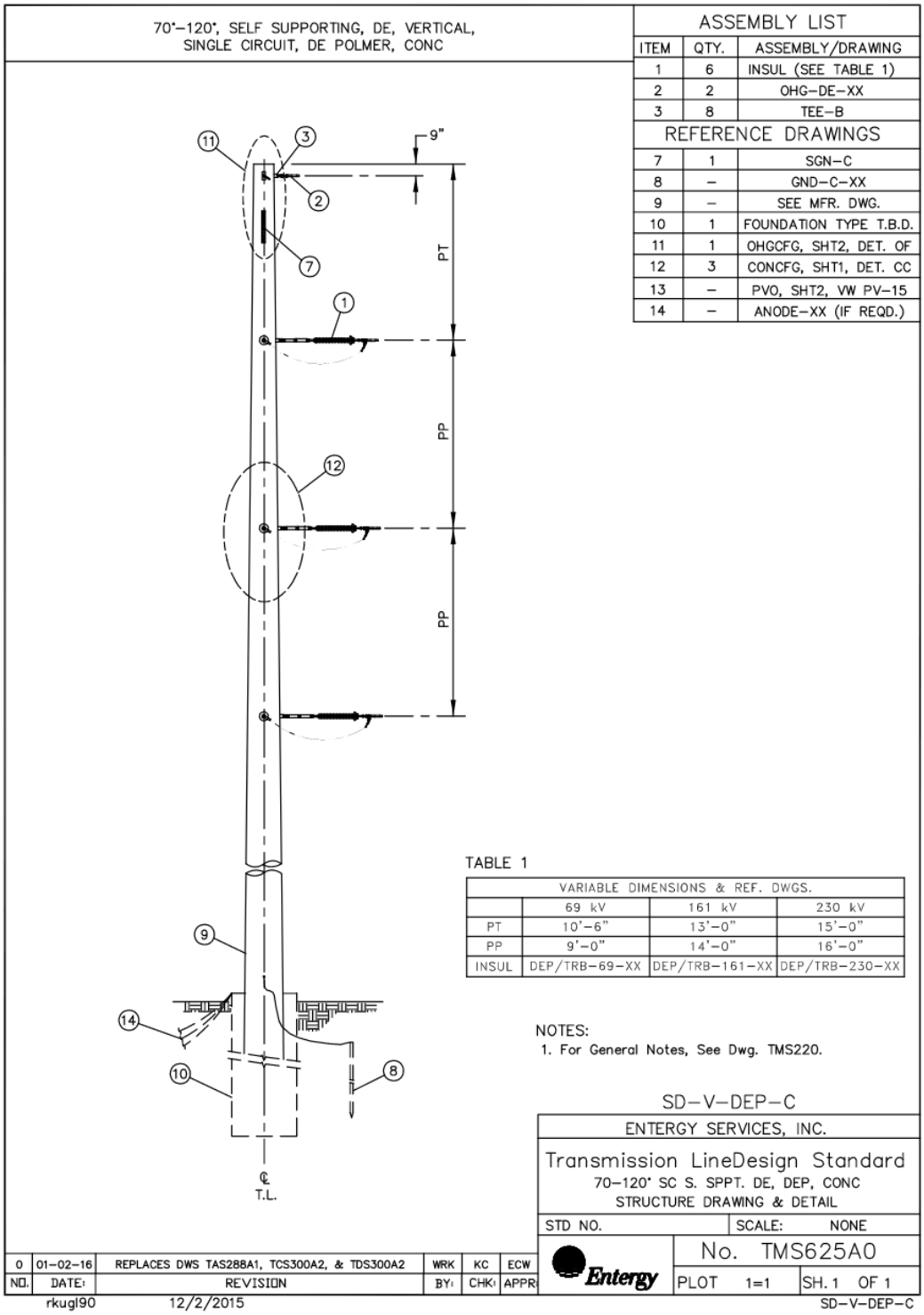
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

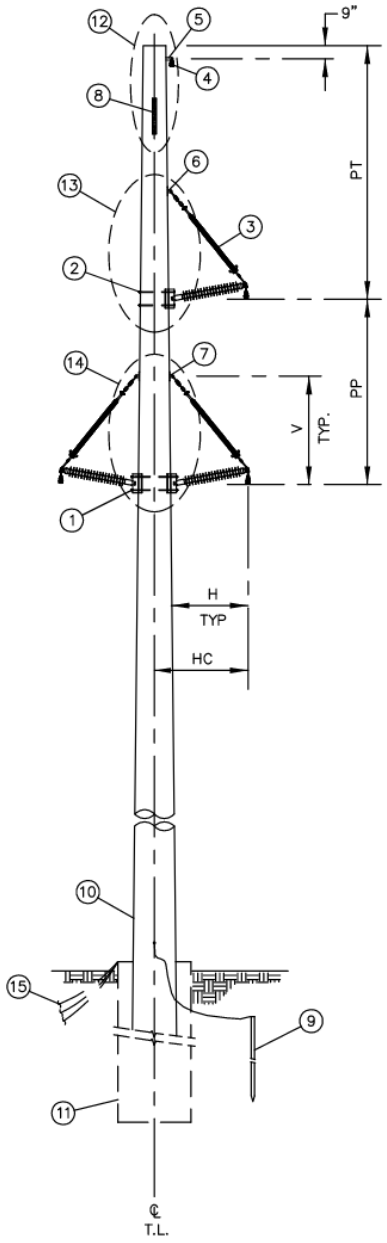


## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

0°–1.5°, DELTA, SINGLE CIRCUIT, BRACED POST 2–1/2", CONC.




| ASSEMBLY LIST | | |
|---|---|---|
| ITEM | QTY. | ASSEMBLY/DRAWING |
| 1 | 1 | BLT–2P–C |
| 2 | 1 | BLT–P–C |
| 3 | 3 | INSUL (SEE TABLE 1) |
| 4 | 1 | OHG–SUS–XX |
| 5 | 1 | TEE–OHG–SUS |
| 6 | 1 | TEE–B |
| 7 | 1 | TEE–B–B |
| REFERENCE DRAWINGS | | |
| 8 | 1 | SGN–C |
| 9 | – | GND–C–XX |
| 10 | – | SEE MFR. DWG. |
| 11 | 1 | FOUNDATION TYPE T.B.D. |
| 12 | 1 | OHGCFG, SHT1, DET. OA |
| 13 | 1 | CONCFG, SHT3, DET. CR |
| 14 | 1 | CONCFG, SHT3, DET. CQ |
| 15 | – | ANODE–XX (IF REQD.) |

NOTES:
1) For General Notes, See Dwg. TMS220.

TABLE 1

| VARIABLE DIMENSIONS & REF. DWGS. | | | |
|---|---|---|---|
| | 69 kV | 161 kV | 230 kV |
| PT | 10'–6" | 15'–0" | 19'–0" |
| PP | 8'–0" | 13'–0" | 14'–0" |
| V | 6'–8" | 8'–6" | 9'–10" |
| H | 5'–0" | 6'–4" | 7'–10" |
| HC | 6'–0" | 7'–2" | 9'–0" |
| INSUL | BP2–69–XX | BP2–161–XX | BP2–230–XX |

A–D–BP2–C

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
0–1.5° SC Delta, BP2, Conc
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: 1"=1"

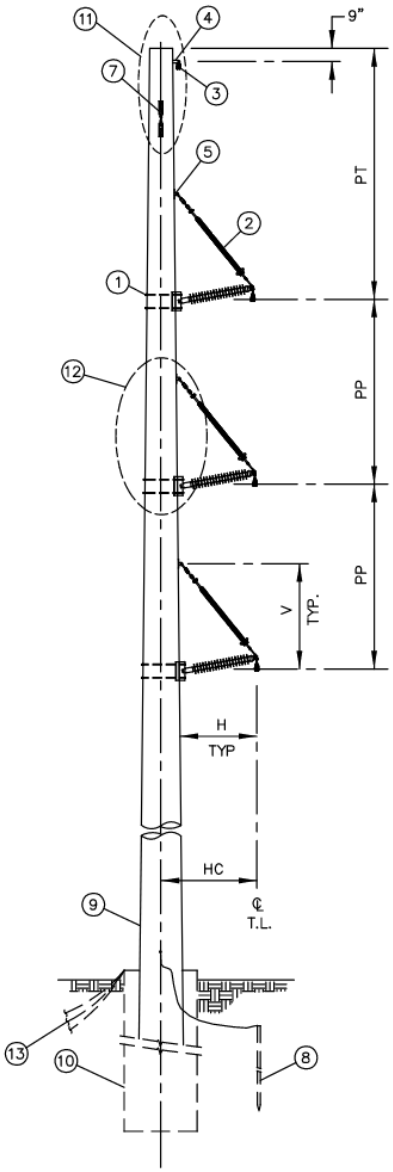
Entergy | No. TMS236A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 0 | 01–02–16 | REPLACES DWS TAS402A1, TCS459A2, & TDS200A2 | WRK | KC | ECW |

rkugl90 12/8/2015 A–D–BP2–C

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

6'–20', SELF SUPPORTING, VERTICAL, SINGLE CIRCUIT,
BRACED POST 2–1/2", CONC




| ASSEMBLY LIST | | |
|---|---|---|
| ITEM | QTY. | ASSEMBLY/DRAWING |
| 1 | 3 | BLT–P–C |
| 2 | 3 | INSUL (SEE TABLE 1) |
| 3 | 1 | OHG–SUS–XX |
| 4 | 1 | TEE–OHG–SUS |
| 5 | 3 | TEE–B |
| 6 | | |
| REFERENCE DRAWINGS | | |
| 7 | 1 | SGN–C |
| 8 | – | GND–C–XX |
| 9 | – | SEE MFR. DWG. |
| 10 | 1 | FOUNDATION TYPE T.B.D. |
| 11 | 1 | OHGCFG, SHT1, DET. OA |
| 12 | 3 | CONCFG, SHT3, DET. CR |
| 13 | – | ANODE–XX (IF REQD.) |

TABLE 1

| VARIABLE DIMENSIONS & REF. DWGS. | | | |
|---|---|---|---|
| | 69 kV | 161 kV | 230 kV |
| PT | 10'–6" | 15'–0" | 19'–0" |
| PP | 8'–0" | 13'–0" | 14'–0" |
| V | 6'–8" | 8'–6" | 9'–10" |
| H | 5'–0" | 6'–4" | 7'–10" |
| HC | 6'–0" | 7'–2" | 9'–0" |
| INSUL | BP2–69–XX | BP2–161–XX | BP2–230–XX |

NOTES:
1. For General Notes, See Dwg. TMS220.
2. Line post adapters are required where line angles greater than 3°, or phase transitions pull suspension hardward toward the pole. See Dwg. TMD415 for additional materials.

SC–V–BP2–C

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
6–20° SC VERT, BP2, CONC
STRUCTURE DRAWING & DETAIL

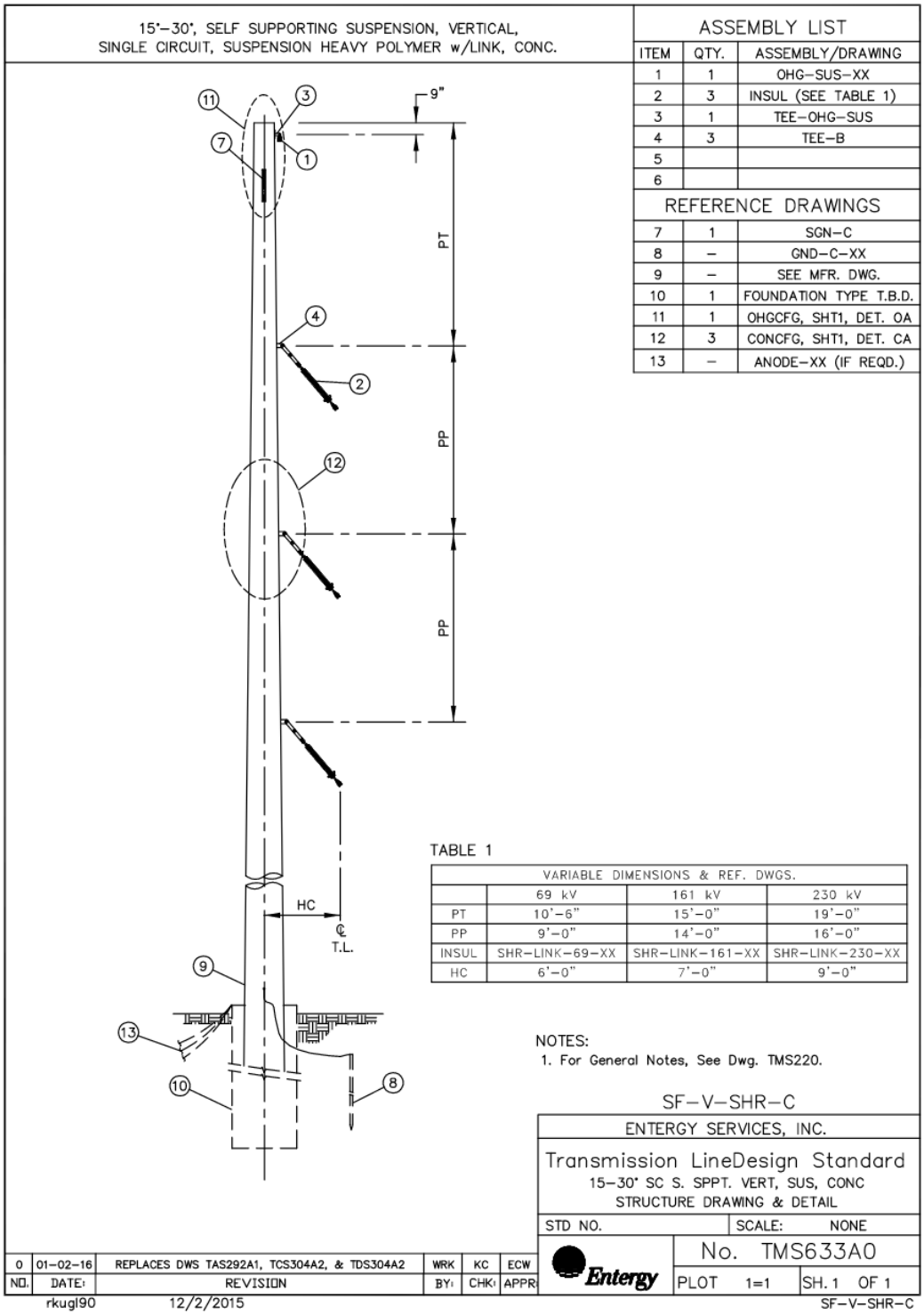
STD NO. | SCALE: NONE

Entergy | No. TMS588A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 01–02–16 | REPLACES DWS TAS458A0, TCS285A2, & TDS283A2 | WRK | KC | ECW |

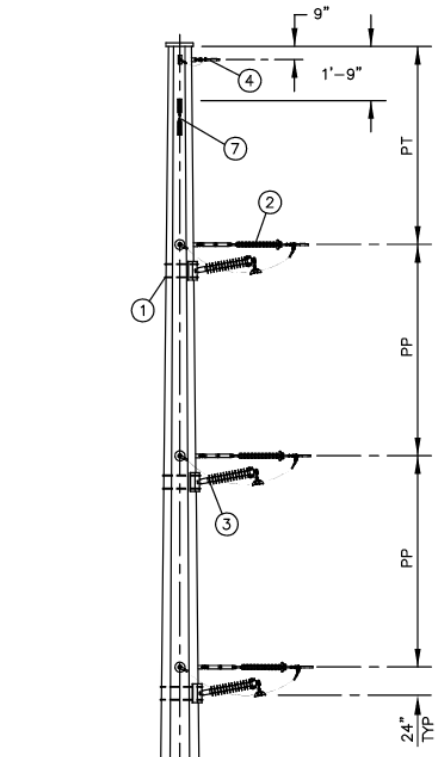
rkugl90 12/2/2015 SC–V–BP2–C

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

0°–5°, SELF SUPPORTING, DE, JUMPER, VERTICAL, SINGLE CIRCUIT, DE POLYMER, STEEL




ASSEMBLY LIST

| ITEM | QTY. | ASSEMBLY/DRAWING |
|---|---|---|
| 1 | 3 | BLT–P–S |
| 2 | 6 | INSUL (SEE TABLE 1) |
| 3 | 3 | INSUL2 (SEE TABLE 1) |
| 4 | 2 | OHG–DE–XX |
| REFERENCE DRAWINGS | | |
| 7 | 1 | SGN–S |
| 8 | – | GND–S–XX |
| 9 | – | SEE MFR. DWG. |
| 10 | 1 | FOUNDATION TYPE T.B.D. |
| 11 | – | PVO, SHT 1, VW PV–19 |
| 12 | – | ANODE–XX (IF REQ.) |

TABLE 1

| VARIABLE DIMENSIONS & REF. DWGS. | | | |
|---|---|---|---|
| | 69 kV | 161 kV | 230 kV |
| PT | 10'–6" | 13'–0" | 15'–0" |
| PP | 9'–0" | 14'–0" | 16'–0" |
| INSUL | DEP/TRB–69–XX | DEP/TRB–161–XX | DEP/TRB–230–XX |
| INSUL2 | JLP–69–XX | JLP–161–XX | JLP–230–XX |

NOTES:
1. For General Notes, See Dwg. TMS220.

SDJA–V–DEP–S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
0–5° SC S. SPPT. DE, DEP W/J, STL
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

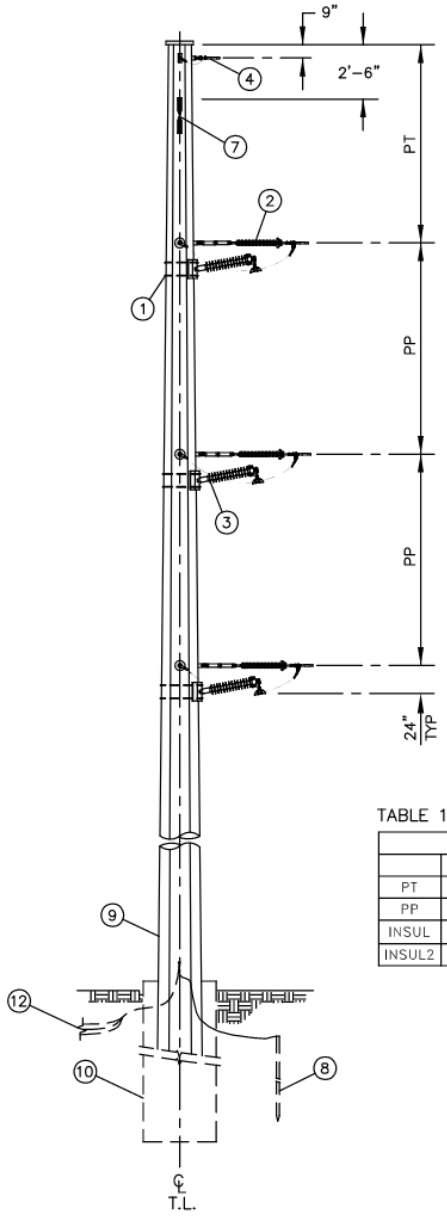
Entergy | No. TMS642A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 0 | 01–02–16 | REPLACES DWS TAS528A0, TCS629A1, & TDS559A1 | WRK | KC | ECW |

rkugl90 12/2/2015 SDJA–V–DEP–S

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

5'–70', SELF SUPPORTING, DE, JUMPER, VERTICAL,
SINGLE CIRCUIT, DE POLYMER, STEEL




ASSEMBLY LIST

| ITEM | QTY. | ASSEMBLY/DRAWING |
|---|---|---|
| 1 | 3 | BLT–P–S |
| 2 | 6 | INSUL (SEE TABLE 1) |
| 3 | 3 | INSUL2 (SEE TABLE 1) |
| 4 | 2 | OHG–DE–XX |
| REFERENCE DRAWINGS | | |
| 7 | 1 | SGN–S |
| 8 | – | GND–S–XX |
| 9 | – | SEE MFR. DWG. |
| 10 | 1 | FOUNDATION TYPE T.B.D. |
| 11 | – | PVO, SHT 1, VW PV–19 |
| 12 | – | ANODE–XX (IF REQ.) |

TABLE 1

| VARIABLE DIMENSIONS & REF. DWGS. | | | |
|---|---|---|---|
| | 69 kV | 161 kV | 230 kV |
| PT | 10'–6" | 13'–0" | 15'–0" |
| PP | 9'–0" | 14'–0" | 16'–0" |
| INSUL | DEP/TRB–69–XX | DEP/TRB–161–XX | DEP/TRB–230–XX |
| INSUL2 | JLP–69–XX | JLP–161–XX | JLP–230–XX |

NOTES:
1. For General Notes, See Dwg. TMS220.

SDJ–V–DEP–S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
5–70' SC S. SPPT. DE, DEP W/J, STL
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

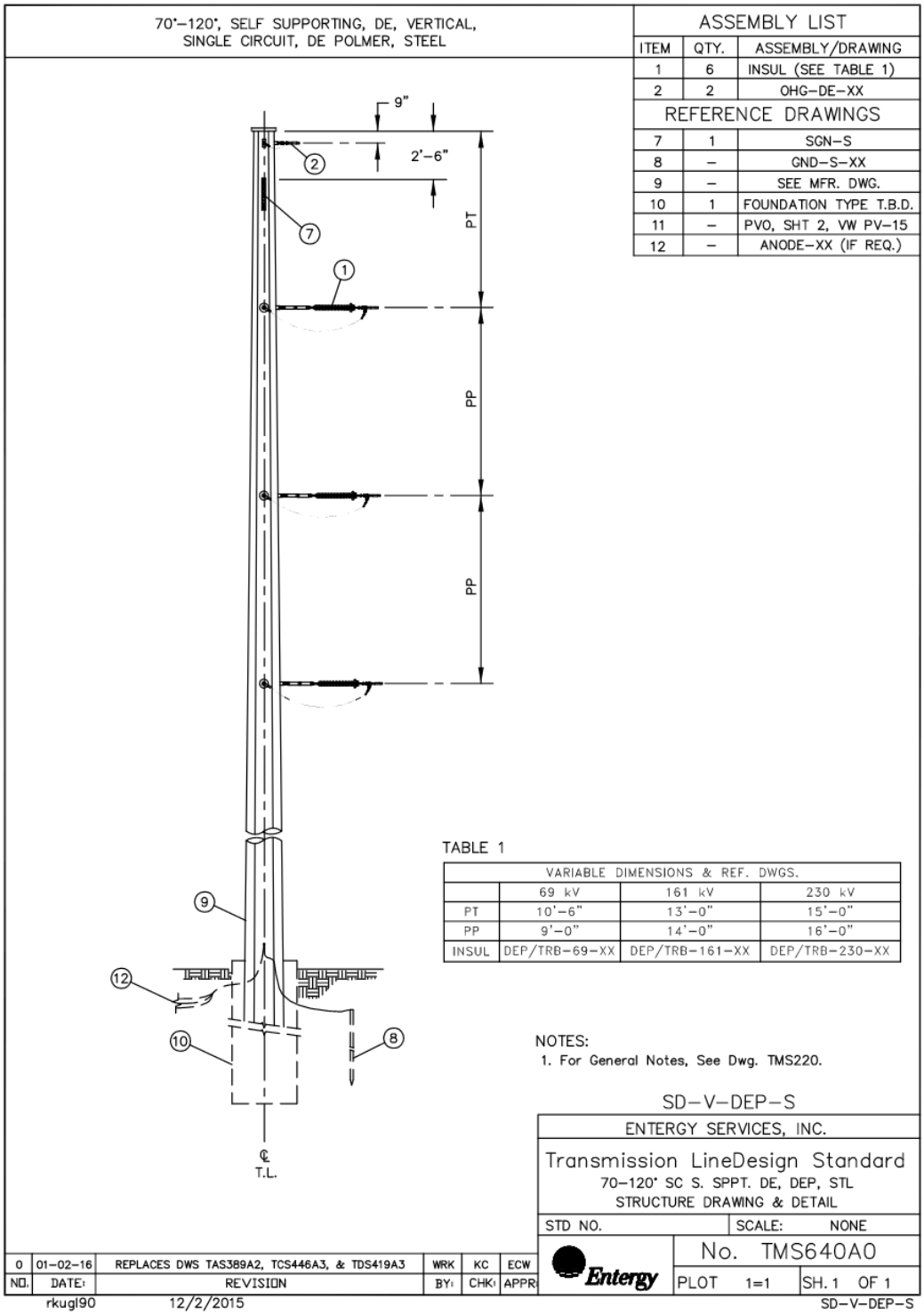
Entergy | No. TMS641A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR |
|---|---|---|---|---|---|
| 0 | 01–02–16 | REPLACES DWS TAS387A3, TCS444A4, & TDS417A4 | WRK | KC | ECW |

rkugl90 12/2/2015 SDJ–V–DEP–S

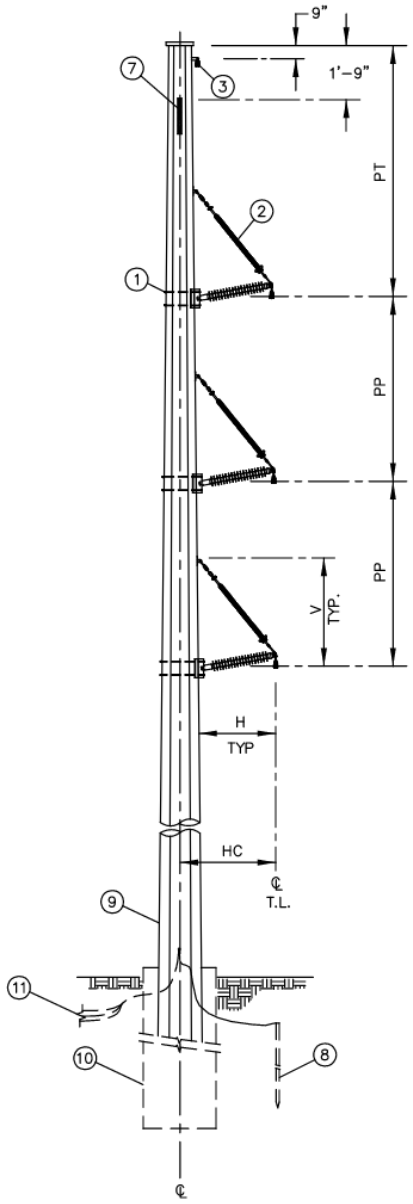
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

0°–1.5°, VERTICAL, SINGLE CIRCUIT, BRACED POST 2–1/2", STEEL




| ASSEMBLY LIST | | |
|---|---|---|
| ITEM | QTY. | ASSEMBLY/DRAWING |
| 1 | 3 | BLT–P–S |
| 2 | 3 | SEE INSUL TABLE 1 |
| 3 | 1 | OHG–SUS–XX |
| 4 | | |
| 5 | | |
| 6 | | |
| REFERENCE DRAWINGS | | |
| 7 | 1 | SGN–S |
| 8 | – | GND–S–XX |
| 9 | – | SEE MFR. DWG. |
| 10 | 1 | FOUNDATION TYPE T.B.D. |
| 11 | – | ANODE–XX (IF REQ.) |

NOTES:
1) For General Notes, See Dwg. TMS220.

TABLE 1

| VARIABLE DIMENSIONS & REF. DWGS. | | | |
|---|---|---|---|
| | 69 kV | 161 kV | 230 kV |
| PT | 10'–6" | 15'–0" | 19'–0" |
| PP | 8'–0" | 13'–0" | 14'–0" |
| V | 6'–8" | 8'–6" | 9'–10" |
| H | 5'–0" | 6'–4" | 7'–10" |
| HC | 6'–0" | 7'–2" | 9'–0" |
| INSUL | BP2–69–XX | BP2–161–XX | BP2–230–XX |

A–V–BP2–S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
0–1.5° SC Vert, BP2, Stl
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

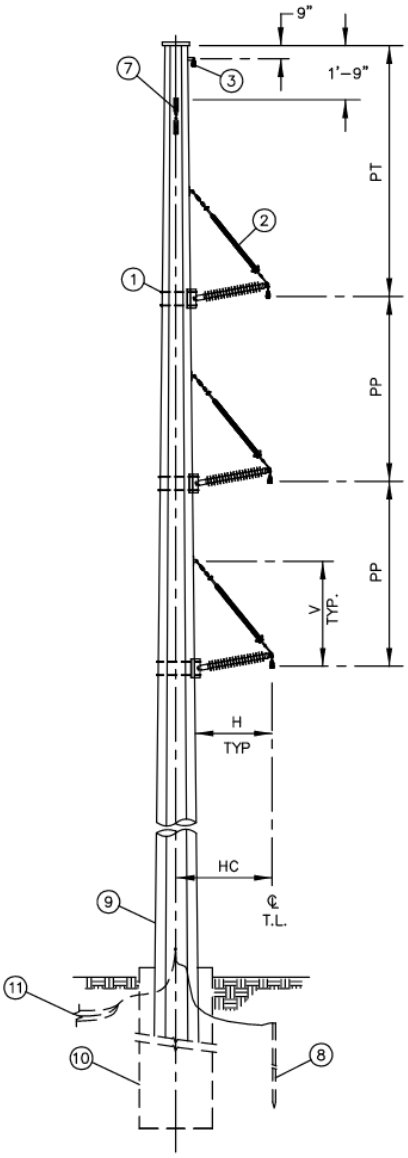
Entergy | No. TMS277A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 0 | 01–02–16 | Replaces Dws TAS411A1, TCS335A2, & TDS323A2 | WRK | KC | ECW |

rkugl90 12/3/2015 A–V–BP2–S

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

6'–20', VERTICAL, SELF SUPPORTING, SINGLE CIRCUIT,
BRACED POST 2–1/2", STEEL




| ASSEMBLY LIST | | |
|---|---|---|
| ITEM | QTY. | ASSEMBLY/DRAWING |
| 1 | 3 | BLT–P–S |
| 2 | 3 | INSUL (SEE TABLE 1) |
| 3 | 1 | OHG–SUS–XX |
| 4 | | |
| 5 | | |
| 6 | | |
| REFERENCE DRAWINGS | | |
| 7 | 1 | SGN–S |
| 8 | – | GND–S–XX |
| 9 | – | SEE MFR. DWG. |
| 10 | 1 | FOUNDATION TYPE T.B.D. |
| 11 | – | ANODE–XX (IF REQ.) |

TABLE 1

| VARIABLE DIMENSIONS & REF. DWGS. | | | |
|---|---|---|---|
| | 69 kV | 161 kV | 230 kV |
| PT | 10'–6" | 15'–0" | 19'–0" |
| PP | 8'–0" | 13'–0" | 14'–0" |
| V | 6'–8" | 8'–6" | 9'–10" |
| H | 5'–0" | 6'–4" | 7'–10" |
| HC | 6'–0" | 7'–2" | 9'–0" |
| INSUL | BP2–69–XX | BP2–161–XX | BP2–230–XX |

NOTES:
1. For General Notes, See Dwg. TMS220.
2. Line post adapters are required where line angles greater than 3°, or phase transitions pull suspension hardward toward the pole. See Dwg. TMD415 for additional materials.

SC–V–BP2–S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
6–20° SC VERT, BP2, STL
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

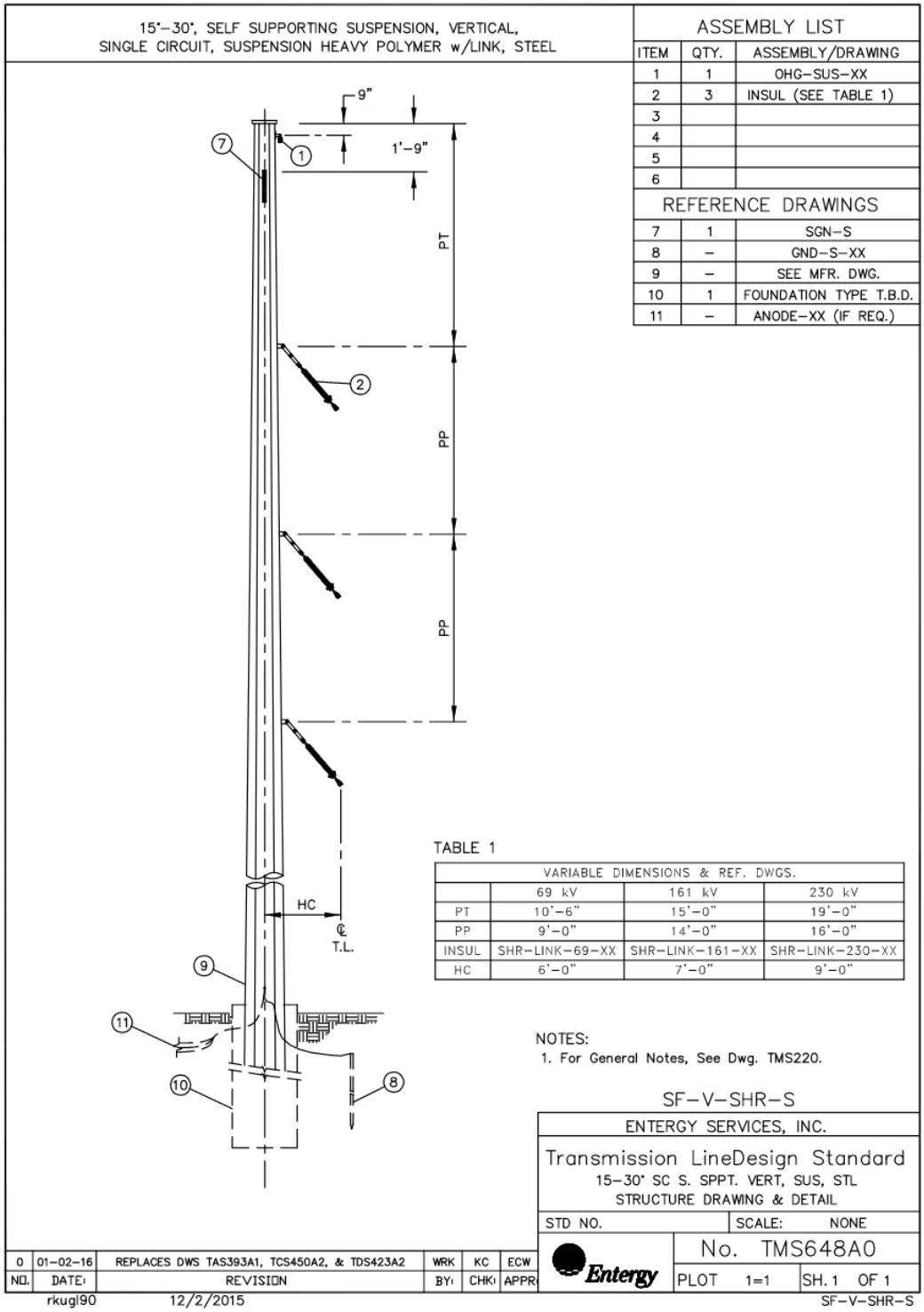
No. TMS606A0

PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 01–02–16 | REPLACES DWS TAS465A0, TCS431A2, & TDS402A2 | WRK | KC | ECW |

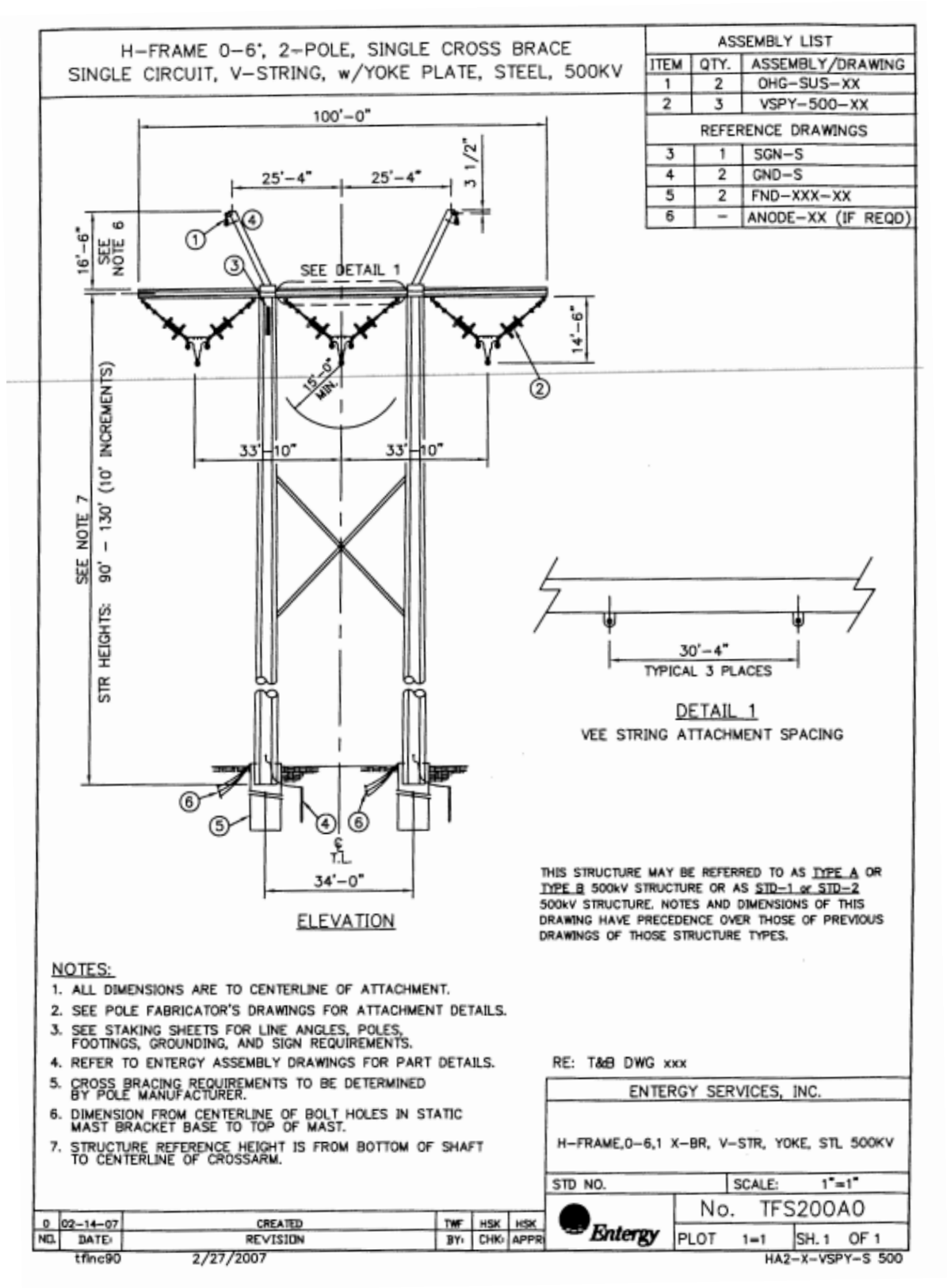
rkugl90 12/2/2015 SC–V–BP2–S

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

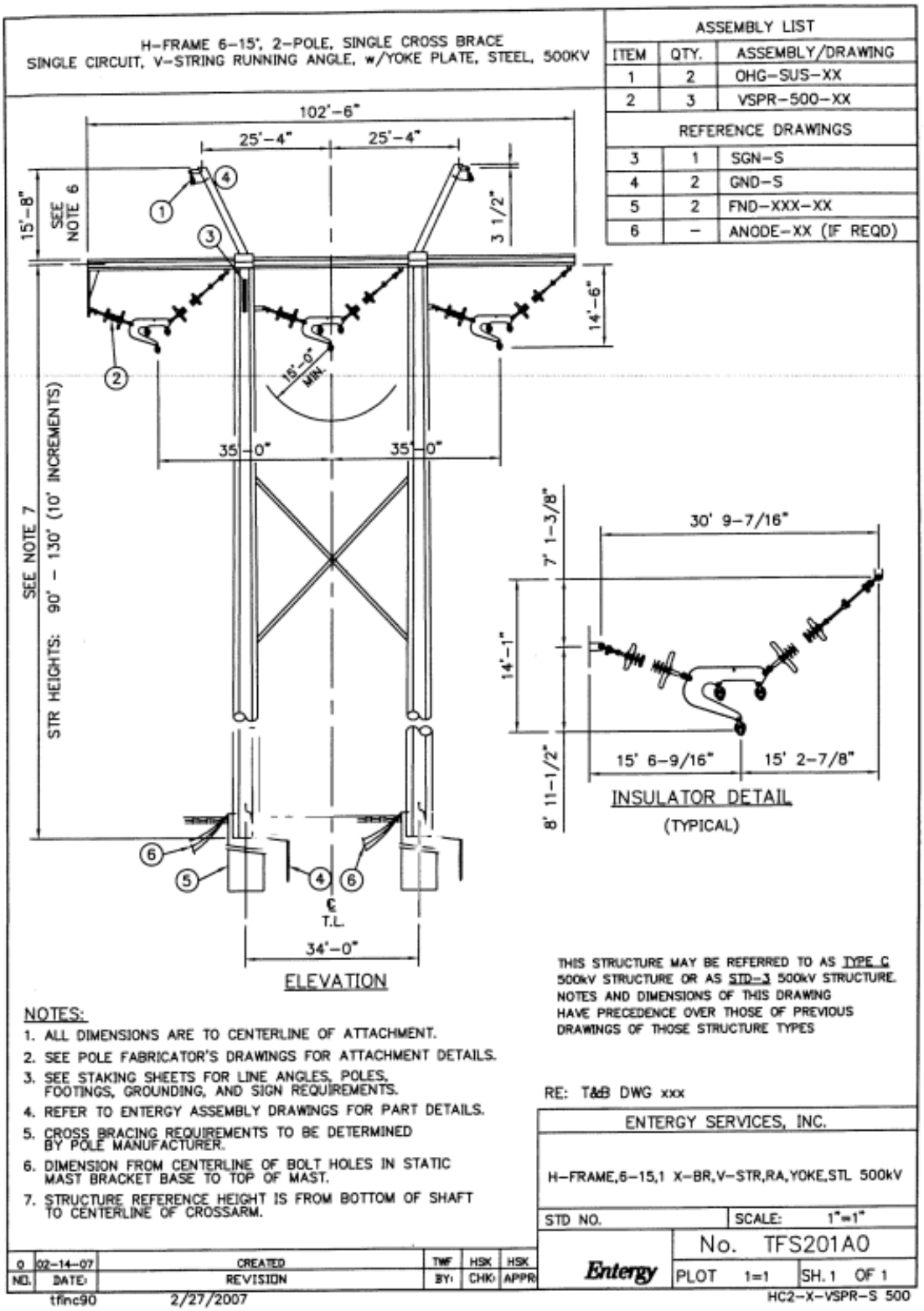


# Appendix 2: High Voltage Overhead Transmission

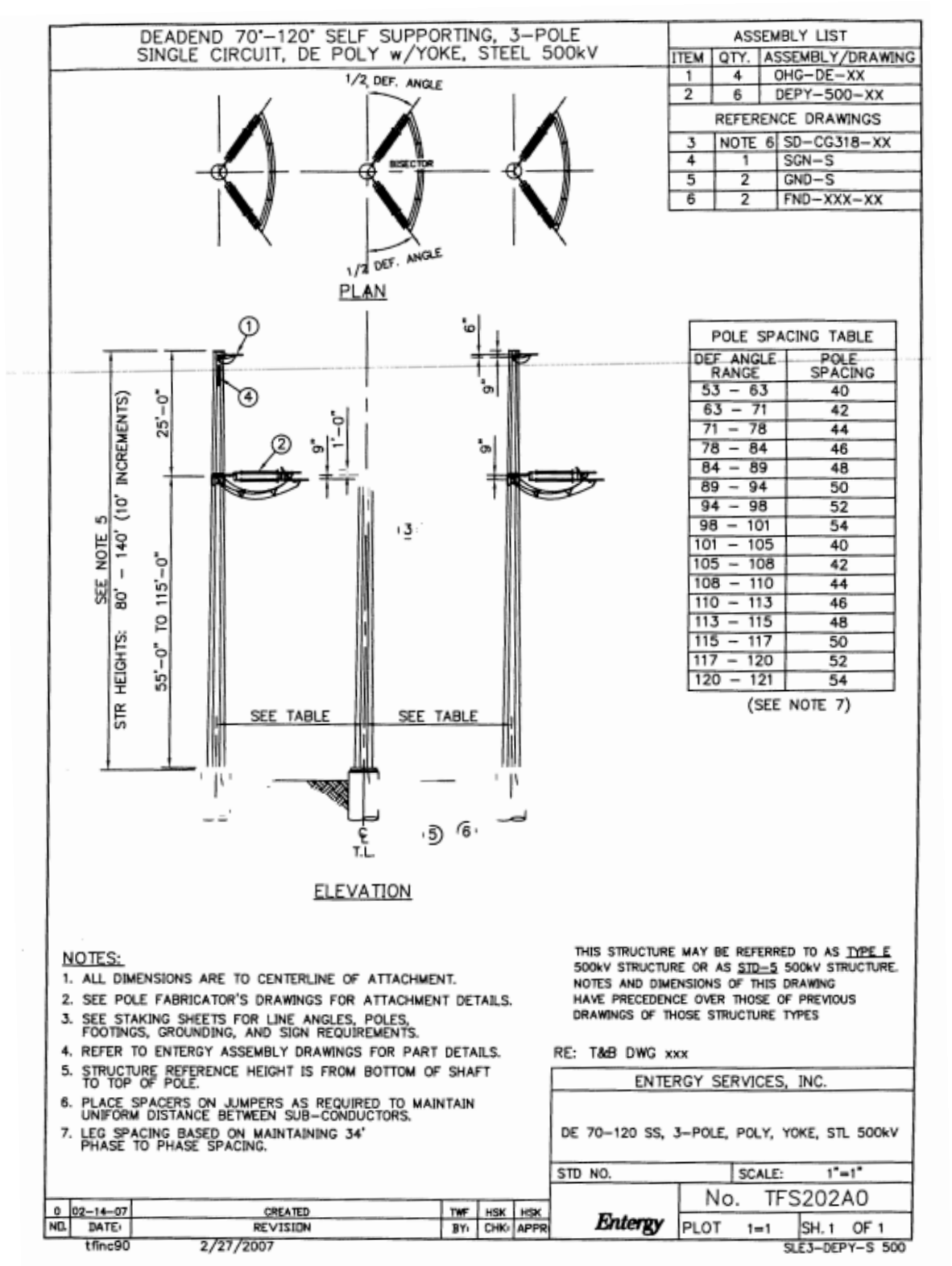
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



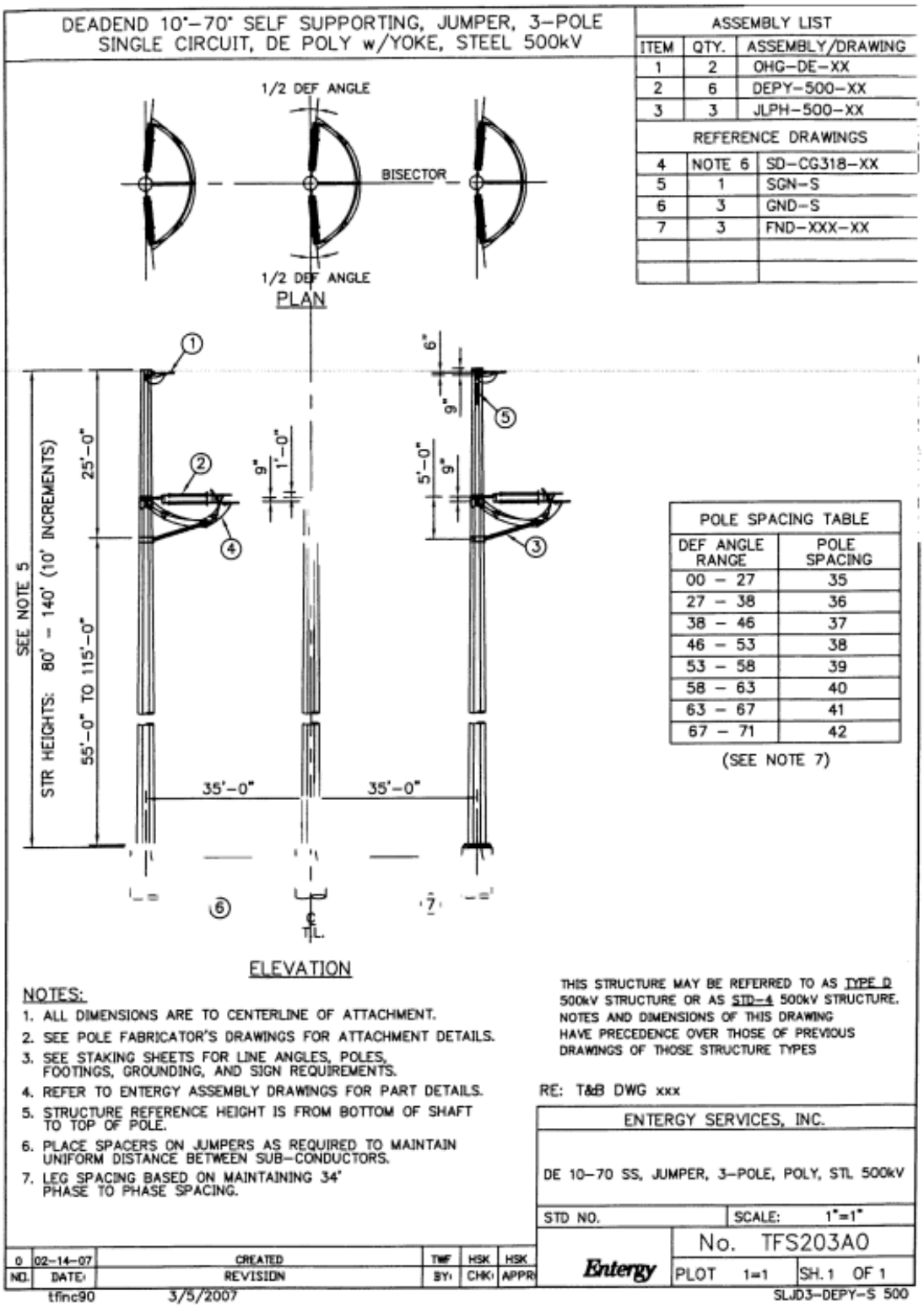
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

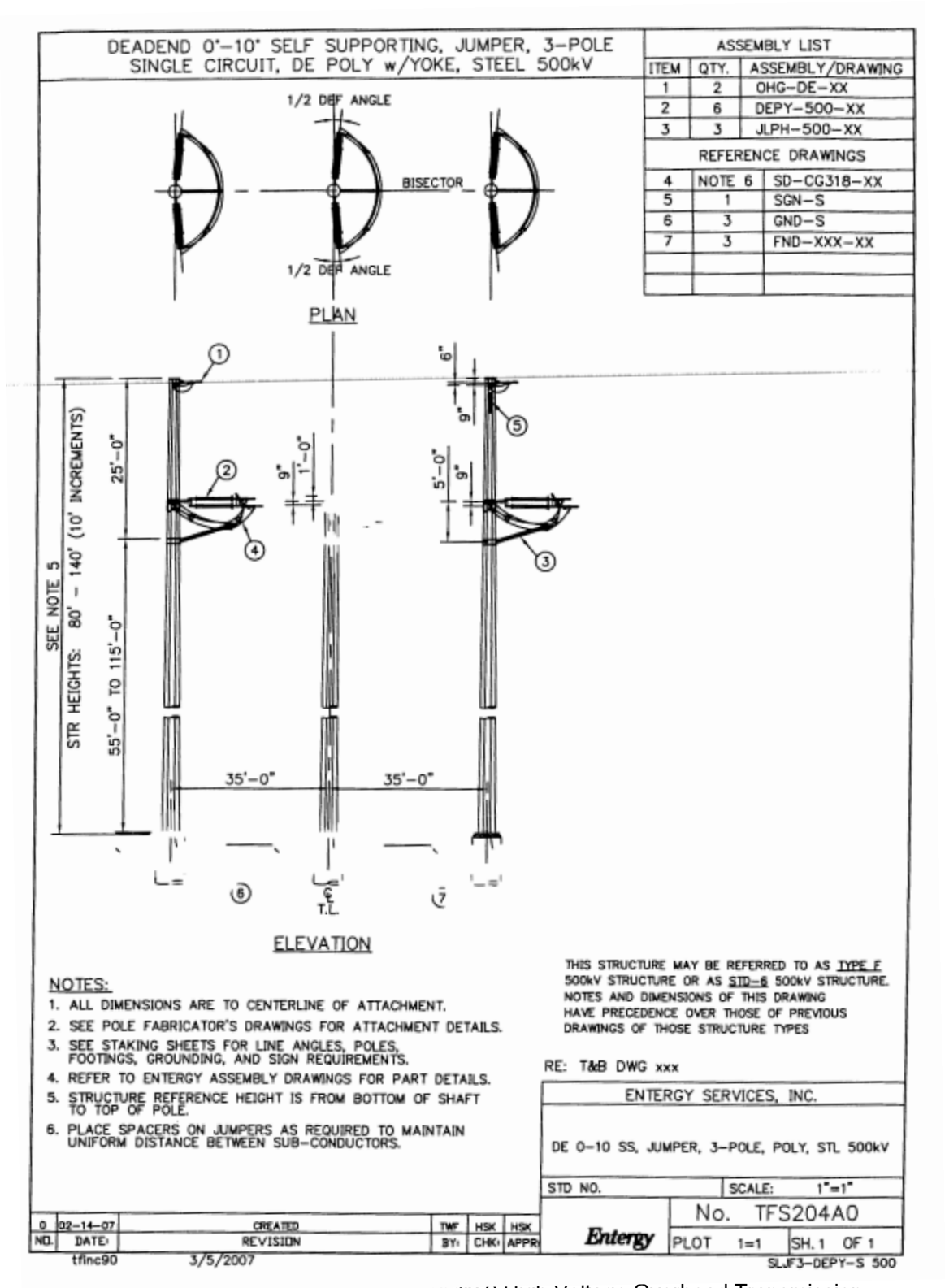


## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



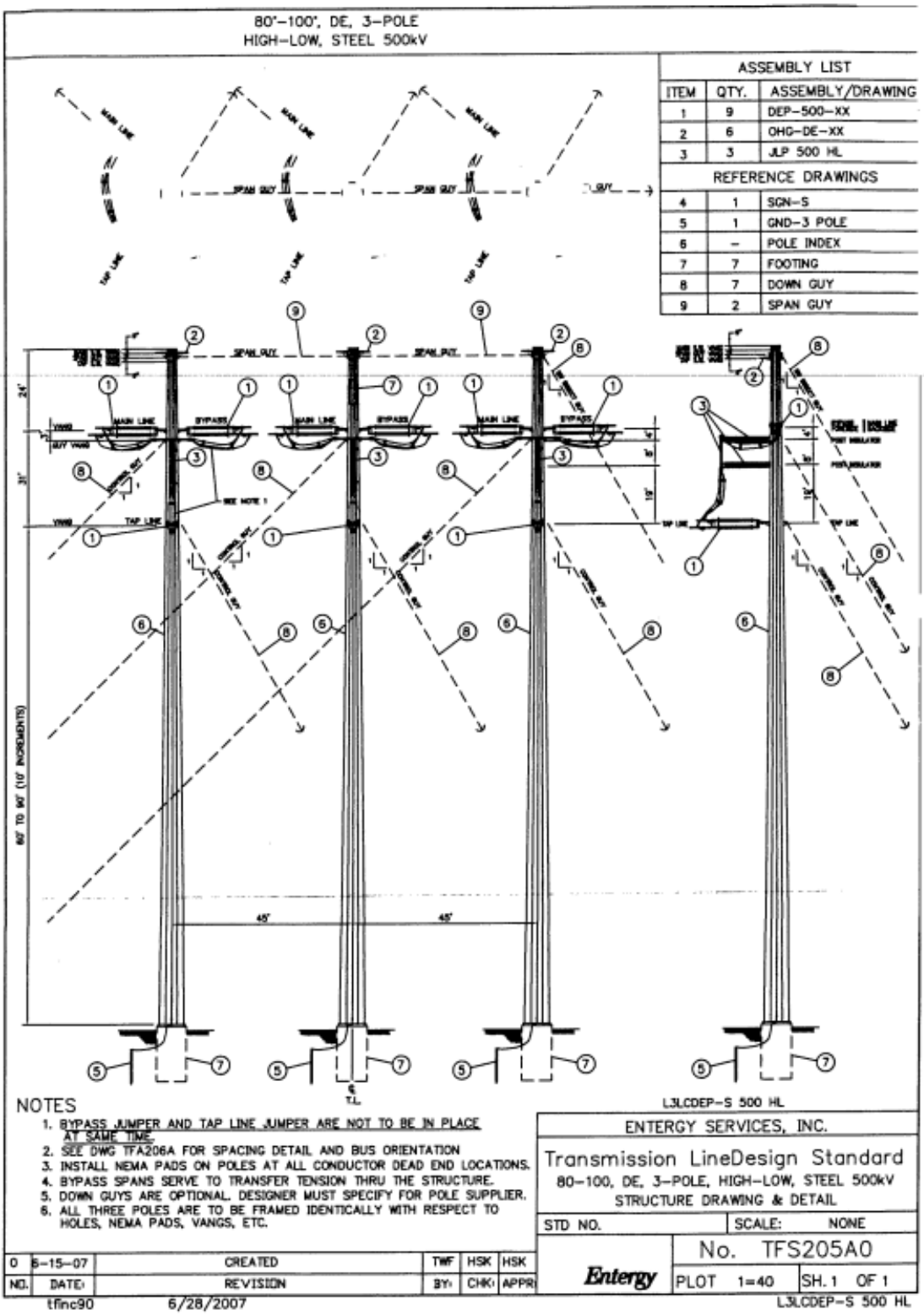
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



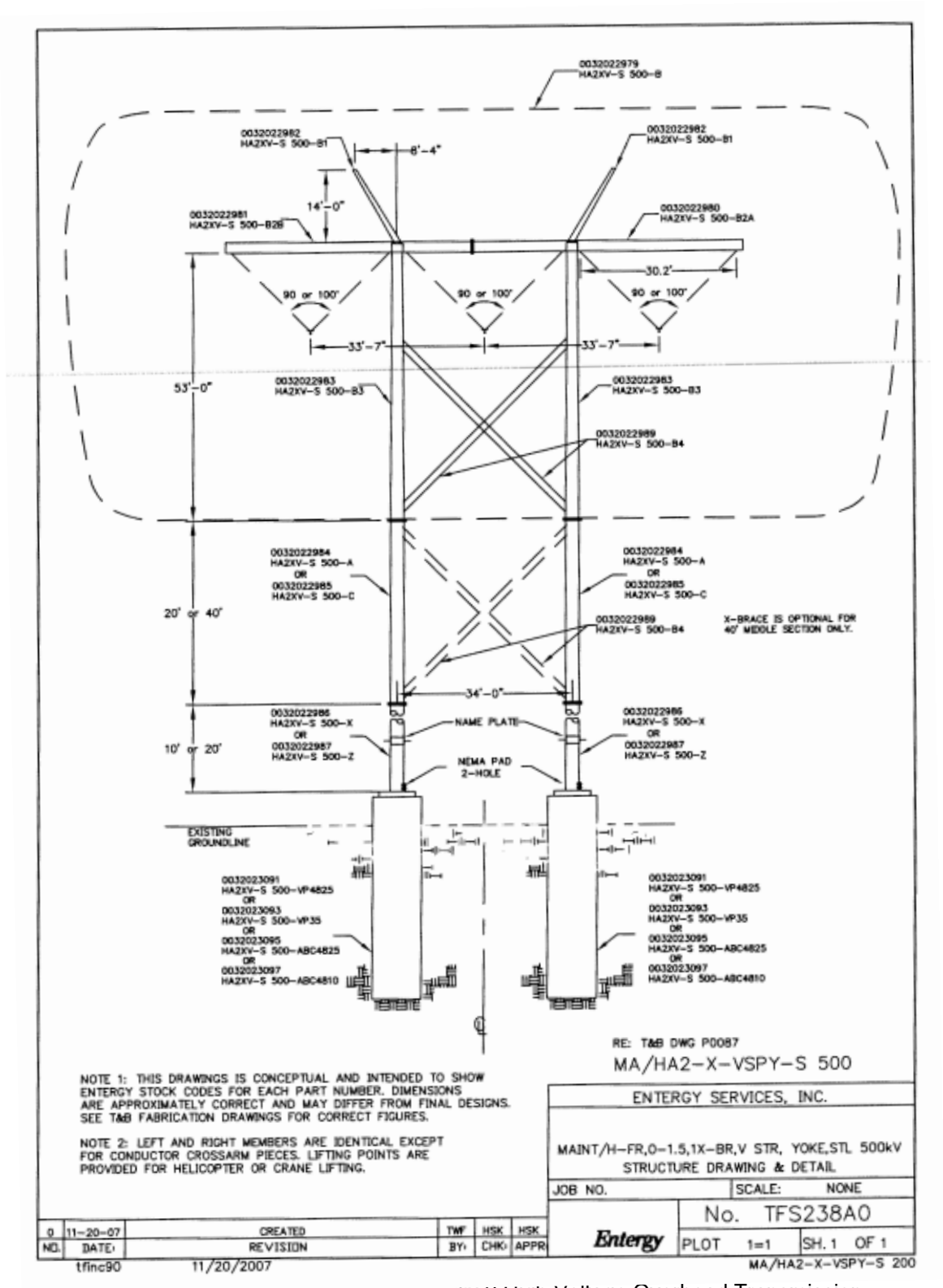
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 | CASE 5 | CASE 6 |
|---|---|---|---|---|---|---|---|
| SHIELDWIRE | T1 | 1760 | 820 | 1859 | 213 | 213 | 213 |
| | V1 | 1343 | 3218 | 557 | 557 | 557 | 557 |
| | L1 | 0 | 0 | 0 | 0 | 2036 | 0 |
| CONDUCTOR | T2 | 9241 | 4278 | 12161 | 1540 | 1540 | 1540 |
| | V2 | 10295 | 16327 | 5015 | 5015 | 5015 | 5015 |
| | L2 | 0 | 0 | 0 | 0 | 0 | 14709 |
| WIND ON STRUCTURE | W | 10 | 0 | 25.6 | 0 | 0 | 0 |
| STRUCTURE WEIGHT | VS | TO BE DETERMINED BY T&B | | | | | |
| LINEMAN & EQUIP. WEIGHT | V3 | 500 | | | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)
CONDUCTOR LOADS ARE TOTAL PER PHASE
(SEE ADDITIONAL CASE 7 BELOW)

### WIRE DATA:

SHIELDWIRE (SEE NOTE 7)

24 FIBER OPGW (GW2400 – 64 mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15°F MAX TENSION 7833 LBS INITIAL
EVERYDAY CONDITION, 60°F TENSION 2036 LBS INITIAL

7#7 ALLUMOWELD
DIA=0.433", WT=0.330 LBS/FT, RTS=19,060 LBS
1" RADIAL ICE, 15°F MAX TENSION 7328 LBS INITIAL
EVERYDAY CONDITION, 60°F TENSION 1740 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" RADIAL ICE, 15°F MAX TENSION 13623 LBS INITIAL(SUB COND)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB COND)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND,15° F. OLF=1.0

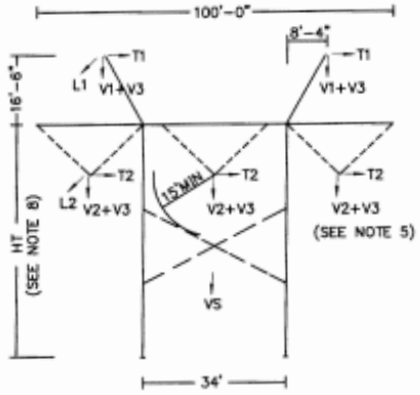
CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

CASE 4 – PRECAMBER: NO WIND, NO ICE, 60° F. OLF=1.0

CASE 5 – BROKEN SHIELDWIRE: NO WIND, NO ICE, 60° F. OLF=1.0

CASE 6 – BROKEN PHASE: NO WIND, NO ICE, 60° F. OLF=1.0

CASE 7 – 25.6 PSF LONG. WIND ON STR. W/O WIRES, OLF=1.0




LOAD TREE 500KV

### SPAN DATA:

WIND SPAN = 1200' at 6° Line Angle – 1600' at 0° Line Angle
WEIGHT SPAN = 1400 FEET
RULING SPAN = 1000 FEET

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T), AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRE AND TRANSVERSE COMPONENT OF THE TENSION DUE TO THE LINE ANGLE.
4. V1 INCLUDES 50 POUNDS FOR EACH SHIELDWIRE ASSEMBLY. V2 INCLUDES 500 POUNDS FOR EACH INSULATOR ASSEMBLY.
5. V3 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. STRUCTURES TO BE DESIGNED FOR MAX OF EITHER 1200' WIND SPAN AT 6° LINE ANGLE OR 1600' WIND SPAN AT 0° LINE ANGLE. ABOVE TABLE REFLECTS CONTROLLING CONFIGURATION FOR EACH LOADING CONDITION. (6° CONTROLS ALL CASES)
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO (2) SHIELD WIRES (FIBER OR 7#7 – ONE PER PEAK). ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLS THE DESIGN
8. STR. REF. HT. IS FROM BOTTOM OF SHAFT TO CL OF CROSSARM. DESIGN STRUCTURE FOR 90' TO 130' HTS. IN 10' INCREMENTS.
9. PROVIDE BASE PLATE DESIGN FOR EACH STRUCTURE.
10. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
11. PROVIDE BASE PLATED PILE DESIGN (DIAMETER & THICKNESS) FOR EACH STRUCTURE (BASED ON 4 FT PILE REVEAL).
12. SEE DRAWING STD-2 FOR STRUCTURE FRAMING.

HA2-X-VSPY-S 500 SK2

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
LOAD TREE, H-FRAME, 0°-6°, 90'-130'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

Entergy | No. TFS239A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007 HA2-X-VSPY-S 500; SK2

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 | CASE 5 | CASE 6 |
|---|---|---|---|---|---|---|---|
| SHIELDWIRE | T1 | 2682 | 2045 | 2392 | 532 | 652 | 532 |
| | V1 | 1343 | 3218 | 557 | 557 | 557 | 557 |
| | L1 | 0 | 0 | 0 | 0 | 5000 | 0 |
| CONDUCTOR | T2 | 14752 | 10669 | 15472 | 3840 | 3840 | 3604 |
| | V2 | 10295 | 16327 | 5015 | 5015 | 5015 | 5015 |
| | L2 | 0 | 0 | 0 | 0 | 0 | 8000 |
| WIND ON STRUCTURE | W | 10 | 0 | 25.6 | 0 | 0 | 0 |
| STRUCTURE WEIGHT | VS | TO BE DETERMINED BY T&B | | | | | |
| LINEMAN & EQUIP. WEIGHT | V3 | 500 | | | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)
CONDUCTOR LOADS ARE TOTAL PER PHASE
(SEE ADDITIONAL CASE 7 BELOW)

### WIRE DATA:

SHIELDWIRE (SEE NOTE 7)

24 FIBER OPGW (GW2400 – 64 mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15°F MAX TENSION 7833 LBS INITIAL
EVERYDAY CONDITION, 60°F TENSION 2036 LBS INITIAL

7#7 ALLUMOWELD
DIA=0.433", WT=0.330 LBS/FT, RTS=19,060 LBS
1" RADIAL ICE, 15°F MAX TENSION 7328 LBS INITIAL
EVERYDAY CONDITION, 60°F TENSION 1740 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" RADIAL ICE, 15°F MAX TENSION 13623 LBS INITIAL(SUB COND)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB COND)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND,15° F. OLF=1.0

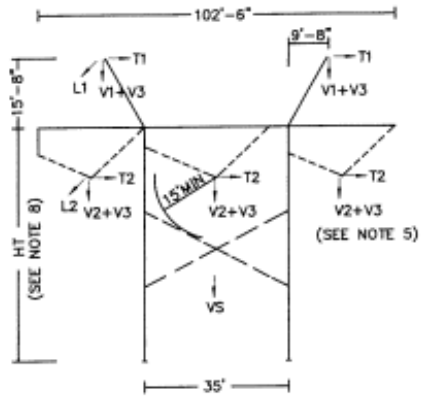
CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

CASE 4 – PRECAMBER: NO WIND, NO ICE, 60° F. OLF=1.0

CASE 5 – BROKEN SHIELDWIRE: NO WIND, NO ICE, 60° F. OLF=1.0

CASE 6 – UNBALANCED PHASE: NO WIND, NO ICE, 60° F. OLF=1.0

CASE 7 – 25.6 PSF LONG. WIND ON STR. W/O WIRES, OLF=1.0




LOAD TREE 500KV

### SPAN DATA:

WIND SPAN = 1000' at 15° Line Angle
WEIGHT SPAN = 1400 FEET
RULING SPAN = 1000 FEET

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T), AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRE AND TRANSVERSE COMPONENT OF THE TENSION DUE TO THE LINE ANGLE.
4. V1 INCLUDES 50 POUNDS FOR EACH SHIELDWIRE ASSEMBLY. V2 INCLUDES 500 POUNDS FOR EACH INSULATOR ASSEMBLY.
5. V3 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. STRUCTURES TO BE DESIGNED FOR 1000' WIND SPAN AT 15° LINE ANGLE. PROVIDE SPAN AND ANGLE CHART FOR 6° TO 14° LINE ANGLE.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO (2) SHIELD WIRES (FIBER OR 7#7 – ONE PER PEAK). ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLS THE DESIGN
8. STR. REF. HT. IS FROM BOTTOM OF SHAFT TO CL OF CROSSARM. DESIGN STRUCTURE FOR 90' TO 130' HTS. IN 10' INCREMENTS.
9. PROVIDE BASE PLATE DESIGN FOR EACH STRUCTURE.
10. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
11. PROVIDE BASE PLATED PILE DESIGN (DIAMETER & THICKNESS) FOR EACH STRUCTURE (BASED ON 4 FT PILE REVEAL).
12. SEE DRAWING STD-3 FOR STRUCTURE FRAMING.

HC2-X-VSPR-S 500 SK3

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
LOAD TREE, H-FRAME, 6°-15°, 90'-130'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

Entergy | No. TFS240A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007

HC2-X-VSPR-S 500; SK3

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 2468 | 2045 | 2111 | 532 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 13712 | 10669 | 13608 | 3840 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 1234 | 1022 | 1055 | 266 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 6933 | 7766 | 4808 | 2019 |
| | COND | T2 | 6856 | 5334 | 6804 | 1920 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 40218 | 40519 | 30442 | 14583 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V4 | 500 | | | |
| JUMPER INSULATOR WEIGHT | | V3 | 215 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND,15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

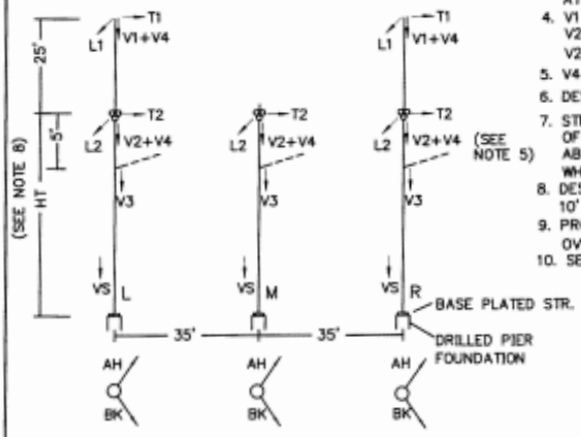
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S). V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT) V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V4 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-4 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3-POLE

SLE3-DEPY-S 500 SK4 (15)

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
LOAD TREE, DEADEND, 15°, SS, 55'-115'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

Entergy | No. TFS241A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007 SLE3-DEPY-S 500; SK4 (15)

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 3669 | 3391 | 2944 | 881 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 20682 | 17691 | 18884 | 6397 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 1835 | 1695 | 1472 | 441 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 6827 | 7647 | 4734 | 1988 |
| | COND | T2 | 10341 | 8846 | 9442 | 3184 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 39604 | 39900 | 29977 | 14360 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V4 | 500 | | | |
| JUMPER INSULATOR WEIGHT | | V3 | 215 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F, TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND, 15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

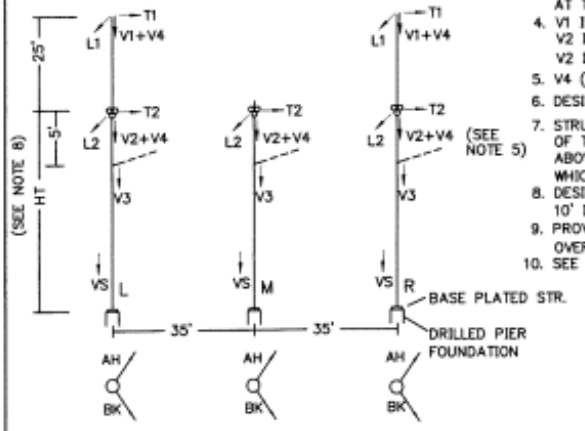
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S).
   V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT)
   V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V4 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-4 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3–POLE

SLE3–DEPY–S 500 SK4 (25)

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
LOAD TREE, DEADEND, 25°, SS, 55°–115°
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

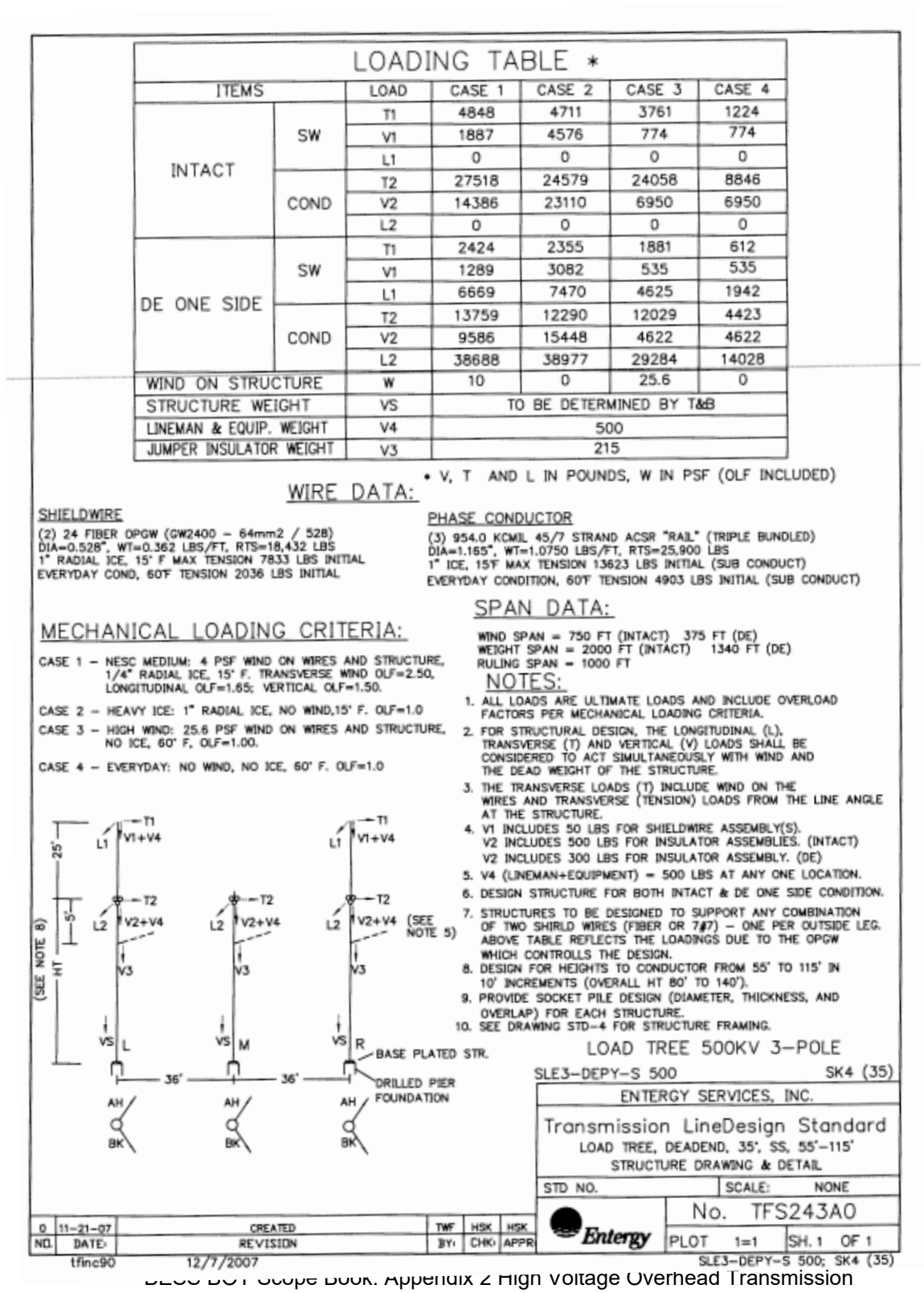
Entergy | No. TFS242A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11–21–07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007

SLE3–DEPY–S 500; SK4 (25)

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 4848 | 4711 | 3761 | 1224 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 27518 | 24579 | 24058 | 8846 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 2424 | 2355 | 1881 | 612 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 6669 | 7470 | 4625 | 1942 |
| | COND | T2 | 13759 | 12290 | 12029 | 4423 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 38688 | 38977 | 29284 | 14028 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V4 | 500 | | | |
| JUMPER INSULATOR WEIGHT | | V3 | 215 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 52B)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND, 15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S).
   V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT)
   V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V4 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIELD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-4 FOR STRUCTURE FRAMING.



LOAD TREE 500KV 3-POLE

SLE3-DEPY-S 500 SK4 (35)

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
LOAD TREE, DEADEND, 35°, SS, 55'-115'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

Entergy | No. TFS243A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007 SLE3-DEPY-S 500; SK4 (35)

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 5994 | 5995 | 4556 | 1558 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 34169 | 31280 | 29093 | 11258 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 2997 | 2998 | 2278 | 779 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 6460 | 7237 | 4480 | 1881 |
| | COND | T2 | 17085 | 15640 | 14546 | 5629 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 37477 | 37758 | 28368 | 13589 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V4 | 500 | | | |
| JUMPER INSULATOR WEIGHT | | V3 | 215 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND,15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

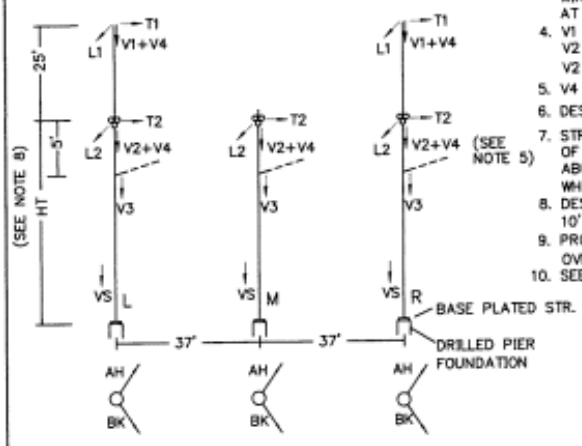
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S).
   V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT)
   V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V4 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-4 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3-POLE
SLE3-DEPY-S 500 SK4 (45)

ENTERGY SERVICES, INC.
Transmission LineDesign Standard
LOAD TREE, DEADEND, 45°, SS, 55'-115'
STRUCTURE DRAWING & DETAIL

| STD NO. | SCALE: NONE |
|---|---|
| Entergy | No. TFS244A0 |
| | PLOT 1=1 SH. 1 OF 1 |

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007

SLE3-DEPY-S 500; SK4 (45)

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 7100 | 7234 | 5323 | 1880 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 40584 | 37742 | 33948 | 13584 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 3550 | 3617 | 2661 | 940 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 6203 | 6948 | 4301 | 1806 |
| | COND | T2 | 20292 | 18871 | 16974 | 6792 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 35982 | 36251 | 27236 | 13047 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V4 | 500 | | | |
| JUMPER INSULATOR WEIGHT | | V3 | 215 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND, 15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

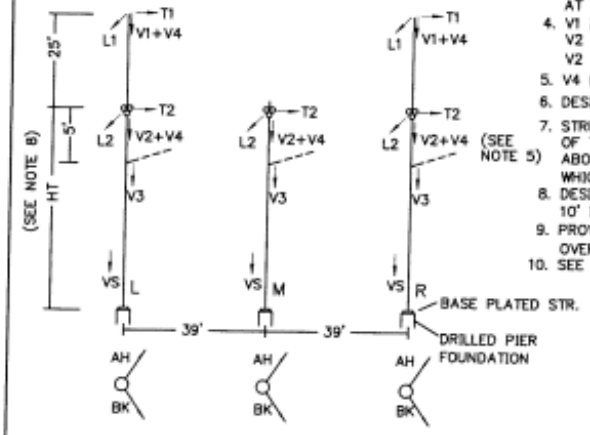
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S).
   V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT)
   V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V4 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-4 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3-POLE
SLE3-DEPY-S 500 SK4 (55)

ENTERGY SERVICES, INC.
Transmission LineDesign Standard
LOAD TREE, DEADEND, 55', SS, 55'-115'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE
No. TFS245A0
PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007

SLE3-DEPY-S 500; SK4 (55)

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 8157 | 8417 | 6056 | 2188 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 46713 | 43918 | 38588 | 15806 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 4078 | 4209 | 3028 | 1094 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 5898 | 6606 | 4090 | 1717 |
| | COND | T2 | 23357 | 21959 | 19294 | 7903 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 34212 | 34469 | 25896 | 12405 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V4 | 500 | | | |
| JUMPER INSULATOR WEIGHT | | V3 | 215 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 52B)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND, 15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

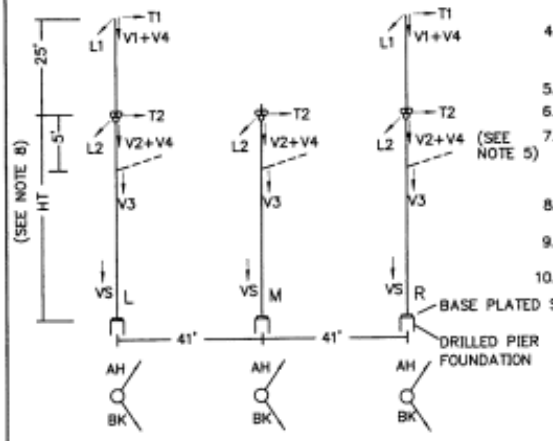
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S). V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT) V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V4 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-4 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3-POLE
SLE3-DEPY-S 500 SK4 (65)

ENTERGY SERVICES, INC.
Transmission LineDesign Standard
LOAD TREE, DEADEND, 65°, SS, 55'-115'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE
No. TFS246A0
PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007 SLE3-DEPY-S 500; SK4 (65)

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 8664 | 8986 | 6407 | 2336 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 49656 | 46883 | 40815 | 16873 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 4332 | 4493 | 3204 | 1168 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 5728 | 6416 | 3972 | 1668 |
| | COND | T2 | 24828 | 23441 | 20408 | 8437 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 33229 | 33478 | 25152 | 12049 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V3 | 500 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND, 15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

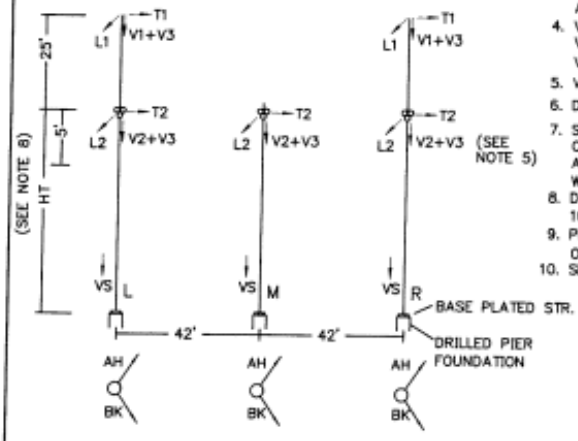
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S).
   V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT)
   V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V3 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-5 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3-POLE
SLE3-DEPY-S 500 SK5 (70)

ENTERGY SERVICES, INC.
Transmission LineDesign Standard
LOAD TREE, DEADEND, 70°, SS, 55'-115'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE
No. TFS247A0
PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007

SLE3-DEPY-S 500; SK5 (70)

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 9632 | 10070 | 7079 | 2617 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 55272 | 52540 | 45066 | 18910 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 4816 | 5035 | 3539 | 1309 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 5357 | 6000 | 3715 | 1560 |
| | COND | T2 | 27636 | 26270 | 22533 | 9455 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 31075 | 31307 | 23521 | 11286 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V3 | 500 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND,15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

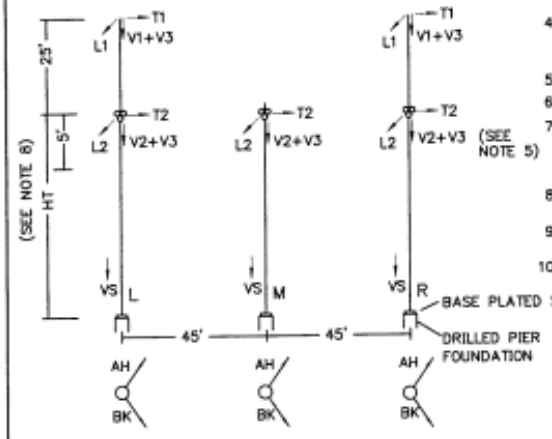
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S).
   V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT)
   V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V3 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-5 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3-POLE
SLE3-DEPY-S 500 SK5 (80)

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
LOAD TREE, DEADEND, 80°, SS, 55'-115'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE

Entergy | No. TFS248A0 | PLOT 1=1 | SH. 1 OF 1

SLE3-DEPY-S 500; SK5 (80)

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 10532 | 11078 | 7702 | 2879 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 60490 | 57797 | 49015 | 20802 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 5266 | 5539 | 3851 | 1440 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 4945 | 5539 | 3429 | 1440 |
| | COND | T2 | 30245 | 28899 | 24508 | 10401 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 28684 | 28899 | 21712 | 10401 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V3 | 500 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND, 15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F, OLF=1.00.

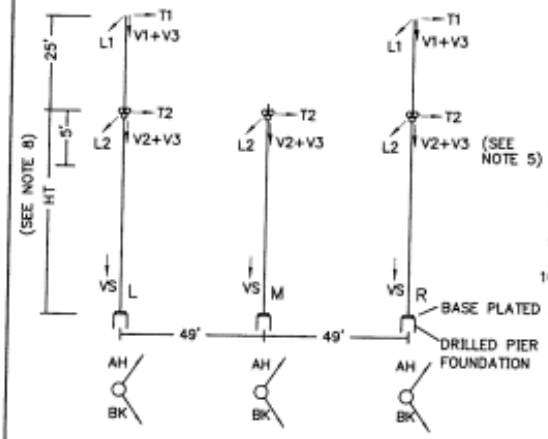
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S). V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT) V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V3 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-5 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3-POLE
SLE3-DEPY-S 500 SK5 (90)

ENTERGY SERVICES, INC.
Transmission LineDesign Standard
LOAD TREE, DEADEND, 90°, SS, 55'-115'
STRUCTURE DRAWING & DETAIL

STD NO. | SCALE: NONE
No. TFS249A0
PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/7/2007

SLE3-DEPY-S 500; SK5 (90)

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### LOADING TABLE *

| ITEMS | | LOAD | CASE 1 | CASE 2 | CASE 3 | CASE 4 |
|---|---|---|---|---|---|---|
| INTACT | SW | T1 | 11356 | 12001 | 8274 | 3119 |
| | | V1 | 1887 | 4576 | 774 | 774 |
| | | L1 | 0 | 0 | 0 | 0 |
| | COND | T2 | 65271 | 62615 | 52635 | 22535 |
| | | V2 | 14386 | 23110 | 6950 | 6950 |
| | | L2 | 0 | 0 | 0 | 0 |
| DE ONE SIDE | SW | T1 | 5678 | 6000 | 4137 | 1560 |
| | | V1 | 1289 | 3082 | 535 | 535 |
| | | L1 | 4495 | 5035 | 3117 | 1309 |
| | COND | T2 | 32636 | 31307 | 26317 | 11268 |
| | | V2 | 9586 | 15448 | 4622 | 4622 |
| | | L2 | 26075 | 26270 | 19737 | 9455 |
| WIND ON STRUCTURE | | W | 10 | 0 | 25.6 | 0 |
| STRUCTURE WEIGHT | | VS | TO BE DETERMINED BY T&B | | | |
| LINEMAN & EQUIP. WEIGHT | | V3 | 500 | | | |

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

### WIRE DATA:

SHIELDWIRE

(2) 24 FIBER OPGW (GW2400 – 64mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15° F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60°F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR

(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15°F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60°F TENSION 4903 LBS INITIAL (SUB CONDUCT)

### MECHANICAL LOADING CRITERIA:

CASE 1 – NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15° F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 – HEAVY ICE: 1" RADIAL ICE, NO WIND,15° F. OLF=1.0

CASE 3 – HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60° F. OLF=1.00.

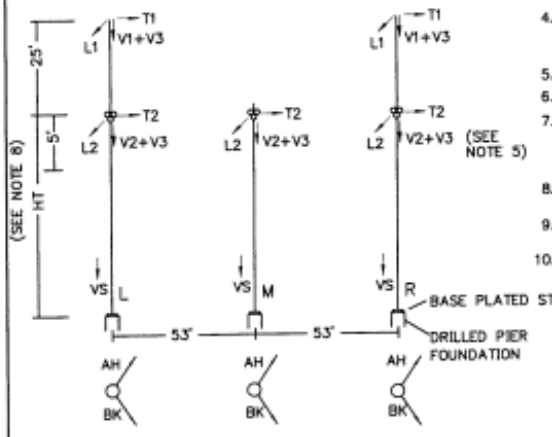
CASE 4 – EVERYDAY: NO WIND, NO ICE, 60° F. OLF=1.0

### SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

### NOTES:

1. ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
2. FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
3. THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
4. V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S). V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT) V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
5. V3 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
6. DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
7. STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIRLD WIRES (FIBER OR 7#7) – ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLLS THE DESIGN.
8. DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
9. PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
10. SEE DRAWING STD-5 FOR STRUCTURE FRAMING.




LOAD TREE 500KV 3–POLE
SLE3–DEPY–S 500 SK5 (100)

ENTERGY SERVICES, INC.
Transmission LineDesign Standard
LOAD TREE, DEADEND, 100', SS, 55'–115'
STRUCTURE DRAWING & DETAIL

| STD NO. | SCALE: NONE |
|---|---|
| Entergy | No. TFS250A0 |
| | PLOT 1=1 SH. 1 OF 1 |

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 11-21-07 | CREATED | TMF | HSK | HSK |

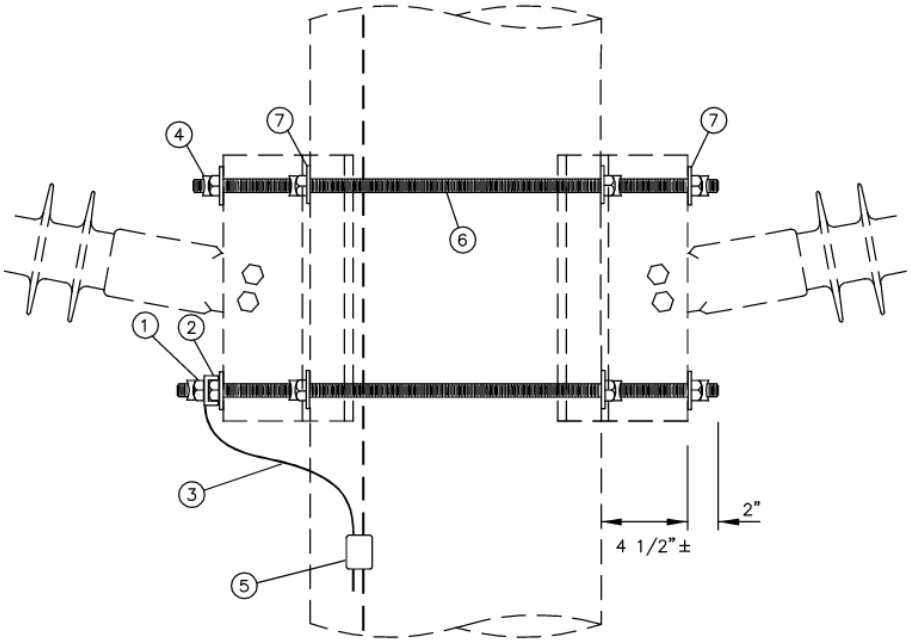
tfinc90 12/7/2007 SLE3–DEPY–S 500; SK5 (100)

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

VARIABLE BOLT ASSY, DOUBLE POLY POST FOR CONCRETE WITH GROUNDING

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | EN000171 | NUT, SQUARE, STL, GALV, ANSI–C135.1, 7/8" DIA, 9 THD |
| 2 | 1 | EN000358 | CLIP, BONDING, 7/8", STL, GALV, FOR GROUNDING TO 7/8" BOLT |
| 3 | 1 | EN000362 | WIRE, COPPERWELD, #4 (.1158 lbs/ft) |
| 4 | 8 | EN000426 | NUT, LOCK, SQUARE, STL, GALV. ANSI–C135.1, 7/8" DIA. 9 THD |
| 5 | 1 | EN000360 | CONNECTOR, #4 COPPER CRIMPIT |
| 6 | 2 | LS909XX | BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS |
| 7 | 8 | EN005685 | WASHER, FLAT ROUND, 2" STEEL, GALV, FOR 7\8" BOLT |




1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

2) Grounding Lug location may be above or below assembly depending on pole tank ground location.

| BLT–2P–C | |
|---|---|
| ENTERGY STANDARD DWG. | |
| DESIGN APPROVAL<br>SIGNED / DATE | STANDARDS APPROVAL<br>SIGNED / DATE |
| BOLT ASSY (CONCRETE)<br>DOUBLE POLYMER POST INS. | |
| APPROVED BY: EJG | DATE: 01–27–97 |
| CHECKED BY: JWS | SCALE: NONE |
| DRAWN BY: ECSI | ESI NO. TMD207A1 |
| Entergy | No. BLT2PC |
| | PLOT 1=8 / SH. 1 OF 1 |

| NO. | DATE: | REVISION | BY: | APPR: |
|---|---|---|---|---|
| 1 | 5–28–03 | REV. DIM., CHANGE WASHER FROM SQ. TO FLAT ROUND | ITRON | |

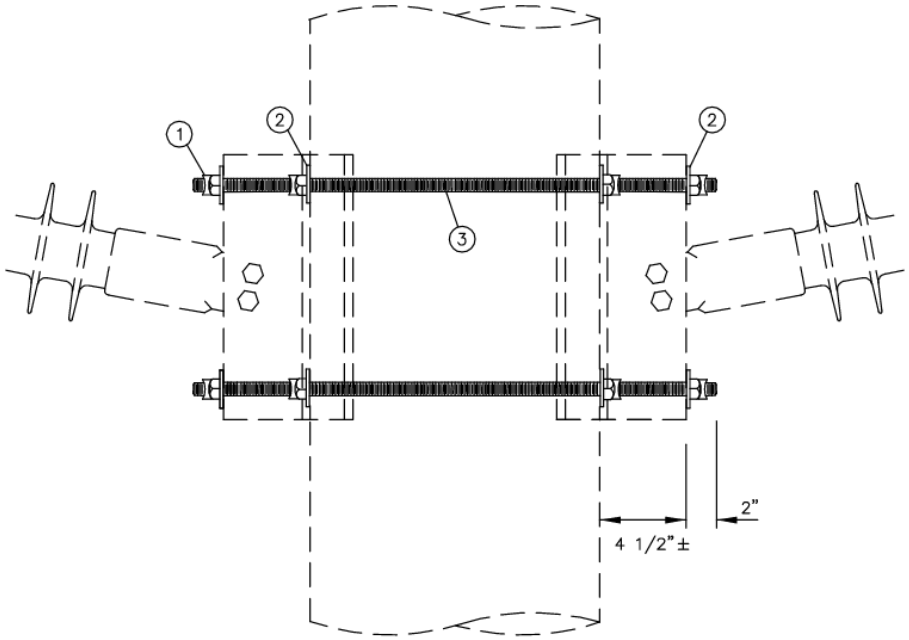
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

VARIABLE BOLT ASSY, DOUBLE POLY POST FOR STEEL

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 8 | EN000426 | NUT, LOCK, SQUARE, STL, GALV, ANSI–C135.1, 7/8" DIA, 9 THD |
| 2 | 8 | EN005685 | WASHER, FLAT ROUND, 2" STEEL, GALV, FOR 7\8" BOLT |
| 3 | 2 | LS909XX | BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS |




1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

BLT–2P–S

ENTERGY STANDARD DWG.

| DESIGN APPROVAL | STANDARDS APPROVAL |
|---|---|
| SIGNED / DATE | SIGNED / DATE |

BOLT ASSY (STEEL)
DOUBLE POLYMER POST INS.

| | |
|---|---|
| APPROVED BY: | DATE: 2–12–96 |
| CHECKED BY: | SCALE: NONE |
| DRAWN BY: ECSI | ESI NO. TMD208A1 |

Entergy No. BLT2PS

PLOT 1=8 SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | APPR: |
|---|---|---|---|---|
| 1 | 5–28–03 | CHANGE WASHER, DIM. | ITRON | |

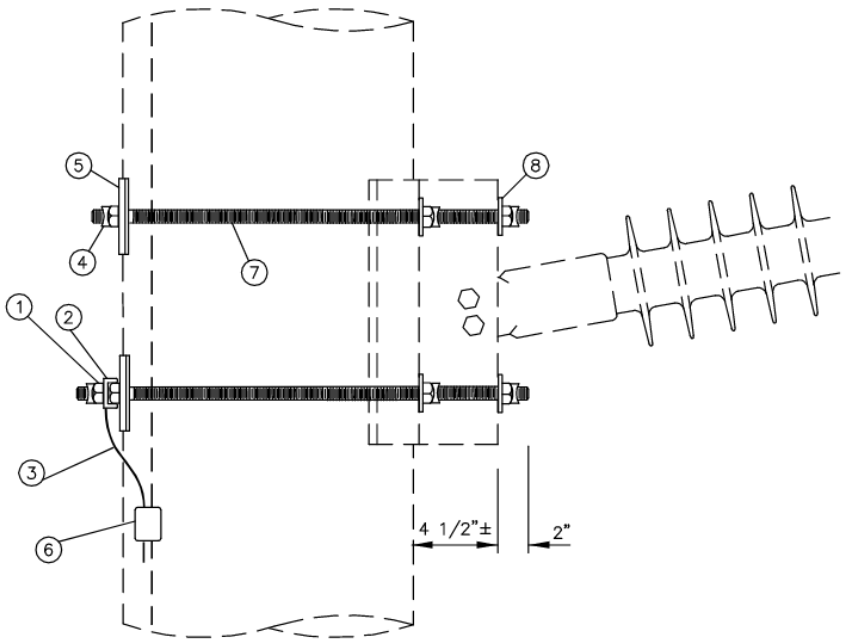
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

VARIABLE BOLT ASSY, SINGLE POLY POST FOR CONCRETE WITH GROUNDING

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | EN000171 | NUT, SQUARE, STL, GALV, ANSI–C135.1, 7/8" DIA, 9 THD |
| 2 | 1 | EN000358 | CLIP, BONDING, 7/8", STL, GALV, FOR GROUNDING TO 7/8" BOLT |
| 3 | 1 | EN000362 | WIRE, COPPERWELD, #4 (.1158 lbs/ft) |
| 4 | 6 | EN000426 | NUT, LOCK, SQUARE, STL, GALV, ANSI–C135.1, 7/8" DIA, 9 THD |
| 5 | 2 | EN012280 | WASHER, SQUARE CURVED, STL, GALV, 7/8" BOLT, 3"x3"x1/4" |
| 6 | 1 | EN000360 | CONNECTOR, #4 COPPER CRIMPIT |
| 7 | 2 | LS909XX | BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS |
| 8 | 4 | EN005685 | WASHER, FLAT ROUND, 2" STEEL, GALV, FOR 7\8" BOLT |




1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

2) Grounding Lug location may be above or below assembly depending on pole tank ground location.

BLT–P–C

ENTERGY STANDARD DWG.

| DESIGN APPROVAL | STANDARDS APPROVAL |
|---|---|
| SIGNED / DATE | SIGNED / DATE |

BOLT ASSY (CONCRETE)
SINGLE POLYMER POST INS.

| | | | |
|---|---|---|---|
| APPROVED BY: | EJG | DATE: | 01–27–97 |
| CHECKED BY: | JWS | SCALE: | NONE |
| DRAWN BY: | ECSI | ESI NO. | TMD211A1 |

Entergy No. BLTPC

PLOT 1=8 SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | APPR: |
|---|---|---|---|---|
| 1 | 5–30–03 | CHANGE WASHER, DIM. | ITRON | |

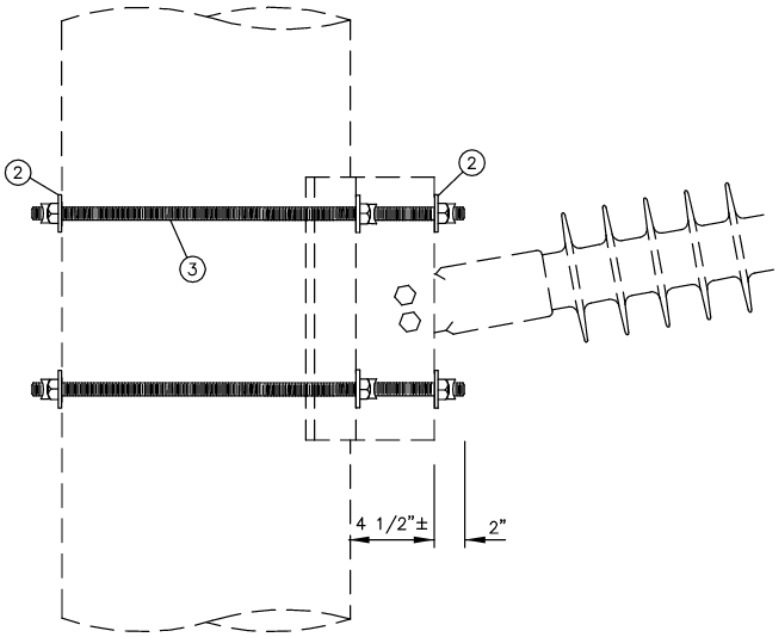
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

VARIABLE BOLT ASSY, SINGLE POLY POST FOR STEEL

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 6 | EN000426 | NUT, LOCK, SQUARE, STL, GALV, ANSI–C135.1, 7/8" DIA, 9 THD |
| 2 | 6 | EN005685 | WASHER, FLAT ROUND, 2" STEEL, GALV, FOR 7/8" BOLT |
| 3 | 2 | LS909XX | BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ. NUTS |




1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 3 | 07–21–10 | ADDED ASSEMBLY NAME | CBM | ECW | ECW |
| 2 | 01–13–10 | INCREASED STOCK NO. ITEM EN005685 FROM 4 TO 6 | BAB | | |
| 1 | 05–30–03 | CHANGE WASHER, DIM. | ITRON | | |
| 0 | 02–12–06 | ISSUED | ECSI | | |

BLT–P–S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

BOLT ASSEMBLY (STEEL) SINGLE POLYMER POST INS.

STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE:

Entergy | No. TMD212A3 | PLOT | SH. OF

cmcgr91 8/11/2010 BLT–P–S

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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

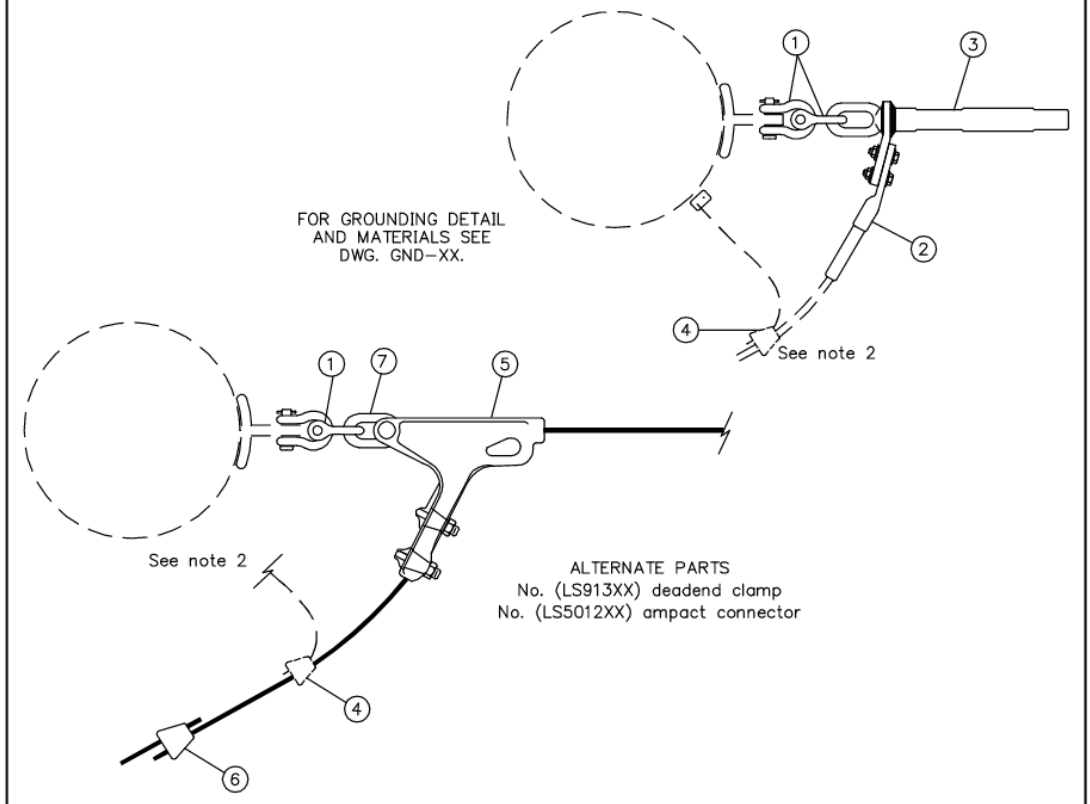
### BILL OF MATERIALS

OHGW DEADEND

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 2 | EN000492 | SHACKLE, ANCHOR, 40K ULT, 3/4" PIN DIA, 2-3/4" LONG |
| 2 | 1 | LS9004XX | TERMINAL CONNECTOR, 15 DEG, FOR VARIABLE SIZE WIRE |
| 3 | 1 | LS9005XX | DEADEND, ALUMINUM COMPRESSION BODY, SINGLE TONGUE, VARIABLE WIRE SIZE |
| 4 | – | LS5012XX | CONNECTOR, AMPACT, SEE GND ASSEMBLY DRAWING FOR MATERIAL |

ALTERNATE FOR BOLTED ASSEMBLY

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 2 | EN000492 | SHACKLE, ANCHOR, 40K ULT, 3/4" PIN DIA, 2-3/4" LONG |
| 4 | – | LS5012XX | CONNECTOR, AMPACT, SEE GND ASSEMBLY DRAWING FOR MATERIAL |
| 5 | 1 | LS913XX | DEADEND BOLTED STRAIN ALUMWELD |
| 6 | 1 | LS5012XX | CONNECTOR, AMPACT, VARIABLE CONDUCTOR SIZE TO VARIABLE CONDUCTOR SIZE |
| 7 | 1 | EN000390 | LINK, CHAIN, XMSN: CONNECTING, CS, 1/2" PITCH; 2 1/4" LONG |




1) Item #2, #3 and #6 are conductor dependent.
2) For grounding detail and materials, see applicable Gnd-xx drawing.
3) For horizontal vang orientation, omit one of item 1.

OHG-DE-XX

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 6 | 07-21-10 | SHOW ITEM 4 ON ASSEMBLY | CBM | ECW | ECW |
| 5 | 08-15-06 | REVISIED ITEM #4 | RJL | | |
| 4 | 01-31-01 | MODIFIED STOCK NUMBER LS5029XX | LS | | |
| 3 | 01-04-01 | MODIFIED CALLOUTS | LS | | |
| 2 | 06-07-00 | MODIFIED STOCK NUMBER LS5012XX | RMB | | |
| 1 | 11-16-99 | ADDED AMPACT & CARTRIDGE DESCRIPTION | RMB | | |
| 0 | | ISSUED | ECSI | | |

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
OVERHEAD GROUNDWIRE DEADEND ASSY
STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD222A6 | PLOT 1=8 | SH. 1 OF 1

rlafon 8/15/2006 OHG-DE-XX

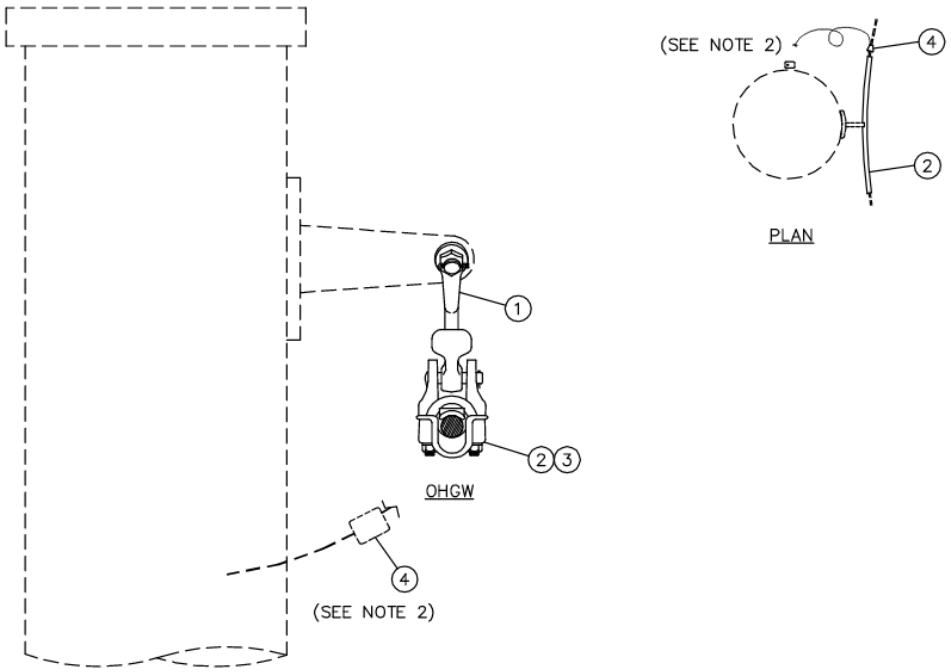
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

**OHGW SUSPENSION, 0-30°**

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | EN004375 | BALL CLEVIS, 45 DEG Y, 30K ULT, 3/4" PIN DIA |
| 2 | 1 | LS9003XX | ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE |
| 3 | 1 | LS9008XX | CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, w/SOCKET EYE |
| 4 | – | LS5012XX | CONNECTOR, AMPACT |




1) Item #2 and #3 are conductor dependent. These items are selected for each project and may be with or without Armor Rod.

2) For grounding detail and materials see applicable GND–XX drawing.

| NO. | DATE: | REVISION | BY: | APPR: |
|---|---|---|---|---|
| 9 | 8–15–06 | REMOVED OPTGW OPTION, DELETED ITEM #4 | RJL | |
| 8 | 12–9–03 | ADDED BACK GROUNDING DETAILS | ITRON | |
| 7 | 5–30–03 | ADDED OPTGW OPTION | ITRON | |
| 6 | 2–17–03 | ADDED POLE CAP AND GROUNDING NOTE 2 | ITRON | |
| 5 | 10–15–02 | REMOVE GROUNDING DETAIL | ITRON | |
| 4 | 1–18–02 | MODIFIED ITEMS 1, 2 AND 3. | LSFT | |
| 3 | 1–29–01 | MODIFIED STOCK NUMBER LS9007XX | LSFT | |
| 2 | 1–29–01 | MODIFIED STOCK NUMBER LS5012XX | RMB | |

OHG–SUS–XX

ENTERGY STANDARD DWG.

| DESIGN APPROVAL | STANDARDS APPROVAL |
|---|---|
| SIGNED / DATE | SIGNED / DATE |

OVERHEAD GROUNDWIRE SUSPENSION ASSY

| | |
|---|---|
| APPROVED BY: | DATE: 2–15–03 |
| CHECKED BY: | SCALE: NONE |
| DRAWN BY: ITRON | ESI NO. TMD223A9 |

Entergy | No. OHGSUS | PLOT 1=8 | SH. 1 OF 1

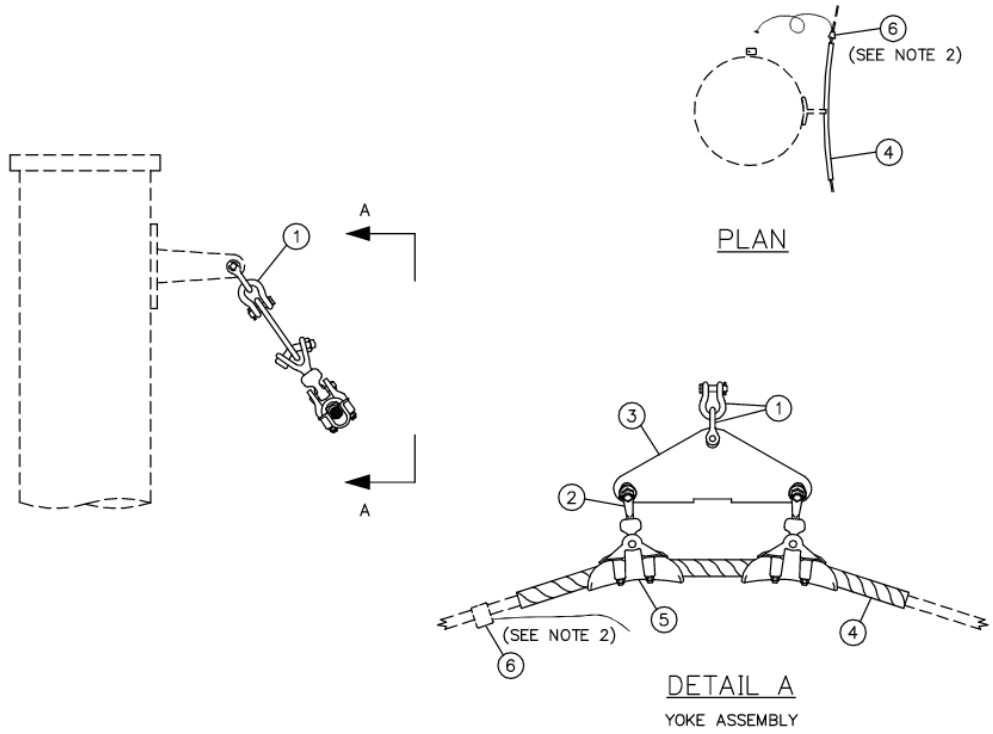
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

OHGW SUSPENSION, 30–50° WITH YOKE PLATE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 2 | EN000492 | SHACKLE, ANCHOR, 40K ULT, 3/4" PIN DIA, 2–3/4" LONG |
| 2 | 2 | EN004375 | BALL CLEVIS, 45 DEG Y, 30K ULT, 3/4 PIN DIA |
| 3 | 1 | EN015676 | PLATE, YOKE, DUCTILE IRON, 18" WIDTH, 30K ULT, 3/4" GALV |
| 4 | 1 | LS9003XX | ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE |
| 5 | 2 | LS9007XX | CLAMP, SUSPENSION, ALUMINUM, VARIABLE SIZE WIRE, W/SOCKET EYE |
| 6 | – | LS5012XX | CONNECTOR, AMPACT, SEE GROUND ASSEMBLY DRAWING FOR MATERIAL |




1) ITEM #4 AND #5 ARE CONDUCTOR DEPENDENT. THESE ITEMS ARE SELECTED FOR EACH PROJECT AND MAY BE WITH OR WITHOUT ARMOR ROD.

2) FOR GROUNDING DETAIL AND MATERIALS SEE APPLICABLE GND–XX DRAWING.

| NO. | DATE: | REVISION | BY: | APPR: |
|---|---|---|---|---|
| 6 | 8–15–06 | REVISED ITEM #6 | RJL | |
| 5 | 12–8–03 | ADDED BACK GROUNDING DETAILS | ITRON | |
| 4 | 2–18–03 | ADDED POLE CAP AND GROUNDING NOTE | ITRON | |
| 3 | 1–29–01 | MODIFIED STOCK NUMBER LS9007XX | LS | |
| 2 | 6–7–00 | MODIFIED STOCK NUMBER LS5012XX | RMB | |
| 1 | 11–16–99 | ADDED AMPACT & CARTRIDGE DESCRIPION | RMB | |

OHG–SUY–XX

ENTERGY STANDARD DWG.

| DESIGN APPROVAL | STANDARDS APPROVAL |
|---|---|
| SIGNED / DATE | SIGNED / DATE |

OVERHEAD GROUNDWIRE HEAVY ANGLE ASSY

| | |
|---|---|
| APPROVED BY: | DATE: 1–29–01 |
| CHECKED BY: | SCALE: NONE |
| DRAWN BY: ECSI | ESI NO. TMD224A6 |
| Entergy | No. OHGSUY |
| PLOT 1=16 | SH. 1 OF 1 |

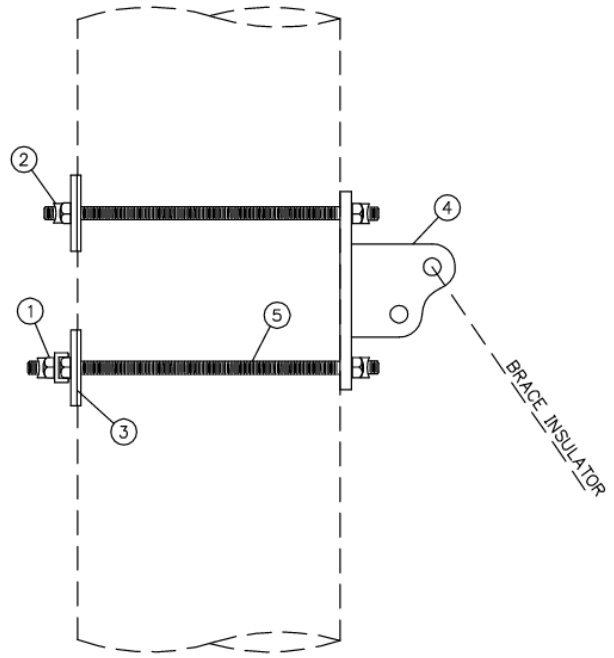
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

TEE ASSY, BRACE POST FOR STEEL WITH BOLTS

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | EN000171 | NUT, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD |
| 2 | 4 | EN000426 | NUT, LOCK, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD |
| 3 | 2 | EN003796 | WASHER, SQUARE CURVED, STL, GALV, ANSI-C135.1, 7/8" BOLT, 1/4" THK, 4"x4" |
| 4 | 1 | EN011909 | PLATE, POLE EYE, GALV STL, DBL EYE, 70K ULT, 8" BOLT SPACING |
| 5 | 2 | LS909XX | BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS |




1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

2) Grounding Lug location may be above or below assembly depending on pole tank ground location.

TEE-B-S

ENTERGY STANDARD DWG.

| DESIGN APPROVAL | STANDARDS APPROVAL |
|---|---|
| SIGNED / DATE | SIGNED / DATE |

TEE ASSY (STEEL)
BRACE

| | |
|---|---|
| APPROVED BY: EJG | DATE: 12-19-00 |
| CHECKED BY: JWS | SCALE: NONE |
| DRAWN BY: ECSI | ESI NO. TMD279A0 |

Entergy No. TBS

PLOT 1=8 SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | APPR: |
|---|---|---|---|---|

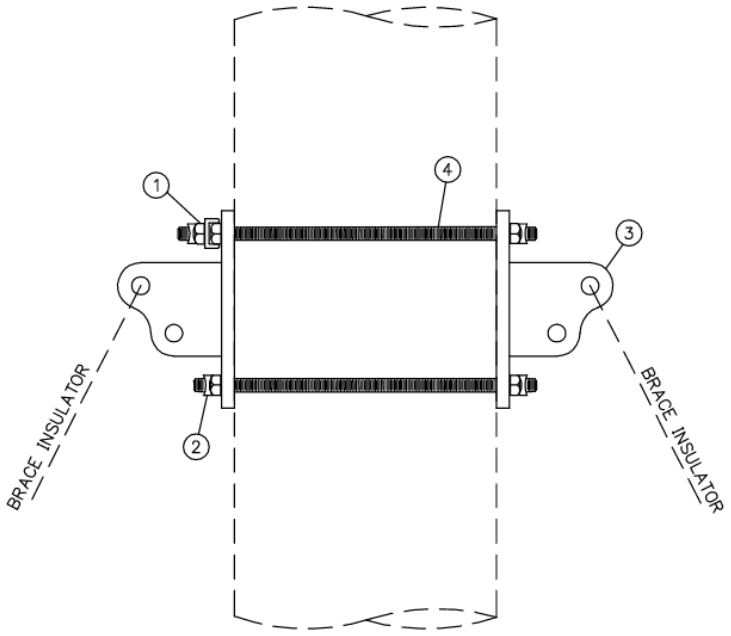
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

TEE ASSY, BRACE TO BRACE FOR STEEL WITH BOLTS

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | EN000171 | NUT, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD |
| 2 | 4 | EN000426 | NUT, LOCK, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD |
| 3 | 2 | EN011909 | PLATE, POLE EYE, GALV STL, DBL EYE, 70K ULT, 8" BOLT SPACING |
| 4 | 2 | LS909XX | BOLT, DBL ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS |




1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

2) Grounding Lug location may be above or below assembly depending on pole tank ground location.

TEE-B-B-S

ENTERGY STANDARD DWG.

| DESIGN APPROVAL | STANDARDS APPROVAL |
|---|---|
| SIGNED / DATE | SIGNED / DATE |

TEE ASSY (STEEL)
BRACE – BRACE

| | |
|---|---|
| APPROVED BY: EJG | DATE: 12-19-00 |
| CHECKED BY: JWS | SCALE: NONE |
| DRAWN BY: ECSI | ESI NO. TMD280A0 |

Entergy No. TBBS

PLOT 1=8 SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | APPR: |
|---|---|---|---|---|

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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

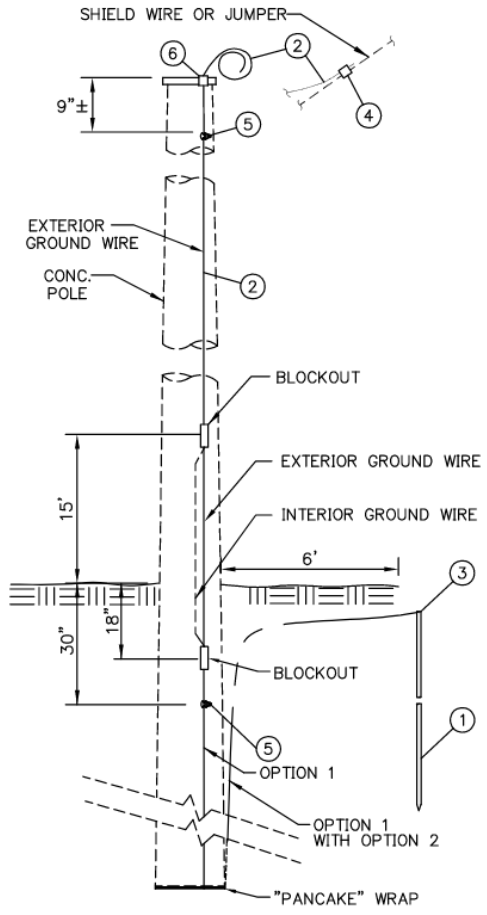
### BILL OF MATERIALS – GROUNDING

| ITEM | TYP. QUANTITY FOR STR. w/ 1 POLE | 2POLE | 3 POLE | STOCK NO. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 1 *** | 2 *** | 3 *** | EN013434 | ROD, GROUND, 5/8"x8', COPPER CLAD |
| 2 | 15 lb.** | 30 lb.** | 44 lb.** | EN000362 | WIRE, COPPERWELD, #4 (.1158lbs/ft) |
| 3 | 1 *** | 2 *** | 3 *** | EN008745 | CONNECTOR, CADWELD, #4 TO TOP OF 5/8" GROUND ROD ("L") |
| 4 | 1 * | 2 | 2 | LS5012XX | CONNECTOR, AMPACT, VARIABLE CONDUCTOR SIZE TO #4 COPPERWELD. |
| 5 | 2 | 4 | 6 | EN014861 | TERMINAL, ELEC:, GROUNDING LUG, 1/2" DIA., 13THD, BRONZE |
| 6 | – | – | – | EN012112 | GROUNDING CLIP SUPPLIED BY POLE MFG. |

* FOR DOUBLE SHIELD WIRE, DOUBLE QTY, OF ITEM 4. ITEM 4 IS NOT USED FOR GROUNDING OPGW TO POLE. FOR OPGW SEE DRAWING TMD396.

** QUANTITY FOR ITEM 2 IS TYPICAL FOR POLES UP TO 100' ABOVE GROUND HEIGHT.

*** FOR HIGH-RESISTANCE SOILS, ADDITIONAL GROUND RODS WILL BE REQUIRED AND "T" CONNECTORS (EN009796) CAN BE USED TO FACILITATE ADDITIONAL RODS.




GENERAL

1. REFERENCE "GROUNDING AND CATHODIC PROTECTION CONSTRUCTION SPECIFICATION". TRANSMISSION LINE STANDARD T00109 FOR GROUNDING REQUIREMENTS.
2. REFERENCE DWGS. TMD222, TMD223 TMD224, AND TMD225 FOR OVERHEAD GROUND WIRE ASSEMBLIES; AND DWG. TMD390 FOR GUY TO POLE BONDING.
3. REFERENCE DWGS. TMD396, TMD397, AND TMD398 FOR OPGW GROUNDING ASSEMBLIES.

GROUNDING – NON OPGW SHIELD WIRE TO POLE

4. REMOVE POLE SUPPLIER PROVIDED GROUND CLIPS (2 ea. W/GREEN BOLTS) AND REPLACE WITH TERMINAL (GROUNDING) LUGS (ITEM 5) AS SHOWN.
5. ATTACH POLE GROUND TO POLE BY THREADING THRU TERMINAL LUGS (ITEM 5). EXTEND GROUND WIRE THRU GROUNDING CLIP (ITEM 6) AND EXTEND 5' COILED.
6. FOR SUSPENSION TYPE CONNECTION, CONNECT TO S.W. WITH AMPACT CONNECTOR (ITEM 4). APPROX. 5' BEYOND ARMOR ROD.
7. FOR DEAD END CONNECTION, CONNECT TO JUMPER WITH AMPACT CONN. (ITEM 4). PROVIDE ENOUGH WIRE TO ALLOW FREE MOVEMENT OF S.W. OR JUMPER. REMOVE EXCESS.

GROUNDING FOR ALL POLES:

8. PROVIDE GROUND WIRE BETWEEN THE TERMINALS (ITEM 5) AT TOP AND BELOW GROUND. BETWEEN THE BLOCKOUTS, THE WIRE MAY BE EXTERNAL OR INTERNAL. INTERNAL PROVIDES PROTECTION FROM THEFT AND SNAGGING BY EQUIPMENT.

OPTIONS FOR GROUNDING BELOW GROUNDLINE (WIRES BELOW GROUNDLINE MUST CONNECT TO BOTTOM TERMINAL):

9. OPTION 1 – PROVIDE GROUND WIRE TO BUTT OF POLE AND FORM COIL OF WIRE (PANCAKE) ON CLIPS PROVIDED (GROUND RODS NOT USED).
10. OPTION 2 – PROVIDE CONTINUOUS GROUND WIRE (NO SPLICE) FROM PANCAKE TO GROUND ROD AND OR COUNTER POISE.

GND–C–EMBED

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 5 | 9-6-17 | REV. NOTES 2 & 3, CLARIFY MULTI-POLE BOM | ECW | CDHH | JRA |
| 4 | 9-30-16 | UPDATED AND REFORMATED BOM'S AND NOTES | ECW | PL | JRA |
| 3 | 08-11-10 | CORRECTED ITEM#'S IN NOTES | CBM | ECW | ECW |
| 2 | 12-31-09 | ADD GROUND ROD DIM | HDR | RCR | ECW |
| 1 | 07-24-06 | REVISED ITEM #5 | RMB | | |
| 0 | 02-11-03 | ISSUED | ITRON | | |

ewilli2 9/6/2017

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

GROUNDING, CONCRETE POLE, DIRECT EMBED STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD293A5 | PLOT 1=32 | SH. 1 OF 1

GNDCEMB

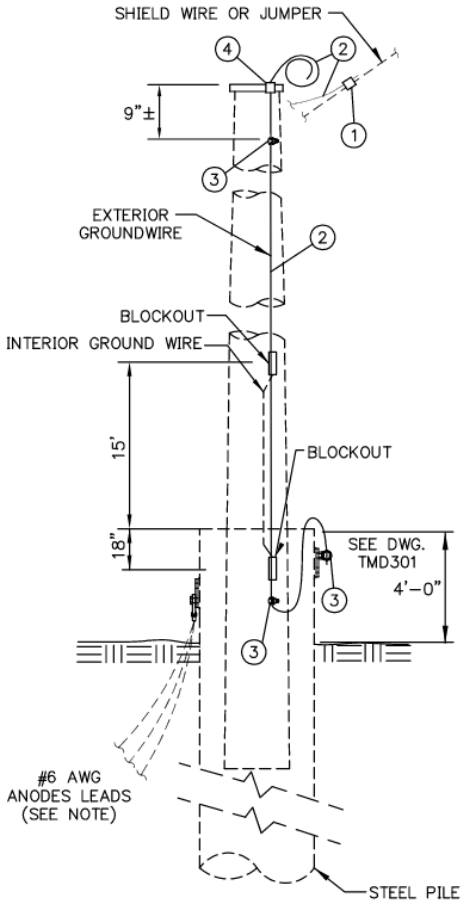
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS – GROUNDING

| ITEM | TYP. QUANTITY FOR STR. w/ 1 POLE | 2 POLES | 3 POLES | STOCK NO. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 1 * | 2 | 2 | LS5012XX | CONNECTOR, AMPACT, VARIABLE CONDUCTOR SIZE TO #4 COPPERWELD. |
| 2 | 12 lb.** | 24 lb.** | 35 lb.** | EN000362 | WIRE, COPPERWELD, #4 (.1158lbs/ft) |
| 3 | 3 | 6 | 9 | EN014861 | TERMINAL, ELEC:, GROUNDING LUG, 1/2" DIA., 13THD, BRONZE |
| 4 | – | – | – | EN012112 | GROUNDING CLIP SUPPLIED BY POLE MFG. |

* FOR DOUBLE SHIELD WIRE, DOUBLE QTY, OF ITEM 1. ITEM 1 IS NOT USED FOR GROUNDING OPGW TO POLE. FOR OPGW SEE DRAWING TMD396.

** QUANTITY FOR ITEM 2 IS TYPICAL FOR POLES UP TO 100' ABOVE GROUND HEIGHT.




GENERAL

1. REFERENCE "GROUNDING APPLICATION GUIDELINE", TRANSMISSION LINE STANDARD TO0109 FOR GROUNDING REQUIREMENTS.
2. REFERENCE DWGS. TMD222, TMD223 TMD224, AND TMD225 FOR OVERHEAD GROUND WIRE ASSEMBLIES; AND DWG. TMD390 FOR GUY TO POLE BONDING.
3. REFERENCE DWGS. TMD396, TMD397, AND TMD398 FOR OPGW GROUNDING ASSEMBLIES.

GROUNDING – NON–OPGW SHIELD WIRE TO POLE

4. REMOVE POLE SUPPLIER PROVIDED GROUND CLIPS (2ea. W/GREEN BOLTS) AND REPLACE WITH TERMINAL (GROUNDING) LUGS (ITEM 3) AS SHOWN. ±
5. ATTACH POLE GROUND TO POLE BY THREADING THRU TERMINAL LUGS. (ITEM 3). EXTEND GROUND WIRE THRU GROUNDING CLIP (ITEM 4) AND EXTEND 5' COILED.
6. FOR SUSPENSION TYPE CONNECTION, CONNECT TO S.W. WITH AMPACT CONNECTOR (ITEM 1). APPROX. 5' BEYOND ARMOR ROD.
7. FOR DEAD END CONNECTION, CONNECT TO JUMPER WITH AMPACT CONNECTOR (ITEM 1). PROVIDE ENOUGH WIRE TO ALLOW FREE MOVEMENT OF S.W. OR JUMPER. REMOVE EXCESS.

GROUNDING FOR ALL POLES

8. PROVIDE GROUND WIRE BETWEEN THE TERMINALS (ITEM 3) AT TOP OF POLE AND BELOW TOP OF PILE BETWEEN THE BLOCKOUTS, THE WIRE MAY BE EXTERNAL OR INTERNAL. INTERNAL PROVIDES PROTECTION FROM THEFT.
9. PROVIDE GROUND WIRE FROM BOTTOM TERMINAL TO GROUND NEMA PAD ON EXTERIOR OF PILE.
10. PANCAKE IS NOT RECOMMENDED ON POLE BUTT BECAUSE OF INCOMPATABLE METALS THAT MIGHT CONTRIBUTE TO CORROSION.

ANODES

11. ANODES SHALL BE CONNECTED TO THE PILE AS DETAILED ON DWG. TMD299 AND INSTALLED ON DWG. TMD299 AND TMD302. ALL MATERIAL FOR ANODE INSTALLATION IS SHOWN ON DWG. TMD299.

GND–C–PILE

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 3 | 9–6–17 | REV. NOTES 2 & 3, CLARIFY MULTI–POLE BOM | ECW | CDHH | JRA |
| 2 | 9–30–16 | UPDATED AND REFORMATED BOM'S AND NOTES | ECW | PL | JRA |
| 1 | 08–15–06 | REPLACE ANGLE BRACKET WITH NEMA PAD, ITEM # | RJL | | |
| 0 | 02–15–03 | ISSUED | ITRON | | |

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

Grounding, Concrete Pole, Steel Pile

STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE:

Entergy No. TMD294A3

PLOT | SH. OF

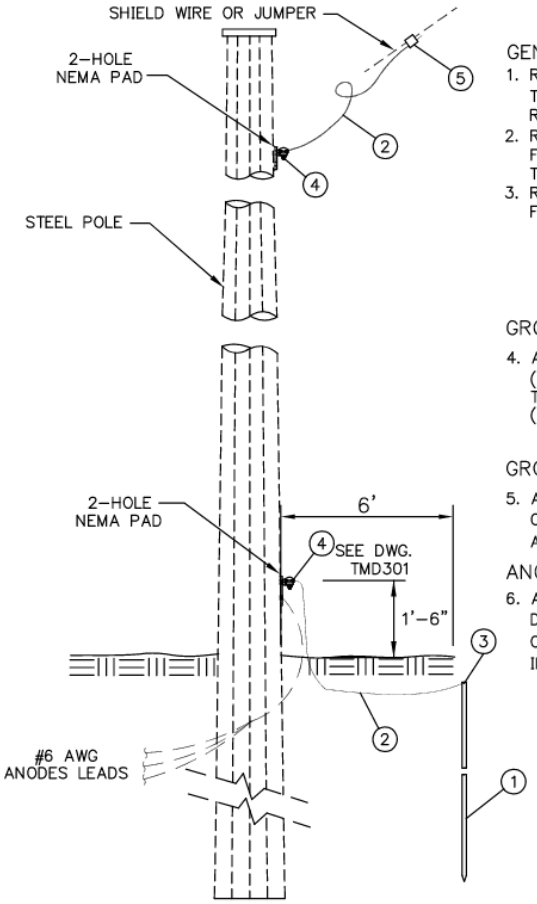
ewilli2 9/6/2017 GND–C–PILE

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS – GROUNDING

| ITEM | TYP. QUANTITY FOR STR. w/ 1 POLE | 2 POLES | 3 POLES | STOCK NO. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 1** | 2** | 3** | EN013434 | ROD, GROUND, 5/8"x8', COPPER CLAD |
| 2 | 2 lb. *** | 4 lb. *** | 4 lb. *** | EN000362 | WIRE, COPPERWELD, #4 (.1158lbs/ft) |
| 3 | 1** | 2** | 3** | EN008745 | CONNECTOR, CADWELD, #4 TO TOP OF 5/8" GROUND ROD ("L") |
| 4 | 2 | 4 | 5 | EN014861 | TERMINAL, GROUNDING LUG, #8–2/0 TO 1/2–13, BRONZE ALLOY |
| 5 | 1 * | 2 * | 2 * | LS5012XX | CONNECTOR, AMPACT, VARIABLE CONDUCTOR SIZE TO #4 COPPERWELD. |

* FOR DOUBLE SHIELD WIRE, DOUBLE QTY, OF ITEM 5. ITEM 5 IS NOT USED FOR GROUNDING OPGW TO POLE. FOR OPGW SEE DRAWING TMD343.
** FOR HIGH–RESISTANCE SOILS, ADDITIONAL GROUND RODS WILL BE REQUIRED AND "T" CONNECTORS (EN009796) CAN BE USED TO FACILITATE ADDITIONAL RODS.
*** SOFT DRAWN COPPER (32159134) MAY BE SUBSTITUTED FOR CONNECTIONS AT TOP OF POLE ONLY.




**GENERAL**

1. REFERENCE "GROUNDING APPLICATION GUIDELINE", TRANSMISSION LINE STANDARD T00109 FOR GROUNDING REQUIREMENTS.
2. REFERENCE DWGS. TMD222, TMD223 TMD224, AND TMD225 FOR OVERHEAD GROUND WIRE ASSEMBLIES; AND DWG. TMD389 FOR GUY TO POLE BONDING.
3. REFERENCE DWGS. TMD389, TMD399, AND TMD402 FOR OPGW GROUNDING ASSEMBLIES.

**GROUNDING – NON–OPGW SHIELD WIRE TO POLE**

4. ATTACH CONNECTING GROUND WIRE TO TERMINAL LUG (ITEM 4) AS DETAILED ON DET. "A", SHT. TMD301 AND TO SHIELD WIRE OR JUMPER WITH AMPACT CONNECTOR (ITEM 5).

**GROUNDING – POLE TO GROUND ROD**

5. ATTACH CONNECTING GROUND WIRE TO TERMINAL LUG ON POLE AS DETAILED ON DET. "A" DWG. TMD300 AND TO GROUND ROD AS SHOWN ON THIS DWG.

**ANODES**

6. ANODES SHALL BE CONNECTED TO THE POLE AS DETAILED ON DET. "A" DWG. TMD300 AND INSTALLED ON DWG. TMD302. ALL MATERIAL FOR ANODE INSTALLATION IS SHOWN ON DWG. TMD300.

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 4 | 9–6–17 | REV. NOTES 2/3, CLARIFY MULTI–POLE BOM, ALT. ITEM 1 | ECW | CDHH | JRA |
| 3 | 9–30–16 | UPDATED AND REFORMATED BOM'S AND NOTES | ECW | PL | JRA |
| 2 | 12–21–09 | ADDED GROUND ROD DIMENSION | HDR | RLR | ECW |
| 1 | 07–24–06 | REVISED ITEM #5 | RMB | | |
| 0 | 02–11–03 | ISSUED | ITRON | | |

GND–S–EMBED

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

GROUNDING, STEEL POLE, DIRECT EMBED STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD295A4 | PLOT 1=32 | SH. 1 OF 1

ewilli2 9/6/2017 GNDSEMB

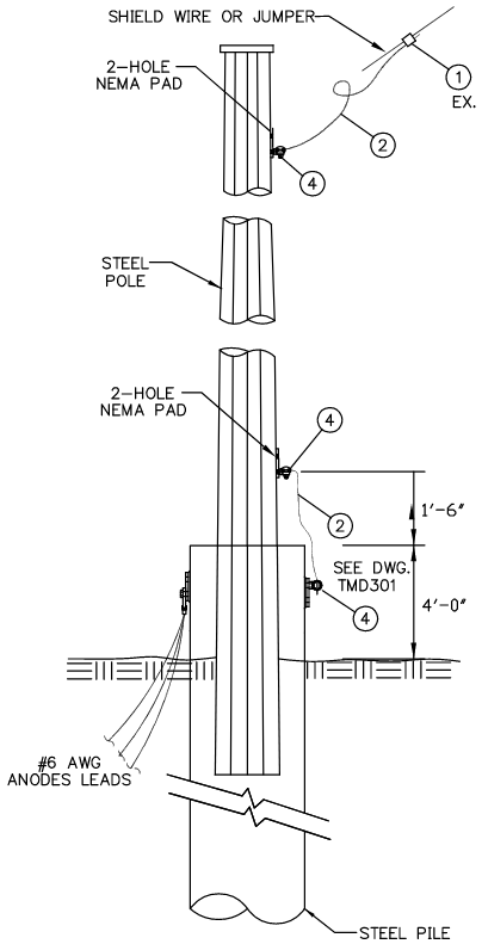
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS – GROUNDING

| ITEM | TYP. QUANTITY FOR STR. w/ 1 POLE | 2 POLES | 3 POLES | STOCK NO. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 1 * | 2 | 2 | LS5012XX | CONNECTOR, AMPACT, VARIABLE CONDUCTOR SIZE TO #4 COPPERWELD. |
| 2 | 2 lb. ** | 4 lb. ** | 6 lb. ** | EN000362 | WIRE, COPPERWELD, #4 (.1158lbs/ft) |
| 3 | 0 | 0 | 0 | – | – |
| 4 | 3 | 6 | 8 | EN014861 | TERMINAL, GROUNDING LUG, #8–2/0 TO 1/2–13, BRONZE ALLOY |

* FOR DOUBLE SHIELD WIRE, DOUBLE QTY, OF ITEM 1. ITEM 1 IS NOT USED FOR GROUNDING OPGW TO POLE. FOR OPGW SEE DRAWING TMD343.

** SOFT DRAWN COPPER (32159134) MAY BE SUBSTITUTED FOR CONNECTIONS AT TOP OF POLE ONLY.




EX. EN010109 USED FOR #4 TO 7#7 CONNECTION

GENERAL

1. REFERENCE "GROUNDING APPLICATION GUIDELINE", TRANSMISSION LINE STANDARD TO0109 FOR GROUNDING REQUIREMENTS.
2. REFERENCE DWGS. TMD222, TMD223 TMD224, AND TMD225 FOR OVERHEAD GROUND WIRE ASSEMBLIES; AND DWG. TMD389 FOR GUY TO POLE BONDING.
3. REFERENCE DWGS. TMD389, TMD399, AND TMD402 FOR OPGW GROUNDING ASSEMBLIES.

GROUNDING – NON–OPGW SHIELD WIRE TO POLE

4. ATTACH CONNECTING GROUND WIRE TO TERMINAL LUG (ITEM 4) AS DETAILED ON DET. "A", SHT. TMD301 AND TO SHIELD WIRE OR JUMPER WITH AMPACT CONNECTOR (ITEM 5).

GROUNDING – POLE TO PILE

5. ATTACH GROUND WIRE TO POLE BY THREADING THROUGH TERMINAL LUG AS SHOWN ON DET. "A", DWG. TMD301. ATTACH GROUND WIRE TO PILE WITH GROUNDING CONNECTOR AS SHOWN ON DETAIL "B", DWG. TMD301.

ANODES

6. ANODES SHALL BE CONNECTED TO THE PILE AS DETAILED ON DET. "A", DWG. TMD299 AND INSTALLED ON DWG. TMD302 AND TMD299. ALL MATERIAL FOR ANODE INSTALLATION IS SHOWN ON DWG. TMD299.

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 4 | 9–6–17 | REV. NOTES 2/3, CLARIFY MULTI–POLE BOM, ALT. ITEM 1 | ECW | CDHH | JRA |
| 3 | 9–30–16 | UPDATED AND REFORMATED BOM'S AND NOTES | ECW | PL | JRA |
| 2 | 1–5–15 | DELETE ITEM 3, REV. QUAN. ITEM 4 | ECW | FWM | WLS |
| 1 | 7–24–06 | REVISED ITEM #1 | RMB | | |
| 0 | 02–12–03 | ISSUED | ITRON | | |

GND–S–PILE

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

Grounding, Steel Pole, Steel Pile

STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE:

Entergy | No. TMD296A4 | PLOT | SH. OF

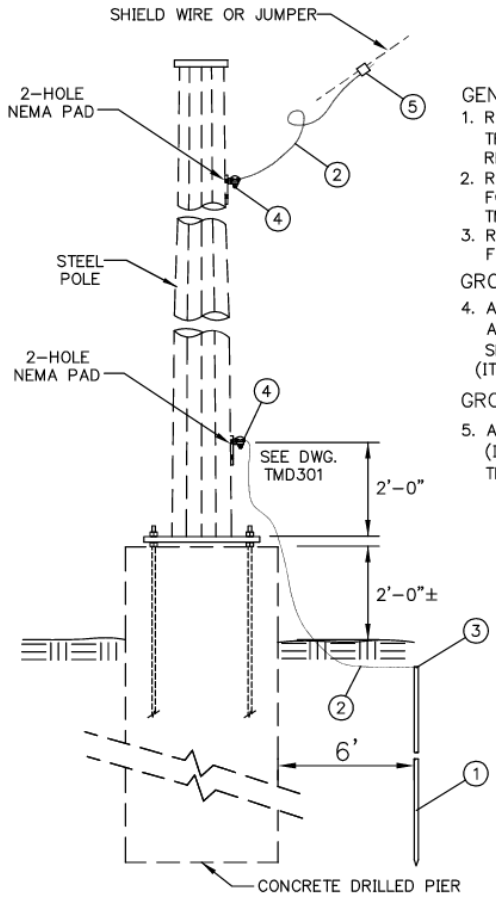
ewilli2 9/6/2017 GND–S–PILE

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS – GROUNDING

| ITEM | TYP. QUANTITY FOR STR. w/ 1 POLE | 2 POLES | 3 POLES | STOCK NO. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 1** | 2** | 3** | EN013434 | ROD, GROUND, 5/8"x8', COPPER CLAD |
| 2 | 2 lb. *** | 4 lb. *** | 6 lb. *** | EN000362 | WIRE, COPPERWELD, #4 (.1158lbs/ft) |
| 3 | 1** | 2** | 3** | EN008745 | CONNECTOR, CADWELD, #4 TO TOP OF 5/8" GROUND ROD ("L") |
| 4 | 2 | 4 | 5 | EN014861 | TERMINAL, GROUNDING LUG, #8–2/0 TO 1/2–13, BRONZE ALLOY |
| 5 | 1 * | 2 * | 2 * | LS5012XX | CONNECTOR, AMPACT, VARIABLE CONDUCTOR SIZE TO #4 COPPERWELD. |

* FOR DOUBLE SHIELD WIRE, DOUBLE QTY, OF ITEM 5. ITEM 5 IS NOT USED FOR GROUNDING OPGW TO POLE. FOR OPGW SEE DRAWING TMD343.
** FOR HIGH–RESISTANCE SOILS, ADDITIONAL GROUND RODS WILL BE REQUIRED AND "T" CONNECTORS (EN009796) CAN BE USED TO FACILITATE ADDITIONAL RODS.
*** SOFT DRAWN COPPER (32159134) MAY BE SUBSTITUTED FOR CONNECTIONS AT TOP OF POLE ONLY.




GENERAL

1. REFERENCE "GROUNDING APPLICATION GUIDELINE", TRANSMISSION LINE STANDARD T00109 FOR GROUNDING REQUIREMENTS.
2. REFERENCE DWGS. TMD222, TMD223 TMD224, AND TMD225 FOR OVERHEAD GROUND WIRE ASSEMBLIES; AND DWG. TMD389 FOR GUY TO POLE BONDING.
3. REFERENCE DWGS. TMD389, TMD399, AND TMD402 FOR OPGW GROUNDING ASSEMBLIES.

GROUNDING – NON–OPGW SHIELD WIRE TO POLE

4. ATTACH CONNECTING GROUND WIRE TO TERMINAL LUG AS DETAILED ON DET. "A", SHT. TMD301 AND TO SHIELD WIRE OR JUMPER WITH AMPACT CONNECTOR (ITEM 5).

GROUNDING – POLE TO GROUND ROD

5. ATTACH CONNECTING GROUND WIRE TO TERMINAL LUG (ITEM 4) ON POLE AS DETAILED ON DET. A DWG. TMD301 AND TO GROUND ROD AS SHOWN ON THIS DWG.

GND–S–PIER

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 5 | 9–6–17 | REV. NOTES 2/3, CLARIFY MULTI–POLE BOM, ALT. ITEM 1 | ECW | CDHH | JRA |
| 4 | 9–30–16 | UPDATED AND REFORMATED BOM'S AND NOTES | ECW | PL | JRA |
| 3 | 12–21–09 | ADDED GROUND ROD DIMENSION | HDR | RLR | ECW |
| 2 | 07–24–06 | REVISED ITEM #5 | RMB | | |
| 1 | 01–25–05 | REMOVED ANODES | RMB | | |

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

GROUNDING, STEEL POLE, CONCRETE DRILLED PIER STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD297A5 | PLOT 1=32 | SH. 1 OF 1

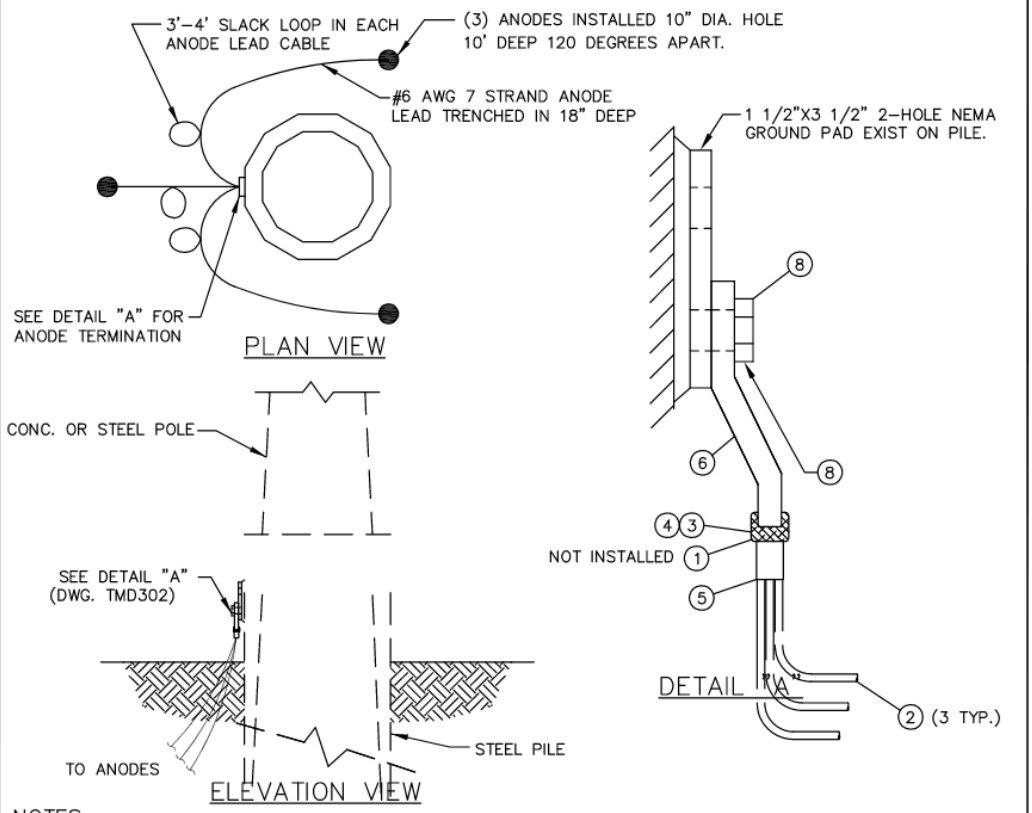
ewilli2 9/6/2017 GND–S–PIER

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1* | EN013170 | HANDLE; CLAMP, METAL; CADWELD, FITS C/E/R 3" MOLDS (1 PER 50 CONN.) |
| 2 | 3 | SEE DWG TMD302 | ANODE, W/#6 AWG., SIZE AND MATERIAL VARY WITH INSTALLATION |
| 3 | 1* | 32122722 | MOLD, EXOTHERMIC, 3/0 STR. CU CABLE TO 1/4"X-1 1/2"LUG, (1 PER 50 CONN.) |
| 4 | 1.5 | EN019108 | CARTRIDGE, THERMOWELD POWDER; #90 CHARGE, CADWELD METAL |
| 5 | 1 | EN019109 | SLEEVE: CADWELD; ADAPTER SLEEVES ARE USED TO ADAPT 1/0, 1 STR |
| 6 | 1 | 32074891 | NEMA 1-HOLE COPPER BUS BAR FOR PIPE PILE FOUNDATIONS |
| 7 | 1 | EN019252 | COMPOUND: ELECTRICAL JOINT, INHIBITOR, GREASE LIKE, 8 OZ TUBE |
| 8 | 1 | 0000018450 | ASSEMBLY, BOLT: MACH, SS, 1/2" DIA. x 1" LG. W/NUT & WASHERS. SEE NOTE 5. |

* - ORDER ONE EA. PER 50 CONNECTIONS




NOTES

1) FOR INSTALLATION OF ANODES REFER STANDARD T00109 AND DWG. TMD302.
2) COAT ALL MECHANICAL CONNECTIONS (THREADS AND BUS BAR TO NUTS) WITH ELECTRICAL JOINT INHIBITOR COMPOUND.
3) ANODE MATERIAL PROVIDED TO PROTECT STEEL PILE. SEE DWG. TMD296 FOR BONDING OF STEEL POLE TO STEEL PILE.
4) USE GALVANIZING TOUCH-UP ENOI9331 IF REQUIRED.
5) ITEM 8 HAS 1 NUT & 1 WASHER THAT WILL NOT BE USED.

ANODE-S-PILE

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 3 | 8-21-14 | REV. STK NO. ITEM 6, CHANGE MOLD ITEM 3 | ECW | | WLS |
| 2 | 03-17-14 | REVISED ITEMS 2 & 6, NOTES 1 & 3 | ECW | JRA | WLS |
| 1 | 08-10-06 | GENERAL DRAWING REVISION | RJL | | |
| 0 | 2-11-03 | CREATED | ITRON | | |

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

ANODE INSTALLATION DETAILS FOR STEEL PILES
STRUCTURAL ASSEMBLY DETAIL

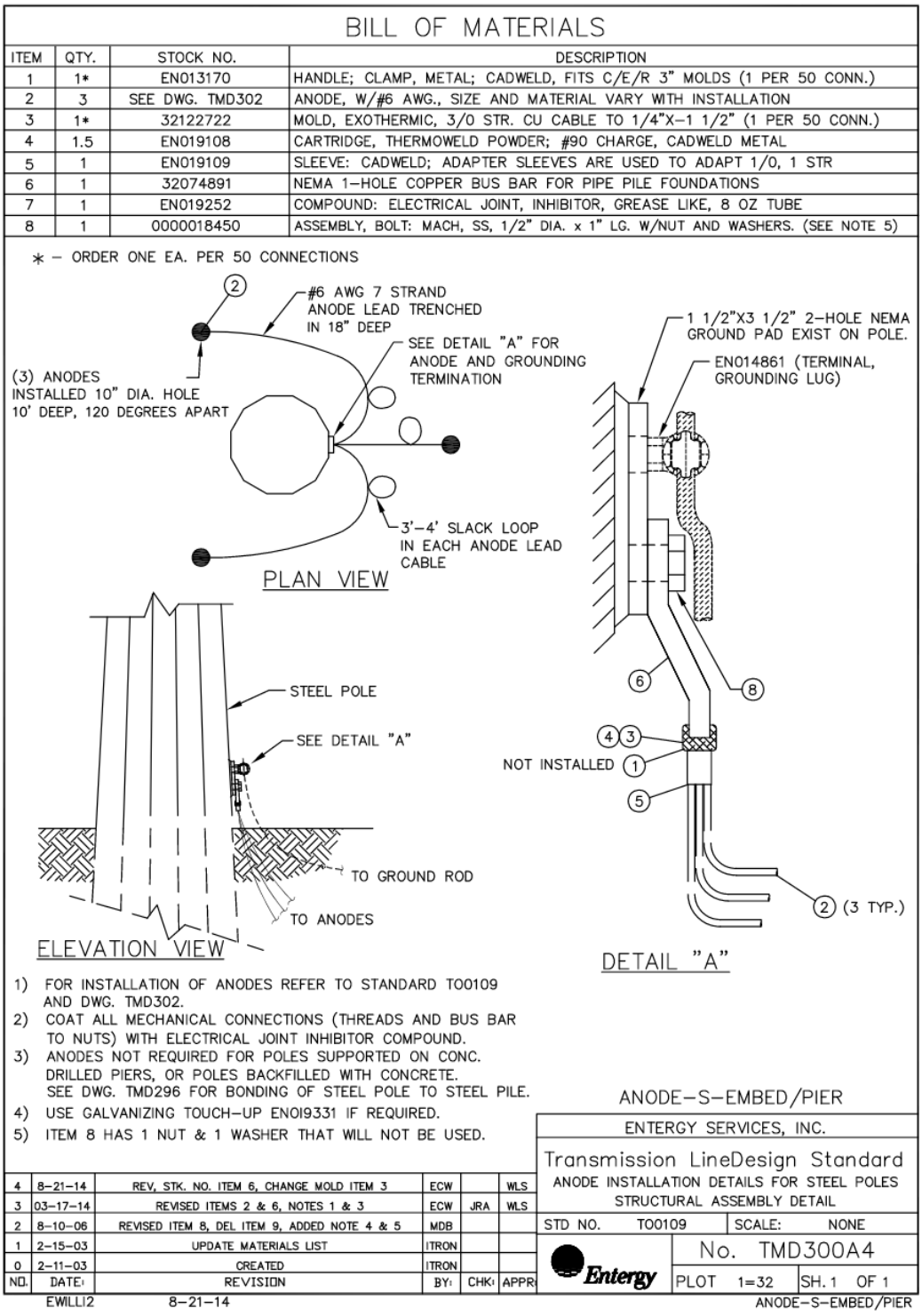
STD NO. T00109 | SCALE: NONE

Entergy | No. TMD299A3 | PLOT 1=32 | SH. 1 OF 1

EWILLI2 8-21-14 ANODE-S-PILE

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



BILL OF MATERIALS

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1* | EN013170 | HANDLE; CLAMP, METAL; CADWELD, FITS C/E/R 3" MOLDS (1 PER 50 CONN.) |
| 2 | 3 | SEE DWG. TMD302 | ANODE, W/#6 AWG., SIZE AND MATERIAL VARY WITH INSTALLATION |
| 3 | 1* | 32122722 | MOLD, EXOTHERMIC, 3/0 STR. CU CABLE TO 1/4"X-1 1/2" (1 PER 50 CONN.) |
| 4 | 1.5 | EN019108 | CARTRIDGE, THERMOWELD POWDER; #90 CHARGE, CADWELD METAL |
| 5 | 1 | EN019109 | SLEEVE: CADWELD; ADAPTER SLEEVES ARE USED TO ADAPT 1/0, 1 STR |
| 6 | 1 | 32074891 | NEMA 1-HOLE COPPER BUS BAR FOR PIPE PILE FOUNDATIONS |
| 7 | 1 | EN019252 | COMPOUND: ELECTRICAL JOINT, INHIBITOR, GREASE LIKE, 8 OZ TUBE |
| 8 | 1 | 0000018450 | ASSEMBLY, BOLT: MACH, SS, 1/2" DIA. x 1" LG. W/NUT AND WASHERS. (SEE NOTE 5) |

* - ORDER ONE EA. PER 50 CONNECTIONS



1) FOR INSTALLATION OF ANODES REFER TO STANDARD T00109 AND DWG. TMD302.
2) COAT ALL MECHANICAL CONNECTIONS (THREADS AND BUS BAR TO NUTS) WITH ELECTRICAL JOINT INHIBITOR COMPOUND.
3) ANODES NOT REQUIRED FOR POLES SUPPORTED ON CONC. DRILLED PIERS, OR POLES BACKFILLED WITH CONCRETE. SEE DWG. TMD296 FOR BONDING OF STEEL POLE TO STEEL PILE.
4) USE GALVANIZING TOUCH-UP EN0I9331 IF REQUIRED.
5) ITEM 8 HAS 1 NUT & 1 WASHER THAT WILL NOT BE USED.

ANODE-S-EMBED/PIER

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 4 | 8-21-14 | REV, STK. NO. ITEM 6, CHANGE MOLD ITEM 3 | ECW | | WLS |
| 3 | 03-17-14 | REVISED ITEMS 2 & 6, NOTES 1 & 3 | ECW | JRA | WLS |
| 2 | 8-10-06 | REVISED ITEM 8, DEL ITEM 9, ADDED NOTE 4 & 5 | MDB | | |
| 1 | 2-15-03 | UPDATE MATERIALS LIST | ITRON | | |
| 0 | 2-11-03 | CREATED | ITRON | | |

EWILLI2 8-21-14

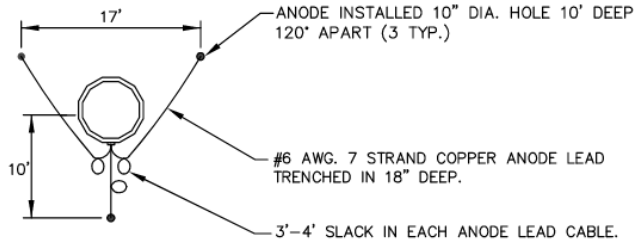
ENTERGY SERVICES, INC.
Transmission LineDesign Standard
ANODE INSTALLATION DETAILS FOR STEEL POLES
STRUCTURAL ASSEMBLY DETAIL
STD NO. T00109 SCALE: NONE
Entergy No. TMD300A4
PLOT 1=32 SH. 1 OF 1
ANODE-S-EMBED/PIER

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

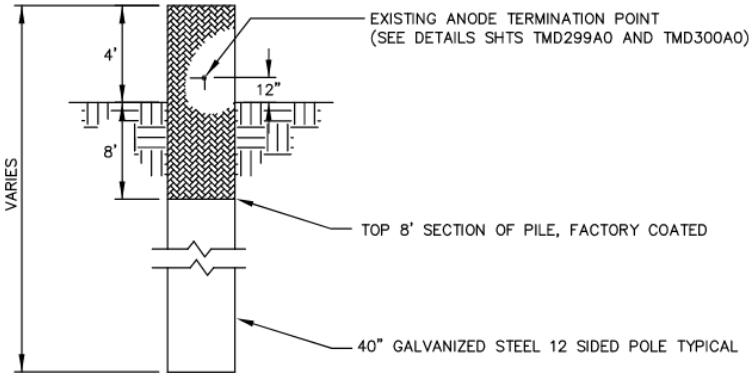
### TYPICAL APPLICATION OF ANODE MATERIALS

| STOCK NO. | DESCRIPTION | TYPICAL APPLICATION |
|---|---|---|
| EN015961 * | ANODE HIGH POTENTIAL MAGNESIUM, 32 LBS, W/ BACKFILL | RESISTIVITY > 2000 OHM-CM |
| EN015964 | ANODE HIGH POTENTIAL MAGNESIUM, 60 LBS, W /BACKFILL | RESISTIVITY > 2000 OHM-CM |
| 32108212 * | ANODE MAGNESIUM ALLOY, 32 LBS, W /BACKFILL | RESISTIVITY 1000 TO 2000 OHM-CM |
| 32108213 * | ANODE MAGNESIUM ALLOY, 50 LBS, W /BACKFILL | RESISTIVITY 1000 TO 2000 OHM-CM |
| EN015968 * | ANODE ZINC, 30 LBS, W /BACKFILL | RESISTIVITY < 1000 OHM-CM |
| EN015970 | ANODE ZINC, 60 LBS, W /BACKFILL | RESISTIVITY < 1000 OHM-CM |
| EN015972 | ANODE ZINC, 120 LBS, W /BACKFILL | RESISTIVITY < 1000 OHM-CM |
| EN015967 * | ANODE ZINC, 30 LBS, W/O BACKFILL | RESISTIVITY < 1000 OHM-CM, VERY SOFT SOIL |
| EN015969 | ANODE ZINC, 60 LBS, W/O BACKFILL | RESISTIVITY < 1000 OHM-CM, VERY SOFT SOIL |
| EN015971 | ANODE ZINC, 120 LBS, W/O BACKFILL | RESISTIVITY < 1000 OHM-CM, VERY SOFT SOIL |

*SEE NOTE 2.




PLAN VIEW




ELEVATION VIEW

1) ANODE WEIGHT IS WEIGHT OF METAL AND DOES NOT INCLUDE BACKFILL, LEADS, ETC., SEE INDUS FOR HANDLING WEIGHTS. LEAD NO. 6 AWG 7S, BSD COPPER THW INSULATION.
2) INSTALL IN 10"-DIA. X 10-FT HOLE. REMOVE PLASTIC BAG, LOWER IN BY LEAD; FILL SOIL AROUND AT ONCE. HOLE DEPTH MAY BE REDUCED TO 8' FOR 30#, 32# AND 50# ANODES.
3) LEAD CONNECTION AS SHOWN IN DRAWING DETAILS.

ANODE-INSTALLATION

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
CATHODIC PROTECTION FOR STEEL STRUCTURES
TYP. ANODE INSTALLATION

STD NO. T00109 | SCALE: NONE

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 1 | 03-17-14 | ADD ALT. MATLS; COATING DIM., REV. NOTES 1 2, & 4 | ECW | JRA | WLS |
| 0 | 02-15-03 | DRAWING ISSUED | ITRON | | |

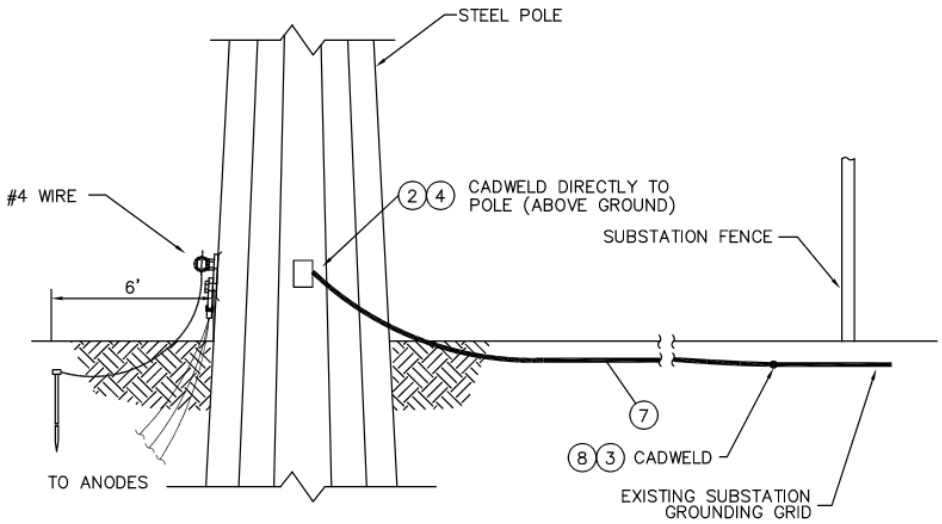
Entergy | No. TMD302A1 | PLOT 1=32 | SH. 1 OF 1

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1* | EN013170 | HANDLE; CLAMP, METAL; CADWELD, FITS C/E/R 3" MOLDS (1 PER 50 CONNECTIONS) |
| 2 | 1 | 32046156 | MOLD, 19 # 9 COPPERWELD STRANDED CABLE TO VERTICAL STEEL (1 PER 10 CONN.) |
| 3 | 1 | EN013619 | CARTRIDGE, EXOTHERMIC, #150 CHARGE, F20 ALLOY FOR Cu-TO-Cu AND Cu-TO-STEEL |
| 4 | 1 | EN013173 | CARTRIDGE, EXOTHERMIC, #200 CHARGE, WELD METAL |
| 5 | 1 | EN019252 | COMPOUND: ELECTRICAL JOINT, INHIBITOR, GREASE LIKE, 8 OZ TUBE |
| 6 | 1 | EN019331 | COATING; PROTECTIVE, 1/2 PINT; TOUCHUP FOR ALL TAR EXTENDED |
| 7 | 50 ft. | 32127987 | WIRE, CAMO COPPERWELD, ANTI-THEFT, 19 #9 AWG, 40% CONDUCTIVITY |
| 8 | 1 | 32046150 | MOLD, 19 # 9 COPPERWELD STRANDED CABLE TO 4/0 (1 PER 10 CONNECTIONS) |

* ORDER ONE EACH PER 50 CONNECTIONS.




NOTES:

1. FOR INSTALLATION OF ANODES REFER TO DOCUMENT TITLED "INSTALLATION OF CATHODIC PROTECTION ANODES". SEE DWG'S. TMD300 AND TMD302 FOR ANODE INSTALLATION DETAILS AND MATERIAL.
2. COAT ALL MECHANICAL CONNECTIONS (THREADS AND BUS BAR TO NUTS) WITH ITEM #5.
3. SEE DWG. TMD295, TMD296 OR TMD297 FOR POLE GROUNDING DETAILS AND MATERIAL.
4. GROUNDING IN ACCORDANCE WITH THIS DRAWING IS FOR POLE(S) THAT SUPPORT SHIELD WIRE SPAN(S) THAT CROSS OR TERMINATE IN A SUBSTATION.
5. ITEMS 1, 2 & 8 ARE CADWELD ITEMS – NOT INSTALLED.

GND-S-POLE-SUBSTA

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 5 | 1-5-15 | BOM, ITEMS 2,3,4,7,& 8, ADD ITEM NUMBERS TO DRG | ECW | FWM | WLS |
| 4 | 07-22-10 | NOTE 4, DEL. EN019108/RENUM IT. #'S, REV. IT. 3 QUAN. | CBM | JRA | ECW |
| 3 | 07-22-10 | GROUND ROD DIM | CBM | ECW | ECW |
| 2 | 12-17-09 | REV STK CODE FOR ITEM 8 | HDR | ECW | ECW |
| 1 | 06-30-06 | GENERAL REVISION | MDB | | |
| 0 | 02-11-03 | ISSUED | ITRON | | |

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

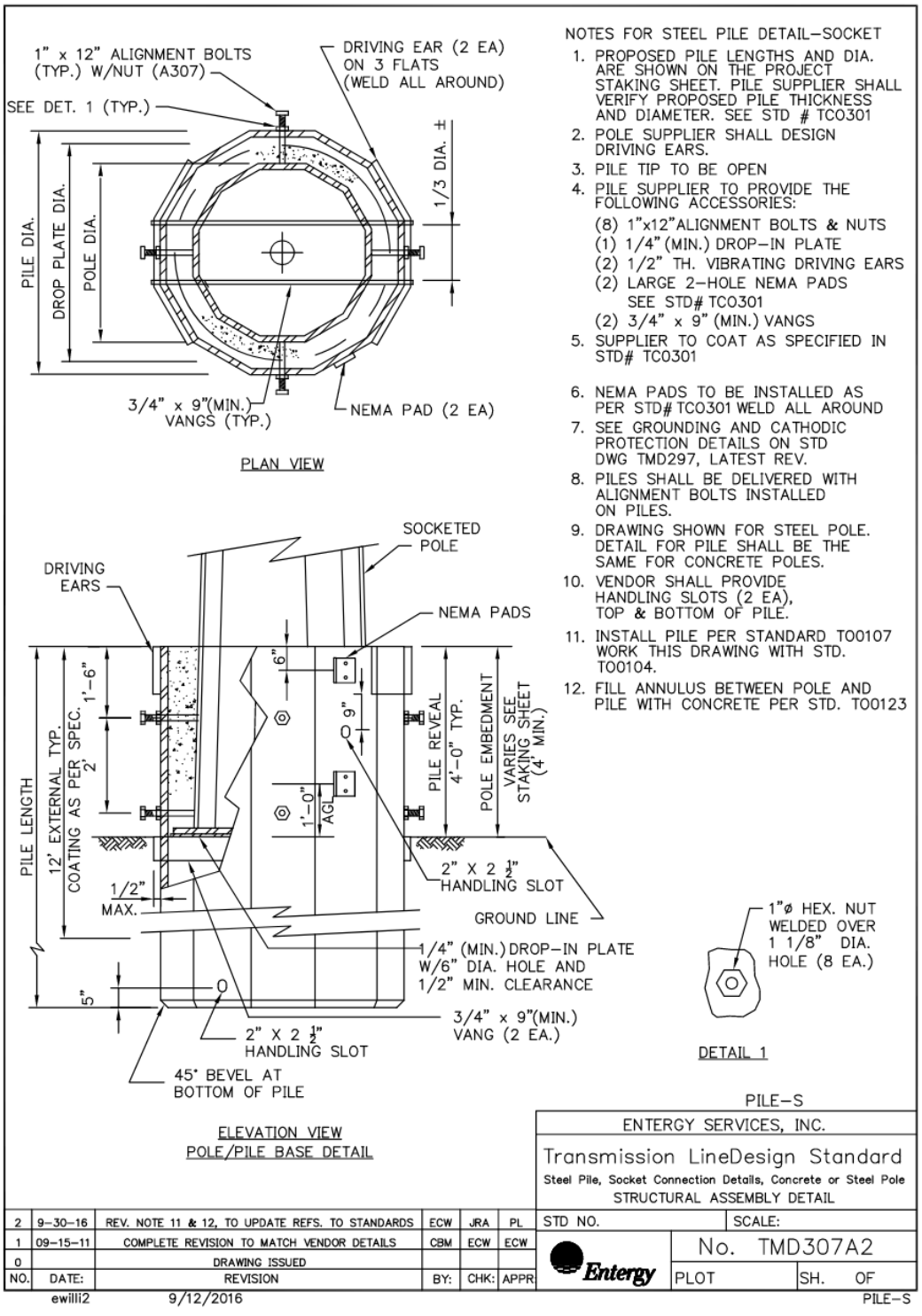
GROUNDING, STEEL POLE TO SUBSTATION GRID STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD303A5 | PLOT 1=1 | SH. 1 OF 1

EWILLI2 12-15-2014 GNDSPSUB

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS




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# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

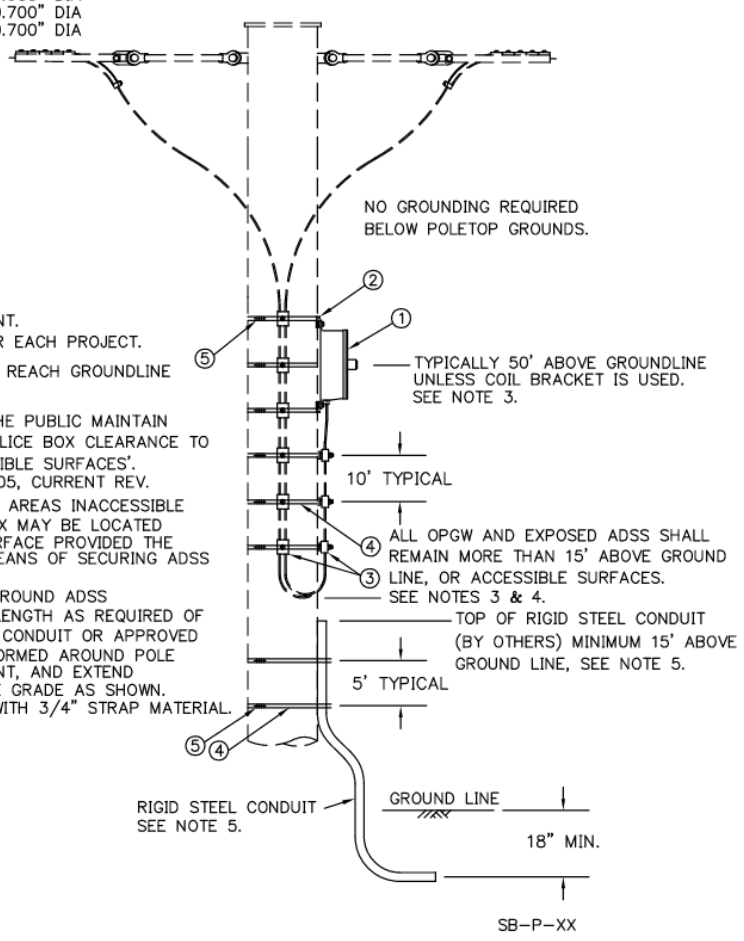
### BILL OF MATERIALS

SPLICE BOX, POLE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0032018592 | SPLICE BOX: FIBER OPTIC, HOLES FOR 1/2" LAG SCREW OR BOLT |
| 2 | 1 | 0032026880 | ADAPTER, ASSEMBLY, BANDING, FIBER OPTIC, FOR 3/4 BAND, CONSISTING OF TWO ADAPTERS AND TWO 1/2" HEX BOLT ASSEMBLIES |
| 3 | 12 | LS9014XX | CLAMP, DOWNLEAD: FIBER OPTIC, WITH BANDING ADAPTER |
| 4 | 1 ROLL | 0000017124 | BAND, STRAPPING, 3/4" WD X 100FT LG ROLL, STAINLESS STEEL, 201 |
| 5 | 12 | 0000017123 | CLAMP, BAND: ADJUSTABLE, 3/8" X 6" BOLT, FOR 3/4" BAND |

ITEM #3 AVAILABLE

| | | |
|---|---|---|
| 57MM | 0032038843 | 0.400–0.500" DIA |
| 64MM | 0032038845 | 0.501–0.600" DIA |
| 52MM | 0032038846 | 0.601–0.700" DIA |
| 92MM | 0032038846 | 0.601–0.700" DIA |




NOTES

1. ITEM #3 IS OPGW DEPENDENT. THIS ITEM IS SELECTED FOR EACH PROJECT.
2. PROVIDE ENOUGH OPGW TO REACH GROUNDLINE PLUS 35 FEET.
3. IN AREAS ACCESSIBLE TO THE PUBLIC MAINTAIN 15' MINIMUM OPGW AND SPLICE BOX CLEARANCE TO GROUND OR TOP OF ACCESIBLE SURFACES'. WORK WITH DRAWING SMC005, CURRENT REV.
4. IN SUBSTATIONS OR OTHER AREAS INACCESSIBLE TO THE PUBLIC, SPLICE BOX MAY BE LOCATED 5' ABOVE THE GROUND SURFACE PROVIDED THE THE ADSS IS SECURED. MEANS OF SECURING ADSS PROVIDED BY OTHERS.
5. WHEN SPLICING TO UNDERGROUND ADSS CONTRACTOR TO PROVIDE LENGTH AS REQUIRED OF GALV. STL. 2" SCHED. 40 CONDUIT OR APPROVED EQUAL. CONDUIT TO BE FORMED AROUND POLE FOUNDATION WHERE PRESENT, AND EXTEND 1.5' MINIMUM BELOW GRADE GRADE AS SHOWN. CONDUIT TO BE SECURED WITH 3/4" STRAP MATERIAL.

| NO. | DATE: | REVISION | BY: | CHK: | APPR. |
|---|---|---|---|---|---|
| 5 | 9–6–17 | ADD GUARD PIPE, REV NOTES 1 – 3, ADD NOTE 4 & 5 | ECW | CDHH | JRA |
| 4 | 2–18–10 | CHANGED UNITS FOR ITEM 4 | TWF | HSK | HSK |
| 3 | 12–08–09 | REPLACE ITEM NOS. IN BOM | HDR | ECW | ECW |
| 2 | 8–3–07 | REPL. ADAPT. W/ ASSY, REV. DIA. RANGES | TWF | HSK | HSK |
| 1 | 05–15–07 | REVISED NAME & DESCRIPTION | TWF | HSK | HSK |

ewilli2 9/6/2017

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

SPLICE BOX, POLE

STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD337A5 | PLOT 1=1 | SH. 1 OF 1

SB–P–XX

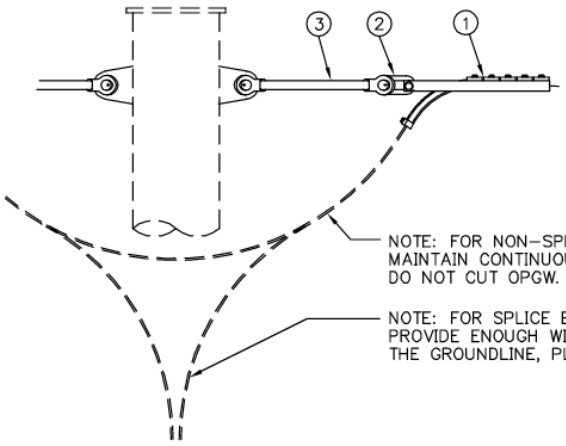
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

OVERHEAD GROUND WIRE, DEADEND, OPGW, POLE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | LS9011XX | DEADEND: BOLTED STRAIN,OPGW,3/4" PIN DIA. |
| 2 | 1 | 0000012586 | LINK, CHAIN: 5/8" X 3-1/4", 40K |
| 3 | 1 | 0000024787 | CLEVIS CLEVIS: Y-Y, 30K, 3/4" PD, 15" LONG |

NOTE: ILLUSTRATED AS TANGENT OR SMALL ANGLE STRUCTURE. LARGER ANGLES WILL HAVE THE PULLOFFS AT DIFFERENT ELEVATIONS BY SEVERAL INCHES.




ITEM #1 AVAILABLE
57MM 0000018531 0.465" DIA
64MM 0032018594 0.528" DIA
52MM 0032018595 0.646" DIA
92MM 0032018596 0.671" DIA

1) ITEM #1 IS OPGW DEPENDENT.
THIS ITEM IS SELECTED FOR EACH PROJECT.

OHG-DE-OP-P-XX

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
OVERHEAD GRNDWIRE, DE, OPGW, POLE
STRUCTURAL ASSEMBLY DETAIL

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 2 | 5-15-07 | REVISED NOTES, NAME & DESCRIPTION | TWF | HSK | HSK |
| 1 | 8-23-06 | UPDATED BILL OF MATERIAL | RJL | HSK | HSK |
| 0 | X | CREATED | | HSK | HSK |

STD NO. | SCALE: NONE

Entergy | No. TMD339A2 | PLOT 1=1 | SH. 1 OF 1

tfinc90 6/25/2007 OHG-DE-OP-P-XX

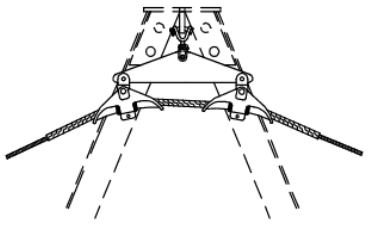
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

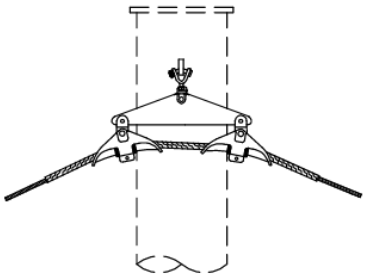
### BILL OF MATERIALS

OVERHEAD GROUND WIRE, SUSP. 30–50° w/YOKE, OPGW

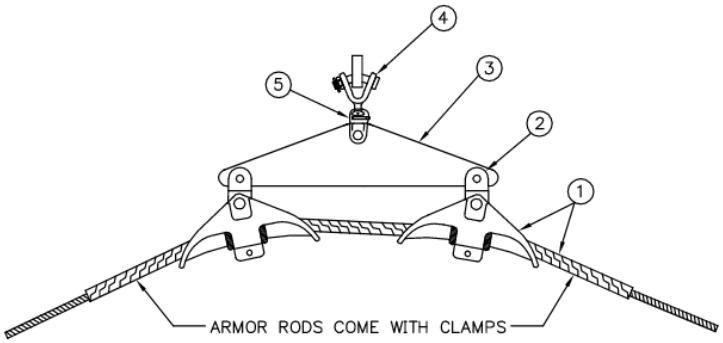
| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | LS9010XX | CLAMP, SUSP: DOUBLE (2 CLAMPS).,ALUM AL,15K,W/48" ARM RODS,30°–60° MAX. ANGLE |
| 2 | 2 | 0032020410 | CLEVIS EYE: STRAIGHT, 30K, 2–7/8" LG,1–5/8" EYE WD,3/4" EYE RAD, 5/8" PIN DIA |
| 3 | 1 | 0032020414 | PLATE, YOKE: DELTA, DUCTILE IRON, 18" LONG, 30K |
| 4 | 1 | 0000004375 | BALL CLEVIS: 45 DEG Y, 30K, 3/4" PD, CLASS 52–3/5 |
| 5 | 1 | 0000000486 | SOCKET CLEVIS: STRAIGHT, 30K, 5/8" PD, CLASS 52–3/5 |



AS ON LATTICE TOWER



AS ON POLE




ITEM #1 AVAILABLE
57MM 0032018593 0.450–0.475" DIA
64MM 0000017195 0.528–0.555" DIA
52MM 0000017196 0.615–0.646" DIA
92MM 0000017198 0.647–0.679" DIA

1) ITEM #1 OPGW DEPENDENT.
THIS ITEM IS SELECTED FOR EACH PROJECT.

OHG–SUY–OP–XX

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
OVERHEAD GRNDWIRE, SUSP 30–50 W/YOKE, OPGW
STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD341A2 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR |
|---|---|---|---|---|---|
| 2 | 5–15–07 | REVISED NAME & DESCRIPTION. COMBINED DWGS TMD340 & TMD341 | TWF | HSK | HSK |
| 1 | 8–01–06 | EXPANDED DESCRIPTIONS OF ITEMS 1 & 2 | CDR | HSK | HSK |
| 0 | 5–24–04 | CREATED | . | HSK | HSK |

tfinc90 6/25/2007 OHG–SUY–OP–XX

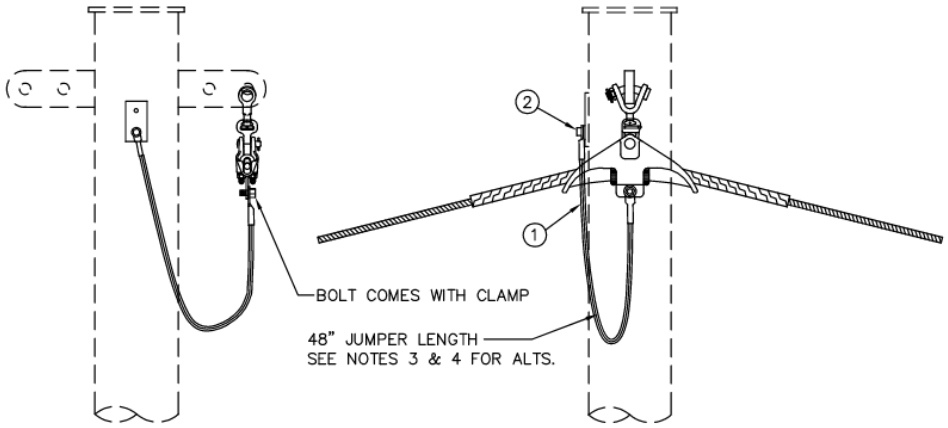
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

GROUND, SUSP. 0–30°, OPGW, STEEL POLE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0032033755 | JUMPER, STATIC LINE: MULTI–STRANDED TINNED COPPER, 133/.0177, 48" LG, W/TERMINALS |
| 2 | 1 | 0000018450 | ASSEMBLY, BOLT: MACH, SS, HEX HEAD, 1/2" DIA. X 1" LG., WITH NUT, 2 WASHERS AND 1 BELLEVILLE WASHER |




NOTES:

1. ITEM 1 CAN BE MADE UP WITH 48" OF THE WIRE (0032018798) AND TWO TERMINALS (0032031548) AND COMPRESSING THE TERMINALS WITH AN INDENT DIE.
2. ITEM 2 HAS 1 NUT AND 1 WASHER THAT WILL NOT BE NEEDED.
3. USE 72" JUMPER (0032052394) FOR APPLICATION ON POLES WITH 3 FOOT SW DAVIT ARMS.
4. SEE DRAWING TMQ207 FOR OTHER AVAILABLE JUMPER LENGTHS.

GND–SUS–OP–S

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 3 | 3–26–14 | ADD NOTES 3 AND 4 WITH ALT. JUMPER LENGTHS. | ECW | JRA | WLS |
| 2 | 3–15–07 | REV. NOTES, NAME & DESCRIPTION. SIDE VIEW ADDED. | TWF | HSK | HSK |
| 1 | 8–17–06 | DELETED 1 BOLT ON CLAMP, MADE JUMPER AND TERMINALS AN ASSEMBLY | RJL | HSK | HSK |
| 0 | 5–24–04 | CREATED | . | HSK | HSK |

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

GROUND, SUSP, 0–30, OPGW, STEEL POLE STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy No. TMD343A3

PLOT 1=1 | SH. 1 OF 1

ewilli2 3–17–14 GND–SUS–OP–S

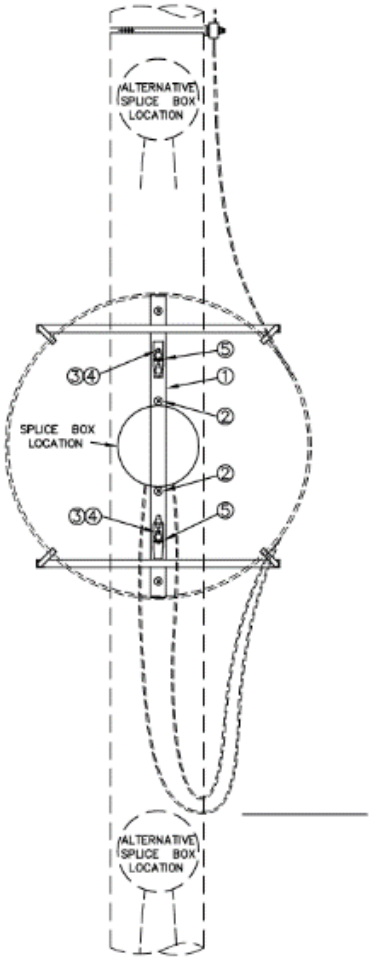
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

COIL BRACKET, OPGW, STEEL POLE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0032031230 | BRACKET, COIL,: 60 INCH, GALV. STEEL, PER ENTERGY DWG TMM060A |
| 2 | 2 | – | BOLT, MACHINE, 1/2"–13 X 1", ALL THREAD, GALV. STEEL, NO NUT, NO WASHER (ANY SUPPLIER) |
| 3 | 0 | 0000000139 | BOLT ASSEMBLY, MACHINE: HEX HEAD, GALV. STEEL, 5/8"–11 X 1–1/2", WITH HEX NUT |
| 4 | 0 | 0000005532 | WASHER, ROUND, FLAT, 11/16" ID, 1–1/2" OD, 1/8" THICK, ASTM A153, GALV. STEEL |
| 5 | 0 | 0032031232 | PLATE, BENT, GALV. STEEL, PER ENTERGY DWG. TMM061A |




NOTE #1: ASSEMBLY WILL TYPICALLY BE BANDED TO POLE USING 3/4" SS BAND MATERIAL AND ADAPTERS SUPPLIED WITH THE SPLICE BOX. ALTERNATELY, THE COIL BRACKET ASSEMBLY MAY BE SECURED WITH TWO 1/2: BOLTS (ITEM 2) USING ANY TWO OF THE FOUR THREADED RECEIVER PROVIDED.

NOTE #2: TWO EACH OF ITEMS 3 AND 5, AND FOUR OF ITEM 4 MAY ALSO BE USED TO SECURE THE COIL BRACKET ASSEMBLY TO POLES ALREADY IN SERVICE THAT WERE MANUFACTURED WITH STEP CLIPS. THE STEP CLIP DETAIL IS COMMON ON OLDER POLES MANUFACTURED BY THOMAS & BETTS.

NOTE #3: COIL BRACKET ASSEMBLY CAN BE INSTALLED WITH EITHER END UP. BEFORE TIGHTENING BOLTS, BE SURE THAT WEIGHT OF COMPONENTS PULLS THEM FIRMLY INTO SLOTTED HOLES IN THE CHANNEL.

NOTE #4: THE LOWEST PART OF THE INSTALLATION MUST BE A MINIMUM OF 15 FEET ABOVE GROUNDINE AND THE CABLE MUST COME INTO THE BOTTOM OF THE SPLICE BOX WITH NO STRAIN ON THE CONNECTORS. ADDITIONAL BANDING MAY BE NECESSARY TO GATHER AND STABILIZE THE EXCESS CABLE LENGTH TO THE BRACKET AND POLE. HOLES ARE PROVIDED IN THE END OF EACH ARM TO ACCOMMODATE CABLE TIES OR WIRE TIES.

15' MINIMUM ABOVE GL. IF ALTERNATE SPLICE BOX LOCATION IS USED, NO PART OF INSTALLATION CAN BE LOWER THAN 15' ABOVE THE GROUND LINE.

CB–OP–S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

COIL BRACKET, OPGW, STEEL POLE

STRUCTURAL ASSEMBLY DETAIL

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 3 | 9–24–15 | ADD REF. LINE FOR 15' MIN. DIMENSION | ECW | | ECW |
| 2 | 8–21–14 | QTY. ITEMS 3–5, REV. NOTES 1 & 2 | ECW | | WLS |
| 1 | 5–15–07 | REVISED NAME & DESCRIPTION | TWF | HSK | HSK |
| 0 | 3–30–06 | CREATED | RMB | HSK | HSK |

STD NO. | SCALE: NONE

Entergy | No. TMD386A3 | PLOT 1=1 | SH. 1 OF 1

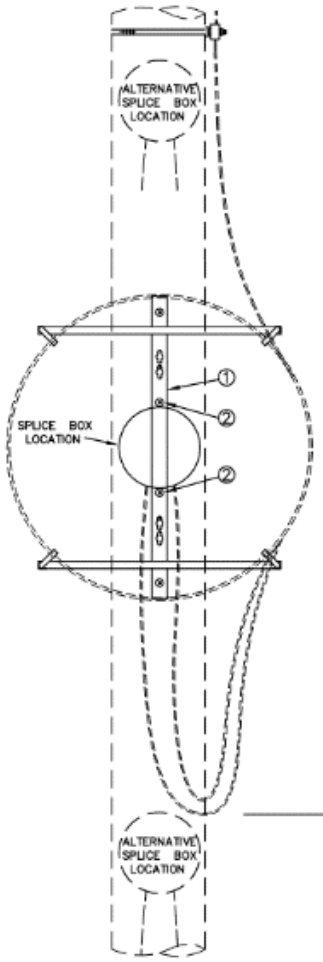
EWILLI2 08–24–15 CB–OP–S

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

COIL BRACKET, OPGW, CONCRETE POLE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0032031230 | BRACKET, COIL,: 60 INCH, GALV. STEEL, PER ENTERGY DWG TMM060A |
| 2 | 2 | – | BOLT, MACHINE, 1/2"–13 X 1", ALL THREAD, GALV. STEEL, NO NUT, NO WASHER (ANY SUPPLIER) |
| – | – | – | – |
| – | – | – | – |
| – | – | – | – |




NOTE #1: ASSEMBLY WILL TYPICALLY BE BANDED TO POLE USING 3/4" SS BAND MATERIAL AND ADAPTERS SUPPLIED WITH THE SPLICE BOX. ALTERNATELY, THE COIL BRACKET ASSEMBLY MAY BE SECURED WITH TWO 1/2: BOLTS (ITEM 2) USING ANY TWO OF THE FOUR THREADED RECEIVER PROVIDED.

NOTE #2: COIL BRACKET ASSEMBLY CAN BE INSTALLED WITH EITHER END UP. BEFORE TIGHTENING BOLTS, BE SURE THAT WEIGHT OF COMPONENTS PULLS THEM FIRMLY INTO SLOTTED HOLES IN THE CHANNEL.

NOTE #3: THE LOWEST PART OF THE INSTALLATION MUST BE A MINIMUM OF 15 FEET ABOVE GROUNDINE AND THE CABLE MUST COME INTO THE BOTTOM OF THE SPLICE BOX WITH NO STRAIN ON THE CONNECTORS. ADDITIONAL BANDING MAY BE NECESSARY TO GATHER AND STABILIZE THE EXCESS CABLE LENGTH TO THE BRACKET AND POLE. HOLES ARE PROVIDED IN THE END OF EACH ARM TO ACCOMMODATE CABLE TIES OR WIRE TIES.

15' MINIMUM ABOVE GL. IF ALTERNATE SPLICE BOX LOCATION IS USED, NO PART OF INSTALLATION CAN BE LOWER THAN 15' ABOVE THE GROUND LINE.

CB–OP–C

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

COIL BRACKET, OPGW, CONCRETE POLE

STRUCTURAL ASSEMBLY DETAIL

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 3 | 9–24–15 | ADD REF. LINE FOR 15' MIN. DIMENSION | ECW | | ECW |
| 2 | 8–21–14 | REV NOTE 1, DEL ITEM 3 & NOTE 2, RENUM NOTES | ECW | | WLS |
| 1 | 5–15–07 | REVISED NAME & DESCRIPTION | TWF | HSK | HSK |
| 0 | 3–30–06 | CREATED | RMB | HSK | HSK |

STD NO. | SCALE: NONE

Entergy | No. TMD387A3 | PLOT 1=1 | SH. 1 OF 1

EWILLI2 8/24/15 CB–OP–C

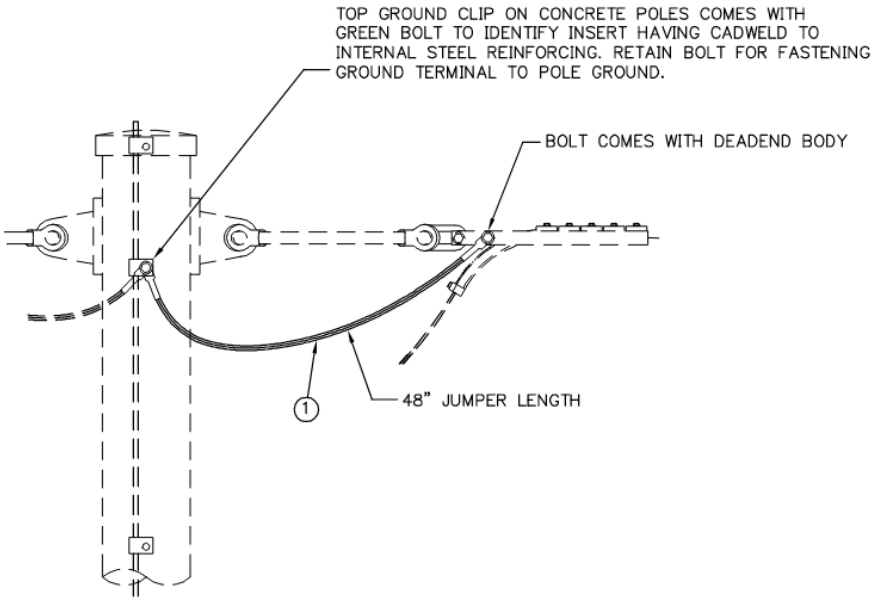
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

GROUND, DEADEND, OPGW, CONCRETE POLE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0032033755 | JUMPER, STATIC LINE: MULTI-STRANDED TINNED COPPER, 133/.0177, 48" LG, W/TERMINALS |

NOTE: ITEM 1 CAN BE MADE UP WITH 48" OF THE WIRE (0032018798) AND TWO TERMINALS (0032031548) AND COMPRESSING THE TERMINALS WITH AN INDENT DIE.




GND-DE-OP-C

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
GROUND, DEADEND, OPGW, CONCRETE POLE
STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

No. TMD398A0

PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 0 | 5-15-07 | CREATED | TWF | HSK | HSK |

tfinc90 5/31/2007

GND-DE-OP-C

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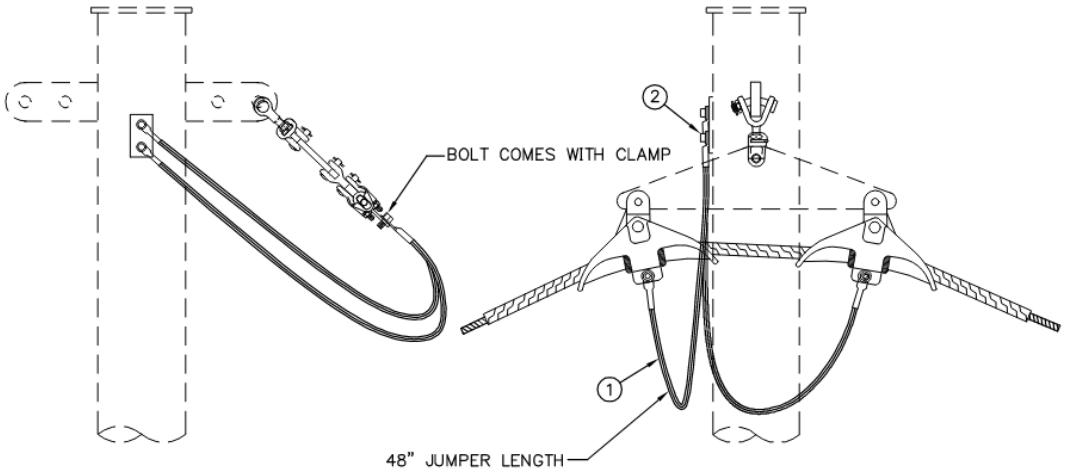
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

GROUND, SUSP. 30–50° w/YOKE, OPGW, STEEL POLE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 2 | 0032033755 | JUMPER, STATIC LINE: MULTI–STRANDED TINNED COPPER, 133/.0177, 48" LG, W/TERMINALS |
| 2 | 2 | 0000018450 | ASSEMBLY, BOLT: MACH, SS, HEX HEAD, 1/2" DIA. X 1" LG., WITH NUT, 2 WASHERS AND 1 BELLEVILLE WASHER |

NOTE: ITEM 1 CAN BE MADE UP WITH 48" OF THE WIRE (0032018798) AND TWO TERMINALS (0032031548) AND COMPRESSING THE TERMINALS WITH AN INDENT DIE.
NOTE: ITEM 2 HAS 1 NUT AND 1 WASHER THAT WILL NOT BE NEEDED.




THIS VIEW REVOLVED FOR CLARITY

THIS DRAWING REPLACES: TMD343B1

GND–SUY–OP–S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

GROUND, SUSP, 30–50, W/YOKE, OPGW, STEEL POLE STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

No. TMD399A0

PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 0 | 5–15–07 | CREATED | TWF | HSK | HSK |

tfinc90 5/31/2007

GND–SUY–OP–S

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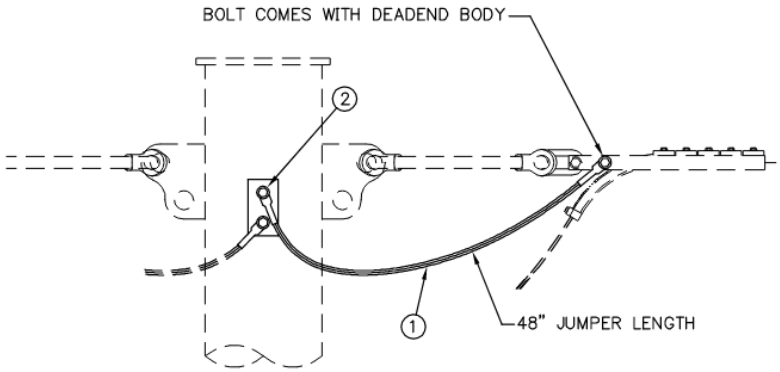
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

GROUND, DEADEND, OPGW, STEEL POLE

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0032033755 | JUMPER, STATIC LINE: MULTI-STRANDED TINNED COPPER, 133/.0177, 48" LG, W/TERMINALS |
| 2 | 1 | 0000018450 | ASSEMBLY, BOLT: MACH, SS, HEX HEAD, 1/2" DIA. X 1" LG., WITH NUT, 2 WASHERS AND 1 BELLEVILLE WASHER |

NOTE: ITEM 1 CAN BE MADE UP WITH 48" OF THE WIRE (0032018798) AND TWO TERMINALS (0032031548) AND COMPRESSING THE TERMINALS WITH AN INDENT DIE.
NOTE: ITEM 2 HAS 1 NUT AND 1 WASHER THAT WILL NOT BE NEEDED.




THIS DRAWING REPLACES: TMD343C1

GND-DE-OP-S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
GROUND, DEADEND, OPGW, STEEL POLE
STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

No. TMD402A0

PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 0 | 5-15-07 | CREATED | TWF | HSK | HSK |

tfinc90 5/31/2007

GND-DE-OP-S

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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

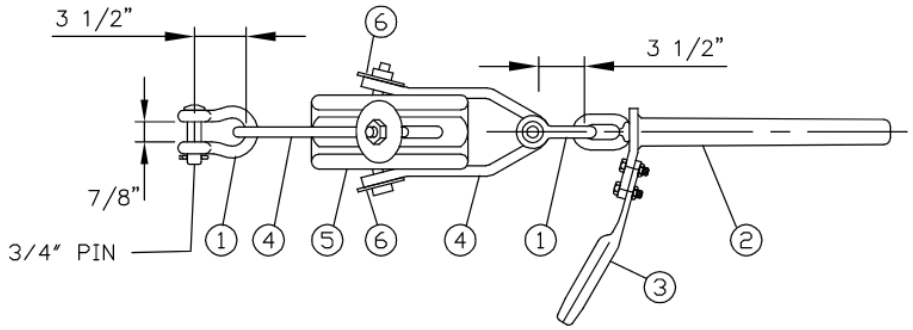
LIST OF COMPONENTS

| QUAN ASSY | ITEM NO. | DESCRIPTION | CATALOG NUMBER | ULTIMATE STRENGTH | BASIC MATERIAL | WEIGHT EACH | ENTERGY STOCK NO. |
|---|---|---|---|---|---|---|---|
| 2 | (1) | ANCHOR SHACKLE | ASH-66A | 50,000 # | F.S. | 2.25 # | EN000491 |
| 1 | (2) | COMPRESSION D.E. | *SEE TABLE* | – | ALUM. | | *SEE TABLE* |
| 1 | (3) | TERMINAL | *SEE TABLE* | – | ALUM. | | *SEE TABLE* |
| 2 | (4) | SHACKLE | J732 | 12,400# | F.S. | 1.46# | ** |
| 1 | (5) | INSULATOR | L506 | 20,000# | PORC. | 2.90# | ** |
| 4 | (6) | CLIPPED WASHER | ASM-7159-1 | | STL | | ** |

** ITEMS 4, 5 & 6 ARE COMBINED INTO ENTERGY STOCK CODE 000125-308.
INDUS CAT ID 000125-308 LISTS THESE ITEMS AS ONE MACLEAN PART NUMBER XXXXXXXXXXXXX.

FOR COMPRESSION DEAD END

| SHIELD WIRE | SHIELD WIRE DIA. | COMP. D.E. (ITEM 2) | ENTERGY STOCK NO. | TERMINAL (ITEM 3) | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. |
|---|---|---|---|---|---|---|
| 7 NO. 7 ALUMOWELD | 0.433 | V3816.484T | EN005526 | 3916.484 | EN028530 | C-7687-OGWDE1-2 |
| 3/8" EHS STEEL | 0.375 | V3814.386T | EN005530 | 3914.386 | EN028531 | C-7687-OGWDE2-2 |
| 7/16" EHS STEEL | 0.438 | V3816.453T | EN005531 | 3914.386 | EN028531 | C-7687-OGWDE4-2 |




GENERAL NOTES

THESE INSULATED SHIELD WIRE ASSEMBLIES ARE PRIMARILY FOR SELECT LINES OF THE 500KV SYSTEM WHERE POWER LOSSES ARE A CONCERN. THERE MAY BE OTHER APPLICATIONS ON THE LOWER VOLTAGE LINES WHERE RADIO INTERFERENCE IS A CONCERN.

OHG-DEJB-XX

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
OVERHEAD GROUNDWIRE DEADEND ASSY
STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD403A0 | PLOT 1=1 | SH. 1 OF 1

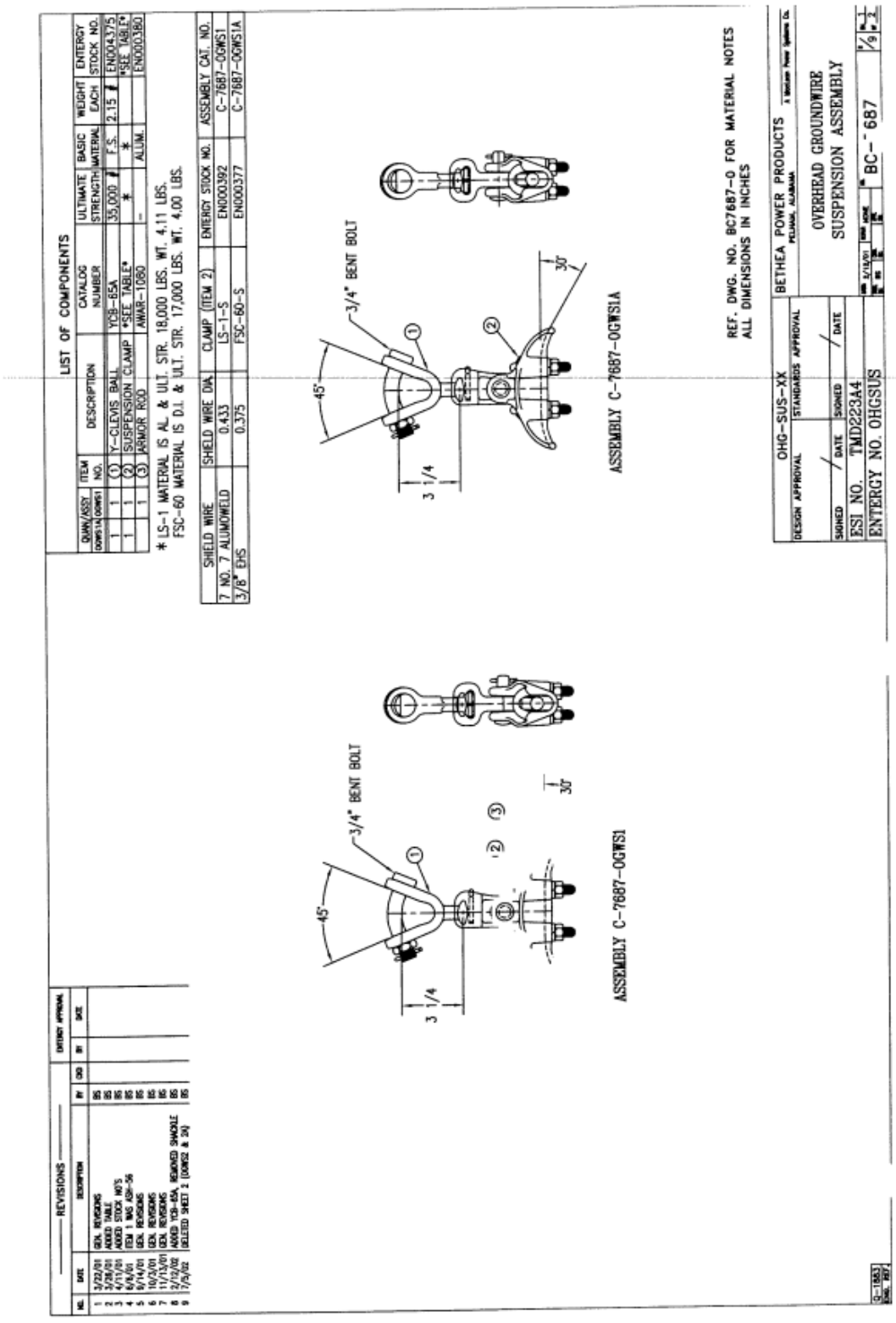
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|---|---|---|---|---|---|
| 0 | 12-13-07 | CREATED | TWF | HSK | HSK |

tfinc90 12/20/2007 OHG-DEJB-XX

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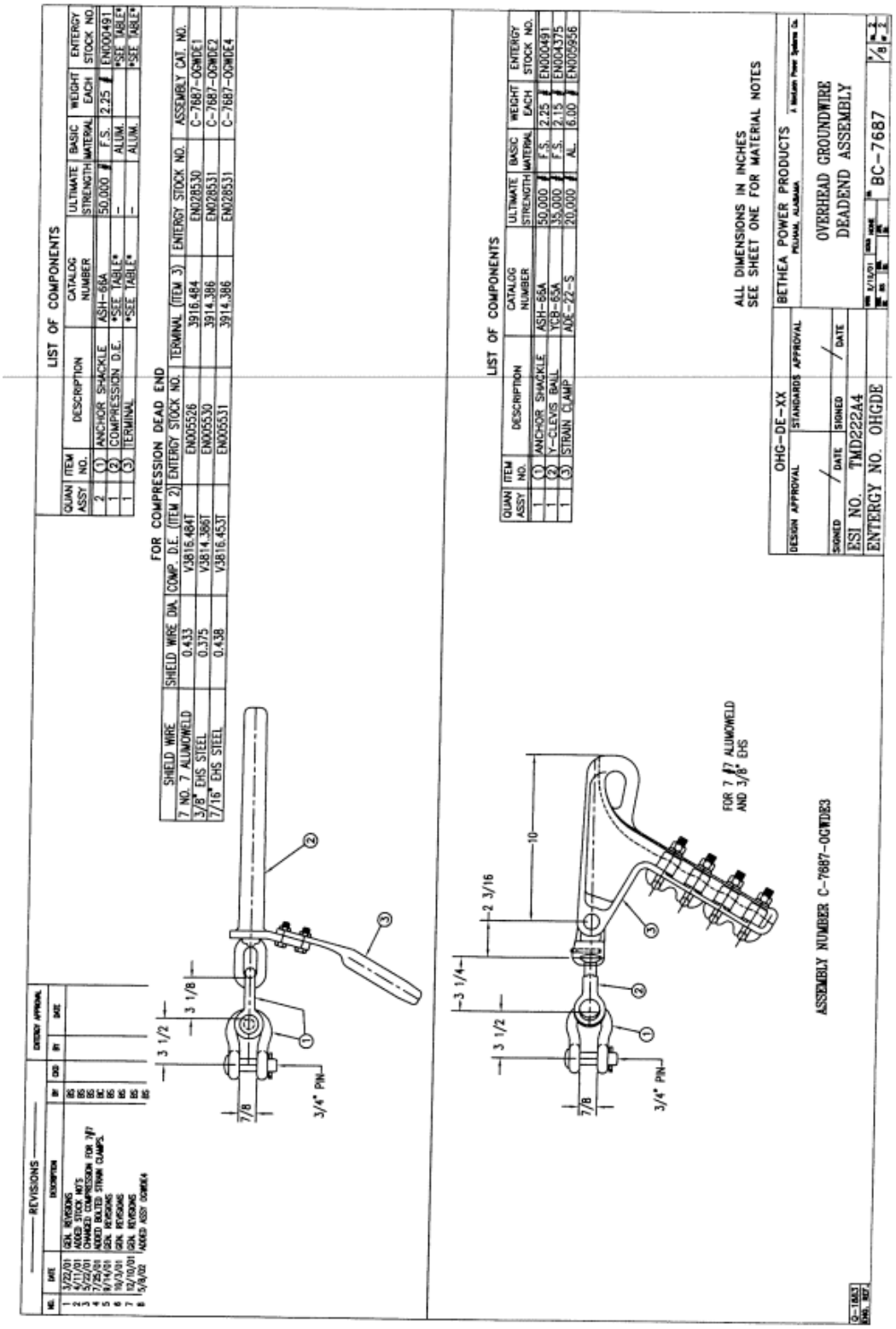
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



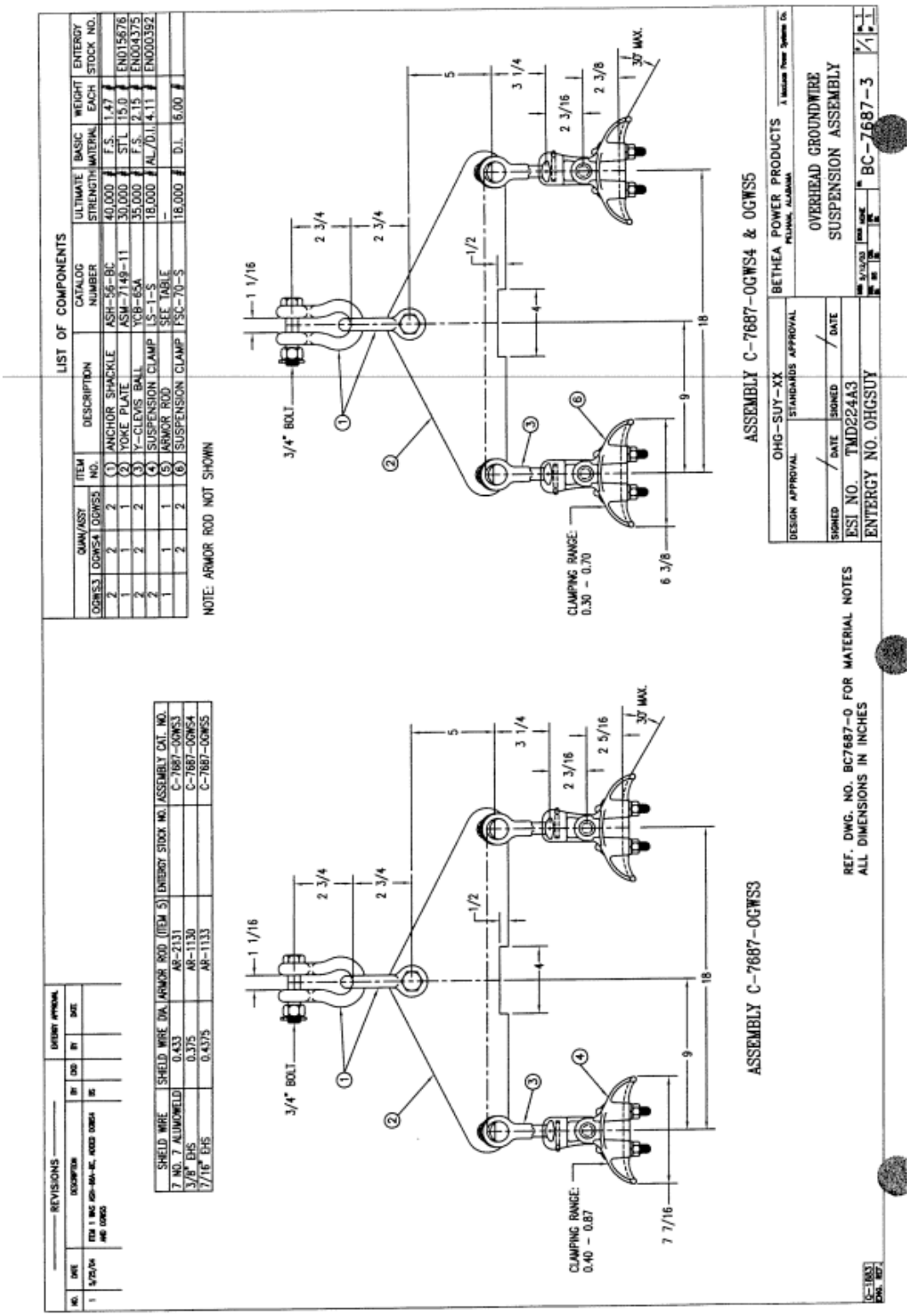
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



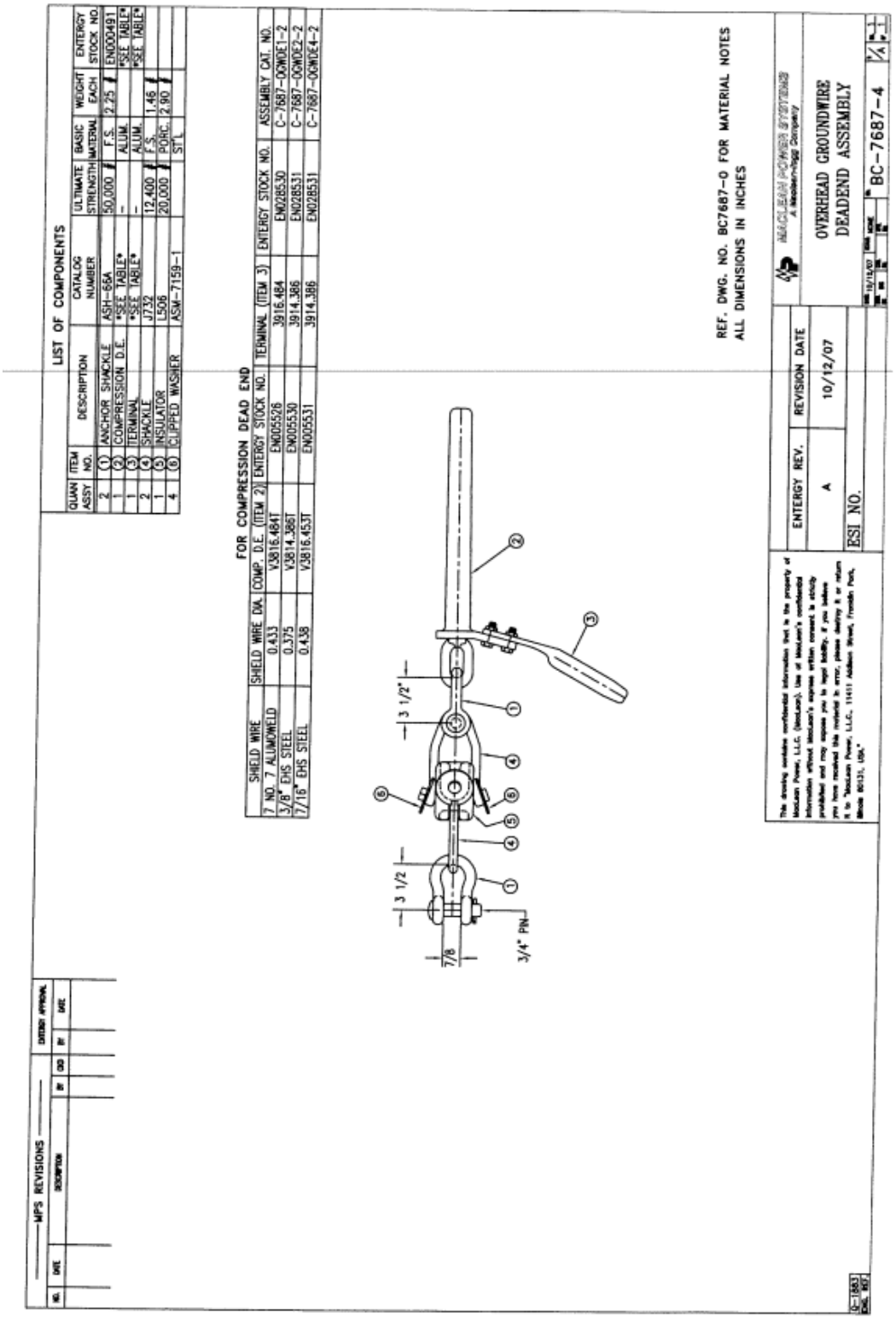
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



LIST OF COMPONENTS

| QUAN ASSY | ITEM NO. | DESCRIPTION | CATALOG NUMBER | ULTIMATE STRENGTH | BASIC MATERIAL | WEIGHT EACH | ENTERGY STOCK NO. |
|---|---|---|---|---|---|---|---|
| 2 | (1) | ANCHOR SHACKLE | ASH-66A | 50,000 # | F.S. | 2.25 # | EN000491 |
| 1 | (2) | COMPRESSION D.E. | *SEE TABLE* | – | ALUM. | | *SEE TABLE* |
| 1 | (3) | TERMINAL | *SEE TABLE* | – | ALUM. | | *SEE TABLE* |
| 2 | (4) | SHACKLE | J732 | 12,400 # | F.S. | 1.46 # | |
| 1 | (5) | INSULATOR | L506 | 20,000 # | PORC. | 2.90 # | |
| 4 | (6) | CLIPPED WASHER | ASM-7159-1 | | STL | | |

FOR COMPRESSION DEAD END

| SHIELD WIRE | SHIELD WIRE DIA. | COMP. D.E. (ITEM 2) | ENTERGY STOCK NO. | TERMINAL (ITEM 3) | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. |
|---|---|---|---|---|---|---|
| 7 NO. 7 ALUMOWELD | 0.433 | V3816.484T | EN005526 | 3916.484 | EN028530 | C-7687-OGWDE1-2 |
| 3/8" EHS STEEL | 0.375 | V3814.386T | EN005530 | 3914.386 | EN028531 | C-7687-OGWDE2-2 |
| 7/16" EHS STEEL | 0.438 | V3816.453T | EN005531 | 3914.386 | EN028531 | C-7687-OGWDE4-2 |

REF. DWG. NO. BC7687-0 FOR MATERIAL NOTES
ALL DIMENSIONS IN INCHES

3 1/2"
3 1/2
7/8
3/4" PIN

MACLEAN POWER SYSTEMS
A Textron Inc. Company

OVERHEAD GROUNDWIRE
DEADEND ASSEMBLY

BC-7687-4

| ENTERGY REV. | REVISION DATE |
|---|---|
| A | 10/12/07 |

ESI NO.

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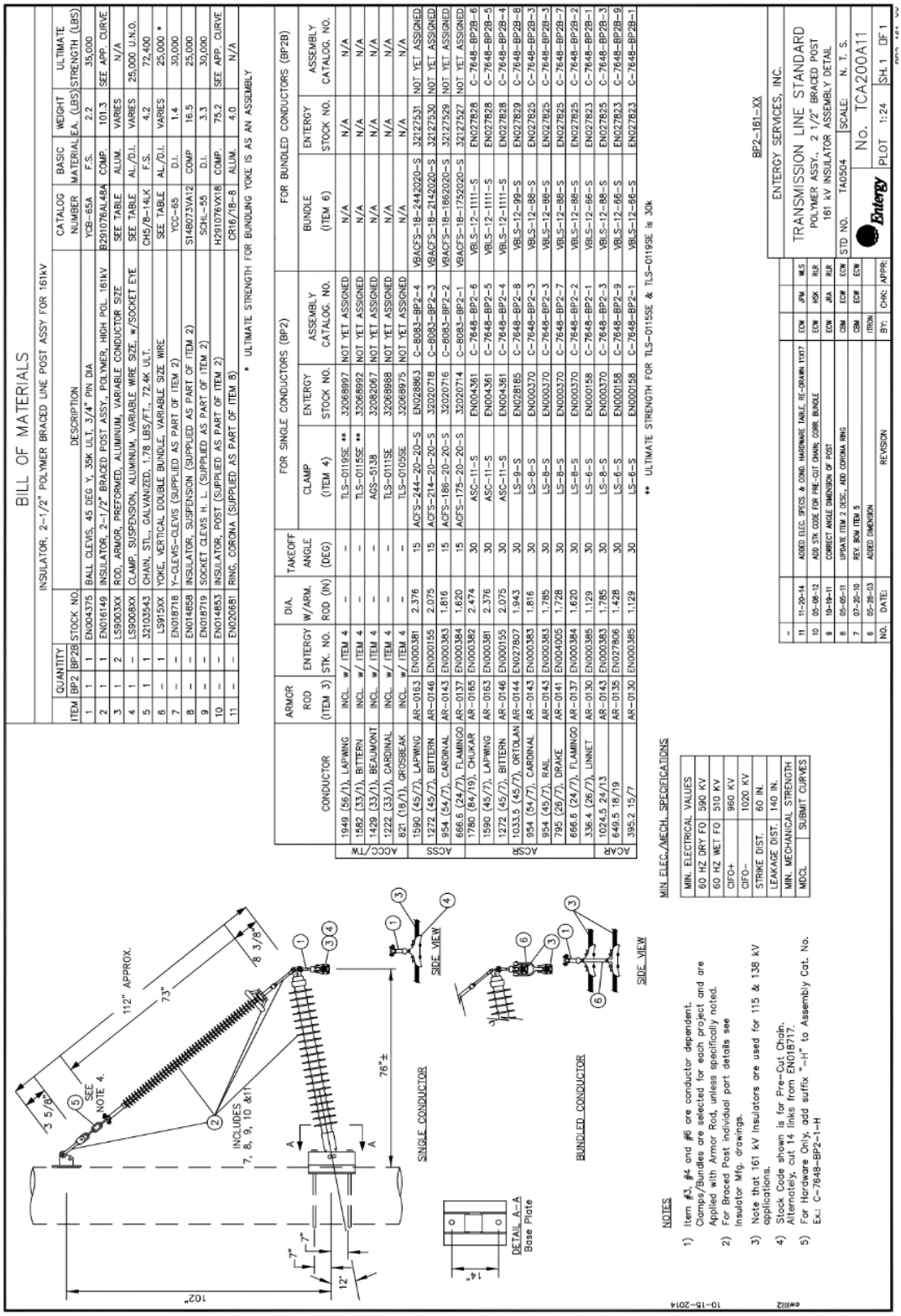
MPS REVISIONS

| NO. | DATE | DESCRIPTION | BY | CHD | BY | DATE |
|---|---|---|---|---|---|---|

ENTERGY APPROVAL

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



BILL OF MATERIALS

INSULATOR, 2-1/2" POLYMER BRACED LINE POST ASSY FOR 161kV

| ITEM | QUANTITY BP2 | QUANTITY BP2B | STOCK NO | DESCRIPTION | CATALOG NUMBER | BASIC MATERIAL | WEIGHT EA. (LBS) | ULTIMATE STRENGTH (LBS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | EN004375 | BALL CLEVIS, 45 DEG Y, 35K ULT, 3/4" PIN DIA | YCB-65A | F.S. | 2.2 | 35,000 |
| 2 | 1 | 1 | EN016149 | INSULATOR, 2-1/2" BRACED POST ASSY., POLYMER, HIGH POL. 161kV | B291076AL48A | COMP. | 101.3 | SEE APP. CURVE |
| 3 | 1 | 2 | LS9003XX | ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE | SEE TABLE | ALUM. | VARIES | N/A |
| 4 | 1 | – | LS9008XX | CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, w/SOCKET EYE | SEE TABLE | AL./D.I. | VARIES | 25,000 U.N.O. |
| 5 | 1 | 1 | 32103543 | CHAIN, STL., GALVANIZED, 1,78 LBS/FT., 72.4K ULT. | CH5/8-14LK | F.S. | 4.2 | 72,400 |
| 6 | – | 1 | LS915XX | YOKE, VERTICAL DOUBLE BUNDLE, VARIABLE SIZE WIRE | SEE TABLE | AL./D.I. | VARIES | 25,000 * |
| 7 | – | – | EN018718 | Y-CLEVIS-CLEVIS (SUPPLIED AS PART OF ITEM 2) | YCC-65 | D.I. | 1.4 | 30,000 |
| 8 | – | – | EN014658 | INSULATOR, SUSPENSION (SUPPLIED AS PART OF ITEM 2) | S1486733VA12 | COMP | 16.5 | 25,000 |
| 9 | – | – | EN018719 | SOCKET CLEVIS H. L. (SUPPLIED AS PART OF ITEM 2) | SCHL-55 | D.I. | 3.3 | 30,000 |
| 10 | – | – | EN014853 | INSULATOR, POST (SUPPLIED AS PART OF ITEM 2) | H291076VX18 | COMP. | 75.2 | SEE APP. CURVE |
| 11 | – | – | EN020681 | RING, CORONA (SUPPLIED AS PART OF ITEM 8) | CR16/18-8 | ALUM. | 4.0 | N/A |

* ULTIMATE STRENGTH FOR BUNDLING YOKE IS AS AN ASSEMBLY

| | CONDUCTOR | ARMOR ROD (ITEM 3) | FOR SINGLE CONDUCTORS (BP2) ENTERGY STK. NO. | DIA. W/ARM. ROD (IN) | TAKEOFF ANGLE (DEG) | CLAMP (ITEM 4) | ENTERGY STOCK NO. | ASSEMBLY CATALOG. NO. | FOR BUNDLED CONDUCTORS (BP2B) BUNDLE (ITEM 6) | ENTERGY STOCK NO. | ASSEMBLY CATALOG. NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ACCC/TW | 1949 (56/1), LAPWING | INCL. w/ ITEM 4 | EN000381 | 2.376 | – | TLS-0119SE ** | 32068997 | NOT YET ASSIGNED | N/A | N/A | N/A |
| | 1582 (33/1), BITTERN | INCL. w/ ITEM 4 | EN000155 | 2.075 | – | TLS-0115SE ** | 32068992 | NOT YET ASSIGNED | N/A | N/A | N/A |
| | 1429 (33/1), BEAUMONT | INCL. w/ ITEM 4 | EN000383 | 1.816 | – | AGS-5138 | 32082067 | NOT YET ASSIGNED | N/A | N/A | N/A |
| | 1222 (33/1), CARDINAL | INCL. w/ ITEM 4 | EN000384 | 1.620 | – | TLS-0111SE | 32068988 | NOT YET ASSIGNED | N/A | N/A | N/A |
| | 821 (19/1), GROSBEAK | INCL. w/ ITEM 4 | EN000382 | 2.474 | – | TLS-0105SE | 32068975 | NOT YET ASSIGNED | N/A | N/A | N/A |
| ACSS | 1590 (45/7), LAPWING | AR-0163 | EN000381 | 2.376 | 15 | AGTS-244-20-20-S | EN028863 | C-8083-BP2-4 | V8AGTS-18-2442020-S | 32127531 | NOT YET ASSIGNED |
| | 1272 (45/7), BITTERN | AR-0146 | EN000155 | 2.075 | 15 | AGTS-214-20-20-S | 32020718 | C-8083-BP2-3 | V8AGTS-18-2142020-S | 32127530 | NOT YET ASSIGNED |
| | 954 (54/7), CARDINAL | AR-0143 | EN000383 | 1.816 | 15 | ACTS-186-20-20-S | 32020716 | C-8083-BP2-2 | V8AGTS-18-1862020-S | 32127529 | NOT YET ASSIGNED |
| | 666.6 (24/7), FLAMINGO | AR-0137 | EN000384 | 1.620 | 15 | ACTS-175-20-20-S | 32020714 | C-8083-BP2-1 | V8AGTS-18-1752020-S | 32127527 | NOT YET ASSIGNED |
| ACSR | 1780 (84/19), CHUKAR | AR-0165 | EN000382 | 2.474 | 30 | ASC-11-S | EN004361 | C-7648-BP2-8 | V8LS-12-1111-S | EN027828 | C-7648-BP2B-6 |
| | 1590 (45/7), LAPWING | AR-0163 | EN000381 | 2.376 | 30 | ASC-11-S | EN004361 | C-7648-BP2-5 | V8LS-12-1111-S | EN027828 | C-7648-BP2B-5 |
| | 1272 (45/7), BITTERN | AR-0146 | EN000155 | 2.075 | 30 | ASC-11-S | EN004361 | C-7648-BP2-4 | V8LS-12-1111-S | EN027828 | C-7648-BP2B-4 |
| | 1033.5 (45/7), ORTOLAN | AR-0144 | EN027807 | 1.943 | 30 | LS-9-S | EN028165 | C-7648-BP2-8 | V8LS-12-99-S | EN027829 | C-7648-BP2B-8 |
| | 954 (54/7), CARDINAL | AR-0143 | EN000383 | 1.816 | 30 | LS-8-S | EN000370 | C-7648-BP2-3 | V8LS-12-88-S | EN027825 | C-7648-BP2B-3 |
| | 954 (45/7), RAIL | AR-0143 | EN000383 | 1.785 | 30 | LS-8-S | EN000370 | C-7648-BP2-3 | V8LS-12-88-S | EN027825 | C-7648-BP2B-3 |
| | 795 (26/7), DRAKE | AR-0141 | EN004005 | 1.728 | 30 | LS-8-S | EN000370 | C-7648-BP2-7 | V8LS-12-88-S | EN027825 | C-7648-BP2B-7 |
| | 666.6 (24/7), FLAMINGO | AR-0137 | EN000384 | 1.620 | 30 | LS-8-S | EN000370 | C-7648-BP2-2 | V8LS-12-88-S | EN027825 | C-7648-BP2B-2 |
| ACAR | 336.4 (26/7), LINNET | AR-0130 | EN000385 | 1.129 | 30 | LS-6-S | EN000158 | C-7648-BP2-1 | V8LS-12-66-S | EN027823 | C-7648-BP2B-1 |
| | 1024.5 24/13 | AR-0143 | EN000383 | 1.785 | 30 | LS-8-S | EN000370 | C-7648-BP2-3 | V8LS-12-88-S | EN027825 | C-7648-BP2B-3 |
| | 649.5 18/19 | AR-0135 | EN027806 | 1.428 | 30 | LS-6-S | EN000158 | C-7648-BP2-9 | V8LS-12-66-S | EN027823 | C-7648-BP2B-9 |
| | 395.2 15/7 | AR-0130 | EN000385 | 1.129 | 30 | LS-6-S | EN000158 | C-7648-BP2-1 | V8LS-12-66-S | EN027823 | C-7648-BP2B-1 |

** ULTIMATE STRENGTH FOR TLS-0115SE & TLS-0119SE is 30k

MIN. ELEC./MECH. SPECIFICATIONS

| | |
|---|---|
| MIN. ELECTRICAL VALUES | |
| 60 HZ DRY FO | 590 KV |
| 60 HZ WET FO | 510 KV |
| CIFO+ | 960 KV |
| CIFO– | 1020 KV |
| STRIKE DIST. | 60 IN. |
| LEAKAGE DIST. | 140 IN. |
| MIN. MECHANICAL STRENGTH | |
| MDCL | SUBMIT CURVES |

| - | | | | | |
|---|---|---|---|---|---|
| 11 | 11-20-14 | ADDED ELEC. SPECS. & CONG. HARDWARE TABLE, RE-DRAWN 11X17 | EDW | JPW | W.S |
| 10 | 05-06-12 | ADD STK CODE FOR PRE-CUT CHAIN, CORE BUNDLE | EDW | HSK | RJR |
| 9 | 10-19-11 | CORRECT ANGLE DIMENSION OF POST | EDW | JPA | RJR |
| 8 | 05-05-11 | UPDATE ITEM 2 DESC., ADD CORONA RING | CBM | ECW | EDW |
| 7 | 07-20-10 | REV. BOM ITEM 5 | CBM | ECW | EDW |
| 6 | 05-28-03 | ADDED DIMENSION | ITRON | | |
| NO. | DATE: | REVISION | BY: | CHK: | APPR: |

ENTERGY SERVICES, INC.

TRANSMISSION LINE STANDARD

POLYMER ASSY., 2 1/2" BRACED POST

161 kV INSULATOR ASSEMBLY DETAIL

BP2-161-XX

STD NO. TA0504 SCALE: N. T. S.

Entergy No. TCA200A11

PLOT 1:24 SH. 1 OF 1

NOTES

1) Item #3, #4 and #6 are conductor dependent. Clamps/Bundles are selected for each project and are Applied with Armor Rod, unless specifically noted.
2) For Braced Post individual part details see Insulator Mfg. drawings.
3) Note that 161 kV Insulators are used for 115 & 138 kV applications.
4) Stock Code shown is for Pre-Cut Chain. Alternately, cut 14 links from EN018717.
5) For Hardware Only, add suffix "-H" to Assembly Cat. No. Ex.: C-7648-BP2-1-H

SINGLE CONDUCTOR

BUNDLED CONDUCTOR

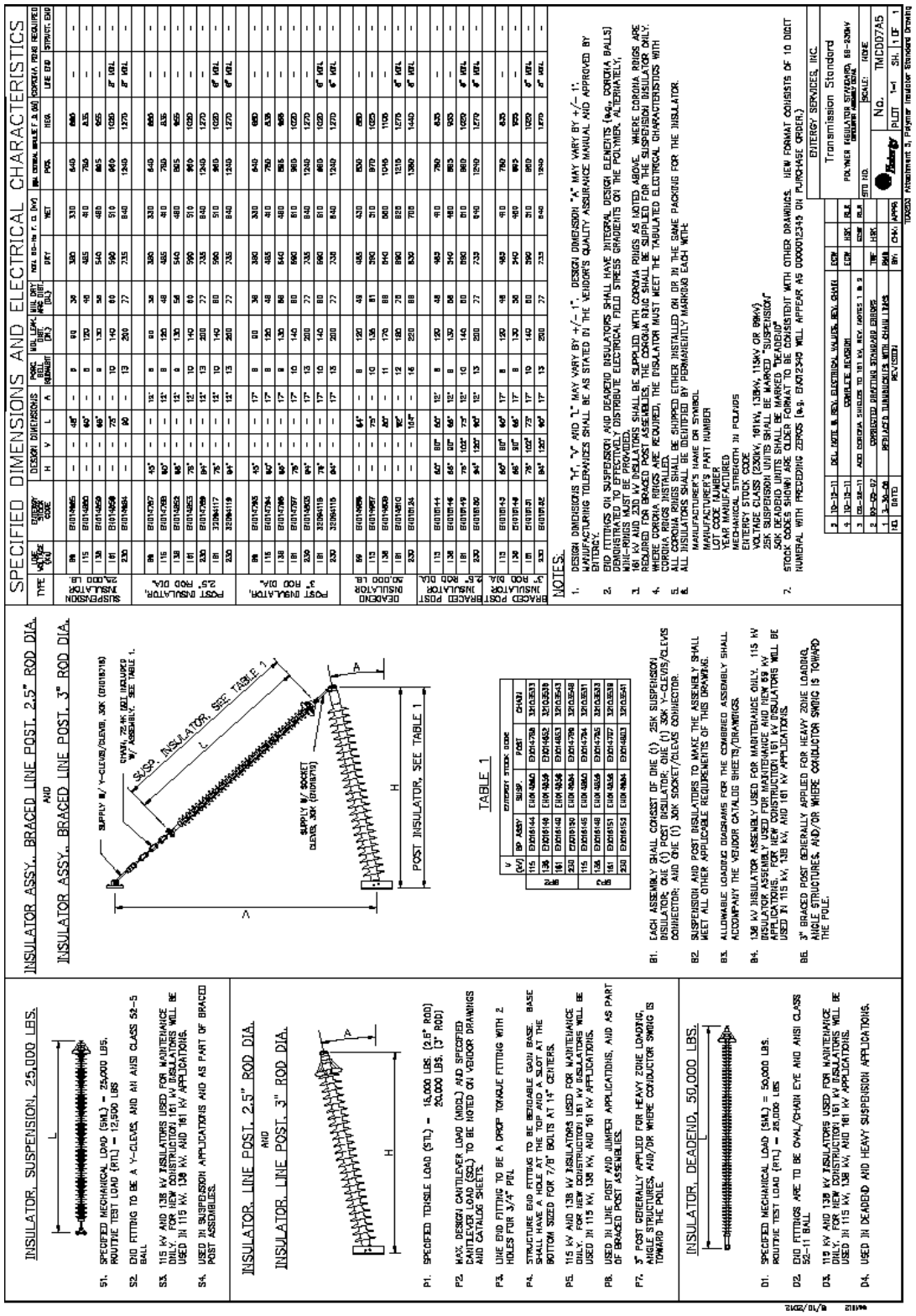
SIDE VIEW

DETAIL A-A Base Plate

10-15-2014

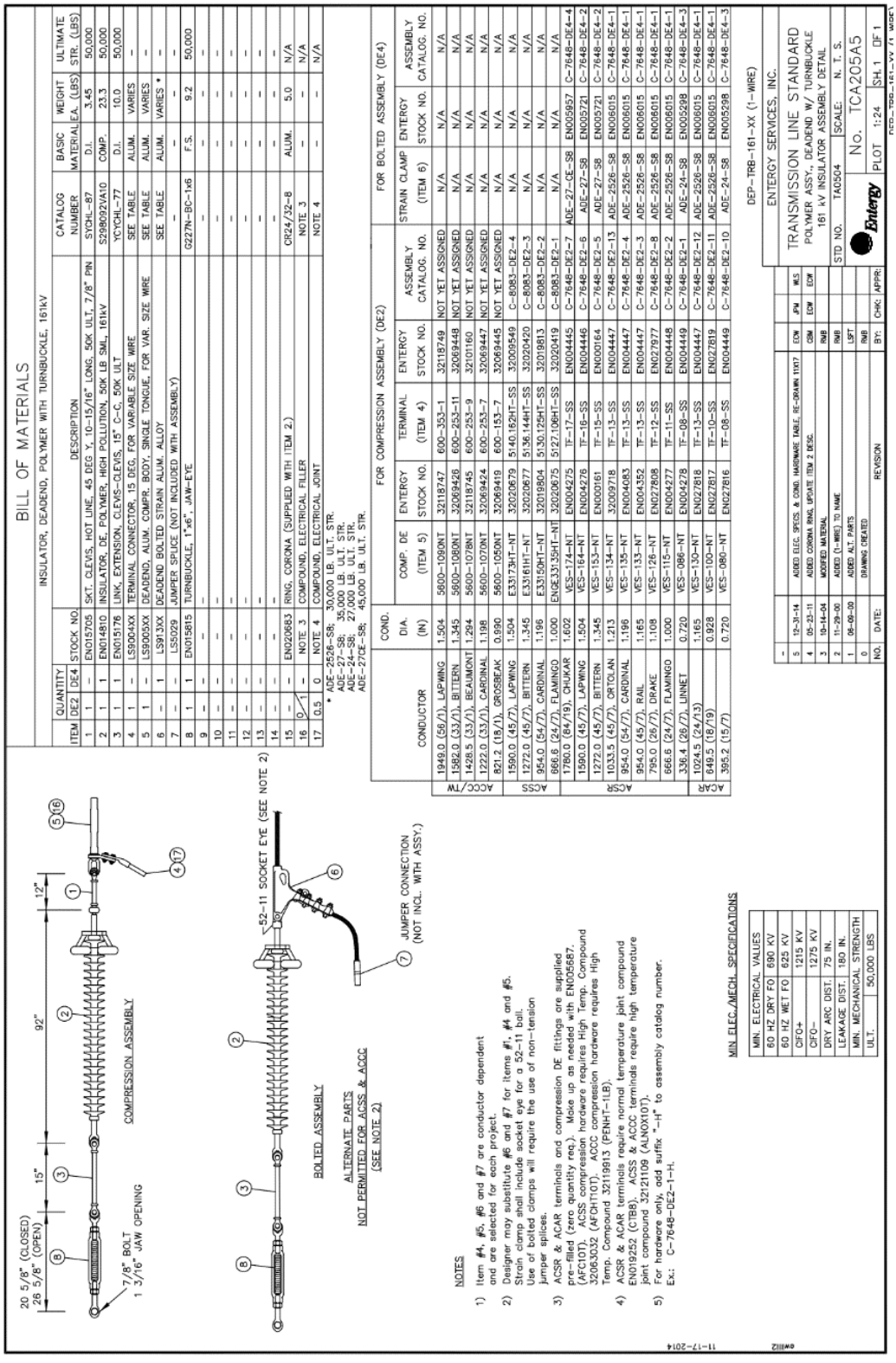
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS




BESS BOT Scope Book: Appendix 2 High Voltage Overhead Transmission

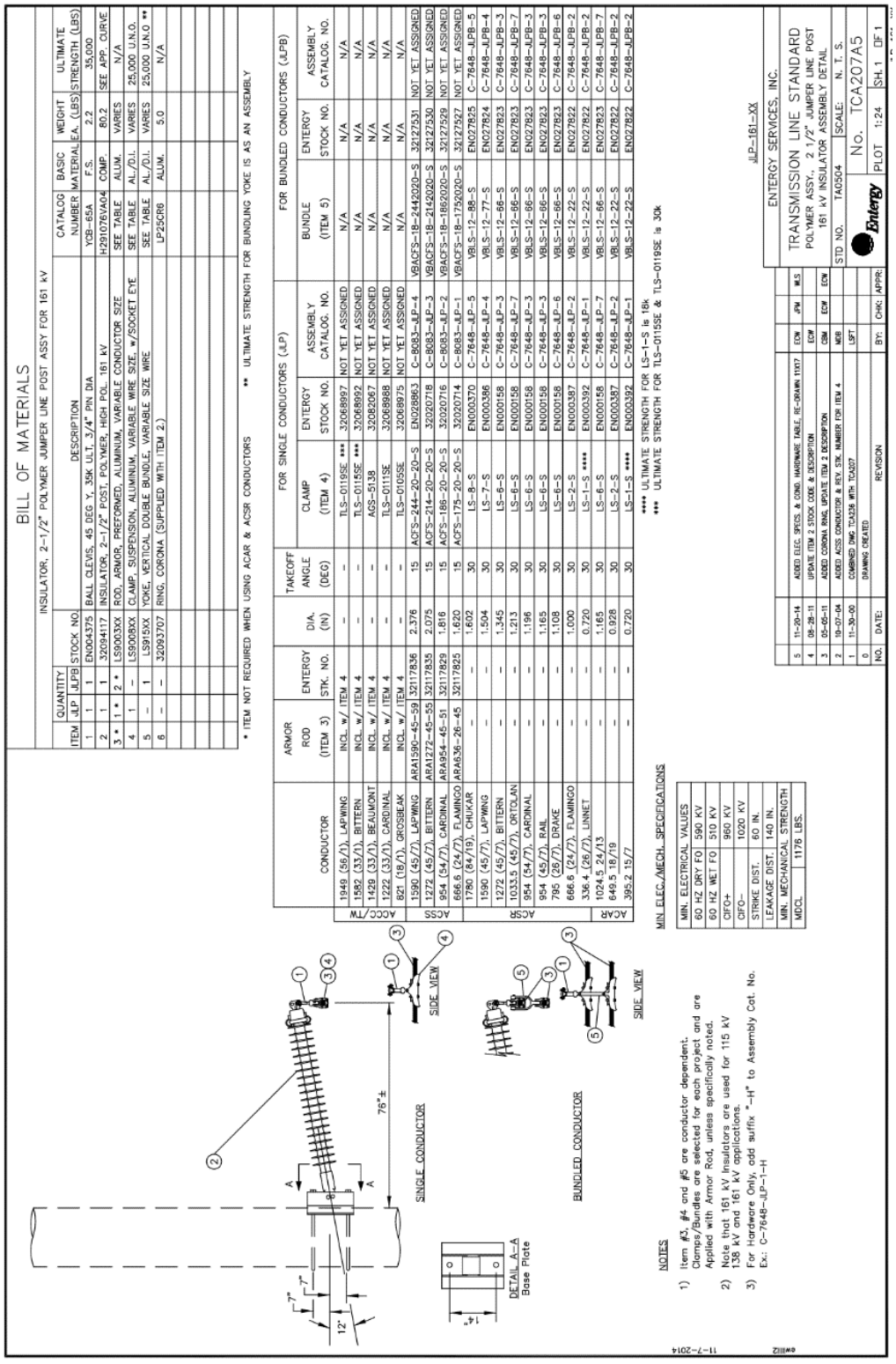
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



BESS BOT Scope Book: Appendix 2 High Voltage Overhead Transmission

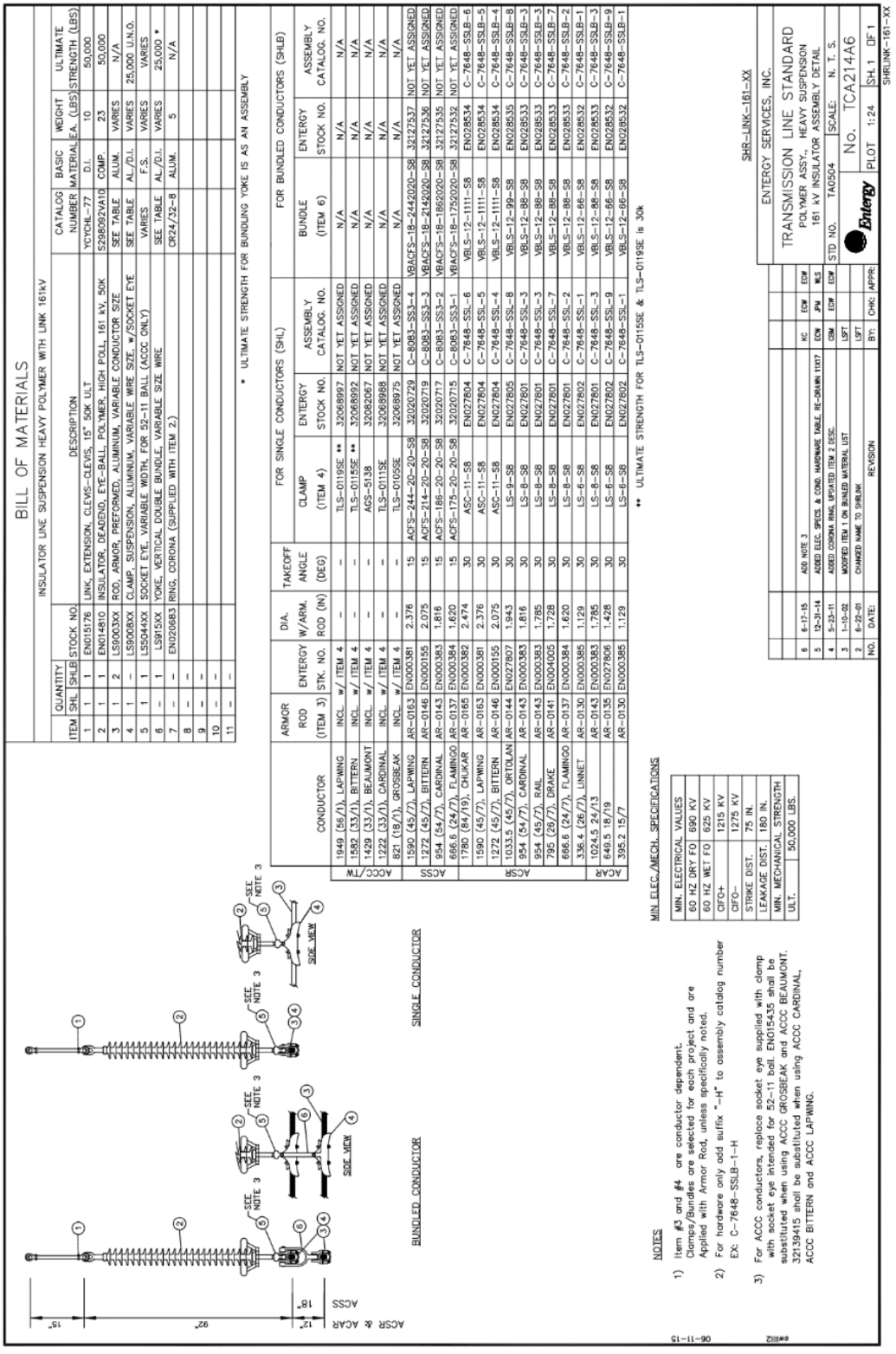
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



BILL OF MATERIALS

INSULATOR LINE SUSPENSION HEAVY POLYMER WITH LINK 161kV

| ITEM | QUANTITY SHL | QUANTITY SHLB | STOCK NO. | DESCRIPTION | CATALOG NUMBER | BASIC MATERIAL | WEIGHT EA. (LBS) | ULTIMATE STRENGTH (LBS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | EN015176 | LINK, EXTENSION, CLEVIS-CLEVIS, 15" 50K ULT | YCYCHL-77 | D.I. | 10 | 50,000 |
| 2 | 1 | 1 | EN014810 | INSULATOR, DEADEND, EYE-BALL, POLYMER, HIGH POLL, 161 KV, 50K | 5298092VA10 | COMP. | 23 | 50,000 |
| 3 | 1 | 2 | LS9003XX | ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE | SEE TABLE | ALUM. | VARIES | N/A |
| 4 | 1 | – | LS9008XX | CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, w/SOCKET EYE | SEE TABLE | AL/D.I. | VARIES | 25,000 U.N.O. |
| 5 | 1 | 1 | LS5044XX | SOCKET EYE, VARIABLE WIDTH, FOR 52-11 BALL (ACCC ONLY) | VARIES | F.S. | VARIES | VARIES |
| 6 | – | 1 | LS915XX | YOKE, VERTICAL DOUBLE BUNDLE, VARIABLE SIZE WIRE | SEE TABLE | AL/D.I. | VARIES | 25,000 * |
| 7 | – | – | EN020683 | RING, CORONA (SUPPLIED WITH ITEM 2.) | CR24/32-8 | ALUM. | 5 | N/A |
| 8 | – | – | | | | | | |
| 9 | – | – | | | | | | |
| 10 | – | – | | | | | | |
| 11 | – | – | | | | | | |

* ULTIMATE STRENGTH FOR BUNDLING YOKE IS AS AN ASSEMBLY

| | CONDUCTOR | ARMOR ROD (ITEM 3) | ENTERGY STK. NO. | DIA. W/ARM. ROD (IN) | TAKEOFF ANGLE (DEG) | FOR SINGLE CONDUCTORS (SHL) CLAMP (ITEM 4) | ENTERGY STOCK NO. | ASSEMBLY CATALOG. NO. | FOR BUNDLED CONDUCTORS (SHLB) BUNDLE (ITEM 6) | ENTERGY STOCK NO. | ASSEMBLY CATALOG. NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ACCC/TW | 1949 (56/1), LAPWING | INCL. w/ ITEM 4 | EN000381 | 2.376 | – | TLS-0119SE ** | 32068997 | NOT YET ASSIGNED | N/A | N/A | N/A |
| | 1582 (33/1), BITTERN | INCL. w/ ITEM 4 | EN000155 | 2.075 | – | TLS-0115SE ** | 32068992 | NOT YET ASSIGNED | N/A | N/A | N/A |
| | 1429 (33/1), BEAUMONT | INCL. w/ ITEM 4 | EN000383 | 1.785 | – | AGS-5138 | 32082067 | NOT YET ASSIGNED | N/A | N/A | N/A |
| | 1222 (33/1), CARDINAL | INCL. w/ ITEM 4 | EN000384 | 1.620 | – | TLS-0111SE | 32069988 | NOT YET ASSIGNED | N/A | N/A | N/A |
| | 821 (18/1), GROSBEAK | INCL. w/ ITEM 4 | EN000385 | 1.129 | – | TLS-0105SE | 32069975 | NOT YET ASSIGNED | N/A | N/A | N/A |
| ACSS | 1590 (45/7), LAPWING | AR-0163 | EN000381 | 2.376 | 15 | ACFS-244-20-20-SB | 32020729 | C-8083-SS3-4 | VBACFS-18-2442020-SB | 32127537 | NOT YET ASSIGNED |
| | 1272 (45/7), BITTERN | AR-0146 | EN000155 | 2.075 | 15 | ACFS-214-20-20-SB | 32020719 | C-8083-SS3-3 | VBACFS-18-2142020-SB | 32127536 | NOT YET ASSIGNED |
| | 954 (54/7), CARDINAL | AR-0143 | EN000383 | 1.816 | 15 | ACFS-186-20-20-SB | 32020717 | C-8083-SS3-2 | VBACFS-18-1862020-SB | 32127535 | NOT YET ASSIGNED |
| | 666.6 (24/7), FLAMINGO | AR-0137 | EN000384 | 1.620 | 15 | ACFS-175-20-20-SB | 32020715 | C-8083-SS3-1 | VBACFS-18-1752020-SB | 32127532 | NOT YET ASSIGNED |
| ACSR | 1780 (84/19), CHUKAR | AR-0165 | EN000382 | 2.474 | 30 | ASC-11-SB | EN027804 | C-7648-SSL-6 | VBLS-12-1111-SB | EN028534 | C-7648-SSLB-6 |
| | 1590 (45/7), LAPWING | AR-0163 | EN000381 | 2.376 | 30 | ASC-11-SB | EN027804 | C-7648-SSL-5 | VBLS-12-1111-SB | EN028534 | C-7648-SSLB-5 |
| | 1272 (45/7), BITTERN | AR-0146 | EN000155 | 2.075 | 30 | ASC-11-SB | EN027804 | C-7648-SSL-4 | VBLS-12-1111-SB | EN028534 | C-7648-SSLB-4 |
| | 1033.5 (45/7), ORTOLAN | AR-0144 | EN027807 | 1.943 | 30 | LS-9-SB | EN027805 | C-7648-SSL-8 | VBLS-12-99-SB | EN028535 | C-7648-SSLB-8 |
| | 954 (54/7), CARDINAL | AR-0143 | EN000383 | 1.816 | 30 | LS-8-SB | EN027801 | C-7648-SSL-3 | VBLS-12-88-SB | EN028533 | C-7648-SSLB-3 |
| | 954 (45/7), RAIL | AR-0143 | EN000383 | 1.785 | 30 | LS-8-SB | EN027801 | C-7648-SSL-3 | VBLS-12-88-SB | EN028533 | C-7648-SSLB-3 |
| | 795 (26/7), DRAKE | AR-0141 | EN004005 | 1.728 | 30 | LS-8-SB | EN027801 | C-7648-SSL-7 | VBLS-12-88-SB | EN028533 | C-7648-SSLB-7 |
| | 666.6 (24/7), FLAMINGO | AR-0137 | EN000384 | 1.620 | 30 | LS-8-SB | EN027801 | C-7648-SSL-2 | VBLS-12-88-SB | EN028533 | C-7648-SSLB-2 |
| | 336.4 (26/7), LINNET | AR-0130 | EN000385 | 1.129 | 30 | LS-6-SB | EN027802 | C-7648-SSL-1 | VBLS-12-66-SB | EN028532 | C-7648-SSLB-1 |
| ACAR | 1024.5 24/13 | AR-0143 | EN000383 | 1.785 | 30 | LS-8-SB | EN027801 | C-7648-SSL-3 | VBLS-12-88-SB | EN028533 | C-7648-SSLB-3 |
| | 649.5 18/19 | AR-0135 | EN027806 | 1.428 | 30 | LS-6-SB | EN027802 | C-7648-SSL-9 | VBLS-12-66-SB | EN028532 | C-7648-SSLB-9 |
| ACAR | 395.2 15/7 | AR-0130 | EN000385 | 1.129 | 30 | LS-6-SB | EN027802 | C-7648-SSL-1 | VBLS-12-66-SB | EN028532 | C-7648-SSLB-1 |

** ULTIMATE STRENGTH FOR TLS-0115SE & TLS-0119SE is 30k

SINGLE CONDUCTOR

BUNDLED CONDUCTOR

ACSR & ACAR

ACSS

SIDE VIEW

SEE NOTE 3

MIN. ELEC./MECH. SPECIFICATIONS

| MIN. ELECTRICAL VALUES | |
|---|---|
| 60 HZ DRY FO | 890 KV |
| 60 HZ WET FO | 625 KV |
| CIFO+ | 1215 KV |
| CIFO– | 1275 KV |
| STRIKE DIST. | 75 IN. |
| LEAKAGE DIST. | 180 IN. |
| MIN. MECHANICAL STRENGTH | |
| ULT: | 50,000 LBS. |

NOTES

1) Item #3 and #4 are conductor dependent. Clamps/Bundles are selected for each project and are Applied with Armor Rod, unless specifically noted.
2) For hardware only add suffix "-H" to assembly catalog number EX: C-7648-SSLB-1-H
3) For ACCC conductors, replace socket eye supplied with clamp with socket eye intended for 52-11 ball. EN015435 shall be substituted when using ACCC GROSBEAK and ACCC BEAUMONT. 32139415 shall be substituted when using ACCC CARDINAL, ACCC BITTERN and ACCC LAPWING.

| NO. | DATE: | REVISION | BY: | CHK: | APPR: |
|---|---|---|---|---|---|
| 6 | 8-17-15 | ADD NOTE 3 | KC | EDW | EDW |
| 5 | 12-31-14 | ADDED ELEC. SPECS. & COND. HARDWARE TABLE, RE-DRAWN 11017 | EDW | JPW | WLS |
| 4 | 5-23-11 | ADDED CORONA RING, UPDATED ITEM 2 DESC. | CBM | EDW | EDW |
| 3 | 1-10-02 | MODIFIED ITEM 1 ON BUNLED MATERIAL LIST | LSFT | | |
| 2 | 6-22-01 | CHANGED NAME TO SHRLINK | LSFT | | |

ENTERGY SERVICES, INC.

TRANSMISSION LINE STANDARD
POLYMER ASSY., HEAVY SUSPENSION
161 kV INSULATOR ASSEMBLY DETAIL

STD NO. TA0504 SCALE: N. T. S.

Entergy No. TCA214A6

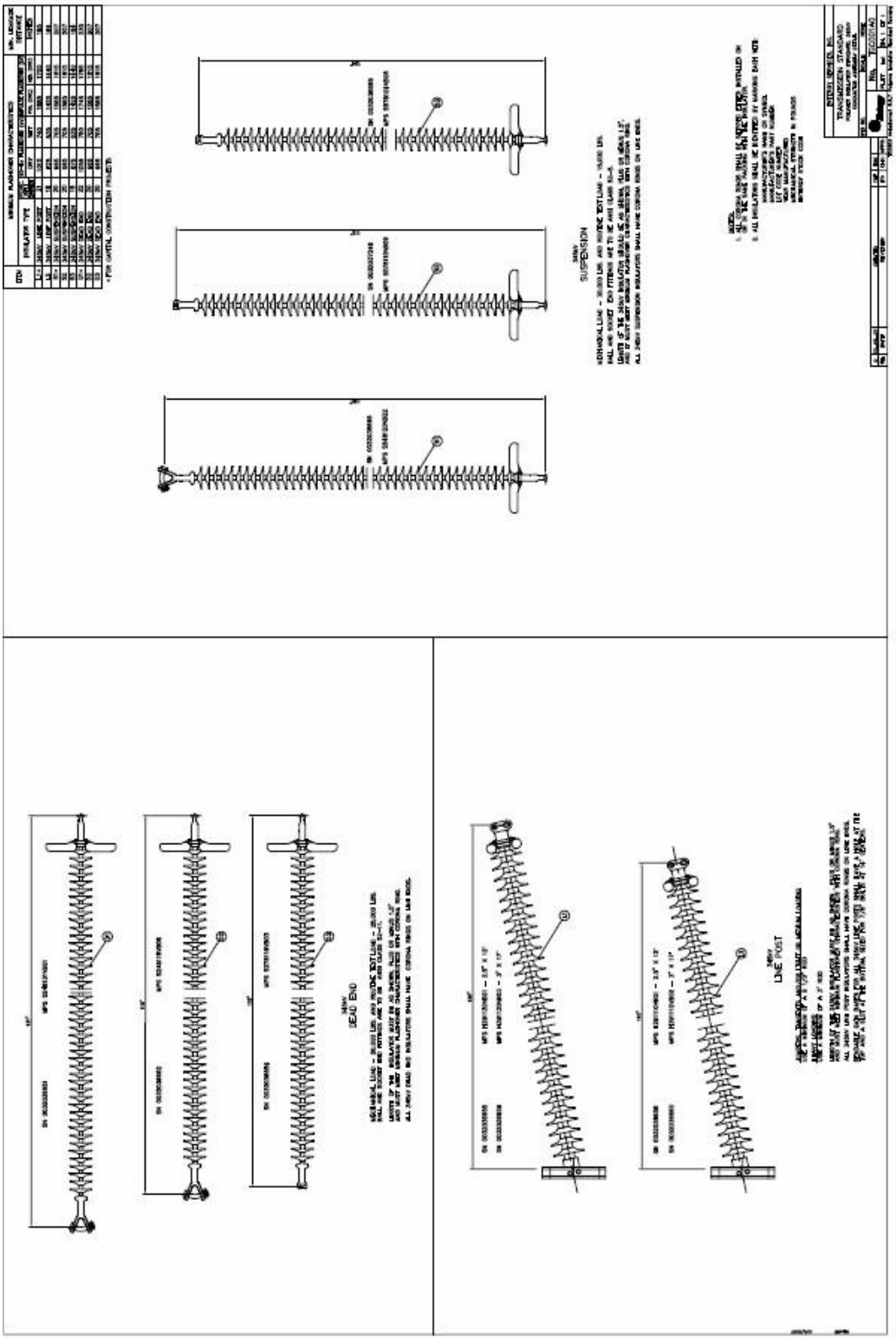
PLOT 1:24 SH. 1 OF 1

SHRLINK-161-XX

06-11-15

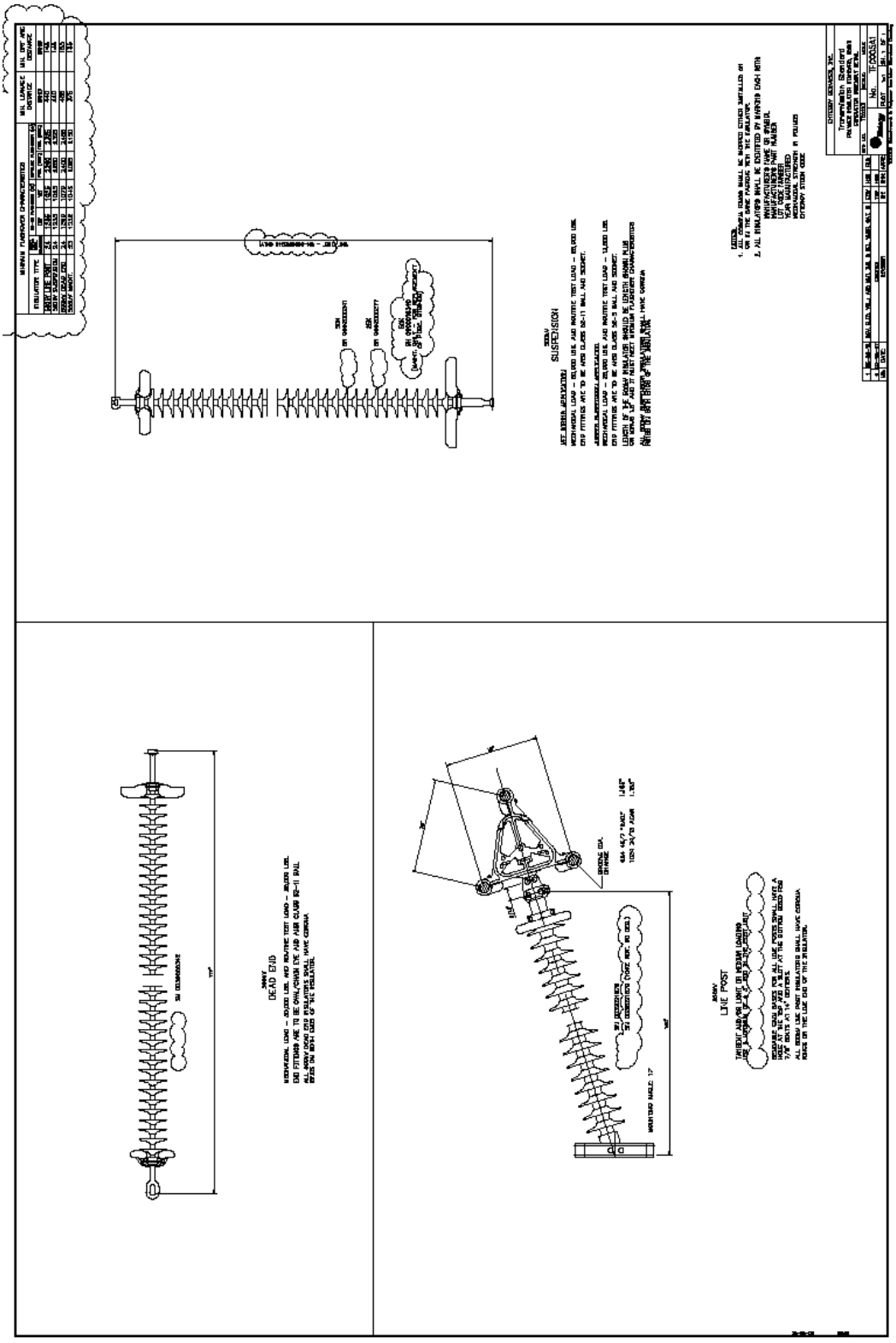
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

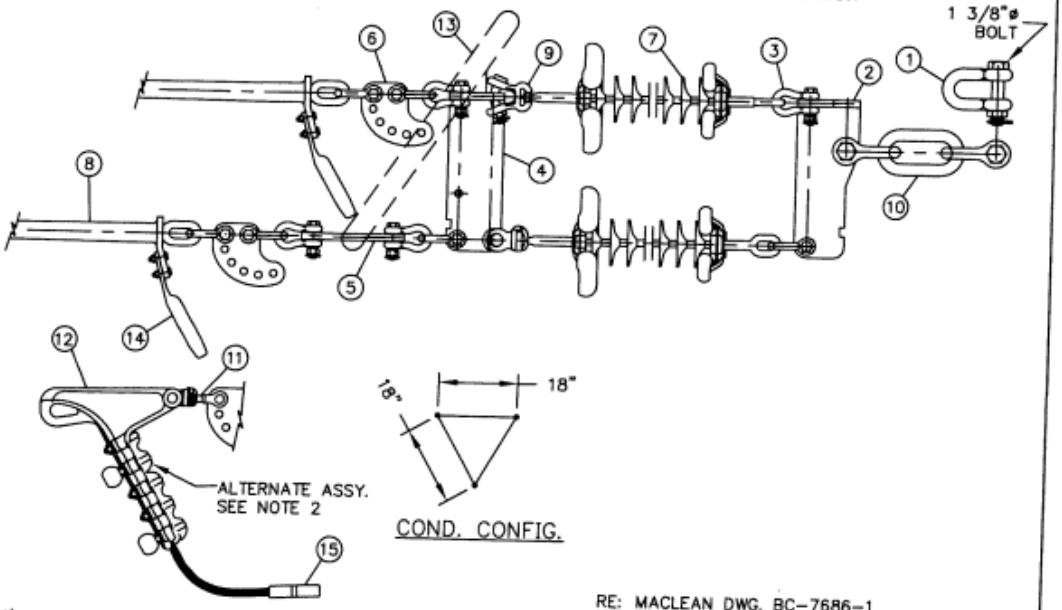
DEADEND, POLYMER, WITH BUNDLING YOKE, 500KV

| ITEM | COMP. QTY. | BOLTED QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|---|
| 1 | 2 | 2 | 0032009672 | SHACKLE, CHAIN, 150k ULT .STR. |
| 2 | 1 | 1 | 0032009669 | YOKE PLATE, TRIPLE BUNDLE, DEADEND, 18" SEPARATION, 110k ULT. STR. |
| 3 | 14 | 11 | 0000000689 | SHACKLE, ANCHOR, 60k ULT. STR. |
| 4 | 1 | 1 | 0032009670 | YOKE PLATE, TRIPLE BUNDLED, DEADEND, 18" SEPARATION, 110k ULT. STR. |
| 5 | 1 | 1 | 0032009665 | LINK EXTENSION, EYE-EYE, 40k ULT. STR. |
| 6 | 3 | 3 | 0032009668 | PLATE, ADJUSTMENT, 40k ULT. STR. |
| 7 | 3 | 3 | 0032000342 | INSULATOR, LINE, EYE-BALL, POLYMER, 500kV, 50k ULT .STR. |
| 8 | 3 | | LS9012XX | DEADEND, COMPRESSION, ALUMINUM, SINGLE TONGUE, 33k, FOR VARIABLE |
| 9 | 3 | 3 | 0000028529 | SOCKET, Y-CLEVIS, 50k |
| 10 | 1 | 1 | 0032000136 | LINK, CHAIN, 132k ULT., 7" LONG |
| 11 | | 3 | 0032021867 | CLEVIS BALL, 35k, BALL CLASS 52-3/5 |
| 12 | | 3 | LS9013XX | DEADEND, BOLTED, STRAIN, ALUM., 30K, FOR VARIABLE WIRE SIZE |
| 13 | 1 | 1 | 0032009685 | CORONA RING, 500kV DEADEND, ALUM. |
| 14 | 3 | | LS9014XX | TERMINAL CONNECTOR, 15 DEG., FOR VARIABLE WIRE SIZE |
| 15* | | 3 | LS5029XX | JUMPER, SPLICE, FOR VARIABLE WIRE SIZE |

| CONDUCTOR | CONDUCTOR DIA. | COMP. D.E. (ITEMS 8 & 14) | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. | ENTERGY STOCK NO. |
|---|---|---|---|---|---|
| 1024 ACAR | 1.165 | VES-130-EHV** | 0032000078 | C-7686-DE1 | NA |
| 954.0 45/7 "RAIL" | 1.165 | VES-133-EHV** | 0032021873 | C-7686-DE2 | NA |
| 954 54/7 "CARDINAL" | 1.196 | VES-135-EHV** | 0032021874 | C-7686-DE4 | NA |

| CONDUCTOR RANGE: | BOLTED STRAIN CLAMP (ITEM 12) | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. | ENTERGY STOCK NO. |
|---|---|---|---|---|
| .710" - 1.318" | ADE-2526-S-SPH4 | 0000028892 | C-7686-DE3 | NA |

* ITEMS 15 ARE NOT FURNISHED WITH THE MACLEAN ASSEMBLIES.
** COMPRESSION DEADEND BODIES COME WITH JUMPER TERMINALS, ITEM 14. EITHER OF OF ITEMS 8 AND 14 CAN BE RETURNED TO STORES WITH THEIR SEPARATE STOCK CODES.




1) ITEM #8, #12, #14 & #15 ARE CONDUCTOR DEPENDENT.
2) DESIGNER MAY SUBSTITUTE #11 & #12 & #15, FOR ITEMS #3 (QTY. 2) & #8. STRAIN CLAMP SHALL INCLUDE SOCKET EYE FOR A 52-3/5 BALL. USE OF BOLTED CLAMPS WILL REQUIRE THE USE OF NON-TENSION JUMPER SPLICES.

RE: MACLEAN DWG. BC-7686-1

ENTERGY SERVICES, INC.

DEADEND, POLYMER, W/BUNDLING YOKE, 500kV

STD NO. | SCALE: NONE

No. TFA200A0

PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 03-05-07 | CREATED | TWF | HSK | |

tfinc90 3/5/2007

DEPY-500-XX; BC-7686-1

# Appendix 2: High Voltage Overhead Transmission

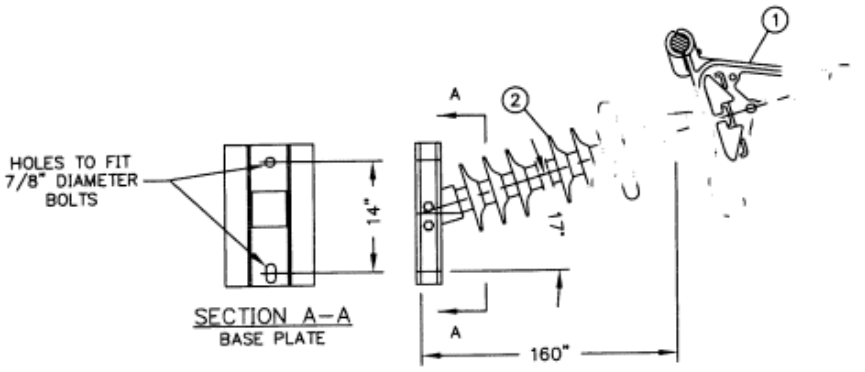
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

JUMPER LINE POST, POLYMER, w/BUNDLING YOKE, HORIZONTAL, 500kV

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | LS9015XX | JUMPER YOKE, 10k ULT. STR. 18" SEPARATION, ALUMINUM ALLOY |
| 2 | 1 | 0032021878 | INSULATOR, LINE POST, 3", POLYMER, 500kV, 10k ULT. STR. |

| CONDUCTOR | CONDUCTOR DIA. | JMPR. YOKE (ITEM 1) | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. | ENTERGY STOCK NO. |
|---|---|---|---|---|---|
| 1024 ACAR | 1.165 | C-7686-4 | 0032021850 | C-7686-J2 | NA |
| 954.0 45/7 "RAIL" | 1.165 | C-7686-4 | 0032021850 | C-7686-J2 | NA |
| 954 54/7 "CARDINAL" | 1.196 | C-7686-4A | 0032021860 | C-7686-J2A | NA |




1) ITEM #1 IS CONDUCTOR DEPENDENT. THIS ITEM IS SELECTED FOR EACH PROJECT (WITHOUT ARMOR RODS).

RE: MACLEAN DWG. BC-7686-4

ENTERGY SERVICES, INC.

JUMPER LINE POST, POLYMER, W/YOKE, HOR, 500kV

STD NO. | SCALE: NONE

No. TFA201A0

PLOT 1=1 | SH. 1 OF 1

JLPB-HJ-500-XX; BC-7686-4

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 03-05-07 | CREATED | TWF | HSK | |

tfinc90 3/19/2007

# Appendix 2: High Voltage Overhead Transmission

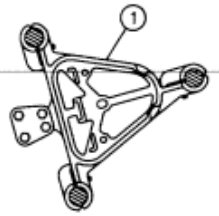
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

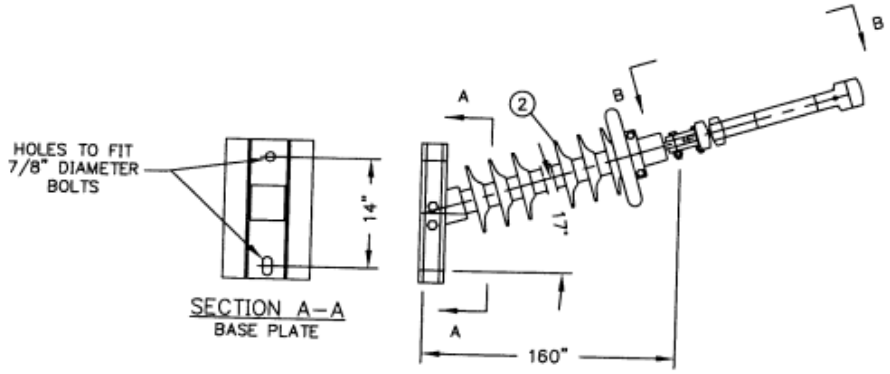
JUMPER LINE POST, POLYMER, w/BUNDLING YOKE, VERTICAL, 500kV

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | LS9015XX | JUMPER YOKE, 10k ULT. STR. 18" SEPARATION, ALUMINUM ALLOY |
| 2 | 1 | 0032021879 | INSULATOR, LINE POST, 3", POLYMER, 500kV, 10k ULT. STR. |

| CONDUCTOR | CONDUCTOR DIA. | JMPR. YOKE (ITEM 1) | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. | ENTERGY STOCK NO. |
|---|---|---|---|---|---|
| 1024 ACAR | 1.165 | C-7686-4 | 0032021850 | C-7686-J3 | NA |
| 954.0 45/7 "RAIL" | 1.165 | C-7686-4 | 0032021850 | C-7686-J3 | NA |
| 954 54/7 "CARDINAL" | 1.196 | C-7686-4A | 0032021860 | C-7686-J3A | NA |




SECTION B-B
YOKE PLATE




SECTION A-A
BASE PLATE

1) ITEM #1 IS CONDUCTOR DEPENDENT. THIS ITEM IS SELECTED FOR EACH PROJECT (WITHOUT ARMOR RODS).

RE: MACLEAN DWG. BC-7686-5

| | | | | | |
|---|---|---|---|---|---|
| 0 | 03-05-07 | CREATED | TWF | HSK | |
| NO. | DATE: | REVISION | BY: | CHK: | APPR: |

tfinc90 3/5/2007

ENTERGY SERVICES, INC.

JUMPER LINE POST, POLYMER, W/YOKE, VER, 500kV

STD NO. | SCALE: NONE

Entergy | No. TFA202A0 | PLOT 1=1 | SH. 1 OF 1

JLPB-VJ-500-XX; BC-7686-5

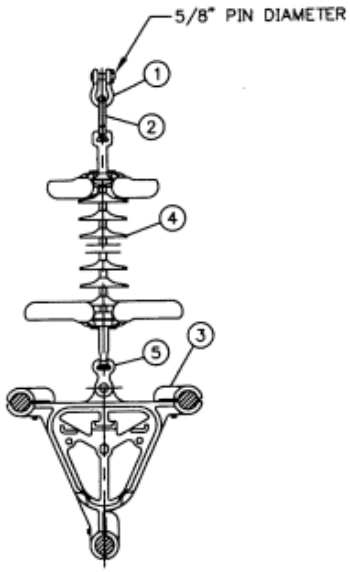
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

### BILL OF MATERIALS

JUMPER SUSPENSION, POLYMER, w/ BUNDLING YOKE 500kV

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0000004466 | SHACKLE, ANCHOR, 30k ULT .STR., 5/8" PIN DIA. 2-13/16" |
| 2 | 1 | 0000028889 | BALL EYE, OVAL, 35k ULT. STR., BALL CLASS 52-3/5 |
| 3 | 1 | LS9016XX | YOKE, JUMPER, 10k ULT. STR. 18" SEPARATION, ALUM. ALLOY |
| 4 | 1 | 0032000277 | INSULATOR, SUSPENSION, B&S, POLYMER, 500kV, 25k ULT. STR. |
| 5 | 1 | 0032021870 | CLEVIS, SOCKET, 30k ULT. STR., CLASS 52-3/5 |

| CONDUCTOR | CONDUCTOR DIA. | JMPR. YOKE (ITEM 3) | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. | ENTERGY STOCK NO. |
|---|---|---|---|---|---|
| 1024 ACAR | 1.165 | C-6549-3 | 0032021827 | C-7686-J1 | NA |
| 954.0 45/7 "RAIL" | 1.165 | C-6549-3 | 0032021827 | C-7686-J1 | NA |
| 954 54/7 "CARDINAL" | 1.196 | C-7686-5 | 0032021863 | C-7686-J1A | NA |




1) ITEM #3 IS CONDUCTOR DEPENDENT. THIS ITEM IS SELECTED FOR EACH PROJECT WITHOUT ARMOR RODS.

RE: MACLEAN DWG. BC-7686-2

ENTERGY SERVICES, INC.

JUMPER SUSPENSION, POLYMER, W/YOKE, 500kV

STD NO. | SCALE: NONE

No. TFA203A0

PLOT 1=1 | SH. 1 OF 1

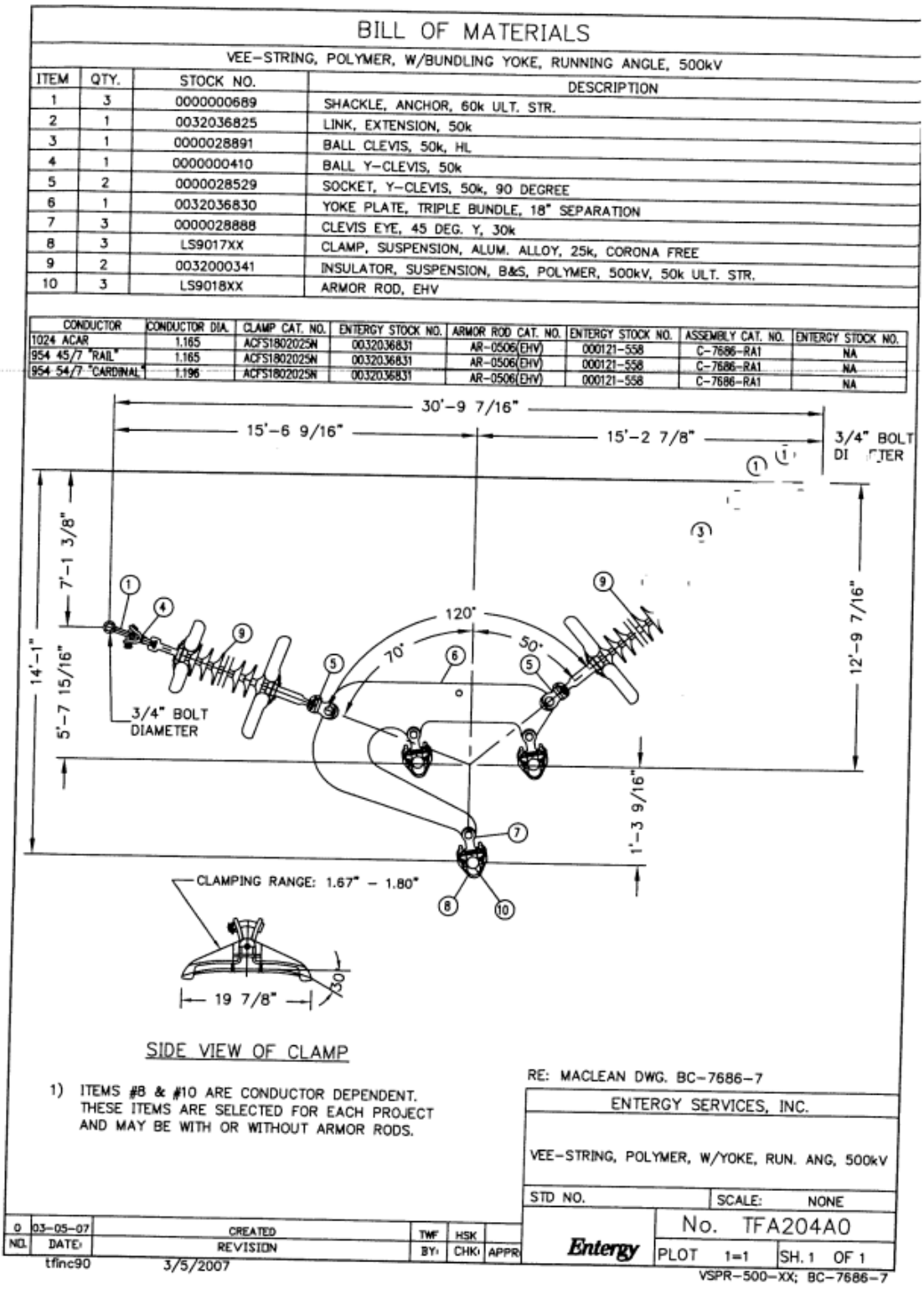
JSPB-500-XX; BC-7686-2

| -05-07 | CREATED | TWF | HSK | |
|---|---|---|---|---|
| DATE: | REVISION | BY: | CHK: | APP |

tfinc90 3 5 2007

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



BILL OF MATERIALS

VEE-STRING, POLYMER, W/BUNDLING YOKE, RUNNING ANGLE, 500kV

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 3 | 0000000689 | SHACKLE, ANCHOR, 60k ULT. STR. |
| 2 | 1 | 0032036825 | LINK, EXTENSION, 50k |
| 3 | 1 | 0000028891 | BALL CLEVIS, 50k, HL |
| 4 | 1 | 0000000410 | BALL Y-CLEVIS, 50k |
| 5 | 2 | 0000028529 | SOCKET, Y-CLEVIS, 50k, 90 DEGREE |
| 6 | 1 | 0032036830 | YOKE PLATE, TRIPLE BUNDLE, 18" SEPARATION |
| 7 | 3 | 0000028888 | CLEVIS EYE, 45 DEG. Y, 30k |
| 8 | 3 | LS9017XX | CLAMP, SUSPENSION, ALUM. ALLOY, 25k, CORONA FREE |
| 9 | 2 | 0032000341 | INSULATOR, SUSPENSION, B&S, POLYMER, 500kV, 50k ULT. STR. |
| 10 | 3 | LS9018XX | ARMOR ROD, EHV |

| CONDUCTOR | CONDUCTOR DIA. | CLAMP CAT. NO. | ENTERGY STOCK NO. | ARMOR ROD CAT. NO. | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. | ENTERGY STOCK NO. |
|---|---|---|---|---|---|---|---|
| 1024 ACAR | 1.165 | ACFS1802025N | 0032036831 | AR-0506(EHV) | 000121-558 | C-7686-RA1 | NA |
| 954 45/7 "RAIL" | 1.165 | ACFS1802025N | 0032036831 | AR-0506(EHV) | 000121-558 | C-7686-RA1 | NA |
| 954 54/7 "CARDINAL" | 1.196 | ACFS1802025N | 0032036831 | AR-0506(EHV) | 000121-558 | C-7686-RA1 | NA |



SIDE VIEW OF CLAMP

1) ITEMS #8 & #10 ARE CONDUCTOR DEPENDENT. THESE ITEMS ARE SELECTED FOR EACH PROJECT AND MAY BE WITH OR WITHOUT ARMOR RODS.

RE: MACLEAN DWG. BC-7686-7

ENTERGY SERVICES, INC.

VEE-STRING, POLYMER, W/YOKE, RUN. ANG, 500kV

STD NO. | SCALE: NONE

Entergy | No. TFA204A0 | PLOT 1=1 | SH. 1 OF 1

VSPR-500-XX; BC-7686-7

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 03-05-07 | CREATED | TWF | HSK | |

tfinc90 3/5/2007

# Appendix 2: High Voltage Overhead Transmission

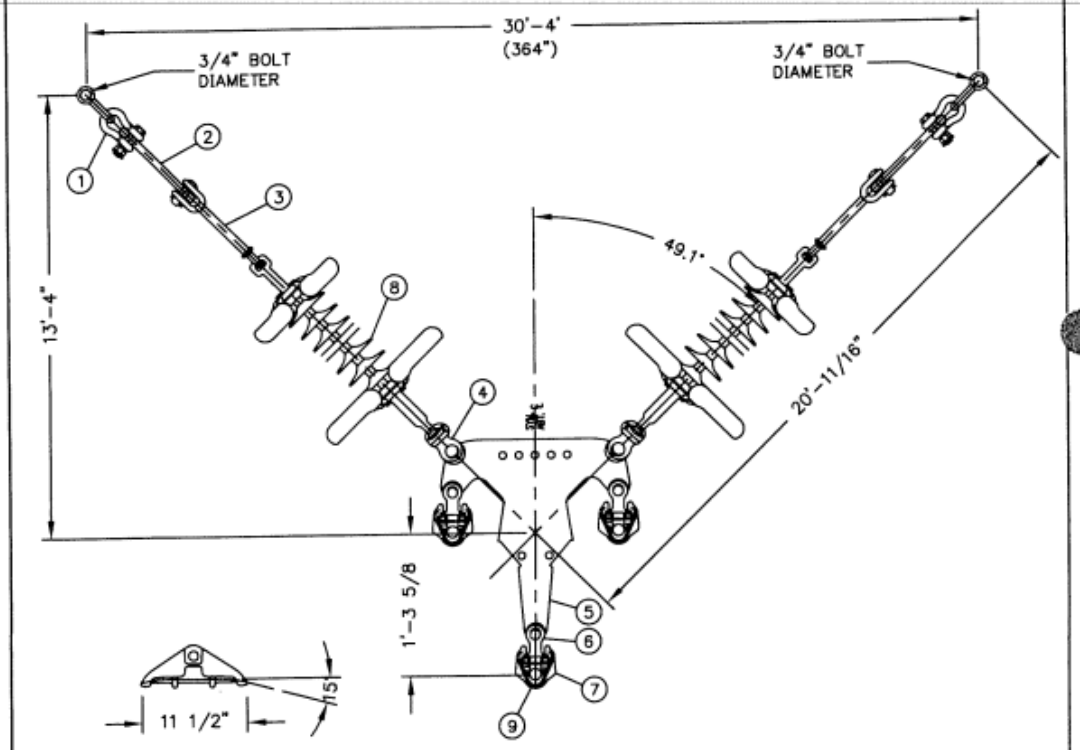
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

VEE-STRING, POLYMER, W/BUNDLING YOKE, 500kV

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 4 | 0000000689 | SHACKLE, ANCHOR, 60k ULT. STR. |
| 2 | 2 | 0032034296 | LINK, EXTENSION, 50k |
| 3 | 2 | 0000028891 | BALL CLEVIS, 50k |
| 4 | 2 | 0000028529 | SOCKET, Y-CLEVIS, 50k |
| 5 | 1 | 0032021845 | YOKE PLATE, TRIPLE BUNDLE, 18" SEPARATION |
| 6 | 3 | 0000028888 | CLEVIS EYE, 45 DEG. Y, 30k |
| 7 | 3 | LS9019XX | CLAMP, SUSPENSION, ALUM. ALLOY, 25k, CORONA FREE |
| 8 | 2 | 0032000341 | INSULATOR, SUSPENSION, B&S, POLYMER, 500kV, 50k ULT. STR. |
| 9 | 3 | LS9018XX | ARMOR ROD, EHV |

| CONDUCTOR | CONDUCTOR DIA. | CLAMP CAT. NO. | ENTERGY STOCK NO. | ARMOR ROD CAT. NO. | ENTERGY STOCK NO. | ASSEMBLY CAT. NO. | ENTERGY STOCK NO. |
|---|---|---|---|---|---|---|---|
| 1024 ACAR | 1.165 | CF-184-N | 0000028890 | AR-0506(EHV) | 000121-558 | C-8098-VS1 | NA |
| 954 45/7 "RAIL" | 1.165 | CF-184-N | 0000028890 | AR-0506(EHV) | 000121-558 | C-8098-VS1 | NA |
| 954 54/7 "CARDINAL" | 1.196 | CF-184-N | 0000028890 | AR-0506(EHV) | 000121-558 | C-8098-VS1 | NA |




SIDE VIEW OF CLAMP

1) ITEMS #7 & #9 ARE CONDUCTOR DEPENDENT. THESE ITEMS ARE SELECTED FOR EACH PROJECT AND MAY BE WITH OR WITHOUT ARMOR RODS.

RE: MACLEAN DWG. BC-8098-1

ENTERGY SERVICES, INC.

VEE-STRING, POLYMER, W/BUNDLING YOKE, 500kV

STD NO. | SCALE: NONE

No. TFA205A0

PLOT 1=1 | SH. 1 OF 1

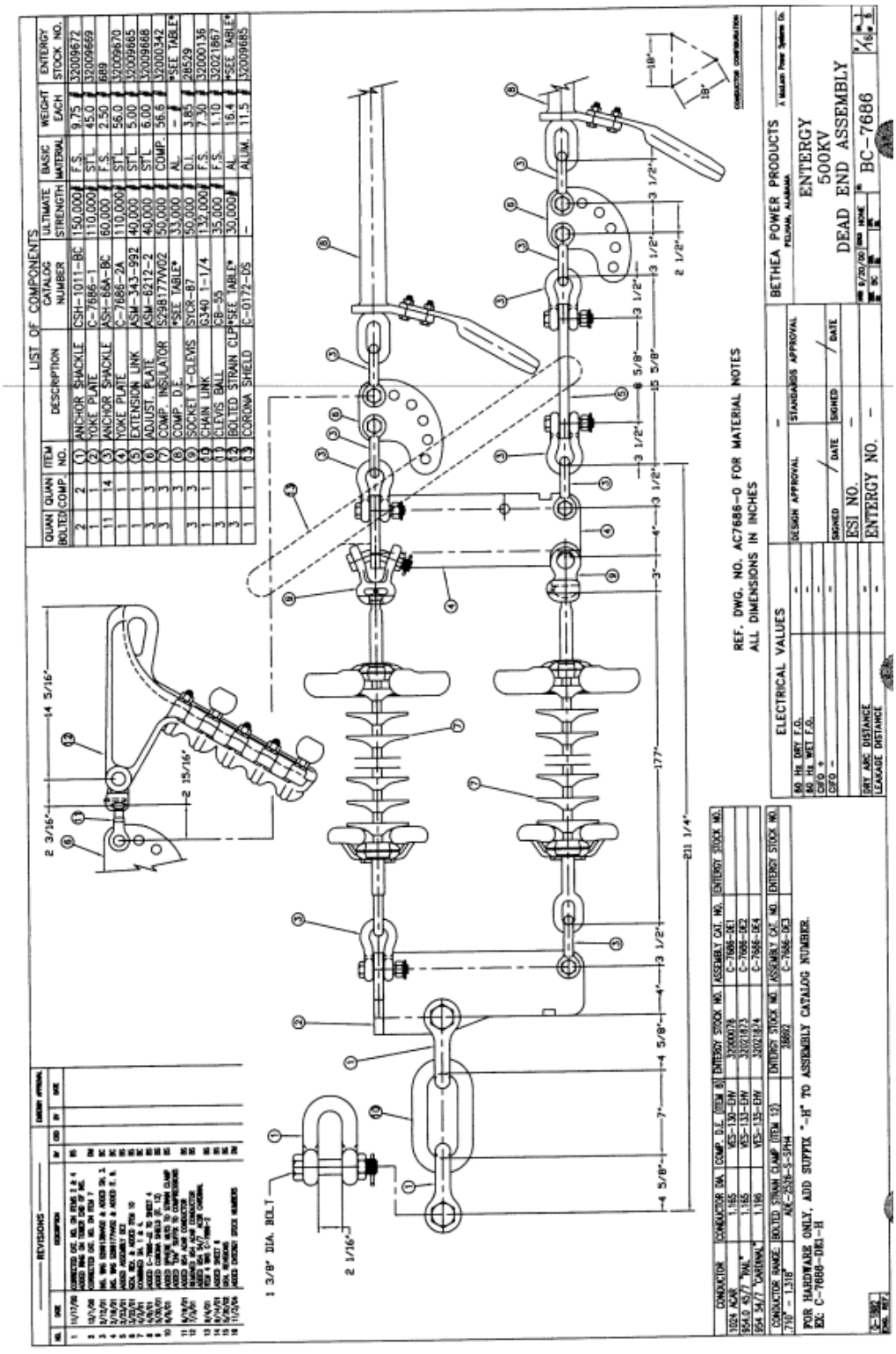
VSPY-500-XX; BC-8098-1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 03-05-07 | CREATED | TWF | HSK | |

tfinc90 3/5/2007

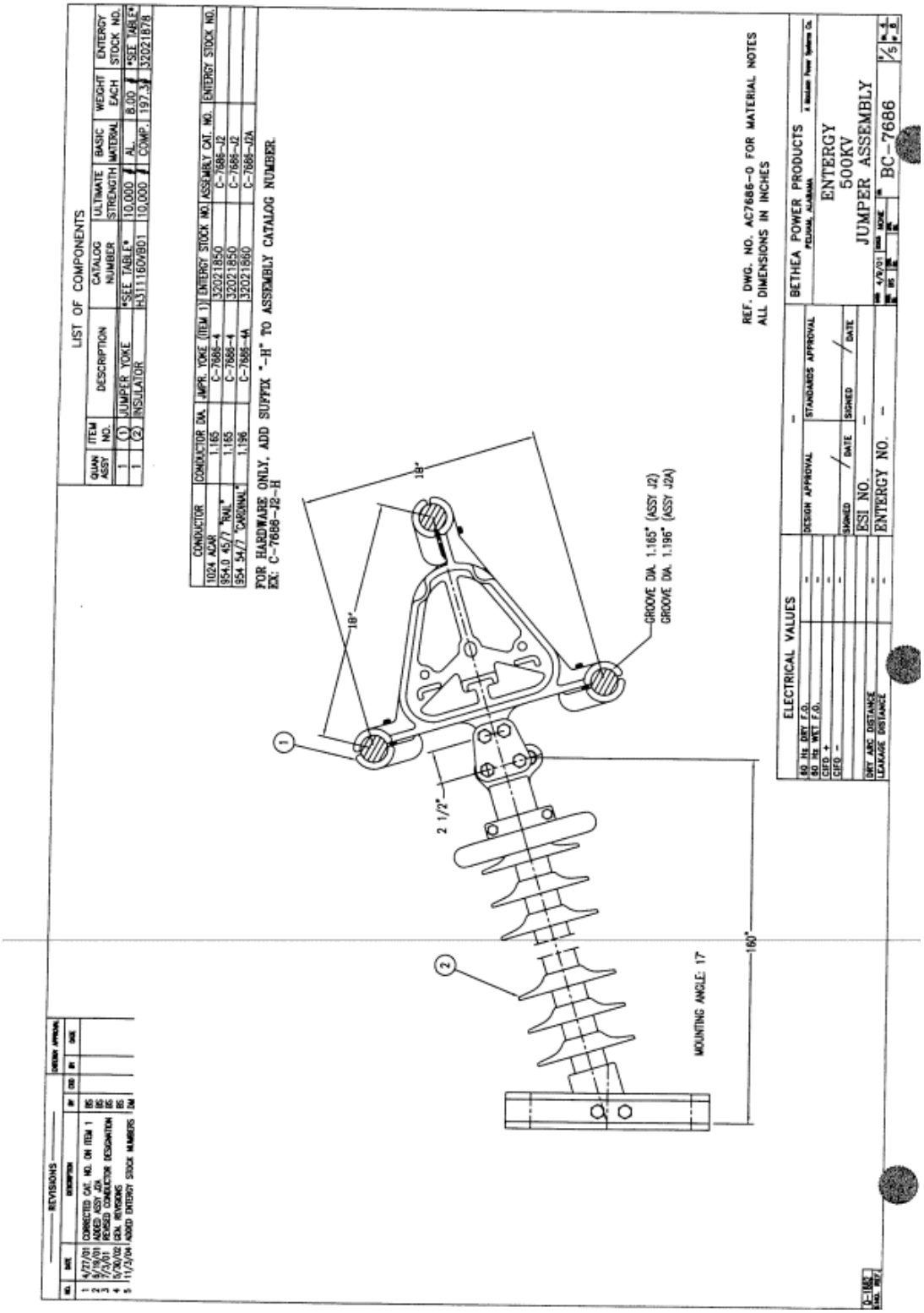
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



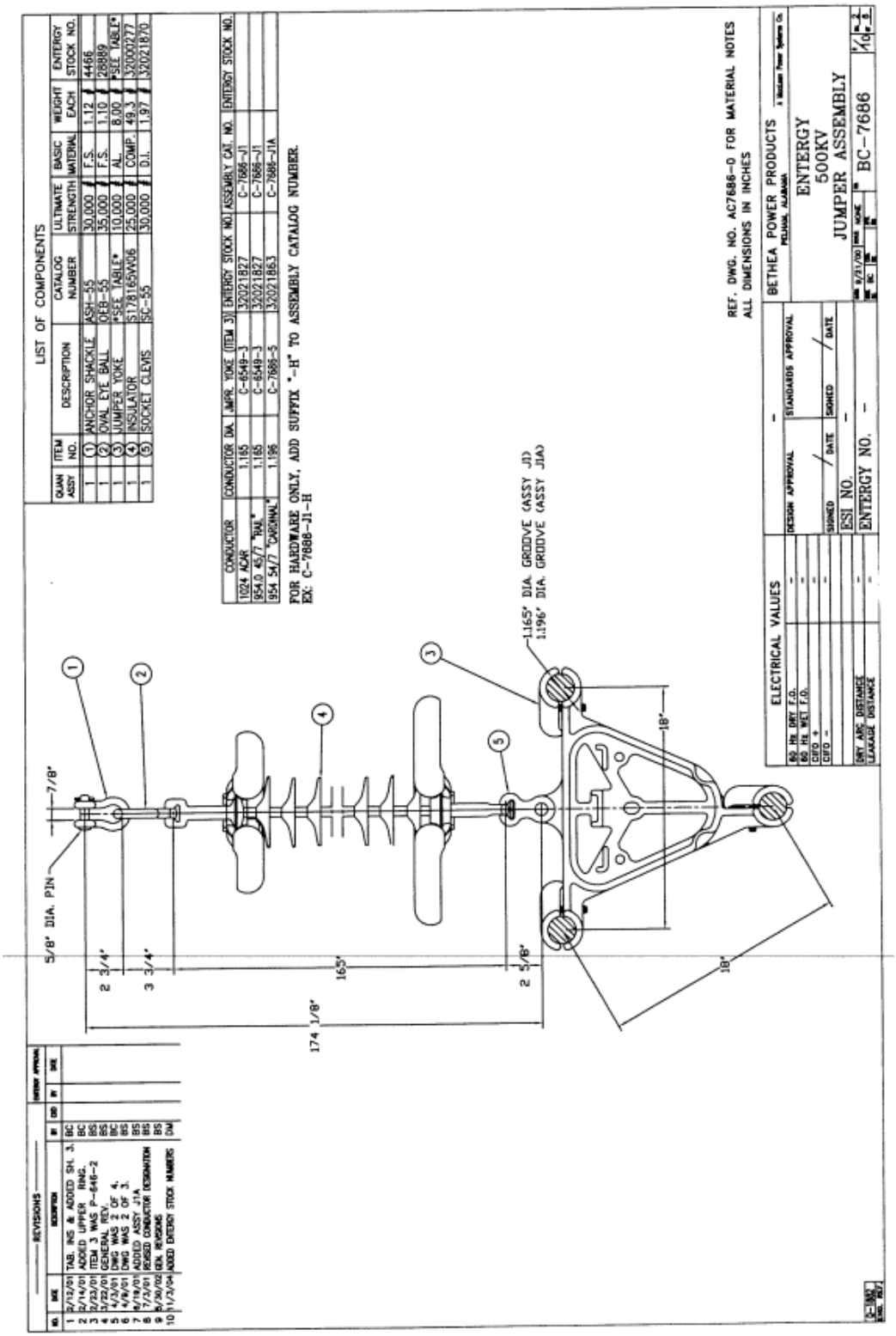
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



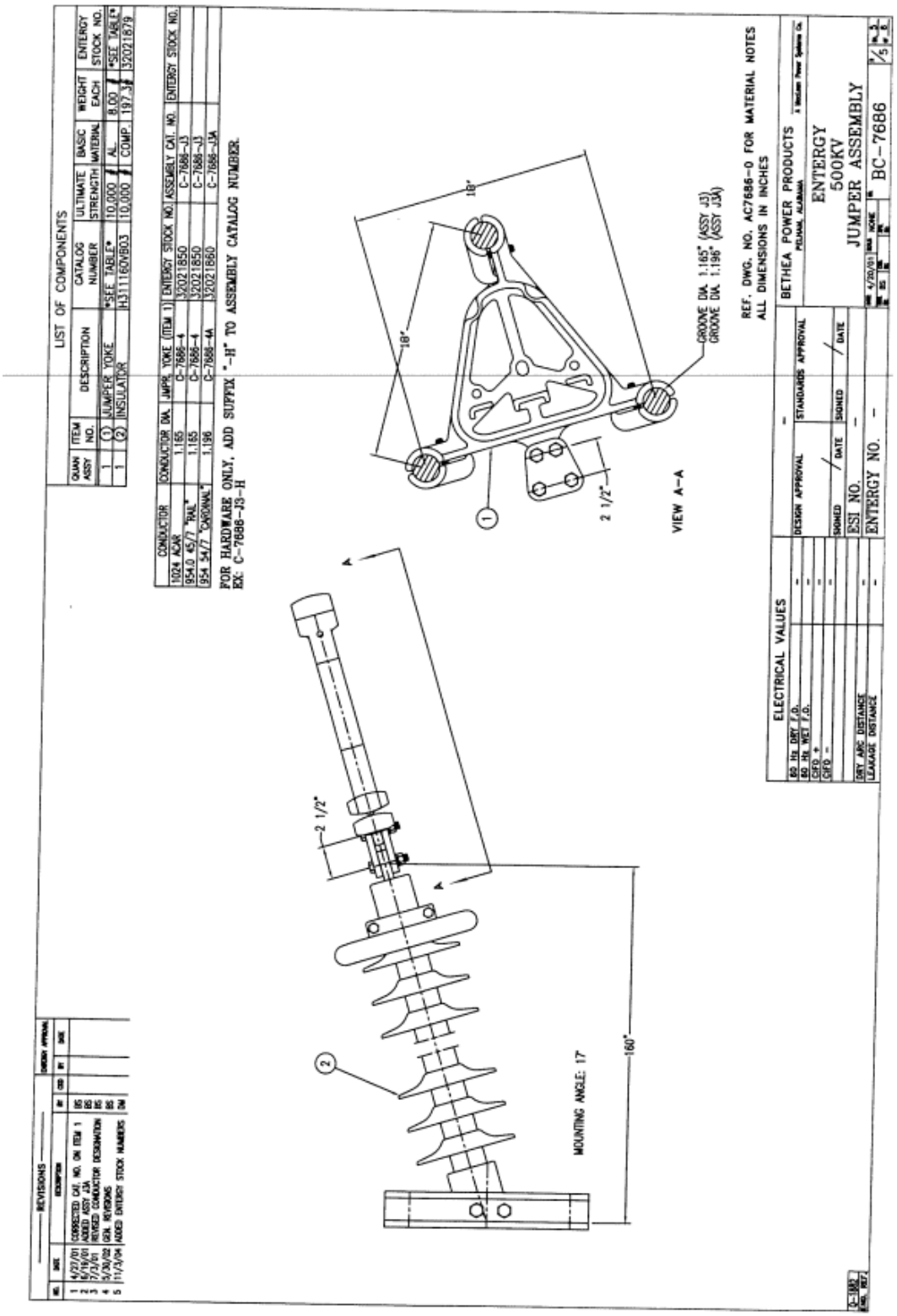
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



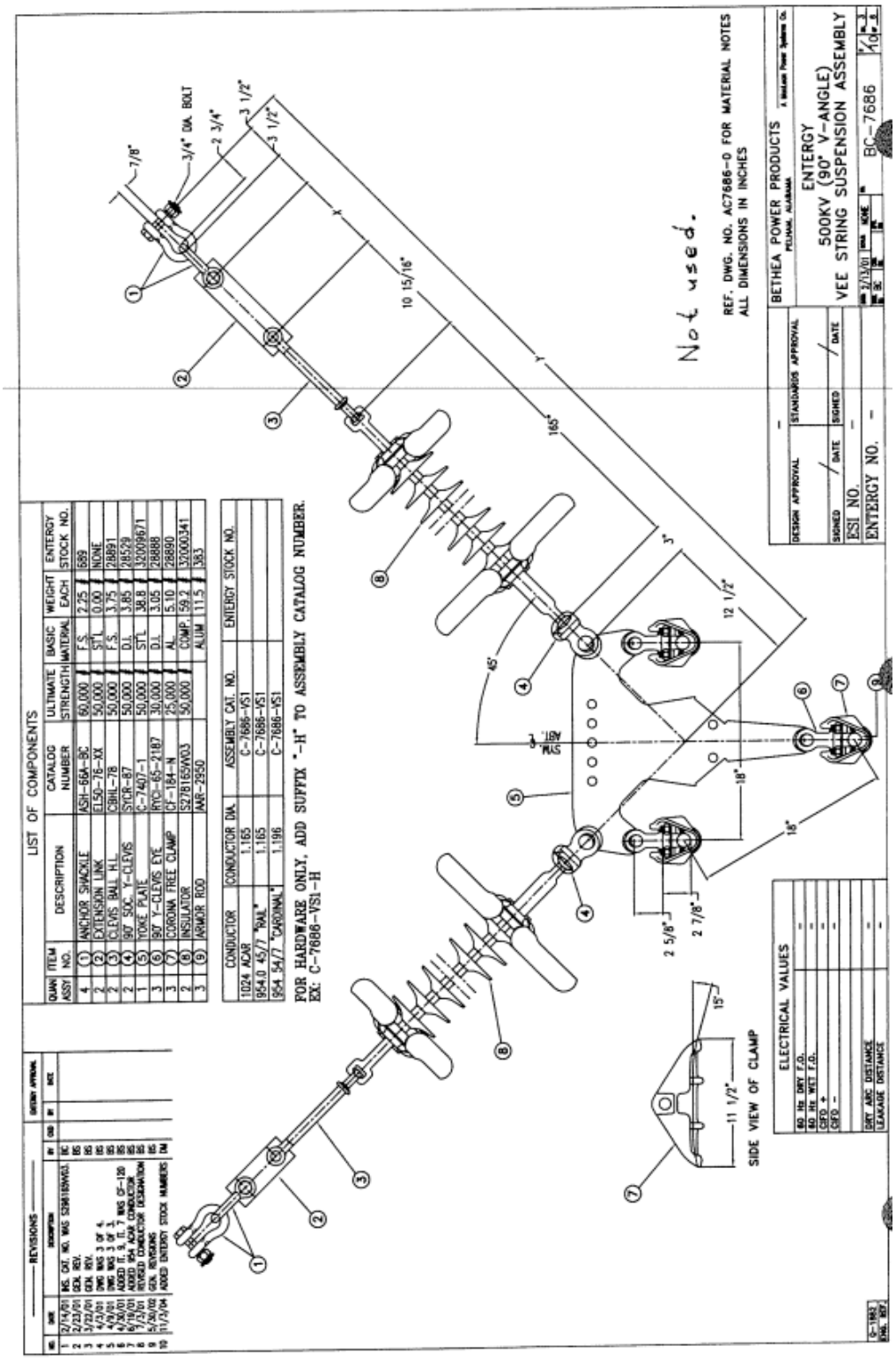
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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



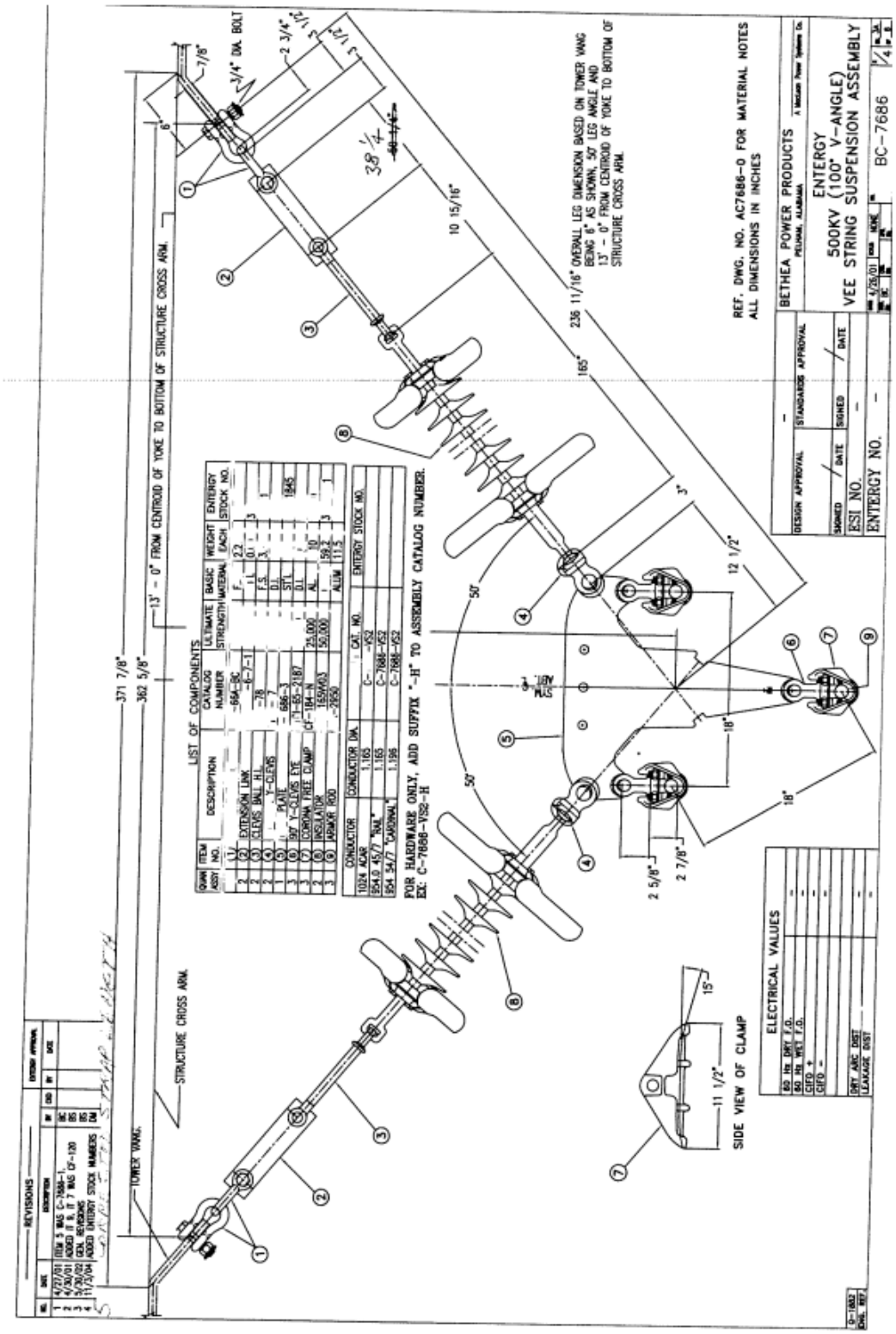
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



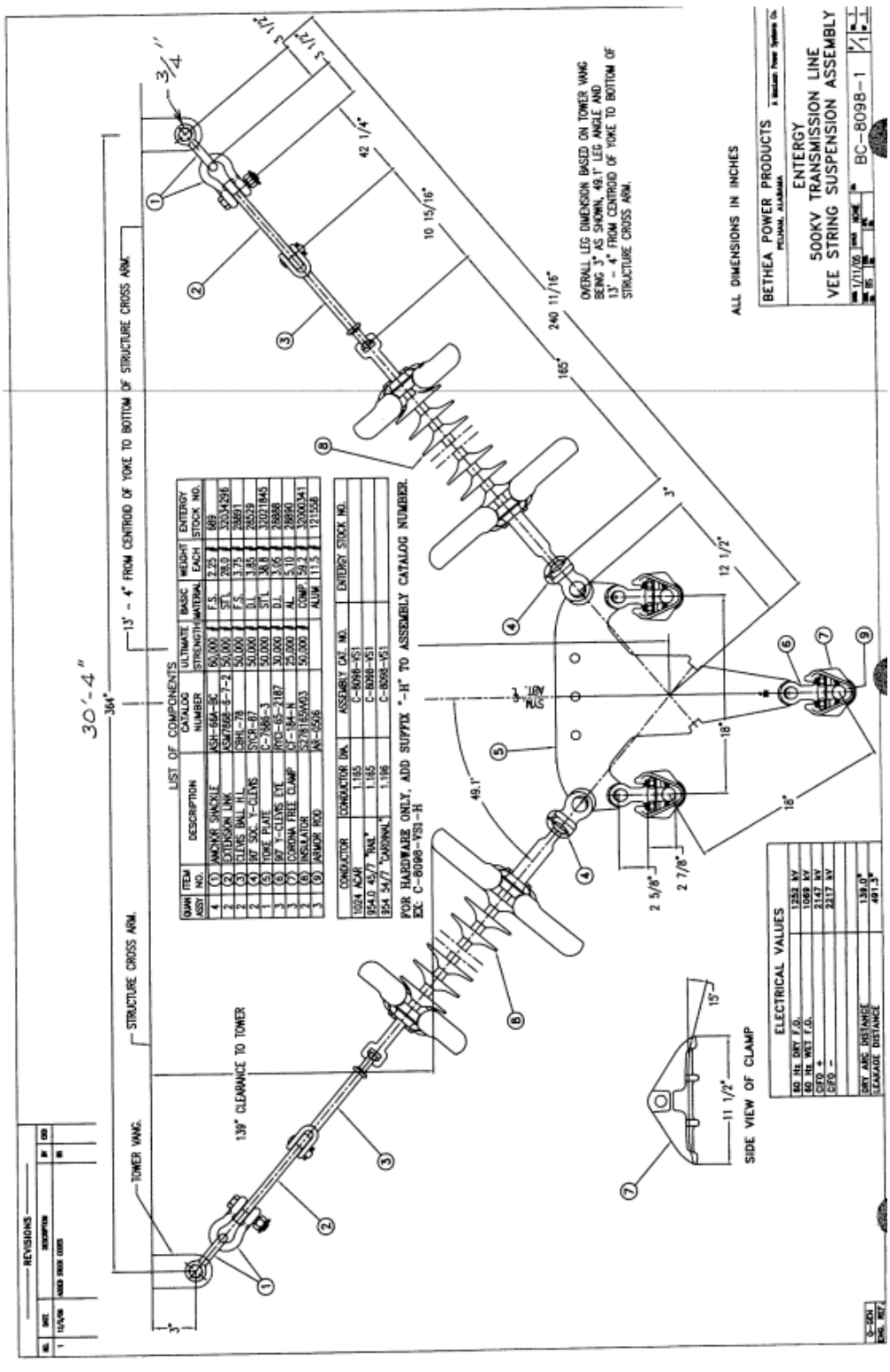
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



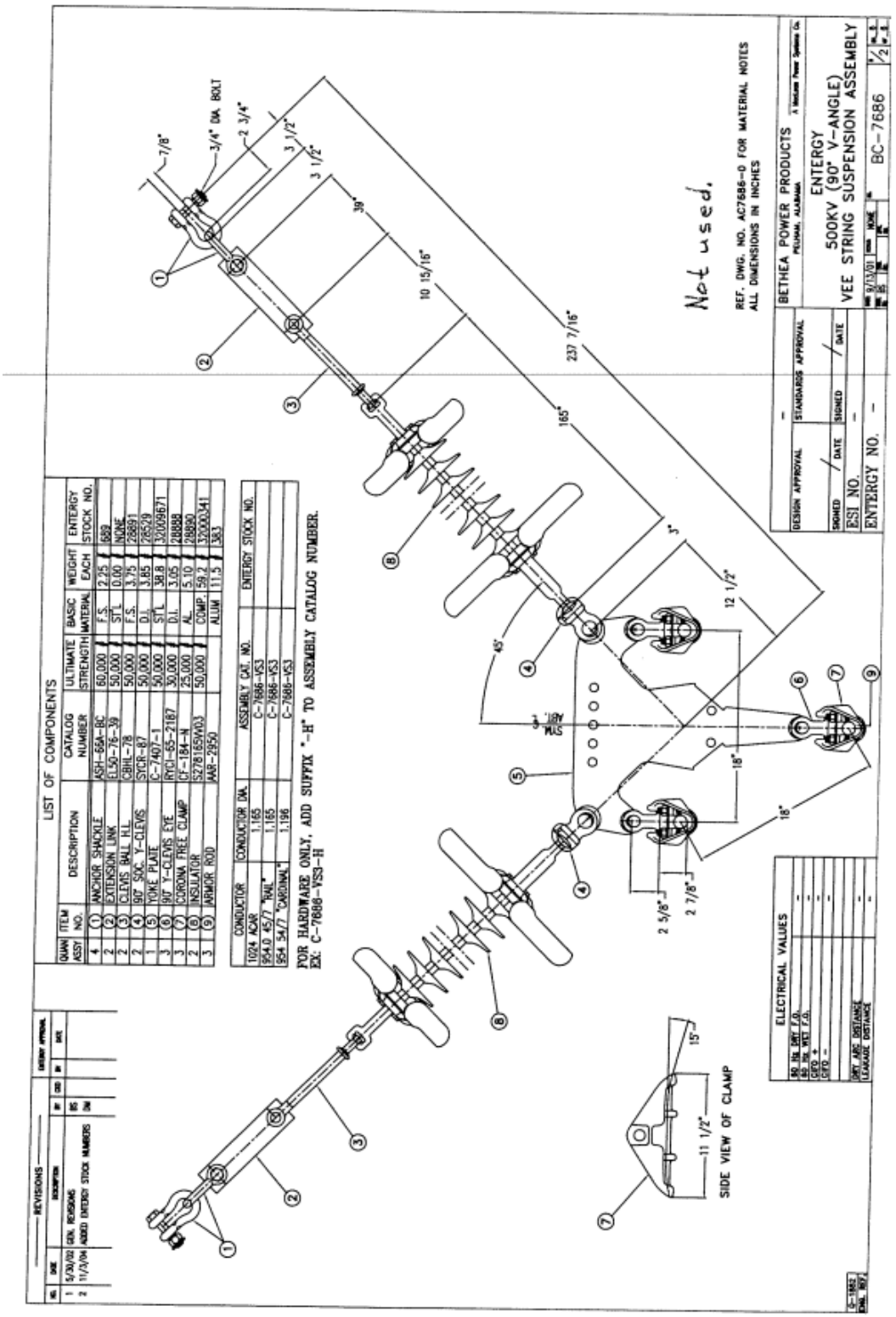
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



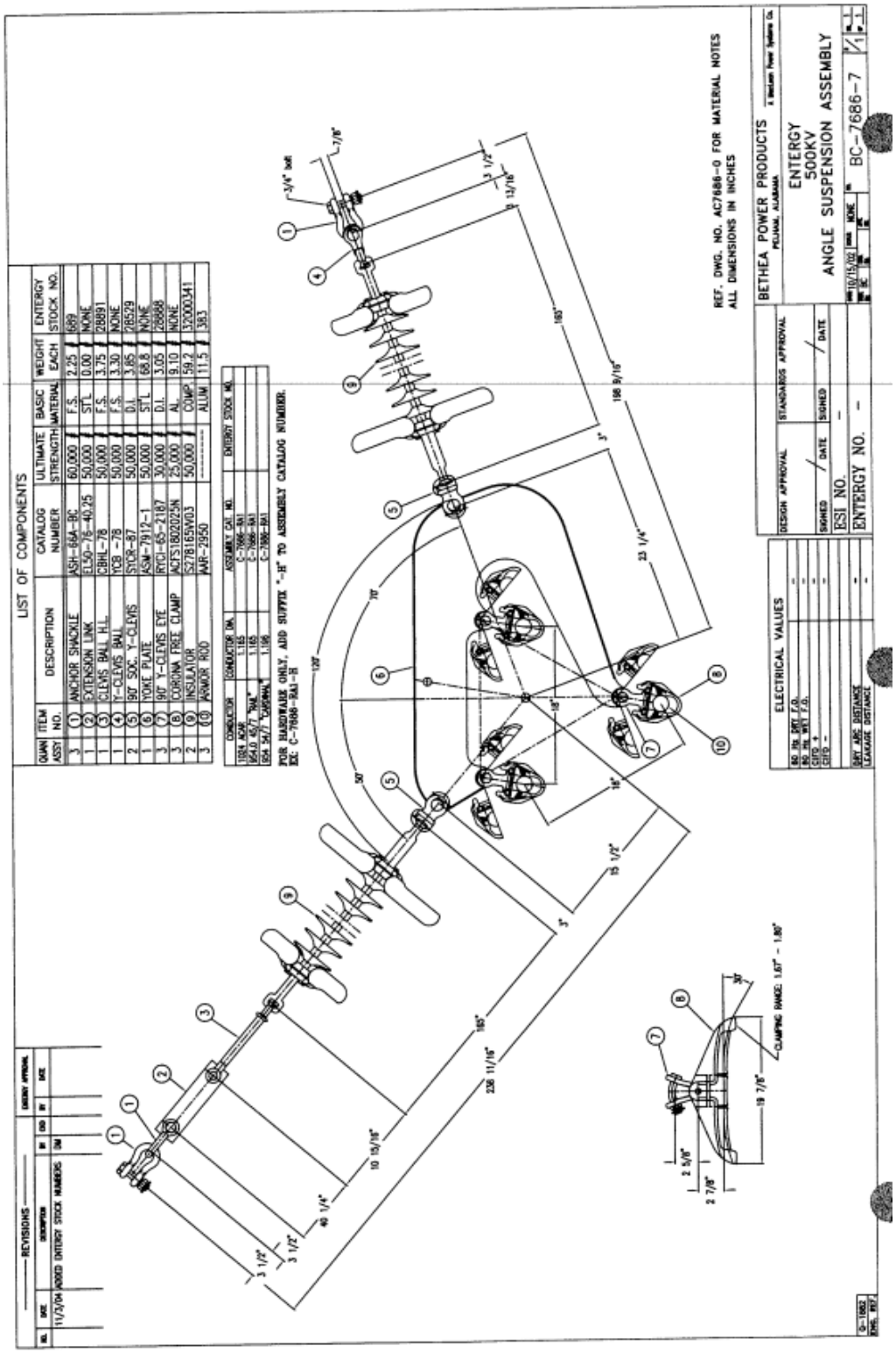
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



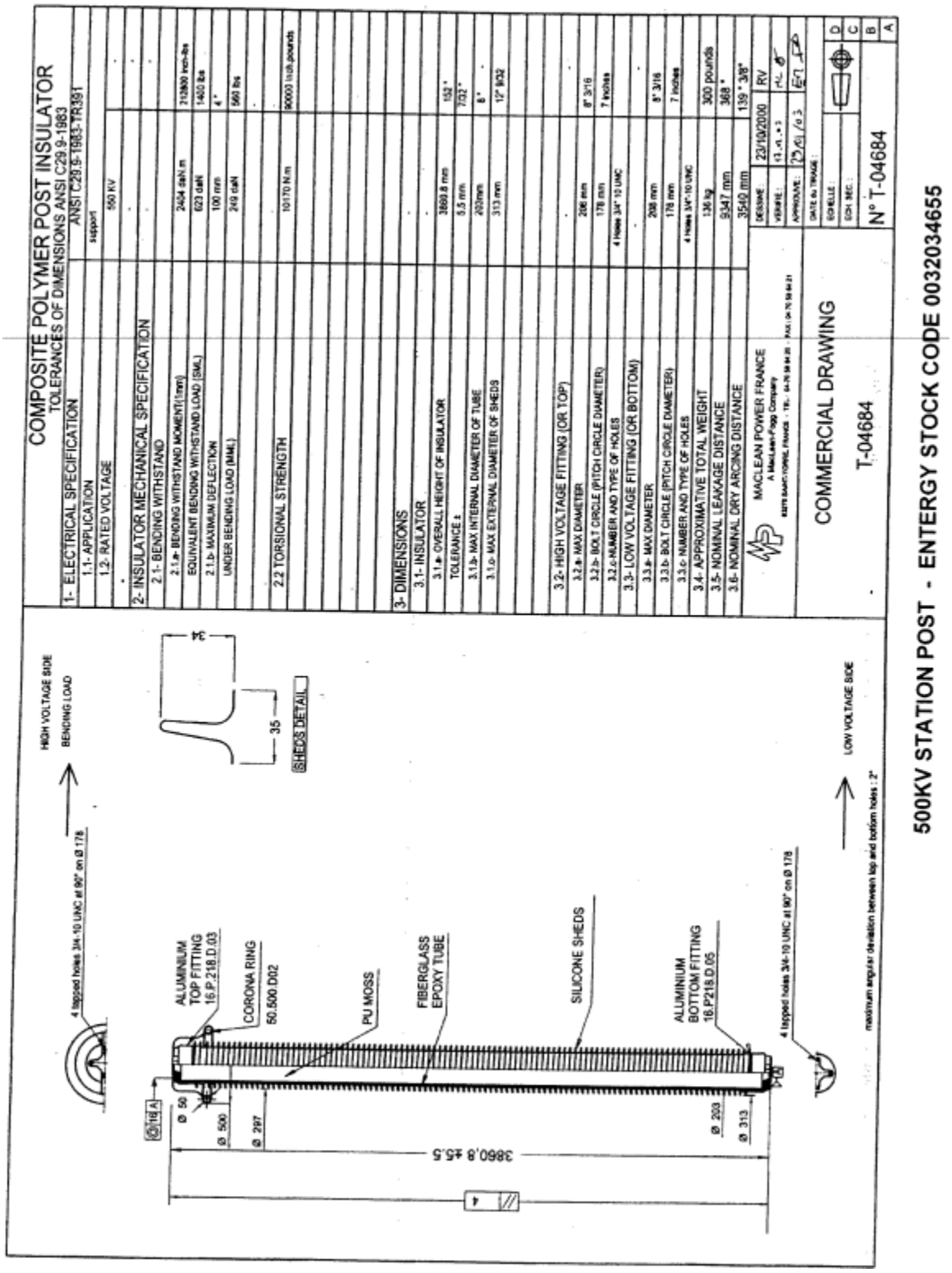
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



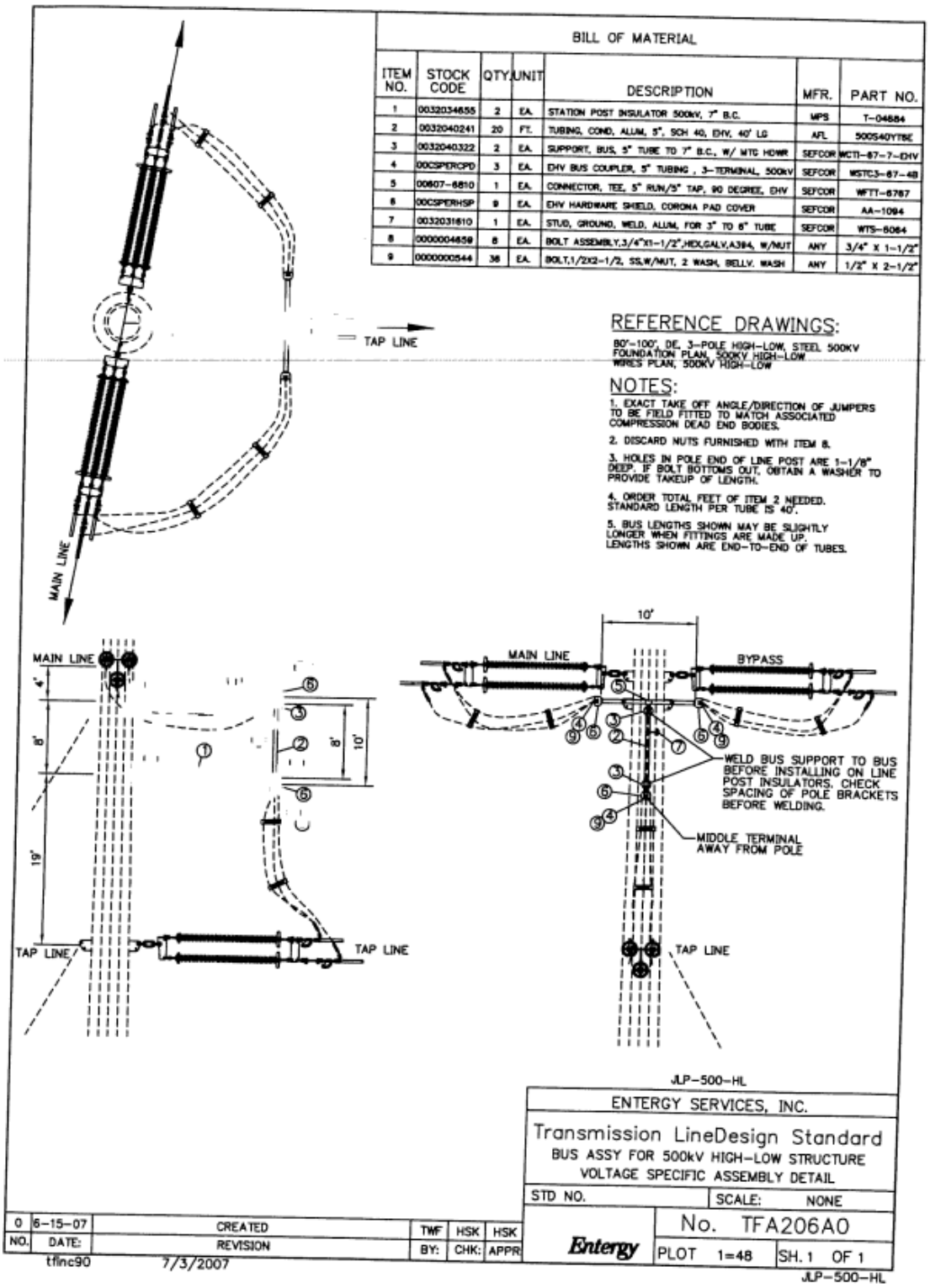
# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



BILL OF MATERIAL

| ITEM NO. | STOCK CODE | QTY. | UNIT | DESCRIPTION | MFR. | PART NO. |
|---|---|---|---|---|---|---|
| 1 | 0032034655 | 2 | EA. | STATION POST INSULATOR 500kV, 7" B.C. | MPS | T-04584 |
| 2 | 0032040241 | 20 | FT. | TUBING, COND, ALUM, 5", SCH 40, EHV, 40' LG | AFL | 500S40Y15E |
| 3 | 0032040322 | 2 | EA. | SUPPORT, BUS, 5" TUBE TO 7" B.C., W/ MTG HDWR | SEFCOR | WCTI-67-7-EHV |
| 4 | 00CSPERCPD | 3 | EA. | EHV BUS COUPLER, 5" TUBING , 3-TERMINAL, 500kV | SEFCOR | WSTC3-67-48 |
| 5 | 00607-6810 | 1 | EA. | CONNECTOR, TEE, 5" RUN/5" TAP, 90 DEGREE, EHV | SEFCOR | WFTT-6767 |
| 6 | 00CSPERHSP | 9 | EA. | EHV HARDWARE SHIELD, CORONA PAD COVER | SEFCOR | AA-1094 |
| 7 | 0032031610 | 1 | EA. | STUD, GROUND, WELD, ALUM, FOR 3" TO 8" TUBE | SEFCOR | WTS-6064 |
| 8 | 0000004659 | 8 | EA. | BOLT ASSEMBLY,3/4"X1-1/2",HDG,GALV,A394, W/NUT | ANY | 3/4" X 1-1/2" |
| 9 | 0000000544 | 36 | EA. | BOLT,1/2X2-1/2, SS,W/NUT, 2 WASH, BELLV. WASH | ANY | 1/2" X 2-1/2" |

REFERENCE DRAWINGS:

80'-100', DE, 3-POLE HIGH-LOW, STEEL 500KV
FOUNDATION PLAN, 500KV HIGH-LOW
WIRES PLAN, 500KV HIGH-LOW

NOTES:

1. EXACT TAKE OFF ANGLE/DIRECTION OF JUMPERS TO BE FIELD FITTED TO MATCH ASSOCIATED COMPRESSION DEAD END BODIES.
2. DISCARD NUTS FURNISHED WITH ITEM 8.
3. HOLES IN POLE END OF LINE POST ARE 1-1/8" DEEP. IF BOLT BOTTOMS OUT, OBTAIN A WASHER TO PROVIDE TAKEUP OF LENGTH.
4. ORDER TOTAL FEET OF ITEM 2 NEEDED. STANDARD LENGTH PER TUBE IS 40'.
5. BUS LENGTHS SHOWN MAY BE SLIGHTLY LONGER WHEN FITTINGS ARE MADE UP. LENGTHS SHOWN ARE END-TO-END OF TUBES.

TAP LINE
MAIN LINE
MAIN LINE
BYPASS
10'
WELD BUS SUPPORT TO BUS BEFORE INSTALLING ON LINE POST INSULATORS. CHECK SPACING OF POLE BRACKETS BEFORE WELDING.
MIDDLE TERMINAL AWAY FROM POLE
TAP LINE
TAP LINE
TAP LINE
JLP-500-HL

ENTERGY SERVICES, INC.
Transmission LineDesign Standard
BUS ASSY FOR 500kV HIGH-LOW STRUCTURE
VOLTAGE SPECIFIC ASSEMBLY DETAIL
STD NO.
SCALE: NONE
No. TFA206A0
PLOT 1=48
SH. 1 OF 1
Entergy

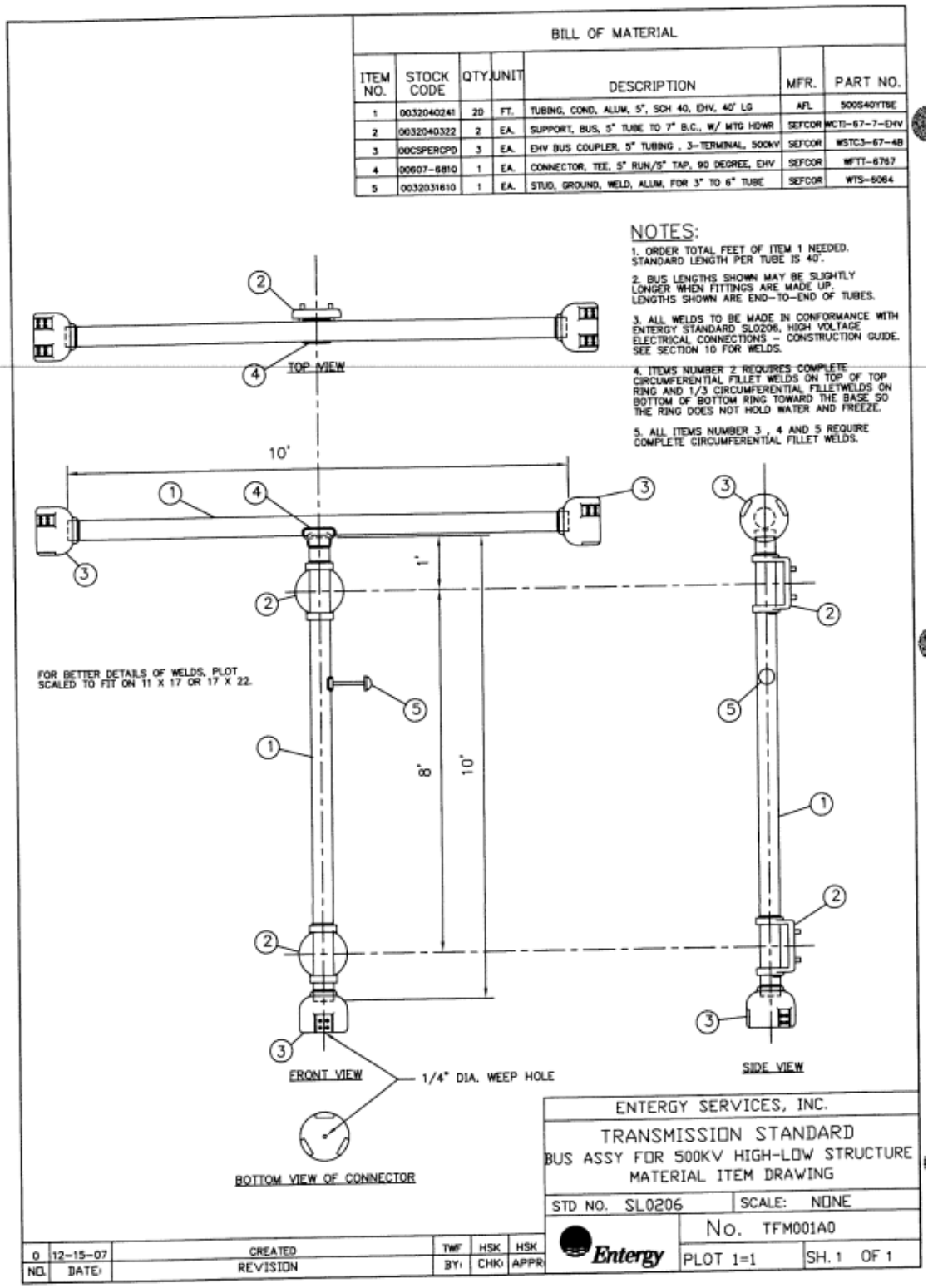
| NO. | DATE: | REVISION | BY: | CHK: | APPR |
|---|---|---|---|---|---|
| 0 | 6-15-07 | CREATED | TWF | HSK | HSK |

tflnc90 7/3/2007

JLP-500-HL

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



BILL OF MATERIAL

| ITEM NO. | STOCK CODE | QTY | UNIT | DESCRIPTION | MFR. | PART NO. |
|---|---|---|---|---|---|---|
| 1 | 0032040241 | 20 | FT. | TUBING, COND, ALUM, 5", SCH 40, EHV, 40' LG | AFL | 500S40YT6E |
| 2 | 0032040322 | 2 | EA. | SUPPORT, BUS, 5" TUBE TO 7" B.C., W/ MTG HDWR | SEFCOR | MCTI-67-7-EHV |
| 3 | 00CSPERCPD | 3 | EA. | EHV BUS COUPLER, 5" TUBING , 3-TERMINAL, 500kV | SEFCOR | WSTC3-67-4B |
| 4 | 00607-6810 | 1 | EA. | CONNECTOR, TEE, 5" RUN/5" TAP, 90 DEGREE, EHV | SEFCOR | WFTT-6767 |
| 5 | 0032031610 | 1 | EA. | STUD, GROUND, WELD, ALUM, FOR 3" TO 6" TUBE | SEFCOR | WTS-6064 |

NOTES:

1. ORDER TOTAL FEET OF ITEM 1 NEEDED. STANDARD LENGTH PER TUBE IS 40'.
2. BUS LENGTHS SHOWN MAY BE SLIGHTLY LONGER WHEN FITTINGS ARE MADE UP. LENGTHS SHOWN ARE END-TO-END OF TUBES.
3. ALL WELDS TO BE MADE IN CONFORMANCE WITH ENTERGY STANDARD SL0206, HIGH VOLTAGE ELECTRICAL CONNECTIONS - CONSTRUCTION GUIDE. SEE SECTION 10 FOR WELDS.
4. ITEMS NUMBER 2 REQUIRES COMPLETE CIRCUMFERENTIAL FILLET WELDS ON TOP OF TOP RING AND 1/3 CIRCUMFERENTIAL FILLETWELDS ON BOTTOM OF BOTTOM RING TOWARD THE BASE SO THE RING DOES NOT HOLD WATER AND FREEZE.
5. ALL ITEMS NUMBER 3 , 4 AND 5 REQUIRE COMPLETE CIRCUMFERENTIAL FILLET WELDS.

TOP VIEW

10'

FOR BETTER DETAILS OF WELDS, PLOT SCALED TO FIT ON 11 X 17 OR 17 X 22.

1"

8'

10'

FRONT VIEW

1/4" DIA. WEEP HOLE

BOTTOM VIEW OF CONNECTOR

SIDE VIEW

ENTERGY SERVICES, INC.

TRANSMISSION STANDARD

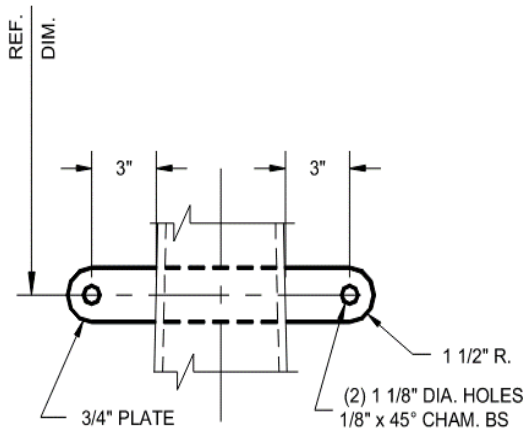
BUS ASSY FOR 500KV HIGH-LOW STRUCTURE MATERIAL ITEM DRAWING

STD NO. SL0206 | SCALE: NONE

Entergy | No. TFM001A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE | REVISION | BY | CHK | APPR |
|---|---|---|---|---|---|
| 0 | 12-15-07 | CREATED | TWF | HSK | HSK |

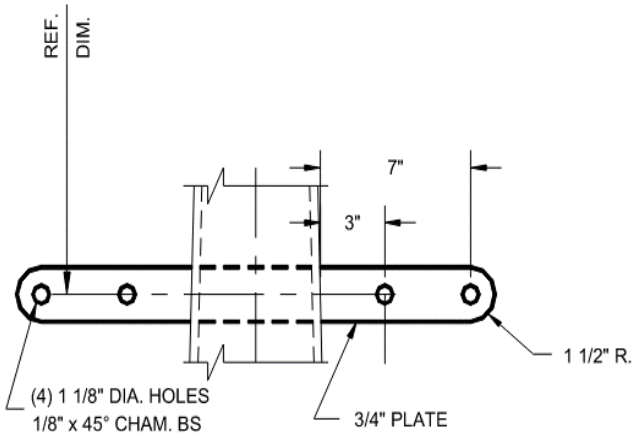
Vang Details for Steel Poles




**LIGHT-DUTY 2-HOLE VANG**

Primary uses:

Support shield wire span guys
Support top of braced-post insulator assemblies
Support conductor swinging angle assemblies




**LIGHT-DUTY 4-HOLE VANG**

Primary use:

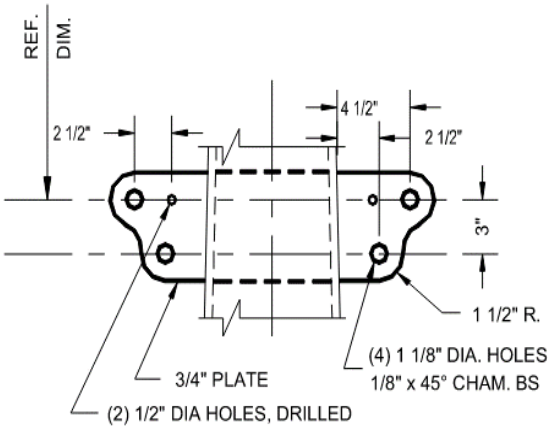
Support shield wire suspension

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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

Vang Details for Steel Poles




**HEAVY-DUTY 4-HOLE VANG**

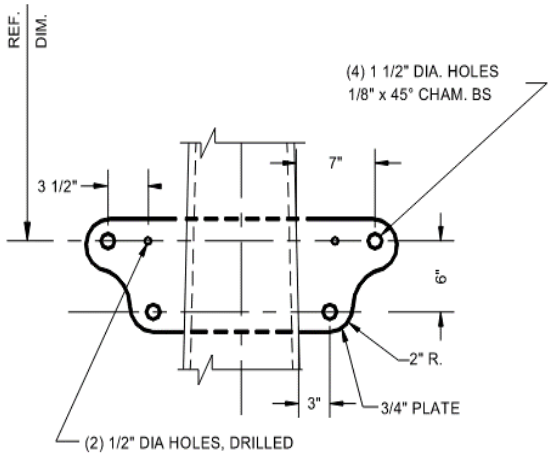
Primary use:

Support shield wire deadend assemblies
Support conductor deadend assemblies
Support conductor deadend down guys
Support conductor bisector down guys
Support shield wire deadend down guys
Support shield wire bisector down guys
All conductor and shield wire vangs on structures with running angle insulators (E, F and G)

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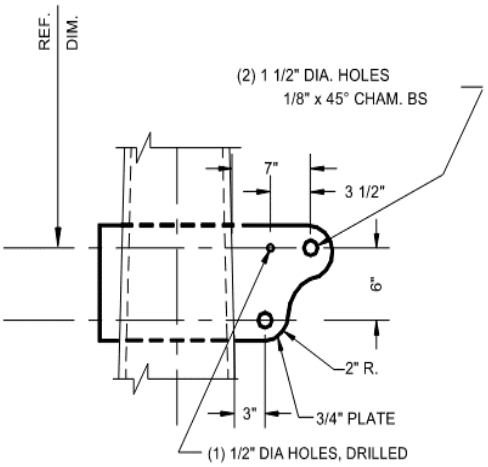
Vang Details for Steel Poles




**HEAVY-DUTY 4-HOLE VANG FOR TRIPLE BUNDLE SINGLE POINT DEAD ENDS**

Primary use:

Support 500kv conductor dead end assemblies where guys will be at the same elevation as the conductors and when guys are not specified.




**HEAVY-DUTY 2-HOLE VANG FOR TRIPLE BUNDLE SINGLE POINT DEAD ENDS**

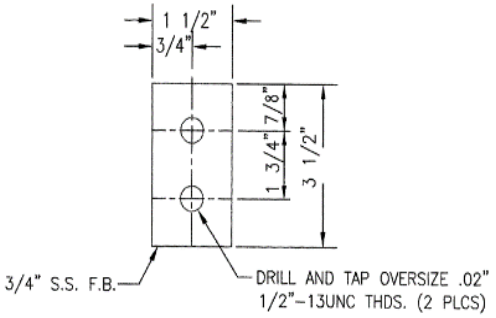
Primary use:

Support 500kv conductor dead end assemblies and guys where guys are specified and will attach at locations below the conductors. Do not install guy vangs on unguyed structures with this type of vang unless specified by Entergy.

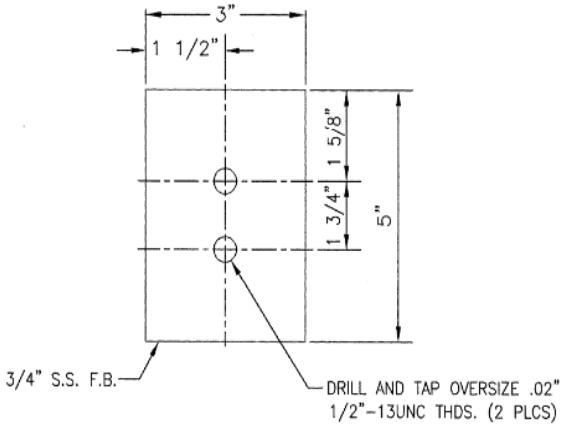
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## NEMA Pad Details for Steel Poles or Caissons




**SMALL NEMA 2-HOLE PAD**



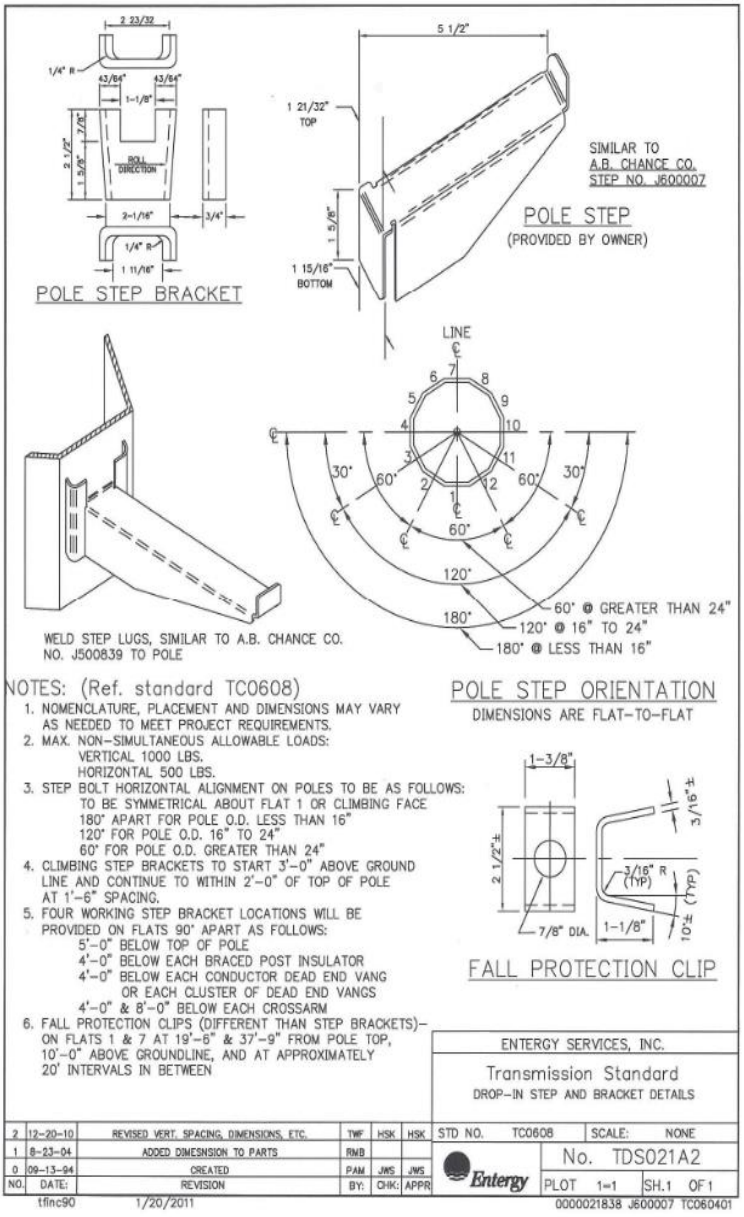

**LARGE NEMA 2-HOLE PAD**

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## Climbing Details

TDS021A1, Step and Bracket Details, represents the Entergy specifications for drop-in steps.

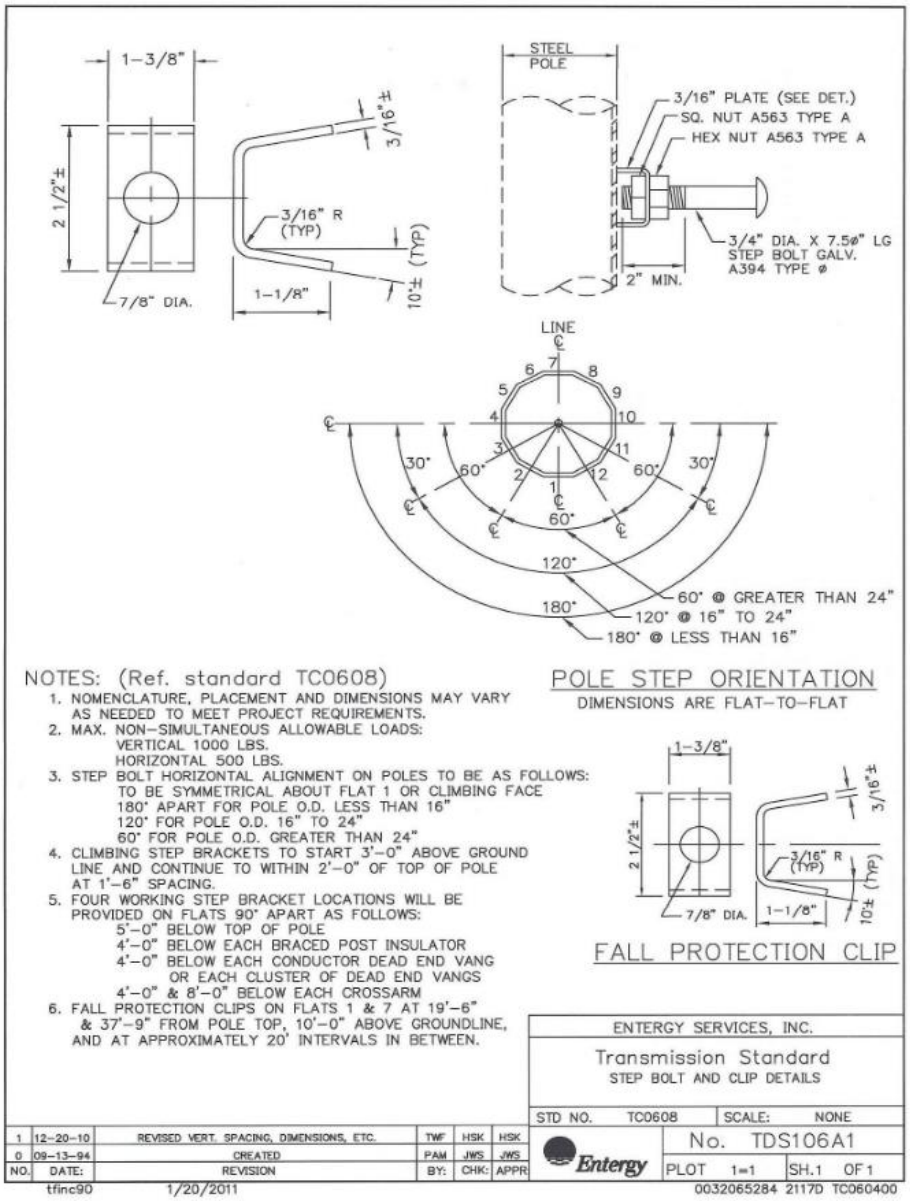



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## Climbing Details

TDS106A1, Step Bolt Details, represents the Entergy specifications for pole steps.



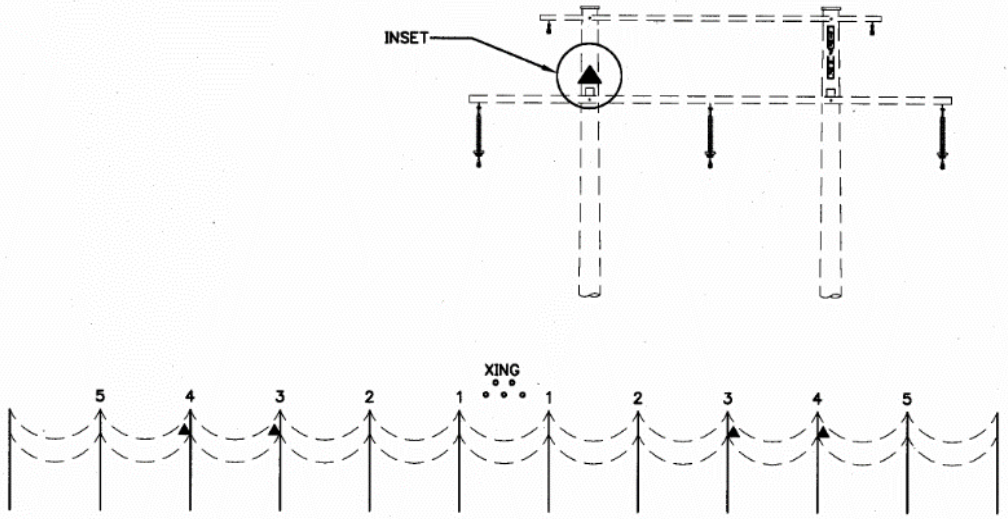

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## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

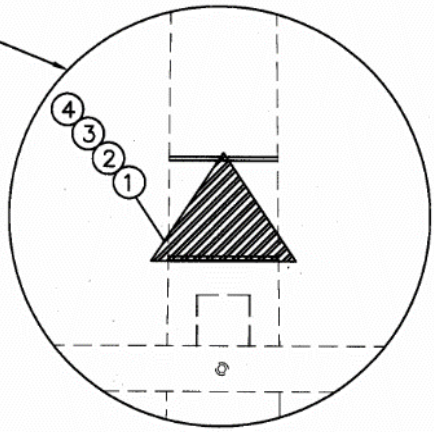
BILL OF MATERIAL

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | NONE | SIGN, SLOW–VEHICLE, ACQUIRED BY LOCAL PURCHASE |
| 2 | 8 FT. | 0000017124 | BAND, STRAPPING, 3/4" WD X 100FT LG ROLL, STAINLESS STEEL, 201 |
| 3 | 2 | 0032047234 | BRACKET, BANDING, FLARED LEG, SS, WITH ONE 5/16"–18 X 3/4" HEX HEAD SS BOLT AND FIBER WASHER, 3/4" SLOT, SHIPPED 50/BOX |
| 4 | 2 | 0000017123 | BOLT, CLAMP ASSEMBLY, CARRIAGE HD, GALVANIZED STEEL, HIGH STRENGTH, ASTM B221 MILITARY QQ–A–200/8, 5 GR, 3/8" DIA, 6" LG HIGH STR CARR BOLT, WASH AND NUT. |




NOTES:

1) This installation is optional with the grids, and represents a standard for uniformity across the system wherever it is used.
2) Install one slow–vehicle sign on third & fourth structures on each side of overhead line crossings of lines to be patrolled by helicopter to provide advance warning of aerial hazard ahead. Additional structures may be marked where sight distance or visibility is limited.
3) Place the markers near the pole tops and away from the hazard so it will be seen as the helicopter approaches the line crossing.
4) Slow–vehicle signs are available for local purchase at farm supply stores and major hardware stores.
5) If there are two overhead line crossings in close proximity of each other, install two markers one above the other on each structure. Some structures in between may require single markers on both sides of each structure.
6) Fasten markers to poles with 3/4" banding as indicated in the Bill of Material above. Wooden poles may have the markers fastened with galvanized lag screws, 1/4" by 2–1/2" and washers. Additional holes or enlarged holes may be necessary in the marker.
7) On wooden poles, do not install hardware cloth over the face of the markers.




SGN–HAZ–XNG

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

LINE CROSSING HAZARD MARKING
STRUCTURAL ASSEMBLY DETAIL

| STD NO. | SCALE: NONE |
|---|---|
| | No. TMD407A0 |
| | PLOT 1=1 / SH. 1 OF 1 |

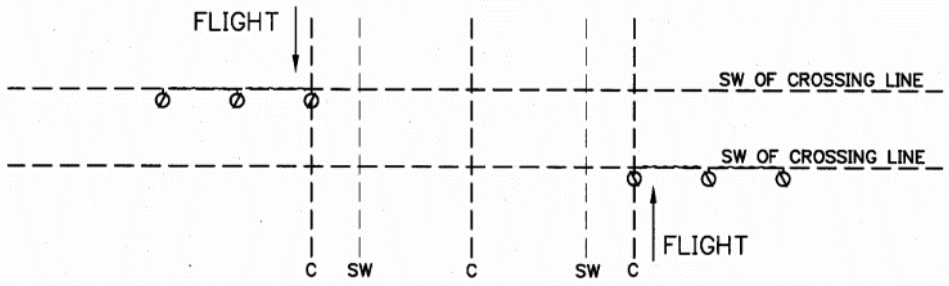
| NO. | DATE: | REVISION | BY: | CHK: | APPR |
|---|---|---|---|---|---|
| 0 | 12–10–08 | CREATED | TWF | HSK | HSK |

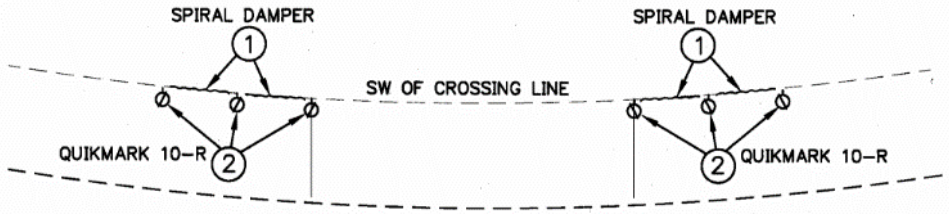
tfinc90 12/11/2008 SGN–HAZ–XNG

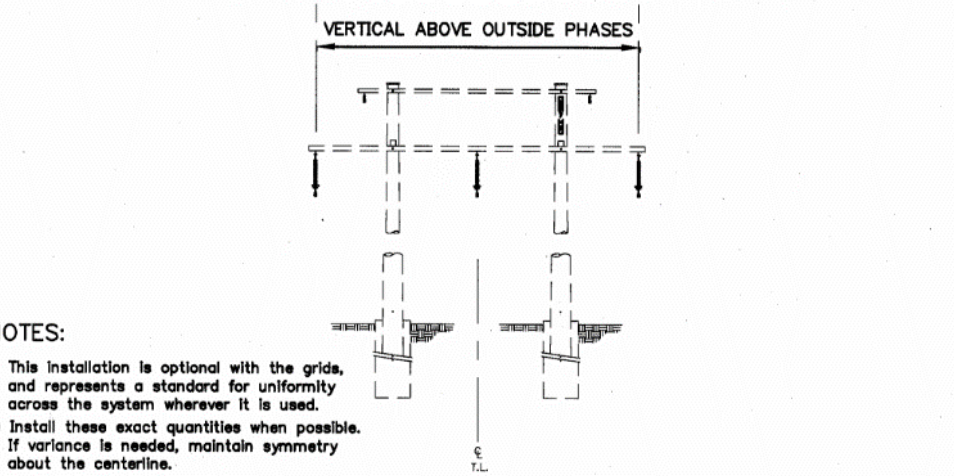
## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIAL

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 4 | 0032045036 | DAMPER, VIBRATION, SPIRAL, YELLOW, FOR 3/8" HSG & 7#7 AW CDR |
| 2 | 6 | 0032054555 | PROTECTOR, WILDLIFE, BIRD, 10" DIA, PLASTIC,ORANGE COLOR WITH REFLECTIVE PANELS ON BOTH SIDES, AND CONDUCTOR CLAMPS. QUIKMARK 10-R |




NOTES:

1) This installation is optional with the grids, and represents a standard for uniformity across the system wherever it is used.
2) Install these exact quantities when possible. If variance is needed, maintain symmetry about the centerline.
3) Place the inside QUIKMARK 10-R's immediately above the outside conductors, but not closer than 15 feet apart.
4) Place the dampers between the QUIKMARK 10-R's and about 1 feet from them.
5) If there are 2 overhead shield wires crossing the Entergy line, place half the devices on each wire unless the owner specifies differently.

SGN-HAZ-OHG

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
OVERHEAD GROUND HAZARD MARKING
STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

No. TMD406A0

PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR |
|---|---|---|---|---|---|
| 0 | 12-10-08 | CREATED | TWF | HSK | HSK |

tfinc90 12/11/2008

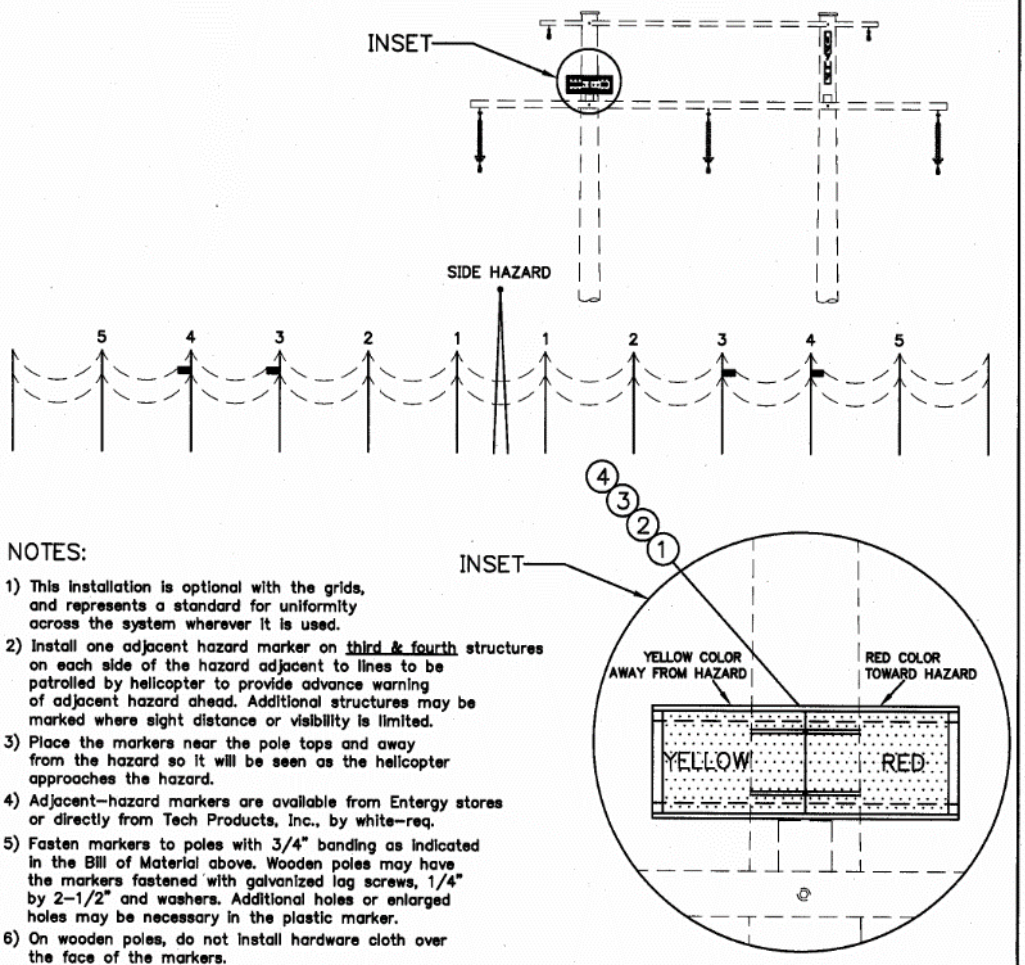
SGN-HAZ-OHG

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIAL

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0032048218 | NUMBER, BLANK, 10" X 14", POLYPROPYLENE, ALL YELLOW BACKGROUND, 0.23" TH |
| 2 | 1 | 0032048221 | NUMBER, BLANK, 10" X 14", POLYPROPYLENE, ALL RED BACKGROUND, 0.23" TH |
| 3 | 1 | 0032048222 | BRACKET, AERIAL NUMBER, ALUM, 30" LG, FOR 2 10"X14" EVERLAST PLAQUES |
| 4 | 8 FT. | 0000017124 | BAND, STRAPPING, 3/4" WD X 100FT LG ROLL, STAINLESS STEEL, 201 |
| 5 | 2 | 0032047234 | BRACKET, BANDING, FLARED LEG, SS, WITH ONE 5/16"-18 X 3/4" HEX HEAD SS BOLT AND FIBER WASHER, 3/4" SLOT, SHIPPED 50/BOX |
| 6 | 2 | 0000017123 | BOLT, CLAMP ASSEMBLY, CARRIAGE HD, GALVANIZED STEEL, HIGH STRENGTH, ASTM B221 MILITARY QQ-A-200/8, 5 GR, 3/8" DIA, 6" LG HIGH STR CARR BOLT, WASH AND NUT. |




NOTES:

1) This installation is optional with the grids, and represents a standard for uniformity across the system wherever it is used.
2) Install one adjacent hazard marker on third & fourth structures on each side of the hazard adjacent to lines to be patrolled by helicopter to provide advance warning of adjacent hazard ahead. Additional structures may be marked where sight distance or visibility is limited.
3) Place the markers near the pole tops and away from the hazard so it will be seen as the helicopter approaches the hazard.
4) Adjacent-hazard markers are available from Entergy stores or directly from Tech Products, Inc., by white-req.
5) Fasten markers to poles with 3/4" banding as indicated in the Bill of Material above. Wooden poles may have the markers fastened with galvanized lag screws, 1/4" by 2-1/2" and washers. Additional holes or enlarged holes may be necessary in the plastic marker.
6) On wooden poles, do not install hardware cloth over the face of the markers.

SGN-HAZ-ADJ

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
ADJACENT HAZARD MARKING
STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

| NO. | DATE: | REVISION | BY: | CHK: | APPR |
|---|---|---|---|---|---|
| 0 | 12-10-08 | CREATED | TWF | HSK | HSK |

Entergy

No. TMD408A0

PLOT 1=1 | SH. 1 OF 1

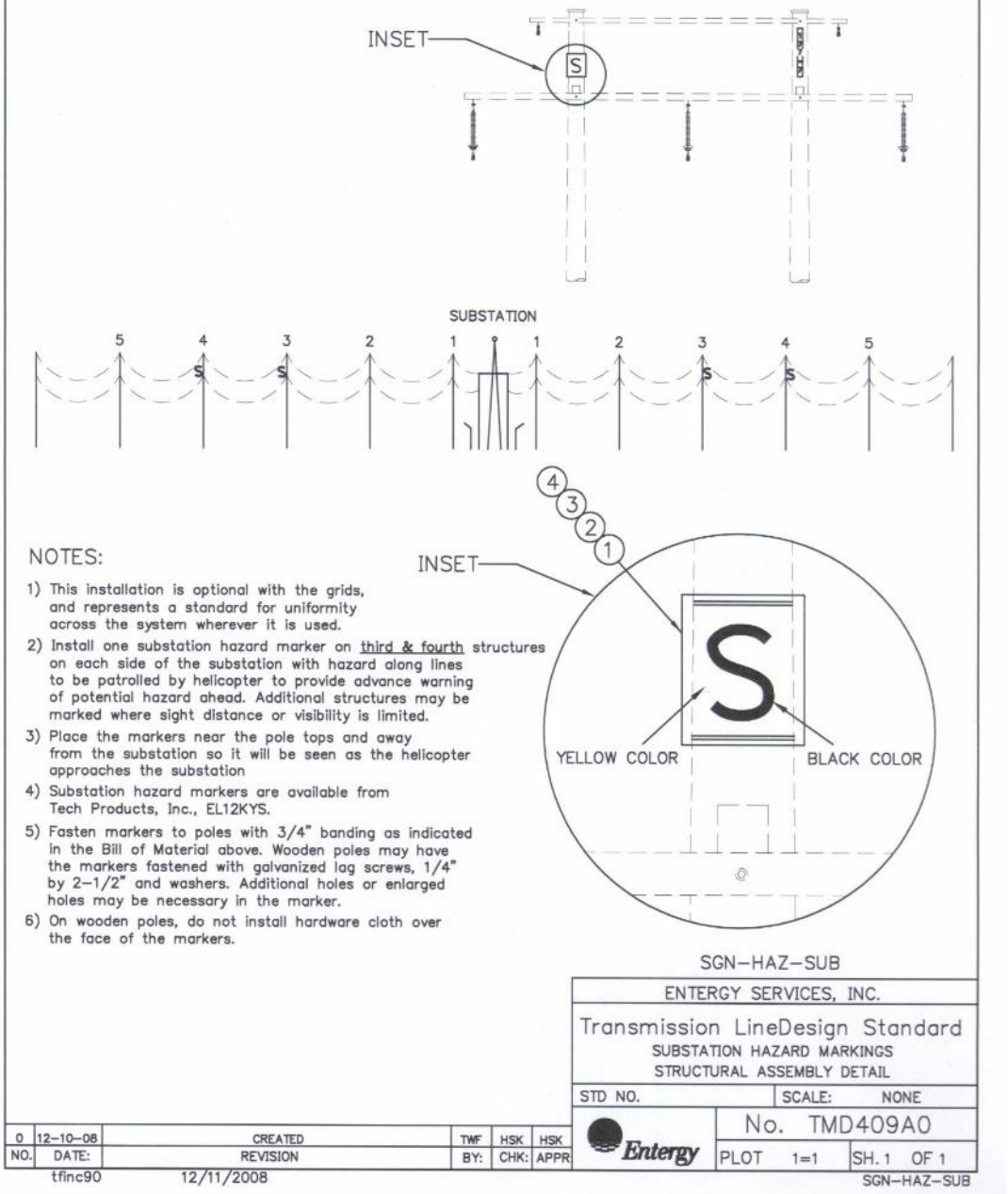
tfinc90 12/11/2008 SGN-HAZ-ADJ

# Appendix 2: High Voltage Overhead Transmission

## Attachment 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIAL

| ITEM | QTY. | STOCK NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 0032054553 | LETTER, "S", 10" X 14", BLACK ON YELLOW, TECH PRODUCTS PART NUMBER EL 12KYS |
| 2 | 8 FT. | 0000017124 | BAND, STRAPPING, 3/4" WD X 100FT LG ROLL, STAINLESS STEEL, 201 |
| 3 | 2 | 0032047234 | BRACKET, BANDING, FLARED LEG, SS, WITH ONE 5/16"-18 X 3/4" HEX HEAD SS BOLT AND FIBER WASHER, 3/4" SLOT, SHIPPED 50/BOX |
| 4 | 2 | 0000017123 | BOLT, CLAMP ASSEMBLY, CARRIAGE HD, GALVANIZED STEEL, HIGH STRENGTH, ASTM B221 MILITARY QQ-A-200/8, 5 GR, 3/8" DIA, 6" LG HIGH STR CARR BOLT, WASH AND NUT. |




NOTES:

1) This installation is optional with the grids, and represents a standard for uniformity across the system wherever it is used.
2) Install one substation hazard marker on third & fourth structures on each side of the substation with hazard along lines to be patrolled by helicopter to provide advance warning of potential hazard ahead. Additional structures may be marked where sight distance or visibility is limited.
3) Place the markers near the pole tops and away from the substation so it will be seen as the helicopter approaches the substation
4) Substation hazard markers are available from Tech Products, Inc., EL12KYS.
5) Fasten markers to poles with 3/4" banding as indicated in the Bill of Material above. Wooden poles may have the markers fastened with galvanized lag screws, 1/4" by 2-1/2" and washers. Additional holes or enlarged holes may be necessary in the marker.
6) On wooden poles, do not install hardware cloth over the face of the markers.

SGN-HAZ-SUB

ENTERGY SERVICES, INC.

Transmission LineDesign Standard
SUBSTATION HAZARD MARKINGS
STRUCTURAL ASSEMBLY DETAIL

STD NO. | SCALE: NONE

Entergy | No. TMD409A0 | PLOT 1=1 | SH. 1 OF 1

| NO. | DATE: | REVISION | BY: | CHK: | APPR |
|---|---|---|---|---|---|
| 0 | 12-10-08 | CREATED | TWF | HSK | HSK |

tfinc90 12/11/2008

SGN-HAZ-SUB

# Appendix 2: High Voltage Overhead Transmission

## Attachment 2: NESC AND ENTERGY CLEARANCE REQUIREMENTS

**Basic NESC Clearance Requirements**

| Rule 230A2, Emergency Vertical Clearances to Ground | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **69** | **115** | **138** | **161** | **230** | **345** | **500** |
| **Truck Accessible** | 16.2 | 17.1 | 17.6 | 18.0 | 19.4 | 21.7 | 24.9 |
| **Pedestrian Only** | 9.7 | 10.6 | 11.1 | 11.5 | 12.9 | 15.2 | 18.4 |

| RULE 232B&C - Vertical Clearance over Ground, Roadway, Rail or Water Surfaces | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **69** | **115** | **138** | **161** | **230** | **345** | **500** |
| Railroad | 27.16 | 28.09 | 28.56 | 29.02 | 30.41 | 32.74 | 35.87 |
| Roads | 19.16 | 20.09 | 20.56 | 21.02 | 22.41 | 24.74 | 27.87 |
| Other Area Traversed by Vehicles | 19.16 | 20.09 | 20.56 | 21.02 | 22.41 | 24.74 | 27.87 |
| Accessible to Pedestrian Traffic Only | 15.16 | 16.09 | 16.56 | 17.02 | 18.41 | 20.74 | 23.87 |

| RULE 233C - Vertical Clearance over Another Wire With or Without Wind | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **69** | **115** | **138** | **161** | **230** | **345** | **500** |
| **0** | 2.66 | 3.59 | 4.06 | 4.52 | 5.91 | 8.24 | 11.85 |
| **13.8** | 2.93 | 3.86 | 4.32 | 4.79 | 6.18 | 8.50 | 12.12 |
| **34.5** | 3.32 | 4.25 | 4.72 | 5.18 | 6.58 | 8.90 | 12.52 |
| **69** | 4.06 | 4.98 | 5.45 | 5.91 | 7.31 | 9.63 | 13.25 |
| **115** | 4.98 | 5.91 | 6.38 | 6.84 | 8.24 | 10.56 | 14.18 |
| **138** | 5.45 | 6.38 | 6.84 | 7.31 | 8.70 | 11.03 | 14.64 |
| **161** | 5.91 | 6.84 | 7.31 | 7.77 | 9.17 | 11.49 | 15.10 |
| **230** | 7.31 | 8.24 | 8.70 | 9.17 | 10.56 | 12.89 | 16.50 |
| **345** | 9.63 | 10.56 | 11.03 | 11.49 | 12.89 | 15.21 | 18.82 |
| **500** | 13.25 | 14.18 | 14.64 | 15.10 | 16.50 | 18.82 | 22.44 |

| RULE 234B, C & G - Vertical Clearance over Various Structures | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 69 | 115 | 138 | 161 | 230 | 345 | 500 |
| Lighting Supports | 5.23 | 6.16 | 6.62 | 7.09 | 8.48 | 10.80 | 13.94 |
| Traffic Signal Supports | 5.23 | 6.16 | 6.62 | 7.09 | 8.48 | 10.80 | 13.94 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Supporting Structures of Other Lines | 5.23 | 6.16 | 6.62 | 7.09 | 8.48 | 10.80 | 13.94 |
| Intermediate Poles in Skip-Span Construction | 5.23 | 6.16 | 6.62 | 7.09 | 8.48 | 10.80 | 13.94 |
| Building Roofs not Accessible to Pedestrians | 13.16 | 14.09 | 14.56 | 15.02 | 16.41 | 18.74 | 21.87 |
| Building Areas Accessible to Pedestrians | 14.16 | 15.09 | 15.56 | 16.02 | 17.41 | 19.74 | 22.87 |
| Building Areas Accessible to Vehicles (not Trucks) | 14.16 | 15.09 | 15.56 | 16.02 | 17.41 | 19.74 | 22.87 |
| Building Areas Accessible to Trucks | 19.16 | 20.09 | 20.56 | 21.02 | 22.41 | 24.74 | 27.87 |
| Signs, Chimneys, Billboards, Radio and TV antennas, Flagpoles and Flags, Banners, Tanks with Catwalks | 14.16 | 15.09 | 15.56 | 16.02 | 17.41 | 19.74 | 22.87 |
| Signs, Chimneys, Billboards, Radio and TV antennas, Flagpoles and Flags, Banners, Tanks without Catwalks | 8.66 | 9.59 | 10.06 | 10.52 | 11.91 | 14.24 | 17.37 |

| **RULE 234B, C & G - Horizontal Clearance to Various Structures with No Wind** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **69** | **115** | **138** | **161** | **230** | **345** | **500** |
| Lighting Supports | 5.00 | 5.66 | 6.12 | 6.59 | 7.98 | 10.30 | 13.44 |
| Traffic Signal Supports | 5.00 | 5.66 | 6.12 | 6.59 | 7.98 | 10.30 | 13.44 |
| Supporting Structures of Other Lines | 5.00 | 5.66 | 6.12 | 6.59 | 7.98 | 10.30 | 13.44 |
| Intermediate Poles in Skip Span Construction | 5.00 | 5.66 | 6.12 | 6.59 | 7.98 | 10.30 | 13.44 |
| Buildings | 8.16 | 9.09 | 9.56 | 10.02 | 11.41 | 13.74 | 16.87 |
| Signs, Chimneys, Billboards, | 8.16 | 9.09 | 9.56 | 10.02 | 11.41 | 13.74 | 16.87 |
| Radio and TV Antennas, Flagpoles & Flags | 8.16 | 9.09 | 9.56 | 10.02 | 11.41 | 13.74 | 16.87 |
| Banners, Tanks | 8.16 | 9.09 | 9.56 | 10.02 | 11.41 | 13.74 | 16.87 |

| **RULE 234B, C & G - Horizontal Clearance to Various Structures with Wind** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **69** | **115** | **138** | **161** | **230** | **345** | **500** |

# Appendix 2: High Voltage Overhead Transmission

## Attachment 2: NESC AND ENTERGY CLEARANCE REQUIREMENTS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lighting Supports | 5.16 | 6.09 | 6.56 | 7.02 | 8.41 | 10.74 | 13.87 |
| Traffic Signal Supports | 5.16 | 6.09 | 6.56 | 7.02 | 8.41 | 10.74 | 13.87 |
| Supporting Structures of Other Lines | 5.16 | 6.09 | 6.56 | 7.02 | 8.41 | 10.74 | 13.87 |
| Intermediate Poles in Skip Span Construction | 5.16 | 6.09 | 6.56 | 7.02 | 8.41 | 10.74 | 13.87 |
| Buildings | 5.16 | 6.09 | 6.56 | 7.02 | 8.41 | 10.74 | 13.87 |
| Signs, Chimneys, Billboards, | 5.16 | 6.09 | 6.56 | 7.02 | 8.41 | 10.74 | 13.87 |
| Radio and TV Antennas, Flagpoles & Flags | 5.16 | 6.09 | 6.56 | 7.02 | 8.41 | 10.74 | 13.87 |
| Banners, Tanks | 5.16 | 6.09 | 6.56 | 7.02 | 8.41 | 10.74 | 13.87 |

**RULE 235C2b1 - Vertical Clearance Between Wires Supported at Different Levels on the Same Structures**

| | **69** | **115** | **138** | **161** | **230** | **345** | **500** |
|---|---|---|---|---|---|---|---|
| **0** | 2.03 | 2.58 | 3.02 | 3.47 | 4.79 | 7.01 | 9.99 |
| **13.8** | 2.03 | 2.85 | 3.29 | 3.73 | 5.06 | 7.27 | 10.25 |
| **34.5** | 2.36 | 3.24 | 3.69 | 4.13 | 5.46 | 7.67 | 10.65 |
| **69** | 3.02 | 3.91 | 4.35 | 4.79 | 6.12 | 8.33 | 11.32 |
| **115** | 3.91 | 4.79 | 5.24 | 5.68 | 7.01 | 9.22 | 12.20 |
| **138** | 4.35 | 5.24 | 5.68 | 6.12 | 7.45 | 9.66 | 12.64 |
| **161** | 4.79 | 5.68 | 6.12 | 6.56 | 7.89 | 10.10 | 13.09 |
| **230** | 6.12 | 7.01 | 7.45 | 7.89 | 9.22 | 11.43 | 14.42 |
| **345** | 8.33 | 9.22 | 9.66 | 10.10 | 11.43 | 13.65 | 16.63 |
| **500** | 11.32 | 12.20 | 12.64 | 13.09 | 14.42 | 16.63 | 19.61 |

# Appendix 2: High Voltage Overhead Transmission

## Attachment 2: NESC AND ENTERGY CLEARANCE REQUIREMENTS

| RULE 235B - Horizontal Clearance Between Wires Supported on the Same Structure | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **69** | **115** | **138** | **161** | **230** | **345** | **500** |
| **0** | 2.08 | 2.96 | 3.41 | 3.85 | 5.18 | 7.39 | 10.37 |
| **13.8** | 2.34 | 3.23 | 3.67 | 4.11 | 5.44 | 7.66 | 10.64 |
| **34.5** | 2.74 | 3.63 | 4.07 | 4.51 | 5.84 | 8.05 | 11.04 |
| **69** | 3.41 | 4.29 | 4.73 | 5.18 | 6.50 | 8.72 | 11.70 |
| **115** | 4.29 | 5.18 | 5.62 | 6.06 | 7.39 | 9.60 | 12.59 |
| **138** | 4.73 | 5.62 | 6.06 | 6.50 | 7.83 | 10.05 | 13.03 |
| **161** | 5.18 | 6.06 | 6.50 | 6.95 | 8.27 | 10.49 | 13.47 |
| **230** | 6.50 | 7.39 | 7.83 | 8.27 | 9.60 | 11.82 | 14.80 |
| **345** | 8.72 | 9.60 | 10.05 | 10.49 | 11.82 | 14.03 | 17.01 |
| **500** | 11.70 | 12.59 | 13.03 | 13.47 | 14.80 | 17.01 | 20.00 |
| **RULE 233B1 - Horizontal Clearance to Other Wires (With or without Wind)** | | | | | | | |
| | 69 | 115 | 138 | 161 | 230 | 345 | 500 |
| 0 | 5.66 | 6.59 | 7.06 | 7.52 | 8.91 | 11.24 | 14.37 |
| 13.8 | 5.94 | 6.87 | 7.33 | 7.80 | 9.19 | 11.52 | 14.65 |
| 34.5 | 6.36 | 7.29 | 7.75 | 8.22 | 9.61 | 11.94 | 15.07 |
| 69 | 7.06 | 7.98 | 8.45 | 8.91 | 10.31 | 12.63 | 15.76 |
| 115 | 7.98 | 8.91 | 9.38 | 9.84 | 11.24 | 13.56 | 16.69 |
| 138 | 8.45 | 9.38 | 9.84 | 10.31 | 11.70 | 14.03 | 17.16 |
| 161 | 8.91 | 9.84 | 10.31 | 10.77 | 12.17 | 14.49 | 17.62 |
| 230 | 10.31 | 11.24 | 11.70 | 12.17 | 13.56 | 15.89 | 19.02 |
| 345 | 12.63 | 13.56 | 14.03 | 14.49 | 15.89 | 18.21 | 21.34 |
| 500 | 15.76 | 16.69 | 17.16 | 17.62 | 19.02 | 21.34 | 24.47 |

### Vertical Clearance Requirements; NESC 2012 & Entergy Design Clearance

| | **69 kV[1]** | | **115/138/161 kV[1]** | | **230 kV[1]** | | **345 kV[1]** | | **500 kV[1] [3]** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NESC[2] @ Max. Sag(ft.) | ETR @ Max. Sag(ft.) | NESC[2] @ Max. Sag(ft.) | ETR @ Max. Sag(ft.) | NESC[2] @ Max. Sag(ft.) | ETR @ Max. Sag(ft.) | NESC[2] @ Max. Sag(ft.) | ETR @ Max. Sag(ft.) | NESC[2] @ Max. Sag(ft.) | ETR @ Max. Sag(ft.) |
| **Railroads** | 27.16 | 33.00 | 29.02 | 35.00 | 30.41 | 37.00 | 32.74 | 41.00 | 35.87 | 48.00 |
| **Roads** | 19.16 | 28.00 | 21.02 | 30.00 | 22.41 | 32.00 | 24.74 | 33.00 | 27.87 | 40.00 |
| **Other Land Traversed by** | 19.16 | 24.00 | 21.02 | 26.00 | 22.41 | 28.00 | 24.74 | 33.00 | 27.87 | 40.00 |

### Attachment 2: NESC AND ENTERGY CLEARANCE REQUIREMENTS

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **any kind of Vehicle** | | | | | | | | | | |
| **Cultivated Farmland** | 19.16 | 27.00 | 21.02 | 29.00 | 22.41 | 31.00 | 24.74 | 33.00 | 27.87 | 40.00 |
| **Land accessible to pedestrians only** | 15.16 | 24.00 | 17.02 | 26.00 | 18.41 | 28.00 | 20.74 | 29.00 | 23.87 | 36.00 |
| **Water Areas Suitable for sailboats:** | | | | | | | | | | |
| Less than 20 acres | 21.16 | 24.00 | 23.02 | 26.00 | 24.41 | 28.00 | 26.74 | 35.00 | 29.87 | 42.00 |
| 20-200 acres | 29.16 | 32.00 | 31.02 | 34.00 | 32.41 | 36.00 | 34.74 | 43.00 | 37.87 | 50.00 |
| 200-2000 acres | 35.16 | 37.00 | 37.02 | 40.00 | 38.41 | 42.00 | 40.74 | 49.00 | 43.87 | 56.00 |
| Over 2000 acres | 41.16 | 44.00 | 43.02 | 46.00 | 44.41 | 48.00 | 46.74 | 55.00 | 49.87 | 62.00 |
| **Sailboat launch sites adjacent to water: Add 5'** | | | | | | | | | | |
| Less than 20 acres | 26.16 | 29.00 | 28.02 | 31.00 | 29.41 | 33.00 | 31.74 | 40.00 | 34.87 | 47.00 |
| 20-200 acres | 34.16 | 37.00 | 36.02 | 39.00 | 37.41 | 41.00 | 39.74 | 48.00 | 42.87 | 53.00 |
| 200-2000 acres | 40.16 | 43.00 | 42.02 | 45.00 | 43.41 | 47.00 | 45.74 | 54.00 | 48.87 | 61.00 |
| Over 2000 acres | 46.16 | 49.00 | 48.02 | 51.00 | 49.41 | 53.00 | 51.74 | 60.00 | 54.87 | 67.00 |
| **Other supply lines 34.5kV and under** | 2.66 | 8.00 | 4.52 | 10.00 | 5.91 | 15.00 | 8.24 | 17.00 | 11.85 | 23.00 |
| **Other supply lines:** | | | | | | | | | | |
| 69 kV | 4.06 | 10.00 | 5.91 | 11.00 | 7.31 | 16.00 | 9.63 | 18.00 | 13.25 | 20.00 |
| 115/138/161 kV | 5.91 | 11.00 | 7.77 | 13.00 | 9.17 | 18.00 | 11.49 | 20.00 | 15.10 | 22.00 |
| 230 kV | 7.31 | 16.00 | 9.17 | 18.00 | 10.56 | 20.00 | 12.89 | 22.00 | 16.50 | 24.00 |
| 345 kV | 9.63 | 18.00 | 11.49 | 20.00 | 12.89 | 22.00 | 15.21 | 24.00 | 18.82 | 26.00 |
| 500 kV | 13.25 | 20.00 | 15.10 | 22.00 | 16.50 | 24.00 | 18.82 | 26.00 | 22.44 | 28.00 |
| **Guys, Neutrals and shield wires** | 2.66 | 8.00 | 4.52 | 10.00 | 5.91 | 15.00 | 8.24 | 17.00 | 11.85 | 19.00 |
| **Communications lines** | 5.66 | 10.00 | 7.52 | 12.00 | 8.91 | 15.00 | 11.24 | 17.00 | 14.37 | 19.00 |

Notes:

(1) Conductor Temperature: 100°C for ACSR, see table 7.1(b) for other conductor types

# Appendix 2: High Voltage Overhead Transmission

## Attachment 2: NESC AND ENTERGY CLEARANCE REQUIREMENTS

(2) NESC Vertical Clearance = Basic Clearance + Voltage Adder; Voltage Adder = 0.4”/kV in excess of 22kV; refer to 2012 NESC Clearance Calculations.
(3) For 500 kV, the NESC clearance is approximately equal to the clearance requirements derived from a Switching Surge factor of 2.6.

# Appendix 2: High Voltage Overhead Transmission

## Attachment 3: QUICK ESTIMATING CORONA LOSS CURVES

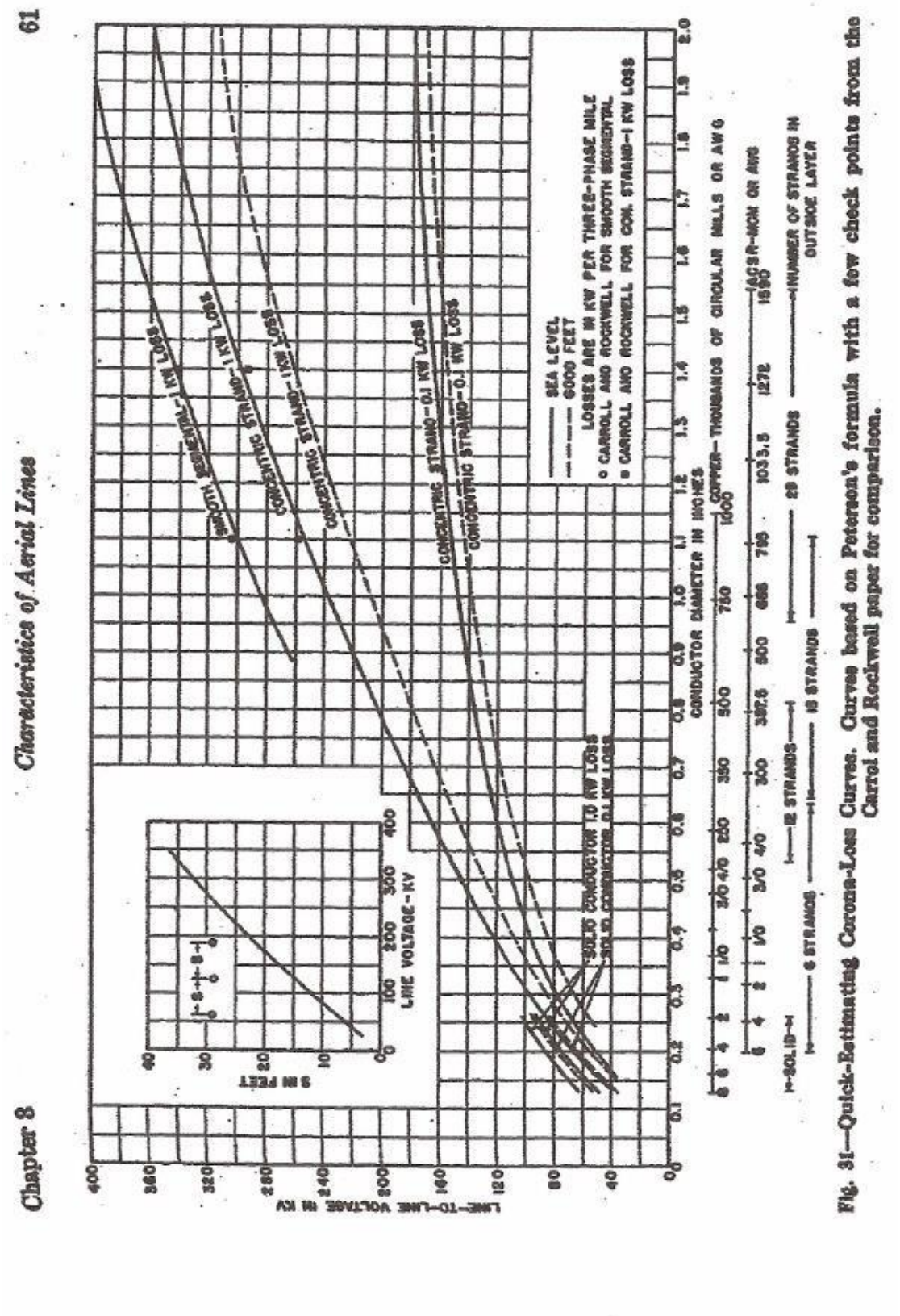
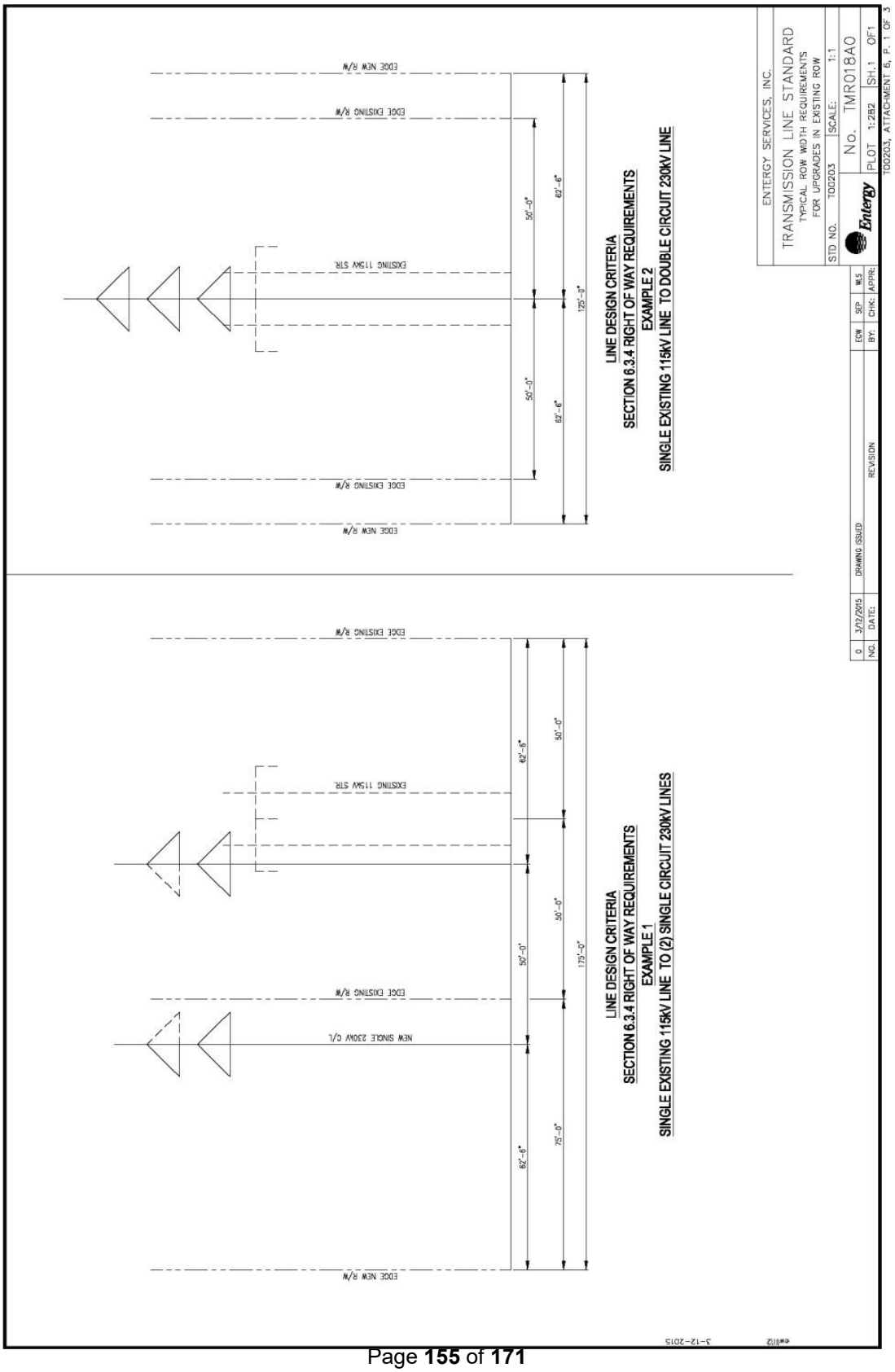



Fig. 31—Quick-Estimating Corona-Loss Curves. Curves based on Peterson's formula with a few check points from the Carrol and Rockwell paper for comparison.

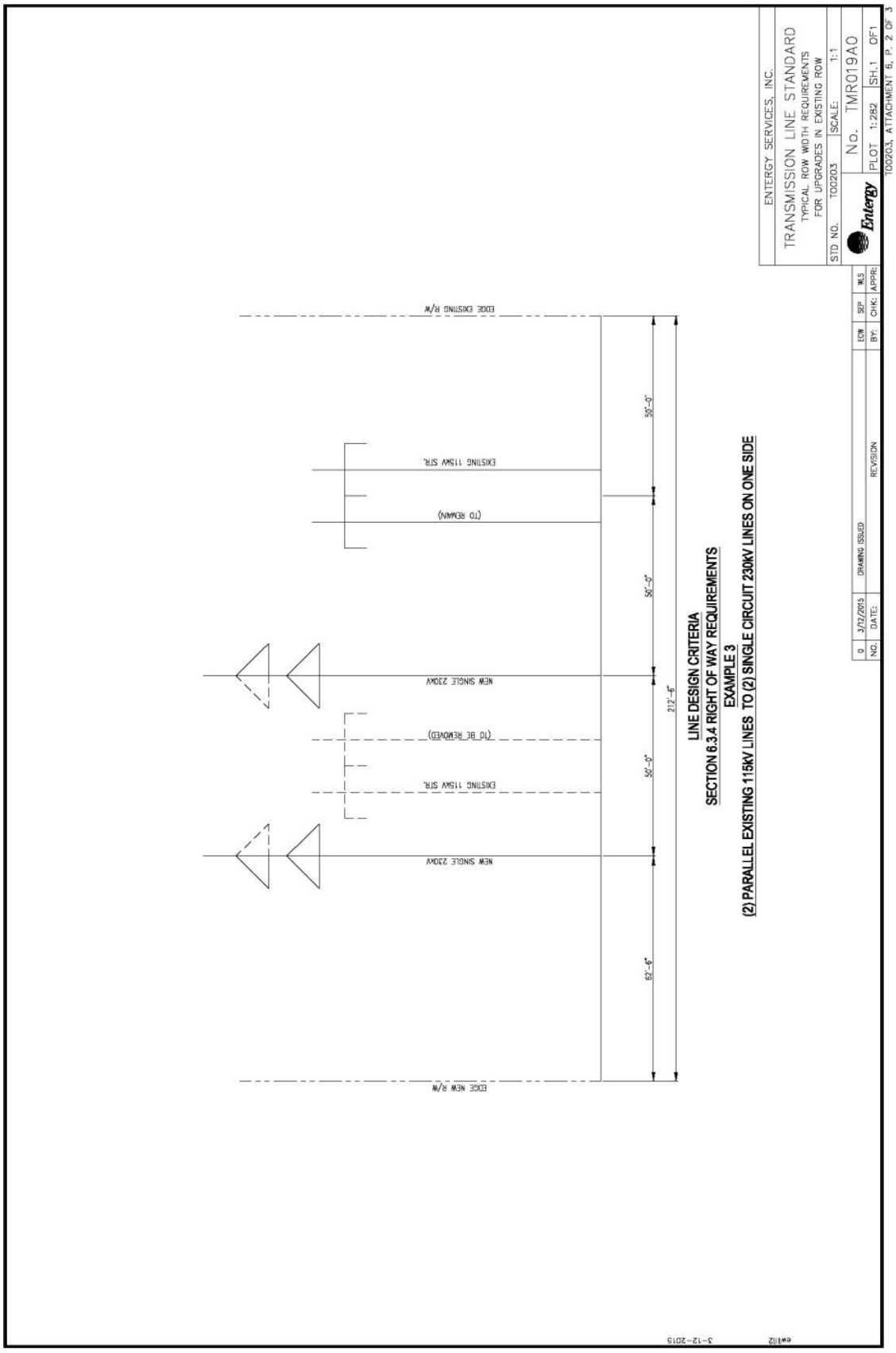
# Appendix 2: High Voltage Overhead Transmission

## Attachment 4: EXAMPLE ROW



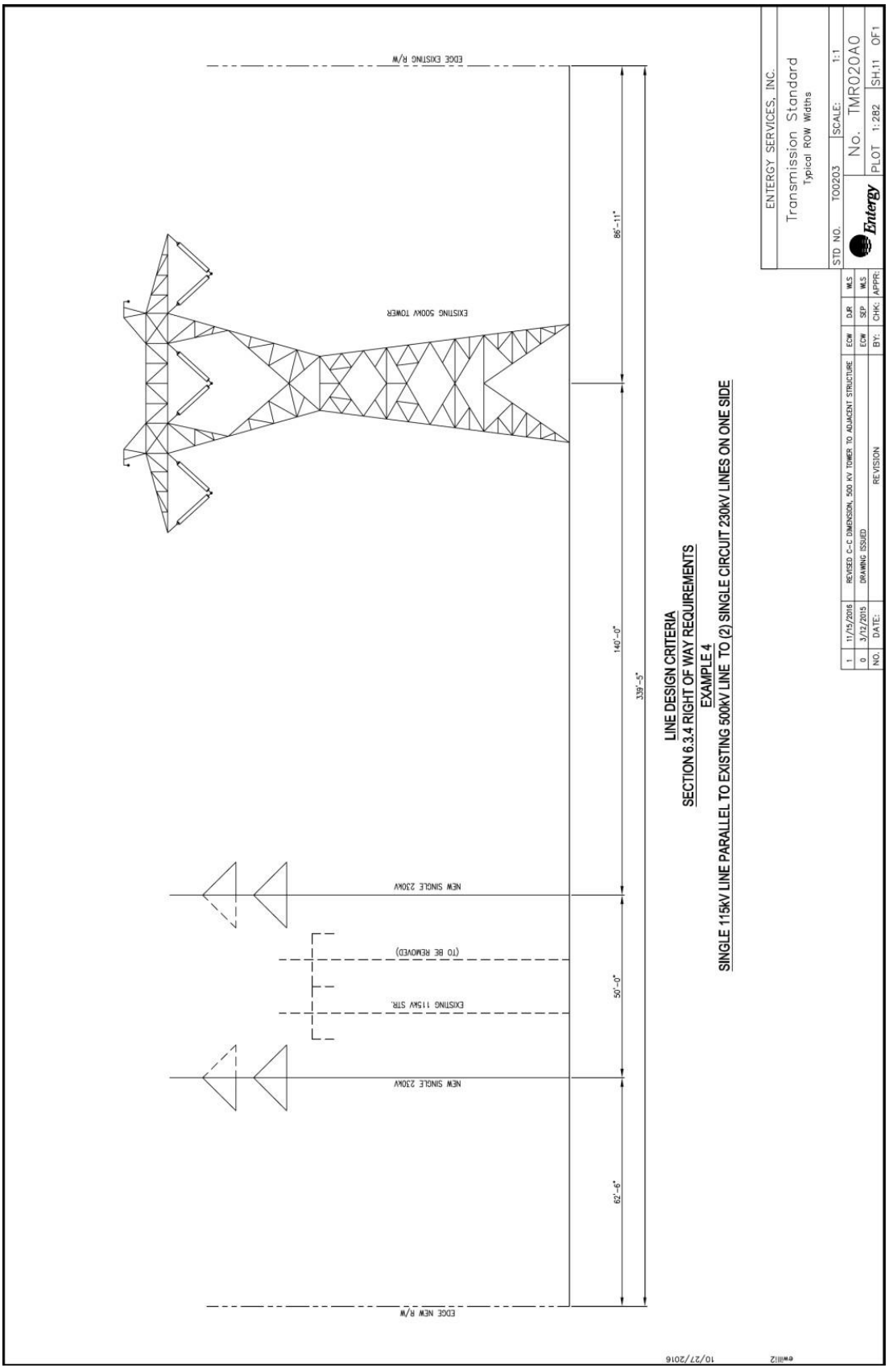
# Appendix 2: High Voltage Overhead Transmission

## Attachment 4: EXAMPLE ROW



# Appendix 2: High Voltage Overhead Transmission

## Attachment 4: EXAMPLE ROW



# Appendix 2: High Voltage Overhead Transmission

## Attachment 5: APPROVED VENDOR LIST

Lead Time — Date last updated: August 22, 2023

| Purchase Spec. | Class | Description | Qualifier | Approved Manufacturer(s) ( )-Preferred | Preferred Supplier |
|---|---|---|---|---|---|
| SA0102 | Arresters | Arrester, Surge | | (Cooper), Siemens, Hitachi Energy | Series 2000 |
| PM0202 | Battery | Batteries | CC | (Enersys) | Exponential Power |
| PM0201 | Battery | Batteries | EC | (Enersys) | Exponential Power |
| PM0301 | Battery | Battery Charger AT-10 | | (Hindle) | Exponential Power |
| PM0301 | Battery | Battery Charger ATEVO | | (Hindle) | Exponential Power |
| | Battery | Battery Fiberglass Enclosure with A/C | | (Exponential) | Exponential Power |
| PM0303 | Battery | Battery Rack | | (Enersys) | Exponential Power |
| | Bolts | Bolts Anchor | | Valmont, Threaded Fasteners | |
| | Bolts | Bolts Anchor cage for Substation Steel | | Valmont, Threaded Fasteners (size limit) | |
| SD0203 | Breaker | Breaker, EHV | 345/500kV (Live Tank) | Hitachi Energy | |
| SD0203 | Breaker | Breaker, EHV | 345/500kV (Dead Tank) | (MEPPI), Hitachi Energy | MEPPI |
| SD0202 | Breaker | Breaker, HV | 69kv | (Siemens), MEPPI, Hitachi Energy | Siemens |
| SD0202 | Breaker | Breaker, HV | 115kV - 40kA | (Siemens), MEPPI, Hitachi Energy | Siemens |
| SD0202 | Breaker | Breaker, HV | 115kV - 63kA | (Siemens), MEPPI, Hitachi Energy | Siemens |
| SD0202 | Breaker | Breaker, HV | 161kV - 40kA | (Siemens), MEPPI, Hitachi Energy | Siemens |
| SD0202 | Breaker | Breaker, HV | 161kV - 63kA | (Siemens), MEPPI, Hitachi Energy | Siemens |
| SD0202 | Breaker | Breaker, HV | 245kV | (Siemens), MEPPI, Hitachi Energy | Siemens |
| SD0202 | Breaker | Brekaer, HV | 245KV, 80ka | (Siemens), MEPPI, Hitachi Energy | Siemens |
| SD0201 | Breaker | Breaker, MV | 15 kV- 27kV | (ABB INC.) MEPPI | ABB Inc. Approval drawings 5 wks from issue date of po |
| SD0201 | Breaker | Breaker, MV | 34.5 kV | (ABB INC.) | ABB Inc. Approval drawings 5 wks from issue date of po |
| SB0101 | Bus | Bus, Aluminum Pipe | | (Three D Metals) AFL | Three D Metals |
| PB0401 | Cable, Control | Control Cable -Shielded and Non-Shielded | | (Southwire), Priority | Southwire |
| SA0303 | Capacitor Bank | Capacitor Banks, Series | | Cooper, Hitachi Energy | Cooper Approval drawings 4 wks from issue date of po |
| SA0301 | Capacitor Bank | Capacitor Banks, Shunt | | Cooper, GE, Hitachi Energy | Cooper Approval drawings 4 wks from issue date of po |
| | Capacitor Bank | Capacitor Cans | Capacitor Cans | Cooper, GE, Hitachi Energy | |
| | Capswitcher | Capswitcher | 34.5kV and below | (Southern States) | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| | Capswitcher | Capswitcher | 245kV - 362kV | (Southern States) | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| | Capswitcher | Capswitcher | 115kV and above | (Southern States) | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| | Capswitcher | Capswitcher | 69kV | (Southern States) | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| | Carrier | Power line Carrier | UPLC | Pulsar | Ametek |
| PN0201 | CCVT | CCVT | 69kV - 500kV | (Ritz), GE, Trench, Hitachi Energy | Aertker Approval drawings 2 wks from issue date of po |
| | | | | | |

Lead Time — Date last updated: August 22, 2023

| Purchase Spec. | Class | Description | Qualifier | Approved Manufacturer(s) ( )-Preferred | Preferred Supplier |
|---|---|---|---|---|---|
| SD1801 | Circuit Switcher | Circuit Switcher | Series 2000 | (S&C) | Curtis Stout Approval drawings 3 wks from issue date of po |
| SD1802 | Circuit Switcher | Circuit Switcher | Mark V | (S&C) | Curtis Stout Approval drawings 3 wks from issue date of po |
| | Conductor | Cable, Aluminum | ACSS, ACSR | (General Cable) - Southwire | Aertker co |
| | Conductor | Cable, Copper (Not Control cable) | | Copperweld /Alcoa | Stuart Irby |
| | Conductor | Cable, Fiber | OPT-GW | AFL | Preferred Sales |
| | Conductor | Cable, Fiber | ADSS | AFL | Preferred Sales |
| | Conduit | Conduit & Accessories | | Cantex, Carlon | Stuart Irby |
| | Connector | Connectors line | ACSS | AFL | Preferred Sales |
| | Connector | Connectors line (Fiber, OPGW, ACSR) | Fiber, OPGW, ACSR | AFL | Preferred Sales |
| | Connector | Connectors, Trans. Line - Insulator Assemblies | | (Maclean Power Sys) | Preferred Sales |
| | Connectors/Fittings | Connectors/Fittings - Substation | | Any Approved Manufacturer | Stuart Irby |
| SL0403 | Control House | Control House | Drop-In (turnkey) | VFP | VFP |
| SL0403 | Control House | Control House | | (Modular Connections), AZZ Inc., Trachte, VFP | Modular Connections |
| PN0301 | CT | CT | 15kV - 34.5kV | ABB Inc, Ritz | |
| PN0301 | CT | CT | 69kv - 138kv | GE, Trench, Hitachi Energy, Ritz | |
| PN0301 | CT | CT | 161kV -230kV | GE, Trench, Hitachi Energy, Ritz | |
| PN0301 | CT | CT | 345kv - 500kV | GE, Trench, Hitachi Energy | |
| | CT | CT | Slipover only | ITEC, ABB Inc., Meramec | ITEC Approval drawings 2-3 wks from issue date of po |
| | DFR | DFR (Digital Fault Recorder) | | MehtaTech | Louisiana, Mississippi, Arkansas only |
| | DFR | DFR (Digital Fault Recorder) | | Qualitrol | Texas only |
| | Fittings | Conductor Fittings Compression | | AFL, Sefcor, Anderson, Hubell | Stuart Irby |
| | Grounds Rods Clamps | Ground Rods, Clamps, & Anodes | | Any Approved Manufacturer | Stuart Irby |
| | Helical Piles | Foundation Piling | | Hubbell, Cyntech | |
| TA0504 | Insulators | Insulator, Line, Polymer | | (Maclean Power Sys) | Preferred Sales |
| TA0504 | Insulators | Insulator, Line, Polymer | (Polymer Insulator Only) | (Maclean Power Sys) | Preferred Sales |
| TA0504 | Insulators | Insulator, Line, Polymer | (Polymer Insulator Assembly) | (Maclean Power Sys) | Preferred Sales |
| TA0504 | Insulators | Insulator, Line, Polymer | Hardware Assembly Only | (Maclean Power Sys) | Preferred Sales |

# Appendix 2: High Voltage Overhead Transmission

## Attachment 5: APPROVED VENDOR LIST

Lead Time — Date last updated: August 22, 2023

| Purchase Spec. | Class | Description | Qualifier | Approved Manufacturer(s) ( )-Preferred | Preferred Supplier |
|---|---|---|---|---|---|
| SA0502 | Insulators | Insulator, Station Post, Porcelain | 161kV (Porcelain) | (Hubbell), Victor, Lapp,NGK, Newell, Vanguard, Seves | Hubbell Power Systems |
| SA0502 | Insulators | Insulator, Station Post, Porcelain | 345/500kV (Porcelain) HI / EXTRA HIGH STRENGTH | Hubbell, Victor, Lapp,NGK, Newell, Vanguard, Seves | |
| SA0502 | Insulators | Insulator, Station Post, Porcelain | 230kV (Porcelain) STANDARD STRENGTH | (Hubbell), Victor, Lapp,NGK, Newell, Vanguard, Seves | Hubbell Power Systems |
| SA0502 | Insulators | Insulator, Station Post, Porcelain | 69kV, 115kV, (Porcelain) | (Hubbell), Victor, Lapp,NGK, Newell, Vanguard, Seves | Hubbell Power Systems |
| SA0502 | Insulators | Insulator, Station Post, Porcelain | 230kV (Porcelain) HI / EXTRA HIGH STRENGTH | Hubbell, Victor, Lapp,NGK, Newell, Vanguard, Seves | |
| | Insulators | Insulator, Station Post, Porcelain | 34.5kV and below (Porcelain) | (Vanguard), Victor, Lapp,NGK, Newell, Seves , Hubbell | Preferred Sales |
| SA0502 | Insulators | Insulator, Station Post, Polymer | 15kV - 230kV | (Maclean Power Sys) | Preferred Sales |
| | Interrupter | Interrupter, Joslyn | | Joslyn | Ruffin |
| | Interrupter | Switches LLS I | | (Southern States) | Preferred Sales |
| | Interrupter | Switches LLS II | | (Southern States) | Preferred Sales |
| | Interrupter | Whip | | (Southern States) | Preferred Sales |
| | Interrupter | Interrupter | | S&C | Curtis Stout |
| | Junction Box | Junction Boxes | | MMR, Premier Control, SEL | All Junction Boxes – (2) weeks before Entergy's delivery date as stated on the PO |
| | Panel | Panel - Battery Switching | | MMR, SEL, Premier Control | (4) weeks before Entergy's delivery date as stated on the PO. |
| | Panel | Panel - Communication rack | | MMR, SEL, Premier Control | (3) weeks before Entergy's delivery date as stated on the PO. |
| PM0101 | Panel | Panel - AC & DC Cabinets | | MMR, SEL, Premier Control, Peterson Panel | (4) weeks before Entergy's delivery date as stated on the PO. |
| | Panel | Panel - Breaker Line | | MMR, SEL, Premier Control | (4) weeks before Entergy's delivery date as stated on the PO. |
| PM0602 | Panel | Panel - Bus Differential | | MMR, SEL, Premier Control | Bus Diff/XFMR Diff/ Breaker Control/ACDC Breaker – (3) weeks before Entergy's delivery date as stated on the PO. |
| PM1803 | Panel | Panel - Line Protection | | MMR, SEL, Premier Control | (4) weeks before Entergy's delivery date as stated on the PO. |
| | Panel | Panel - Meter | | MMR, SEL, Premier Control | (4) weeks before Entergy's delivery date as stated on the PO. |

Lead Time — Date last updated: August 22, 2023

| Purchase Spec. | Class | Description | Qualifier | Approved Manufacturer(s) ( )-Preferred | Preferred Supplier |
|---|---|---|---|---|---|
| | Poles | Pole Caissons | T-Line - after approval | (Valmont) | Preferred Sales |
| TC0609 | Poles | Pole, Concrete | | (Valmont) | Preferred Sales |
| TC0608 | Poles | Pole, Steel | after approval | Valmont) | Preferred Sales |
| PN0701 | PT | PT | 15kV - 34.5kV | ABB Inc, GE, Ritz | |
| PN0701 | PT | PT | 69kv - 230kv | Hitachi Energy, GE, Trench, | |
| SN0903 | Reactor | Reactor, Dry Type Shunt | Below 230kV | Hitachi Energy, Coil Innovations, Trench | |
| SN0902 | Reactor | Reactor, Limiting | | Hitachi Energy, Coil Innovations, Trench | |
| SN0904 | Reactor | Reactor, Oil filled Shunt | 230kV, 500kV | Hitachi Energy, Prolec GE, MEPPI, Siemens, SMIT | |
| SN1002 | Regulators | Regulator | | Pennsylvania Transformers | Curtis Stout |
| | Relay | SEL Relays | SEL Relay | SEL | Power Connection |
| | Relay | SEL cables | Cable & Fiber | SEL | Power Connection |
| | RTU | ACS RTU - Peripherals | NTX-U20 & Upgrades | ACS (Automated Control Systems) | Ruffin & Associates |
| | RTU | ACS Cables | NTX cables | ACS (Automated Control Systems) | Ruffin & Associates |
| | RTU | GE Parts | Accessories & Cables | G.E. Grid Solutions | Perferred Sales |
| PM3002 | RTU | RTU | IO cabinet standard RTU | G.E. Grid Solutions | Perferred Sales |
| PM3002 | RTU | RTU - Kits & Parts | D400, D20, DNPIO Kits & Parts | G.E. Grid Solutions | Perferred Sales |
| | Rupter | Rupters/S&C ALDUTI 15 kV Vac | | (S&C) | Curtis Stout Approval drawings 5 wks from issue date of po |
| SL1301 | Signs | Signs - Entergy Substation Switchyard | | Impco | Impco |
| | Signs | Signs - General | | Stuart Irby | Stuart Irby |

# Appendix 2: High Voltage Overhead Transmission

## Attachment 5: APPROVED VENDOR LIST

Lead Time — Date last updated: August 22, 2023

| Purchase Spec. | Class | Description | Qualifier | Approved Manufacturer(s) ( )-Preferred | Preferred Supplier |
|---|---|---|---|---|---|
| SC0401, SL0505 | Structure | Steel | Substation, Octagonal | (Distran), Valmont | Distran |
| SC0401, SL0505 | Structure | Steel | Substation, Lattice | (Distran), Industrial Steel | Distran |
| | Structure | Steel | MISC Substation Steel | Distran, Industrial Steel | |
| | Structure | Steel Standard and Tapered Tubular | Substation, existing details | (Distran),Valmont | Distran |
| | Structure | Steel Standard and Tapered Tubular | (Design Required) | (Distran), Valmont Note: * Pending approval | Distran |
| PM3401 | Switch | ASCO ATS (Automatic Transfer Switch) | | Utility and Industrial Supply,LLC, WESCO | |
| | Switch | Switch, T-Line | Switch group operated 245kV and below | SEECO | Southern Utility Sales Agency |
| SD1501 | Switch | Switch, Disconnect | 115 & 230kV Air Break | (Southern States), USCO, Pascor Atlantic | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| SD1501 | Switch | Switch, Disconnect | 69kV - 230kV | (Southern States), USCO, Pascor Atlantic | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| SD1501 | Switch | Switch, Disconnect | 69kV Air Break | (Southern States), USCO, Pascor Atlantic | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| SD0601 | Switch | Switch, Disconnect | 15kV - 34.5kV | (Southern States), USCO | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| SD1502 | Switch | Switch, Disconnect | 345/500kV | (Southern States), Pascor Atlantic | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| SD0701 | Switch | Switch, Disconnect, Hookstick | 15kV - 34.5kV | (Southern States), USCO | Preferred Sales Approval drawings 4-6 wks from issue date of po |
| | Switch | Switch, Fuse (SMD style) | 15 kV | (S&C) | Curtis Stout Approval drawings 5 wks from issue date of po |
| SD1601 | Switch/Motor Operators | Motor Operator | Southern States MO | (Southern States) | Preferred Sales |
| | Switch/Motor Operators | Motor Operator | S&C MO | (S&C) | Curtis Stout Approval drawings 5 wks from issue date of po |
| SN1101 | Transformer | SSVT; Station Service Voltage Transformer | 230kV | Trench, Hitachi Energy | |
| SN1101 | Transformer | SSVT; Station Service Voltage Transformer | 46kV -161kV | Trench, Hitachi Energy | Hitachi 46 |

Lead Time — Date last updated: August 22, 2023

| Purchase Spec. | Class | Description | Qualifier | Approved Manufacturer(s) ( )-Preferred | Preferred Supplier |
|---|---|---|---|---|---|
| SN0103, SN0104 | Transformer | Transformer, Auto | 230kV and Above 100MVA | Hitachi Energy, MEPPI, Siemens, SMIT, Waukesha | |
| SN0102 | Transformer | Transformer, Small Auto | below 230kv and 100MVA | (Waukesha ), Hitachi Energy, Delta Star | Aertker Co. Approval drawings 16 wks from issue date of po |
| | Transrupter | Transrupter II | | (S&C) | Curtis Stout Approval drawings 5 wks from issue date of po |
| PM0802 | Trap | Trap, Line Carrier | | Trench ( No other supplier approved) | Curtis Stout Approval drawings 4-5 wks from issue date of po |
| | Trench | | | (Concast), Trenway, Old Castle | GHMR |
| PM0804 | Tuner | Tuner, Line Carrier | | Trench | Curtis Stout Approval drawings 4-5 wks from issue date of po |

# Appendix 2: High Voltage Overhead Transmission

## Attachment 5: APPROVED VENDOR LIST

revised OCT 2023

### TWO-WINDING & AUTO-TRANSFORMERS RATED < 100MVA (3-phase) and HV ≤ 230kV

| Production Facility & Location | Currently qualifying or already qualified | Maximum ratings approved by Entergy | | Capabilities reported by facility | |
|---|---|---|---|---|---|
| | | MVA (3ø) | KV | MVA (3ø) | KV |
| ABB / Crystal Springs, MS USA | qualified | 50 (MS) | 161 (MS) | ~60 (MS) | 161 (MS) |
| Delta Star / Lynchburg, VA | qualified | 100 | 230 | ~200 | 230 |
| Waukesha Electric (SPX), Goldsboro, NC & Waukesha, WI USA | qualified | 80 (NC), 100 (WI) | 230 (NC), 230 (WI) | ~80 (NC), 800 (WI) | 230 (NC), 345 (WI) |

### AUTO-TRANSFORMERS RATED ≥ 100MVA (3-phase) or HV > 230kV

| Production Facility & Location | Currently qualifying or already qualified | Maximum ratings approved by Entergy | | Capabilities reported by facility | |
|---|---|---|---|---|---|
| | | MVA (3ø) | KV | MVA (3ø) | KV |
| ABB / Varennes, Quebec, Canada; Guarulhos, Brazil; Cordoba, Spain | qualified | 1000 (Can), 500 (Br), 800 (Sp) | 500 (Can), 500 (Br), 500 (Sp) | 1200 (Can), 600 (Br), 800 (Sp) | 765 (Can), 765 (Br), 500 (Sp) |
| Mitsubishi / Ako, Japan | qualified | ~1000 | 500 | ~1500 | 1000+ |
| Siemens / Linz & Weiz, Austria; Nuremburg, Germany; Jundiai, Brazil; Bogota, Colombia | qualified | 1000 (Aus, Ger), 800 (Br), 200 (Col) | 500 (Aus, Ger, Br), 230 (Col) | 2000 (Aus), 1100 (Ger), 1000 (Br), 250 (Col) | 765 (Aus), 1000+ (Ger), 765 (Br), 345 (Col) |
| SMIT / Nijmegen, Netherlands | qualified | ~800 | 500 | ~1200 | 765 |
| Waukesha Electric (SPX), Waukesha, WI USA | qualified | ~600 | 345 | ~800 | 345 |

# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS

| State | County | Extreme Wind mph | NESC District | | | Extreme Ice inches | Entergy Load Case |
|---|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | | |
| AR | Arkansas | 100 | | M | | 1 | LC-2 |
| AR | Ashley | 100 | | M | | 1 | LC-2 |
| AR | Baxter | 100 | | | H | 1 | LC-1 |
| AR | Benton | 100 | | | H | 1 | LC-1 |
| AR | Boone | 100 | | | H | 1 | LC-1 |
| AR | Bradley | 100 | | M | | 1 | LC-2 |
| AR | Calhoun | 100 | | M | | 1 | LC-2 |
| AR | Carroll | 100 | | | H | 1 | LC-1 |
| AR | Chicot | 100 | | M | | 1 | LC-2 |
| AR | Clark | 100 | | | H | 1 | LC-1 |
| AR | Clay | 100 | | | H | 1 | LC-1 |
| AR | Cleburne | 100 | | | H | 1 | LC-1 |
| AR | Cleveland | 100 | | M | | 1 | LC-2 |
| AR | Columbia | 100 | | M | | 1 | LC-2 |
| AR | Conway | 100 | | | H | 1 | LC-1 |
| AR | Craighead | 100 | | M | | 1 | LC-2 |
| AR | Crawford | 100 | | | H | 1 | LC-1 |
| AR | Crittenden | 100 | | M | | 1 | LC-2 |
| AR | Cross | 100 | | M | | 1 | LC-2 |
| AR | Dallas | 100 | | M | | 1 | LC-2 |
| AR | Desha | 100 | | M | | 1 | LC-2 |
| AR | Drew | 100 | | M | | 1 | LC-2 |
| AR | Faulkner | 100 | | | H | 1 | LC-1 |
| AR | Franklin | 100 | | | H | 1 | LC-1 |
| AR | Fulton | 100 | | | H | 1 | LC-1 |
| AR | Garland | 100 | | | H | 1 | LC-1 |
| AR | Grant | 100 | | M | | 1 | LC-2 |
| AR | Greene | 100 | | | H | 1 | LC-1 |
| AR | Hempstead | 100 | | | H | 1 | LC-1 |
| AR | Hot Spring | 100 | | | H | 1 | LC-1 |
| AR | Howard | 100 | | | H | 1 | LC-1 |
| AR | Independence | 100 | | | H | 1 | LC-1 |
| AR | Izard | 100 | | | H | 1 | LC-1 |
| AR | Jackson | 100 | | | H | 1 | LC-1 |
| AR | Jefferson | 100 | | M | | 1 | LC-2 |

# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS

| State | County | Extreme Wind mph | NESC District | | | Extreme Ice inches | Entergy Load Case |
|---|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | | |
| AR | Johnson | 100 | | | H | 1 | LC-1 |
| AR | Lafayette | 100 | | M | | 1 | LC-2 |
| AR | Lawrence | 100 | | | H | 1 | LC-1 |
| AR | Lee | 100 | | M | | 1 | LC-2 |
| AR | Lincoln | 100 | | M | | 1 | LC-2 |
| AR | Little River | 100 | | | H | 1 | LC-1 |
| AR | Logan | 100 | | | H | 1 | LC-1 |
| AR | Lonoke | 100 | | M | | 1 | LC-2 |
| AR | Madison | 100 | | | H | 1 | LC-1 |
| AR | Marion | 100 | | | H | 1 | LC-1 |
| AR | Miller | 100 | | M | | 1 | LC-2 |
| AR | Mississippi | 100 | | M | | 1 | LC-2 |
| AR | Monroe | 100 | | M | | 1 | LC-2 |
| AR | Montgomery | 100 | | | H | 1 | LC-1 |
| AR | Nevada | 100 | | M | | 1 | LC-2 |
| AR | Newton | 100 | | | H | 1 | LC-1 |
| AR | Ouachita | 100 | | M | | 1 | LC-2 |
| AR | Perry | 100 | | | H | 1 | LC-1 |
| AR | Phillips | 100 | | M | | 1 | LC-2 |
| AR | Pike | 100 | | | H | 1 | LC-1 |
| AR | Poinsett | 100 | | M | | 1 | LC-2 |
| AR | Polk | 100 | | | H | 1 | LC-1 |
| AR | Pope | 100 | | | H | 1 | LC-1 |
| AR | Prairie | 100 | | M | | 1 | LC-2 |
| AR | Pulaski | 100 | | | H | 1 | LC-1 |
| AR | Randolph | 100 | | | H | 1 | LC-1 |
| AR | St. Francis | 100 | | M | | 1 | LC-2 |
| AR | Saline | 100 | | | H | 1 | LC-1 |
| AR | Scott | 100 | | | H | 1 | LC-1 |
| AR | Searcy | 100 | | | H | 1 | LC-1 |
| AR | Sebastian | 100 | | | H | 1 | LC-1 |
| AR | Sevier | 100 | | | H | 1 | LC-1 |
| AR | Sharp | 100 | | | H | 1 | LC-1 |
| AR | Stone | 100 | | | H | 1 | LC-1 |
| AR | Union | 100 | | M | | 1 | LC-2 |
| AR | Van Buren | 100 | | | H | 1 | LC-1 |
| AR | Washington | 100 | | | H | 1 | LC-1 |
| AR | White | 100 | | | H | 1 | LC-1 |
| AR | Woodruff | 100 | | M | | 1 | LC-2 |
| AR | Yell | 100 | | | H | 1 | LC-1 |
| MO | Dunklin | 100 | | | H | 1 | LC-1 |
| MO | New Madrid | 100 | | | H | 1 | LC-1 |
| MO | Oregon | 100 | | | H | 1 | LC-1 |
| MO | Pemiscot | 100 | | | H | 1 | LC-1 |
| MO | Stoddard | 100 | | | H | 1 | LC-1 |
| MO | Taney | 100 | | | H | 1 | LC-1 |

# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS

| State | Parish | Extreme Wind mph | NESC District | | | Extreme Ice inches | Entergy Load Case |
|---|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | | |
| LA | Acadia | 150 | L | | | 0.5 | LC-3D |
| LA | Allen | 125 | L | | | 0.5 | LC-3B |
| LA | Ascension | 150 | L | | | 0.5 | LC-3D |
| LA | Assumption | 150 | L | | | 0.5 | LC-3D |
| LA | Avoyelles | 110 | L | | | 0.5 | LC-3F |
| LA | Beauregard | 125 | L | | | 0.5 | LC-3B |
| LA | Bienville | 100 | | M | | 0.75 | LC-2D |
| LA | Bossier | 100 | | M | | 0.75 | LC-2D |
| LA | Calcasieu | 150 | L | | | 0.5 | LC-3D |
| LA | Caldwell | 100 | | M | | 0.75 | LC-2D |
| LA | Cameron | 150 | L | | | 0.5 | LC-3D |
| LA | Catahoula | 100 | L | | | 0.5 | LC-3E |
| LA | Claiborne | 100 | | M | | 0.75 | LC-2D |
| LA | Concordia | 100 | L | | | 0.5 | LC-3E |
| LA | Desoto | 100 | | M | | 0.75 | LC-2D |
| LA | East Baton Rouge | 150 | L | | | 0.5 | LC-3D |
| LA | East Carrol | 100 | | M | | 0.75 | LC-2D |
| LA | East Feliciana | 125 | L | | | 0.5 | LC-3B |
| LA | Evangeline | 125 | L | | | 0.5 | LC-3B |
| LA | Franklin | 100 | | M | | 0.75 | LC-2D |
| LA | Grant | 100 | L | | | 0.75 | LC-2C |
| LA | Iberia | 150 | L | | | 0.5 | LC-3D |
| LA | Iberville | 150 | L | | | 0.5 | LC-3D |
| LA | Jackson | 100 | | M | | 0.75 | LC-2D |
| LA | Jefferson | 150 | L | | | 0.5 | LC-3D |
| LA | Jefferson Davis | 150 | L | | | 0.5 | LC-3D |
| LA | Lafayette | 150 | L | | | 0.5 | LC-3D |
| LA | Lafourche | 150 | L | | | 0.5 | LC-3D |
| LA | Lasalle | 100 | L | | | 0.75 | LC-3C |
| LA | Lincoln | 100 | | M | | 0.75 | LC-2D |
| LA | Livingston | 150 | L | | | 0.5 | LC-3D |
| LA | Madison | 100 | L | | | 0.75 | LC-3C |
| LA | Morehouse | 100 | | M | | 0.75 | LC-2D |
| LA | Natchitoches | 100 | | M | | 0.75 | LC-2D |
| LA | Orleans | 150 | L | | | 0.5 | LC-3D |
| LA | Ouachita | 100 | | M | | 0.75 | LC-2D |
| LA | Plaquemines | 150 | L | | | 0.5 | LC-3D |
| LA | Point Coupee | 125 | L | | | 0.5 | LC-3B |
| LA | Rapides | 100 | L | | | 0.5 | LC-3E |
| LA | Red River | 100 | | M | | 0.75 | LC-2D |
| LA | Richland | 100 | | M | | 0.75 | LC-2D |
| LA | Sabine | 100 | | M | | 0.75 | LC-2D |
| LA | St. Bernard | 150 | L | | | 0.5 | LC-3D |
| LA | St. Charles | 150 | L | | | 0.5 | LC-3D |

# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS

| State | Parish | Extreme Wind mph | NESC District | | | Extreme Ice inches | Entergy Load Case |
|---|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | | |
| LA | St. Helena | 125 | L | | | 0.5 | LC-3B |
| LA | St. James | 150 | L | | | 0. 5 | LC-3D |
| LA | St. John the Baptist | 150 | L | | | 0.5 | LC-3D |
| LA | St. Landry | 125 | L | | | 0.5 | LC-3B |
| LA | St. Martin, North | 150 | L | | | 0.5 | LC-3D |
| LA | St. Martin, South | 150 | L | | | 0.5 | LC-3D |
| LA | St. Mary | 150 | L | | | 0.5 | LC-3D |
| LA | St. Tammany | 150 | L | | | 0.5 | LC-3D |
| LA | Tangipahoa | 150 | L | | | 0.5 | LC-3D |
| LA | Tensas | 100 | L | | | 0.5 | LC-3E |
| LA | Terrebonne | 150 | L | | | 0.5 | LC-3D |
| LA | Union | 100 | | M | | 0.75 | LC-2D |
| LA | Vermillion | 150 | L | | | 0.5 | LC-3D |
| LA | Vernon | 100 | L | | | 0.5 | LC-3E |
| LA | Washington | 125 | L | | | 0.5 | LC-3B |
| LA | Webster | 100 | | M | | 0.75 | LC-2D |
| LA | West Baton Rouge | 150 | L | | | 0.5 | LC-3D |
| LA | West Carrol | 100 | | M | | 0.75 | LC-2D |
| LA | West Feliciana | 125 | L | | | 0.5 | LC-3B |
| LA | Winn | 100 | | M | | 0.75 | LC-2D |

# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS

| State | County | Extreme Wind mph | NESC District | | | Extreme Ice inches | Entergy Load Case |
|---|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | | |
| MS | Adams | 100 | L | | | 0.5 | LC-3E |
| MS | Amite | 110 | L | | | 0.5 | LC-3F |
| MS | Attala | 100 | L | | | 0.5 | LC-3E |
| MS | Benton | 100 | | M | | 1 | LC-2 |
| MS | Bolivar | 100 | | M | | 1 | LC-2 |
| MS | Calhoun | 100 | | M | | 1 | LC-2 |
| MS | Carrol | 100 | | M | | 1 | LC-2 |
| MS | Chickasaw | 100 | | M | | 1 | LC-2 |
| MS | Choctaw | 100 | | M | | 1 | LC-2 |
| MS | Claiborne | 100 | L | | | 0.5 | LC-3E |
| MS | Clay | 100 | | M | | 1 | LC-2 |
| MS | Coahoma | 100 | | M | | 1 | LC-2 |
| MS | Copiah | 100 | L | | | 0.5 | LC-3E |
| MS | Covington | 110 | L | | | 0.5 | LC-3F |
| MS | Desoto | 100 | | M | | 1 | LC-2 |
| MS | Franklin | 100 | L | | | 0.5 | LC-3E |
| MS | Grenada | 100 | | M | | 1 | LC-2 |
| MS | Hinds | 100 | L | | | 0.5 | LC-3E |
| MS | Holmes | 100 | | M | | 1 | LC-2 |
| MS | Humphreys | 100 | | M | | 1 | LC-2 |
| MS | Issaquena | 100 | L | | | 1 | LC-3G |
| MS | Jefferson | 100 | L | | | 0.5 | LC-3E |
| MS | Jefferson Davis | 110 | L | | | 0.5 | LC-3F |
| MS | Lafayette | 100 | | M | | 1 | LC-2 |
| MS | Lawrence | 110 | L | | | 0.5 | LC-3F |
| MS | Leake | 100 | L | | | 0.5 | LC-3E |
| MS | Leflore | 100 | | M | | 1 | LC-2 |
| MS | Lincoln | 110 | L | | | 0.5 | LC-3F |
| MS | Madison | 100 | L | | | 0.5 | LC-3E |
| MS | Marion | 110 | L | | | 0.5 | LC-3F |
| MS | Marshall | 100 | | M | | 1 | LC-2 |
| MS | Montgomery | 100 | | M | | 1 | LC-2 |
| MS | Neshoba | 100 | L | | | 0.5 | LC-3E |
| MS | Newton | 100 | L | | | 0.5 | LC-3E |
| MS | Panola | 100 | | M | | 1 | LC-2 |
| MS | Pike | 110 | L | | | 0.5 | LC-3F |
| MS | Ponotoc | 100 | | M | | 1 | LC-2 |
| MS | Quitman | 100 | | M | | 1 | LC-2 |
| MS | Rankin | 100 | L | | | 0.5 | LC-3E |
| MS | Scott | 100 | L | | | 0.5 | LC-3E |
| MS | Sharkey | 100 | L | | | 0.75 | LC-3C |
| MS | Simpson | 100 | L | | | 0.5 | LC-3E |
| MS | Smith | 110 | L | | | 0.5 | LC-3F |

# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS

| State | County | Extreme Wind mph | NESC District | | | Extreme Ice inches | Entergy Load Case |
|---|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | | |
| MS | Sunflower | 100 | | M | | 1 | LC-2 |
| MS | Tallahatchie | 100 | | M | | 1 | LC-2 |
| MS | Tate | 100 | | M | | 1 | LC-2 |
| MS | Tippah | 100 | | M | | 1 | LC-2 |
| MS | Tunica | 100 | | M | | 1 | LC-2 |
| MS | Union | 100 | | M | | 1 | LC-2 |
| MS | Walthall | 110 | L | | | 0.5 | LC-3F |
| MS | Warren | 100 | L | | | 0.5 | LC-3E |
| MS | Washington | 100 | | M | | 1 | LC-2 |
| MS | Webster | 100 | | M | | 1 | LC-2 |
| MS | Wilkinson | 110 | L | | | 0.5 | LC-3F |
| MS | Winston | 100 | L | | | 0.5 | LC-3E |
| MS | Yalobusha | 100 | | M | | 1 | LC-2 |
| MS | Yazoo | 100 | L | | | 0.75 | LC-3C |

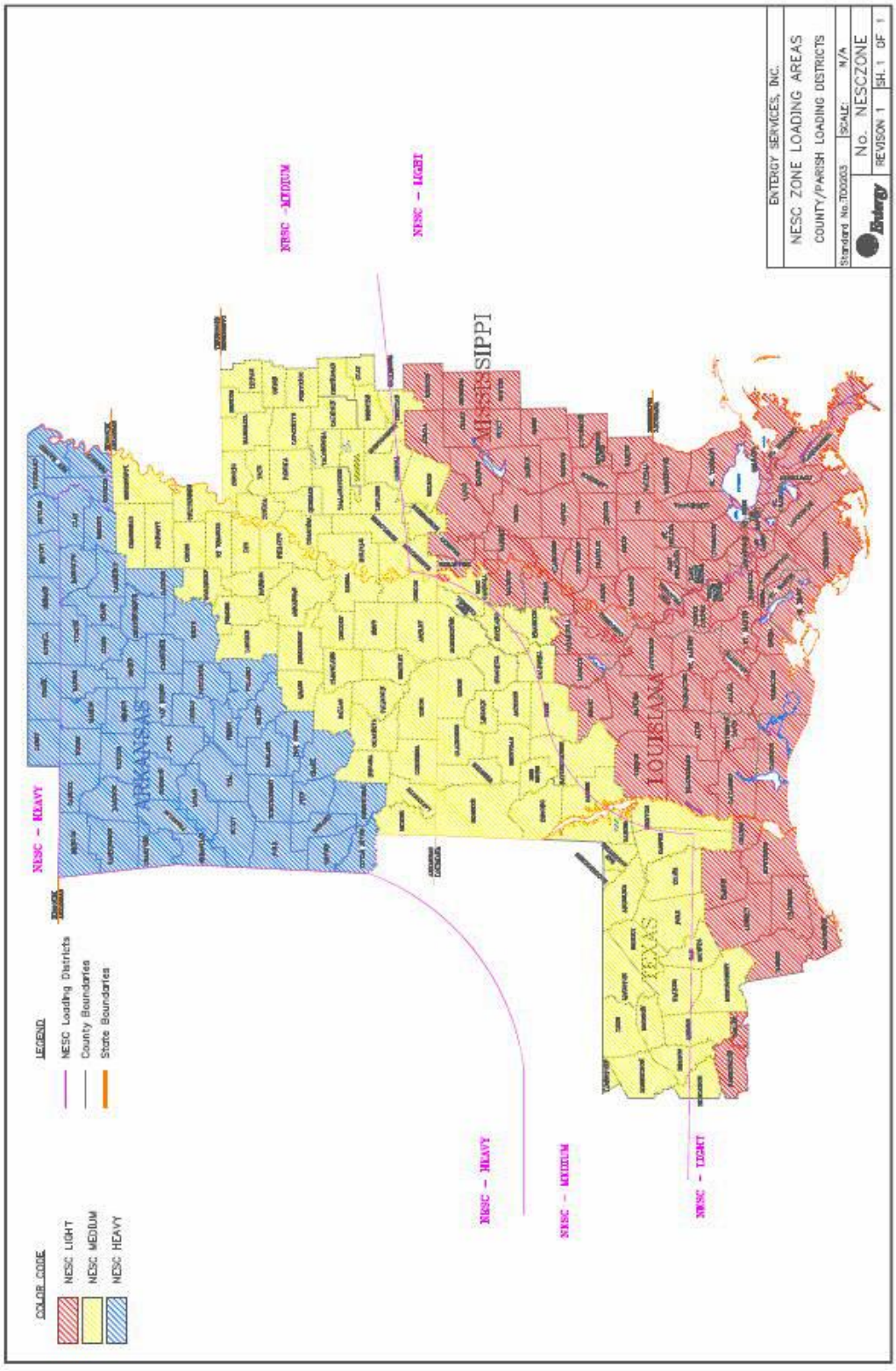
# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS

| State | County | Extreme Wind mph | NESC District | | | Extreme Ice inches | Entergy Load Case |
|---|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | | |
| TX | Angelina | 100 | | M | | 0.75 | LC-2D |
| TX | Brazos | 100 | | M | | 0.75 | LC-2D |
| TX | Burleson | 100 | | M | | 0.5 | LC-2B |
| TX | Chambers | 150 | L | | | 0.5 | LC-3D |
| TX | Galveston | 150 | L | | | 0.5 | LC-3D |
| TX | Grimes | 100 | | M | | 0.75 | LC-2D |
| TX | Hardin | 125 | L | | | 0.5 | LC-3B |
| TX | Harris | 125 | L | | | 0.5 | LC-3B |
| TX | Houston | 100 | | M | | 0.75 | LC-2D |
| TX | Jasper | 125 | | M | | 0.5 | LC-2C |
| TX | Jefferson | 150 | L | | | 0.5 | LC-3D |
| TX | Leon | 100 | | M | | 0.75 | LC-2D |
| TX | Liberty | 125 | L | | | 0.5 | LC-3B |
| TX | Limestone | 100 | | M | | 0.75 | LC-2D |
| TX | Madison | 100 | | M | | 0.75 | LC-2D |
| TX | Montgomery | 110 | | M | | 0.5 | LC-2A |
| TX | Nacoqdoches | 100 | | M | | 0.75 | LC-2D |
| TX | Newton | 125 | | M | | 0.5 | LC-2C |
| TX | Orange | 150 | L | | | 0.5 | LC-3D |
| TX | Polk | 110 | | M | | 0.75 | LC-2E |
| TX | Robertson | 100 | | M | | 0.75 | LC-2D |
| TX | Sabine | 100 | | M | | 0.75 | LC-2D |
| TX | San Augustine | 100 | | M | | 0.75 | LC-2D |
| TX | San Jacinto | 100 | | M | | 0.75 | LC-2D |
| TX | Trinity | 100 | | M | | 0.75 | LC-2D |
| TX | Tyler | 110 | | M | | 0.75 | LC-2E |
| TX | Walker | 100 | | M | | 0.75 | LC-2D |
| TX | Waller | 110 | L | | | 0.5 | LC-3F |
| TX | Washington | 100 | L | | | 0.5 | LC-3E |

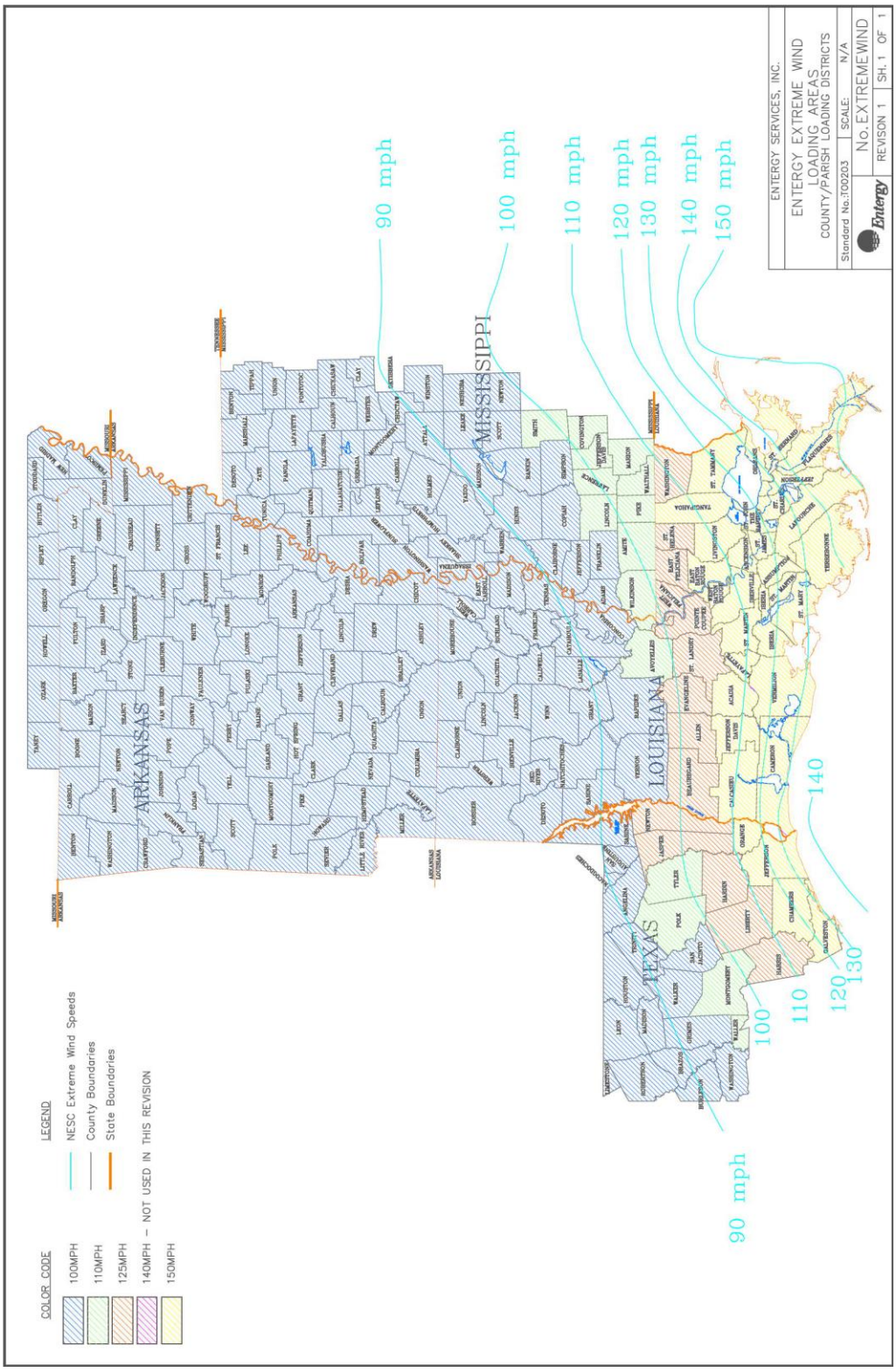
# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS



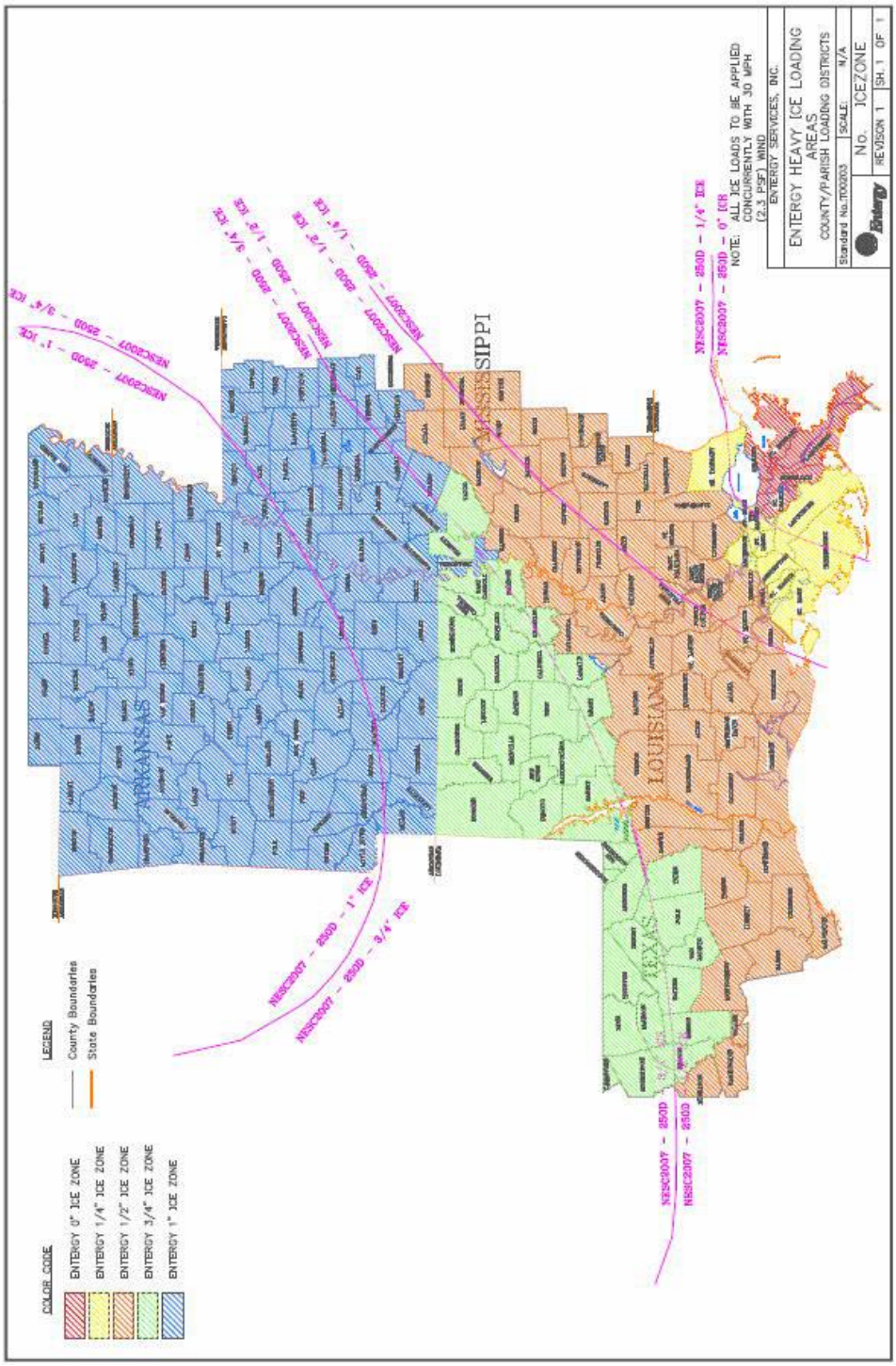
# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS



# Appendix 2: High Voltage Overhead Transmission

## ATTACHMENT 6: ENTERGY LOADING DISTRICTS



# BESS BOT Scope Book

# Appendix 3

# Seller Provided Information

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 25-1 | 5/19/2025 | All | Original Publication |
| 25-2 | 11/3/2025 | All | General Updates |
| | | | |
| | | | |

# 1 General Project Information

Seller to populate cells shaded orange in Table 1 and Table 2 below.

Table 1: Project Physical Location

| Item No. | Parameter | Value |
|---|---|---|
| 1.1 | **Address** | |
| 1.2 | **Location** | |
| 1.3 | **POI** | |

Table 2: Guaranteed System Performance at Substantial Completion

| Item No. | Parameter | Value | Unit | Notes |
|---|---|---|---|---|
| 1.4 | Guaranteed Charge Power | | MW (AC) | at POI |
| 1.5 | Guaranteed Discharge Power | | MW (AC) | at POI |
| 1.6 | Duration | | Hours | at POI |
| 1.7 | Guaranteed Energy Capacity | | MWh (AC) | at POI |
| 1.8 | Guaranteed Round-Trip Efficiency, excluding auxiliary loads | | % | At POI. Buyer prefers value meeting or exceeding 85%. |
| 1.9 | Guaranteed Response Time | | Seconds | At POI. Buyer prefers value meeting or exceeding 3 sec. |

# 2 Proposed Equipment

Seller to populate cells shaded orange in Table 3, Table 4, Table 5, and Table 6 below.

Table 3: Battery Energy Storage System (BESS)

| Item No. | Parameter | Value | Notes |
|---|---|---|---|
| 2.1 | Manufacturer | | |
| 2.2 | Model | | |
| 2.3 | Energy/Container | | |
| 2.4 | Number of Containers | | |
| 2.5 | UL 1973 Certified | Yes/No | |
| 2.6 | UL 9540 Testing Completed | Yes/No | |
| 2.7 | UL 9540A Testing Completed | Yes/No | |
| 2.8 | UL 9540A Confirms thermal runaway will not propagate rack to rack | Yes/No | |

Table 4: PCS Inverters

| Item No. | Parameter | Value | Notes |
|---|---|---|---|
| 2.9 | Manufacturer | | |
| 2.10 | Model | | |
| 2.11 | Maximum Output Power @40˚C | | |
| 2.12 | Maximum Output Power @50˚C | | |
| 2.13 | AC Voltage | | |
| 2.14 | DC Max Voltage | | |
| 2.15 | DC Voltage Range | | |
| 2.16 | PCS Charge/Discharge Efficiency | | |
| 2.17 | Peak Auxiliary Power Consumption | | |
| 2.18 | Operational Frequency | | |

**Appendix 3: Seller Provided Information**

Table 5: PCS Transformers

| Item No. | Parameter | Value | Notes |
|---|---|---|---|
| 2.19 | Manufacturer | | |
| 2.20 | Model | | |
| 2.21 | Primary Voltage | | |
| 2.22 | Secondary Voltage | | |
| 2.23 | Transformer Rating [kVA] | | |
| 2.24 | Transformer Specification | | |
| 2.25 | Transformer type | | |

Table 6: SCADA

| Item No. | Parameter | Value | Notes |
|---|---|---|---|
| 2.26 | Manufacturer | | |
| 2.27 | Model | | |
| 2.28 | Source of Programming | | |
| 2.29 | Application Software Used | | |
| 2.30 | Open Source | Yes/No | |
| 2.31 | Transformer Specification | | |
| 2.32 | Transformer type | | |

# 3 Project Performance with LTSA

Seller to populate cells shaded orange in Table 7 below with proposed performance guarantees assuming Seller provides a long-term service agreement (LTSA). Note Buyer prefers annual State of Health and Round-Trip Efficiency guarantees over 20 years.

Table 7: Guaranteed Performance Over Equipment Life -At Battery Unit Output Terminals

| Item No. | Year | SOH (%) | Round Trip Efficiency % (excluding aux consumption) | Notes |
|---|---|---|---|---|
| 3.1 | 0 | | | |
| 3.2 | 1 | | | |
| 3.3 | 2 | | | |
| 3.4 | 3 | | | |
| 3.5 | 4 | | | |
| 3.6 | 5 | | | |
| 3.7 | 6 | | | |
| 3.8 | 7 | | | |
| 3.9 | 8 | | | |
| 3.10 | 9 | | | |
| 3.11 | 10 | | | |
| 3.12 | 11 | | | |
| 3.13 | 12 | | | |
| 3.14 | 13 | | | |
| 3.15 | 14 | | | |
| 3.16 | 15 | | | |
| 3.17 | 16 | | | |
| 3.18 | 17 | | | |
| 3.19 | 18 | | | |
| 3.20 | 19 | | | |
| 3.21 | 20 | | | |

## Appendix 3: Seller Provided Information

Seller to populate cells shaded orange in
Table 8 below with proposed performance guarantees. Information provided at table below shall be based on a relevant point of measurement pertinent to the LTSA such as inverter AC Output, Transformer Output, etc. These provided values are for informational purposes only.

Table 8: Guaranteed Performance at Point of Measurement

| Point of Measurement | | | | | | |
|---|---|---|---|---|---|---|
| **Item No.** | **Year** | **Power MW (AC)** | **Capacity MWh (AC)** | **Round Trip Efficiency % (including aux loads)** | **State of Health %** | **Maximum Auxiliary Consumption per Day MWh (AC)** |
| 3.22 | 0 | | | | | |
| 3.23 | 1 | | | | | |
| 3.24 | 2 | | | | | |
| 3.25 | 3 | | | | | |
| 3.26 | 4 | | | | | |
| 3.27 | 5 | | | | | |
| 3.28 | 6 | | | | | |
| 3.29 | 7 | | | | | |
| 3.30 | 8 | | | | | |
| 3.31 | 9 | | | | | |
| 3.32 | 10 | | | | | |
| 3.33 | 11 | | | | | |
| 3.34 | 12 | | | | | |
| 3.35 | 13 | | | | | |
| 3.36 | 14 | | | | | |
| 3.37 | 15 | | | | | |
| 3.38 | 16 | | | | | |
| 3.39 | 17 | | | | | |
| 3.40 | 18 | | | | | |
| 3.41 | 19 | | | | | |
| 3.42 | 20 | | | | | |

# 4 Project Performance without LTSA

Seller to populate cells shaded orange in

Table 9 below with proposed performance guarantees assuming Seller doesn't provide a long-term service agreement (LTSA).

Note Buyer prefers annual State of Health and Round-Trip Efficiency guarantees over 20 years.

Table 9: Guaranteed Performance Over Equipment Life - At Battery Unit Output Terminals

| Item No. | Year | SOH (%) | Round Trip Efficiency % (excluding aux consumption) | Notes |
|---|---|---|---|---|
| 4.1 | 0 | | | |
| 4.2 | 1 | | | |
| 4.3 | 2 | | | |
| 4.4 | 3 | | | |
| 4.5 | 4 | | | |
| 4.6 | 5 | | | |
| 4.7 | 6 | | | |
| 4.8 | 7 | | | |
| 4.9 | 8 | | | |
| 4.10 | 9 | | | |
| 4.11 | 10 | | | |
| 4.12 | 11 | | | |
| 4.13 | 12 | | | |
| 4.14 | 13 | | | |
| 4.15 | 14 | | | |
| 4.16 | 15 | | | |
| 4.17 | 16 | | | |
| 4.18 | 17 | | | |
| 4.19 | 18 | | | |
| 4.20 | 19 | | | |
| 4.21 | 20 | | | |

## Appendix 3: Seller Provided Information

Seller to populate cells shaded orange in

Table 10 below with expected performance values assuming Seller doesn't provide a long-term service agreement (LTSA).

Table 10: Indicative Performance at POI

| Item No. | Year | Power MW (AC) | Capacity MWh (AC) | Round Trip Efficiency % (including aux loads) | State of Health % | Maximum Auxiliary Consumption per Day MWh (AC) |
|---|---|---|---|---|---|---|
| 4.22 | 0 | | | | | |
| 4.23 | 1 | | | | | |
| 4.24 | 2 | | | | | |
| 4.25 | 3 | | | | | |
| 4.26 | 4 | | | | | |
| 4.27 | 5 | | | | | |
| 4.28 | 6 | | | | | |
| 4.29 | 7 | | | | | |
| 4.30 | 8 | | | | | |
| 4.31 | 9 | | | | | |
| 4.32 | 10 | | | | | |
| 4.33 | 11 | | | | | |
| 4.34 | 12 | | | | | |
| 4.35 | 13 | | | | | |
| 4.36 | 14 | | | | | |
| 4.37 | 15 | | | | | |
| 4.38 | 16 | | | | | |
| 4.39 | 17 | | | | | |
| 4.40 | 18 | | | | | |
| 4.41 | 19 | | | | | |
| 4.42 | 20 | | | | | |

# 5 Technical Data

Seller to populate cells shaded orange in Table 11 below with Technical Data. Note items 5.32, 5.33, and 5.34 below shall be provided on a per use case basis.

Table 11: Technical Data

| Item No. | Parameter | Unit of Measure | Value | Notes |
|---|---|---|---|---|
| 5.1 | Installation type: container, building, pack | Quantity | | |
| 5.2 | Installed DC | MWh | | |
| 5.3 | Rated Discharge Power – ESS | kW | | |
| 5.4 | Rated Charge Power – ESS | kW | | |
| 5.5 | Rated Reactive Power – ESS | kVAR | | |
| 5.6 | Rated Apparent Power – ESS | kVA | | |
| 5.7 | Capability Curve | | | |
| 5.8 | Voltage Tolerance | % | | |
| 5.9 | Available Discharge Energy – ESS | kW | | |
| 5.10 | Recommended Discharge Energy – BOL | kW | | |
| 5.11 | Degradation Scale Until EOL | % | | |
| 5.12 | Recommended Maximum State of Charge | % | | |
| 5.13 | Recommended Minimum State of Charge | % | | |
| 5.14 | Average State of Charge | % | | |
| 5.15 | Charge Duration | hours | | |
| 5.16 | Recommended Charge Power | kW | | |
| 5.17 | Roundtrip Efficiency - ESS AC to AC (RTEAC) | % | | |
| 5.18 | Charge Ramp Rate | kW/h | | |
| 5.19 | Discharge Ramp Rate | kW/h | | |
| 5.20 | System Latency | seconds | | |
| 5.21 | Self-Discharge Rate at 77 °F / 25 °C | kW/h | | |
| 5.22 | Cycle Life Ratings | | | |
| 5.23 | Specified Duty Cycle | | | |
| 5.24 | Annual Degradation for Specified Duty Cycle | | | |
| 5.25 | End of Life (EOL) Criteria | | | |
| 5.26 | Overload Discharge Power | kW | | |

| | | | | |
|---|---|---|---|---|
| 5.27 | Overload Charge Power | kW | | |
| 5.28 | Overload Reactive Power | kW | | |
| 5.29 | Overload AC Current | kW | | |
| 5.30 | Roundtrip Efficiency at Various Discharge Capacities-ESS AC to AC (RTEAC) | % | | |
| 5.31 | Response Time | seconds | | |
| 5.32 | Rise Time | seconds | | |
| 5.33 | Settling Time | seconds | | |
| 5.34 | "Ready" State Energy Consumption | kW | | |
| 5.35 | "Standby" State Energy Consumption | kW | | |
| 5.36 | Auxiliary Power Provision [source] | | | |
| 5.37 | Thermal Management System Type | | | |
| 5.38 | Thermal System Capacity | Btu/hr. | | |
| 5.39 | "Sleep" State Energy Consumption | kW | | |
| 5.40 | "OFF" State Energy Consumption | kW | | |
| 5.41 | Auxiliary Power – Peak | kW | | |
| 5.42 | Auxiliary Power – Continuous | kW | | |
| 5.43 | Auxiliary Power Nominal Voltage | kW | | |
| 5.44 | Thermal Tolerance Duration [hours] | hours | | |
| 5.45 | Coolant Liquid Required (if Any) | N/A | | |
| 5.46 | ESS Operational Temperature Range [degrees F] | ˚F | | |
| 5.47 | ESS Storage Temperature Range [degrees F] | ˚F | | |
| 5.48 | ESS Operational Humidity Range [degrees F] | ˚F | | |
| 5.49 | ESS Storage Humidity Range [degrees F] | ˚F | | |
| 5.50 | Other Equipment Storage requirements | N/A | | |
| 5.51 | ESS Enclosure Rating | N/A | | |
| 5.52 | ESS Enclosure Coating Rating | N/A | | |
| 5.53 | Hazardous Location Classification | N/A | | |
| 5.54 | Dust, Rodent and Insect Barriers | N/A | | |
| 5.55 | Sound Emissions from Enclosure(s) [dB] | dB | | |
| 5.56 | Warranty Period [years] | years | | |
| 5.57 | Performance Warranty Period | years | | |
| 5.58 | Defective Warranty Period | years | | |
| 5.59 | LTSA Option | Yes/No | | |

| | | | | |
|---|---|---|---|---|
| 5.60 | Expected System Availability | | | |
| 5.61 | Expected battery refresh charge and discharge cycles per year | | | |
| 5.62 | Expected Yearly Planned Down-Time for Maintenance | days | | |
| 5.63 | Expected Yearly Unplanned Down-Time of System for Repair | days | | |
| 5.64 | Expected Service Life before Major Replacement | years | | |
| 5.65 | Startup Time | seconds | | |
| 5.66 | Wake Time | seconds | | |
| 5.67 | Shutdown Time | seconds | | |
| 5.68 | Control Power UPS Back-Up Time | hours | | |
| 5.69 | Behavior when Main Power is Interrupted | | | |
| 5.70 | Behavior when Main Power Returns | | | |
| 5.71 | Behavior when Aux Power is Interrupted | | | |
| 5.72 | System Behavior when Aux Power Recovers | | | |
| 5.73 | Sleep Time | hours | | |
| 5.74 | Long-Term Downtime (Hibernation or Storage) | hours | | |
| 5.75 | Hibernation Process | | | |
| 5.76 | Expected filter replacement schedule | months | | |
| 5.77 | MTBF | years | | |
| 5.78 | System Power Factor Range | pu | | |
| 5.79 | PT/CTs Requirements | | | |
| 5.80 | MV Protection Type | | | |
| 5.81 | Output Voltage Range – ESS | kV | | |
| 5.82 | Minimum DC Input Voltage | kV | | |
| 5.83 | Maximum DC Input Voltage | kV | | |
| 5.84 | Additional Interconnection Compliance Capability | | | |
| 5.85 | Current THD | % | | |
| 5.86 | Voltage THD | | | |
| 5.87 | DC Injection | % | | |
| 5.88 | Phase Imbalance Limits (IEEE 1547) | | | |
| 5.89 | Voltage Unbalance Limits | | | |

| | | | | |
|---|---|---|---|---|
| 5.90 | Maximum AC short circuit current - ESS | | | |
| 5.91 | Output Frequency Range | Hz | | |
| 5.92 | Power Conversion System Switching Frequency | | | |
| 5.93 | Withstand Voltage | | | |
| 5.94 | Additional Power Quality Support Equipment | | | |

# 6 Design Characteristics

Seller to populate cells shaded orange in Table 12 below with Technical Data for BESS. If parameter is not applicable to project Seller to populate cell with N/A and provide justification in Notes column.

Notes to Seller:

- In response to Parameter 6.6 Seller shall provide at a minimum the door swing distance, Seller shall also provide the side(s) in which this distance is required.
- In response to Parameter 6.7 Seller shall provide any special consideration for setting the containers
- In response to Parameter 6.8 Seller shall provide any special consideration for heating/cooling the container

Table 12: Design Characteristics BESS

| Item No. | Parameter | Unit of Measure | Value | Notes |
|---|---|---|---|---|
| 6.1 | Number of Battery Containers | Quantity | | |
| 6.2 | Container Length (each) | Feet and Inches | | |
| 6.3 | Container Width (each) | Feet and Inches | | |
| 6.4 | Container Height (each) | Feet and Inches | | |
| 6.5 | Container Weight (fully loaded) | Lbs. | | |
| 6.6 | Minimum maintenance distance | Feet and Inches | | |
| 6.7 | Container support requirements | N/A | | |
| 6.8 | Container external cooling/heating requirements | N/A | | |
| 6.9 | Number and size of DC conduits | Quantity and Size | | |
| 6.10 | Number and size of AC conduits | Quantity and Size | | |
| 6.11 | Number and size of DC cable terminations | Quantity and Size | | |
| 6.12 | Number and size of AC cable terminations | Quantity and Size | | |
| 6.13 | Number and size of LV AC conduits | Quantity and Size | | |

**Appendix 3: Seller Provided Information**

| | | | | |
|---|---|---|---|---|
| 6.14 | Number and size of LV AC cables | Quantity and Size | | |
| 6.15 | Number and size of fiber conduits | Quantity and Size | | |
| 6.16 | Number and size of fiber cables | Quantity and Size | | |
| 6.17 | Number and size of fire department connections | Quantity and Size | | |

## Appendix 3: Seller Provided Information

Seller to populate cells shaded orange in Table 13 below with Technical Data for PCS. If parameter is not applicable to project Seller to populate cell with N/A and provide justification in Notes column.

Notes to Seller:

- In response to Parameter 6.23 Seller shall provide at a minimum the door swing distance, Seller shall also provide the side(s) in which this distance is required.
- In response to Parameter 6.24 Seller shall provide any special consideration for heating/cooling the container
- In response to Parameter 6.25 Seller shall provide any special consideration for setting the containers

Table 13: Design Characteristics PCS

| Item No. | Parameter | Unit of Measure | Value | Notes |
|---|---|---|---|---|
| 6.18 | Number of PCS Skids (inverter) | Quantity | | |
| 6.19 | PCS Length (each) | Feet and Inches | | |
| 6.20 | PCS Width (each) | Feet and Inches | | |
| 6.21 | PCS Height (each) | Feet and Inches | | |
| 6.22 | PCS Weight (fully loaded) | Lbs. | | |
| 6.23 | Minimum maintenance distance | Feet and Inches | | |
| 6.24 | PCS external cooling/heating requirements | N/A | | |
| 6.25 | PCS support requirements | N/A | | |
| 6.26 | Number and size of DC conduits | Quantity and Size | | |
| 6.27 | Number and size of AC conduits | Quantity and Size | | |
| 6.28 | Number and size of DC cable terminations | Quantity and Size | | |
| 6.29 | Number and size of AC cable terminations | Quantity and Size | | |
| 6.30 | Number and size of fiber conduits | Quantity and Size | | |
| 6.31 | Number and size of fiber cables | Quantity and Size | | |

## Appendix 3: Seller Provided Information

Seller to populate cells shaded orange in Table 14 below with Technical Data for Transformer Skids. If parameter is not applicable to project Seller to populate cell with N/A and provide justification in Notes column.

Notes to Seller:

- In response to Parameter 6.37 Seller shall provide at a minimum the door swing distance, Seller shall also provide the side(s) in which this distance is required.
- In response to Parameter 6.38 Seller shall provide any special consideration for setting the containers

Table 14: Design Characteristics Transformer Skids

| Item No. | Parameter | Unit of Measure | Value | Notes |
|---|---|---|---|---|
| 6.32 | Number of LV/MV transformer skids | Quantity | | |
| 6.33 | LV/MV XFRMR Length (each) | Feet and Inches | | |
| 6.34 | LV/MV XFRMR Width (each) | Feet and Inches | | |
| 6.35 | LV/MV XFRMR Height (each) | Feet and Inches | | |
| 6.36 | LV/MV XFRMR Weight (fully loaded) | Lbs. | | |
| 6.37 | Minimum maintenance distance | Feet and Inches | | |
| 6.38 | LV/MV XFRMR support requirements | N/A | | |
| 6.39 | Number and size of AC conduits | Quantity and Size | | |
| 6.40 | Number and size of AC cable terminations | Quantity and Size | | |
| 6.41 | Number and size of control conduits | Quantity and Size | | |
| 6.42 | Number and size of control cables | Quantity and Size | | |

## Appendix 3: Seller Provided Information

Seller to populate cells shaded orange in Table 15 below with Technical Data for SCADA Skids. If parameter is not applicable to project Seller to populate cell with N/A and provide justification in Notes column.

Notes to Seller:

- In response to Parameter 6.48 Seller shall provide at a minimum the door swing distance, Seller shall also provide the side(s) in which this distance is required.
- In response to Parameter 6.49 Seller shall provide any special consideration for setting the containers

Table 15: Design Characteristics SCADA Skids

| Item No. | Parameter | Unit of Measure | Value | Notes |
|---|---|---|---|---|
| 6.43 | Number of SCADA skids | Quantity | | |
| 6.44 | SCADA skid Length (each) | Feet and Inches | | |
| 6.45 | SCADA skid Width (each) | Feet and Inches | | |
| 6.46 | SCADA skid Height (each) | Feet and Inches | | |
| 6.47 | SCADA skid Weight (fully loaded) | Lbs. | | |
| 6.48 | Minimum maintenance distance | Feet and Inches | | |
| 6.49 | SCADA Skid support requirements | N/A | | |
| 6.50 | Number and size of AC conduits | Quantity and Size | | |
| 6.51 | Number and size of AC cable terminations | Quantity and Size | | |
| 6.52 | Number and size of control conduits | Quantity and Size | | |
| 6.53 | Number and size of control cables | Quantity and Size | | |
| 6.54 | Number and size of fiber conduits | Quantity and Size | | |
| 6.55 | Number and size of fiber cables | Quantity and Size | | |

## Appendix 3: Seller Provided Information

Seller to populate cells shaded orange in Table 16 below with Technical Data for SCADA Skids. If parameter is not applicable to project Seller to populate cell with N/A and provide justification in Notes column.

Notes to Seller:

- In response to Parameter 6.61 Seller shall provide at a minimum the door swing distance, Seller shall also provide the side(s) in which this distance is required.
- In response to Parameter 6.62 Seller shall provide any special consideration for setting the containers

Table 16: Design Characteristics Additional Skids

| Item No. | Parameter | Unit of Measure | Value | Notes |
|---|---|---|---|---|
| 6.56 | Number of Additional skids | Quantity | | |
| 6.57 | Additional Skid Length (each) | Feet and Inches | | |
| 6.58 | Additional Skid Width (each) | Feet and Inches | | |
| 6.59 | Additional Skid Height (each) | Feet and Inches | | |
| 6.60 | Additional Skid Weight (fully loaded) | Lbs. | | |
| 6.61 | Minimum maintenance distance | Feet and Inches | | |
| 6.62 | Additional Skid support requirements | N/A | | |
| 6.63 | Additional Skid Requirements | N/A | | |

# BESS BOT Scope Book

# Appendix 4

# Project Performance Tests and Liquidated Damages

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 25-1 | 5/19/2025 | All | Original Publication |
| 25-2 | 11/3/2025 | All | General Update, Updated Charge Test to Discharge Test |
| | | | |
| | | | |

# 1 Introduction

This Appendix describes the Six[1] Project Performance Tests Seller is required to perform to demonstrate satisfactory performance of the BESS. These tests shall be performed as required in Article IX of the Agreement and the Energy Storage Integration Council (ESIC) Energy Storage Test Manual 3002021710 (the ESIC Manual). Buyer provided Acceptance Criterion may be found in Appendix 5 (Buyer Provided Information).

Additionally, this Appendix outlines a regime by which performance-related liquidated damages may be calculated. The liquidated damage formulas in this Appendix 4 are preliminary and remain under Buyer review. The liquidated damage terms, if and as updated, are expected to be representative of reasonable market terms.

# 2 Performance Tests

## 2.1 BESS Available Energy Capacity (AC) Performance Test

Seller shall perform Section 6.1.1 of the ESIC Manual to determine the BESS Available Energy Capacity (AC). Seller shall determine the Tested BESS Available Energy Capacity (AC) $CAP_{ACT}$ of the Project, which shall be calculated as follows:

$$CAP_{ACT} = E_D - E_{AD}$$

Equation 1: Tested BESS Available Energy Capacity (AC)

Where:

- $E_D$ has the meaning set forth in Section 6.1.1 of the ESIC Manual (in the context of BESS Available Energy Capacity (AC) determinations)
- $E_{AD}$ has the meaning set forth in Section 6.1.1 of the ESIC Manual (in the context of BESS Available Energy Capacity (AC) determinations)
- $CAP_{ACT}$ is the Tested BESS Available Energy Capacity (AC)

To satisfy the BESS Available Energy Capacity (AC) Performance Test, $CAP_{ACT}$ must be equal to or greater than the Minimum BESS Available Energy Capacity (AC) ($CAP_{ACM}$) as specified in Appendix 5 (Buyer Provided Information). $CAP_{ACT}$ is greater than or equal $CAP_{ACM}$ but not equal to or greater than the Guaranteed BESS Available Energy Capacity (AC) ($CAP_{ACG}$)as specified in Appendix 5 (Buyer Provided Information), then Seller shall be liable to Buyer for liquidated damages calculated as follows:

[1] The BESS Auxiliary Load Performance Test (test number 5) is not expected to apply to BESS facilities pursuant to the BOT Agreement.

$$LD_{AC} = \left(1 - \frac{(CAP_{ACT})}{(CAP_{ACG})}\right) \times PP$$

Equation 2: BESS Available Energy Capacity (AC) Liquidated Damages

Where:

- $LD_{AC}$ is the BESS Available Energy (AC) Liquidated Damages
- $CAP_{ACT}$ is the Tested BESS Available Energy Capacity (AC) as defined in Equation 1
- $CAP_{ACG}$ is the Guaranteed BESS Available Energy Capacity (AC) as specified in Appendix 5 (Buyer Provided Information)
- PP is the Purchase Price

If $CAP_{ACT}$ is less than $CAP_{ACM}$, then Seller may re-perform the BESS Available Energy Capacity (AC) Performance Test and/or make such changes to the Project as may be required to allow $CAP_{ACT}$ to be equal to or greater than $CAP_{ACM}$, in each case, in accordance with Section 9.2 of the Agreement.

The BESS Available Energy Capacity (AC) Performance Test shall not be satisfied unless and until:

(i) $CAP_{ACT}$ is equal to or greater than the $CAP_{ACG}$ or
(ii) $CAP_{ACT}$ is equal to or greater than $CAP_{ACM}$ and Seller has paid Buyer all liquidated damages required pursuant to this Section 2.1.

### 2.2 BESS Available Energy Capacity (DC) Performance Test

Seller shall perform Section 6.1.1 of the ESIC Manual to determine the BESS Available Energy Capacity (DC). Seller shall determine the Tested BESS Available Energy Capacity (DC) $CAP_{DCT}$ of the Project, which shall be calculated as follows:

$$CAP_{DCT} = E_D - E_{AD}$$

Equation 3: Tested BESS Available Energy Capacity (DC)

Where:

- $E_D$ has the meaning set forth in Section 6.1.1 of the ESIC Manual (in the context of BESS Available Energy Capacity (DC) determinations)
- $E_{AD}$ has the meaning set forth in Section 6.1.1 of the ESIC Manual (in the context of BESS Available Energy Capacity (DC) determinations)
- $CAP_{DCT}$ is the Tested BESS Available Energy Capacity (DC)

To satisfy the BESS Available Energy Capacity (DC) Performance Test, $CAP_{DCT}$ must be equal to or greater than the Minimum BESS Available Energy Capacity (DC) ($CAP_{DCM}$) as specified in Appendix 5 (Buyer Provided Information). $CAP_{DCT}$ is greater than or equal $CAP_{DCM}$ but not equal to or greater than the Guaranteed BESS Available Energy Capacity (DC) ($CAP_{DCG}$) as specified in Appendix 5 (Buyer Provided Information), then Seller shall be liable to Buyer for liquidated damages calculated as follows:

$$LD_{DC} = \left(1 - \frac{(CAP_{DCT})}{(CAP_{DCG})}\right) \times PP$$

Equation 4: BESS Available Energy Capacity (DC) Liquidated Damages

Where:

- $LD_{DC}$ is the BESS Available Energy (DC) Liquidated Damages
- $CAP_{DCT}$ is the Tested BESS Available Energy Capacity (DC) as defined in Equation 3
- $CAP_{DCG}$ is the Guaranteed BESS Available Energy Capacity (DC) as specified in Appendix 5 (Buyer Provided Information)
- PP is the Purchase Price

If $CAP_{DCT}$ is less than $CAP_{DCM}$, then Seller may re-perform the BESS Available Energy Capacity (DC) Performance Test and/or make such changes to the Project as may be required to allow $CAP_{DCT}$ to be equal to or greater than $CAP_{DCM}$, in each case, in accordance with Section 9.2 of the Agreement.

The BESS Available Energy Capacity (DC) Performance Test shall not be satisfied unless and until:

(i) $CAP_{DCT}$ is equal to or greater than the $CAP_{DCG}$ or
(ii) $CAP_{DCT}$ is equal to or greater than $CAP_{DCM}$ and Seller has paid Buyer all liquidated damages required pursuant to this Section 2.2.

### 2.3 BESS Discharge Duration Performance Test

Seller shall perform Section 6.1.2 of the ESIC Manual, the BESS Discharge Duration Performance Test to determine the Discharge Duration ($t_D$).

The discharge duration $t_D$ is determined through logging of power at Location B and C during a discharge interval. While the discharge test continues to the minimum allowable SOC, only the energy transferred while at the rated power is included in the discharge duration. The discharge duration is considered completed when the minimum SOC value is reached. Near the end of discharge the length of time should be noted when the ESS curtails the power more than 2% and maintains that tolerance.

To satisfy the BESS Discharge Duration Performance Test, $t_D$ must be equal to or less than the maximum BESS Discharge Duration ($t_{DM}$) as specified in Appendix 5 (Buyer Provided Information). If the Tested BESS Discharge Duration ($t_{DT}$) is less than or equal to $t_{DM}$ but not equal to or less than the guaranteed BESS Discharge Duration ($t_{DG}$) as specified in Appendix 5 (Buyer Provided Information), then Seller shall be liable to Buyer for liquidated damages calculated as follows:

$$LD_{CD} = \left(1 - \frac{(t_{DT})}{(t_{DG})}\right) \times PP$$

Equation 5: BESS Discharge Duration Liquidated Damages

Where:

- $LD_{CD}$ is the BESS Discharge Duration Liquidated Damages
- $t_{DG}$ is the Guaranteed BESS Discharge Duration as specified in Appendix 5 (Buyer Provided Information)
- $t_{DT}$ is the Tested BESS Discharge Duration
- PP is the Purchase Price

If the $t_{DT}$ is greater than the $t_{DM}$, then Seller may re-perform the BESS Discharge Duration Performance Test and/or make such changes to the Project as may be required to allow the $t_{DT}$ to be equal to or less than $t_{DM}$, in each case, in accordance with Section 9.2 of the Agreement.

The BESS Discharge Duration Performance Test shall not be satisfied unless and until:

(i) $t_{DT}$ is equal to or less than $t_{DG}$ or
(ii) $t_{DT}$ is equal to or less than the $t_{DM}$ and Seller has paid Buyer all liquidated damages required pursuant to this Section 2.3.

### 2.4 BESS Rated Continuous Power Performance Test

Seller shall perform Section 6.1.3 of the ESIC Manual, the BESS Rated Continuous Power Performance Test. Seller shall determine the AC Active Discharge Power of the Project as defined in equation 6-3 in Section 6.1.3.3 of the Test Manual.

To satisfy the BESS Rated Continuous Power Performance Test, the Tested BESS Rated Continuous Power ($P_{DT}$) must be equal to or greater than the minimum BESS Rated Continuous Power ($P_{DM}$) as specified in Appendix 5 (Buyer Provided Information). If $P_{DT}$ is greater than or equal to $P_{DM}$ but not equal to or greater than the guaranteed BESS Rated Continuous Power ($P_{DG}$) as specified in Appendix 5 (Buyer Provided Information), then Seller shall be liable to Buyer for liquidated damages calculated as follows:

$$LD_{PD} = \left(1 - \frac{P_{DT}}{P_{DG}}\right) \times PP$$

Equation 6: BESS Rated Continuous Power Performance Liquidated Damages

Where:

- $LD_{PD}$ is the BESS Rated Continuous Power Performance Liquidated Damages

- $P_{DG}$ is the Guaranteed BESS Rated Continuous Power as specified in Appendix 5 (Buyer Provided Information)
- $P_{DT}$ is the Tested BESS Rated Continuous Power
- PP is the Purchase Price

If $P_{DT}$ is less than $P_{DM,}$ then Seller may re-perform the BESS Rated Continuous Power Performance Test and/or make such changes to the Project as may be required to allow the $P_{DT}$ to be equal to or greater than the $P_{DM}$, in each case, in accordance with Section 9.2 of the Agreement.

The BESS Rated Continuous Power Performance Test shall not be satisfied unless and until:

(i) $P_{DT}$ is equal to or greater than $P_{DG}$ or
(ii) $P_{DT}$ is equal to or greater than the $P_{DM}$ and Seller has paid Buyer all liquidated damages required pursuant to this Section 2.4.

### 2.5 BESS Auxiliary Load Performance Test

Seller shall perform Section 6.1.4 of the ESIC Manual, the BESS Auxiliary Load Performance Test. Seller shall determine the BESS Auxiliary Loads of the Project as defined in equation 6-11 in Section 6.1.4.4 of the Test Manual.

To satisfy the BESS Auxiliary Load Performance Test, the Tested Auxiliary Load ($P_{AUXT}$) must be equal to or less than the maximum BESS Auxiliary Load ($P_{AUXM}$) as specified in Appendix 5 (Buyer Provided Information). If $P_{AUXT}$ is less than or equal to $P_{AUXM}$ but not equal to or less than the guaranteed BESS Auxiliary Load ($P_{AUXG}$) as specified in Appendix 5 (Buyer Provided Information), then Seller shall be liable to Buyer for liquidated damages calculated as follows:

$$LD_{PAUX} = \left(1 - \frac{P_{AUXG}}{P_{AUXT}}\right) \times PP$$

Equation 7: BESS Auxiliary Load Liquidated Damages

Where:

- $LD_{PAUX}$ is the BESS Auxiliary Load Liquidated Damages
- $P_{AUXG}$ is the Guaranteed Auxiliary Load as specified in Appendix 5 (Buyer Provided Information)
- $P_{AUXT}$ is the Tested Auxiliary Load
- PP is the Purchase Price

If $P_{AUXT}$ is greater than $P_{AUXM}$, then Seller may re-perform the BESS Rated Continuous Power Performance Test and/or make such changes to the Project as may be required to allow the $P_{AUXT}$ to be equal to or less than the $P_{AUXM}$, in each case, in accordance with Section 9.2 of the Agreement.

The BESS Rated Continuous Power Performance Test shall not be satisfied unless and until:

(i) $P_{AUXT}$ is equal to or less than $P_{AUXG}$ or
(ii) $P_{AUXT}$ is equal to or less than the $P_{AUXM}$ and Seller has paid Buyer all liquidated damages required pursuant to this Section 2.5.

### 2.6 BESS Round Trip Efficiency Performance Test

Seller shall perform Section 6.1.5 of the ESIC Manual, the BESS Round Trip Efficiency Performance Test. Seller shall determine the Round Trip Efficiency (RTE) of the Project as defined in equation 6-13 or 6-14 (dependent on where loads are measured) in Section 6.1.5.4 of the Test Manual.

To satisfy the BESS Round Trip Efficiency Performance Test, the Tested BESS Round Trip Efficiency ($RTE_T$) must be equal to or greater than the maximum BESS RTE ($RTE_M$) as specified in Appendix 5 (Buyer Provided Information). If $RTE_T$ is greater than or equal to $RTE_M$ but not equal to or greater than the guaranteed RTE ($RTE_G$) as specified in Appendix 5 (Buyer Provided Information), then Seller shall be liable to Buyer for liquidated damages calculated as follows:

$$LD_{RTE} = \left(1 - \frac{RTE_T}{RTE_G}\right) \times PP$$

Equation 8: BESS Round Trip Efficiency Liquidated Damages

Where:

- $LD_{RTE}$ is the BESS Round Trip Efficiency Liquidated Damages
- $RTE_G$ is the Guaranteed Round Trip Efficiency as specified in Appendix 5 (Buyer Provided Information)
- $RTE_T$ is the Tested Round Trip Efficiency
- PP is the Purchase Price

If $RTE_T$ is less than $RTE_M$, then Seller may re-perform the BESS Round Trip Efficiency Performance Test and/or make such changes to the Project as may be required to allow the $RTE_T$ to be equal to or greater than the $RTE_M$, in each case, in accordance with Section 9.2 of the Agreement.

The BESS Round Trip Efficiency Performance Test shall not be satisfied unless and until:

(i) $RTE_T$ is equal to or greater than $RTE_G$ or
(ii) $RTE_T$ is equal to or greater than the $RTE_M$ and Seller has paid Buyer all liquidated damages required pursuant to this Section 2.6.

# BESS BOT Scope Book
# Appendix 5
# Buyer Provided Information

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 25-1 | 5/19/2025 | All | Original Publication |
| 25-2 | 11/3/2025 | All | General Update |
| | | | |
| | | | |

## Appendix 5: Buyer Provided Information

Table 1: General Information

| Item No. | Item | Value | Notes |
|---|---|---|---|
| *1.* | Duration [hrs.] | | |
| *2.* | Power Factor | | |
| *3.* | Required Energy type | | |
| *4.* | Project Life (years) | | |
| *5.* | Design Life (years) | | |
| *6.* | Maximum Sound Level | | |
| *7.* | Design Blackout Duration | | |
| *8.* | Maximum Inactive Period | | |
| *9.* | Power/Energy Measuring Point | | |
| *10.* | Performance Warranty Period | | |
| *11.* | Minimum defective warranty period for all components | | |
| *12.* | Required Availability [%] | | |
| *13.* | Required Round Trip Efficiency (RTE) (BESS System-DC) | | |
| *14.* | Required Round Trip Efficiency (RTE) (BESS System-AC) | | |
| *15.* | BESS Programming language | | |

**Appendix 5: Buyer Provided Information**

Table 2: Performance Tests

| Item No. | Test | Acceptance Criteria | Notes |
|---|---|---|---|
| 16. | BESS Available Energy Capacity (AC) Performance Test: | Minimum BESS Available Energy Capacity (AC) = 90% of Target BESS Available Energy Capacity (AC) = [_____]<br><br>Guaranteed BESS Available Energy Capacity (AC) = 95% of Target BESS Available Energy Capacity (AC) = [____]<br><br>Target BESS Available Energy Capacity (AC) = [_____] | |
| 17. | BESS Available Energy Capacity (DC) Performance Test: | Minimum BESS Available Energy Capacity (DC) = 90% of Target BESS Available Energy Capacity (DC) = [_____]<br><br>Guaranteed BESS Available Energy Capacity (DC) = 95% of Target BESS Available Energy Capacity (DC) = [_____]<br><br>Target BESS Available Energy Capacity (DC) = [__] | |
| 18. | BESS Discharge Duration Performance Test: | Minimum BESS Discharge Duration = 90% of Target BESS Charge Duration = [_____]<br><br>Guaranteed BESS Discharge Duration = 95% of Target BESS Discharge Duration = [_____]<br><br>Target BESS Discharge Duration = [____] | |
| 19. | BESS Rated Continuous Power Performance Test: | Minimum BESS Rated Continuous Power = 90% of Target BESS Rated Continuous Power= [____]<br><br>Guaranteed BESS Rated Continuous Power = 95% of Target BESS Rated Continuous Power= [__]<br><br>Target BESS Rated Continuous Power = [_____] | |
| 20. | BESS Auxiliary Load Performance Test: | Maximum BESS Auxiliary Load = 110% of Target BESS Auxiliary Load= [____]<br><br>Guaranteed BESS Auxiliary Load = 105% of Target BESS Auxiliary Load= [____]<br><br>Target BESS Auxiliary Load = [___] | |

| | | | |
|---|---|---|---|
| 21. | BESS Round Trip Efficiency Performance Test: | Minimum BESS Round Trip Efficiency = 90% of Required Round Trip Efficiency (AC) = [_____]<br><br>Guaranteed BESS Round Trip Efficiency = 95% of Required Round Trip Efficiency (AC) = [___]<br><br>Target BESS Round Trip Efficiency = 100% of Required Round Trip Efficiency (AC) = [___] (refer to item 14) | |

**Appendix 5: Buyer Provided Information**

Table 3: Functional Testing[1][2]

| Item No. | Test | Pass/Fail Criteria | Notes |
|---|---|---|---|
| 22. | Self Discharge Rate (Per Section 6.2.1) | Self Discharge Rate @ 77˚F / 25˚C within +25/-100% of Eq. 6-15 /Eq. 6-17 | |
| 23. | Startup and Shutdown Time (Per Section 6.2.2) | Startup Time within +/-25% of $t_{startup}$<br>Shutdown Time within +/-25% of $t_{shutdown}$<br>(refer to Figure 6-10) | |
| 24. | Response Rise and Settling Time (Per Section 6.2.3) | Response Time within +/-25% of Equation 6-19<br>Rise Time within +/- 25% of Equation 6-23<br>Settling Time within +/-25% of Equation 6-20 | |
| 25. | Synchronization (Per Section 6.2.4) | Must demonstrate ability to Synchronize | |
| 26. | Harmonic Distortion (Per Section 6.2.5) | Must meet IEEE 1547 requirements | |
| 27. | Charge/Discharge Management (Per Section 7.1) | <u>Active Power Smoothing Methodology</u><br>System can receive, respond to, and dispatch the BESS in 1-second or less at the requested power within the specified tolerance of the dispatch signal measured at the Point of Common Coupling. (Refer to Section 7.1.7.1)<br><br><u>Frequency Regulation Methodology</u><br>System can receive, respond to, and dispatch the BESS in 4-seconds or less at the requested power within the specified tolerance of the dispatch | |

[1] Items within this table provide successful test criteria for Commissioning Tests defined in Energy Storage Integration Council's (ESIC) Energy Storage Test Manual (3002021710), Section Numbers Referenced refer to the Section of Test Manual.

[2] Buyer and Seller to agree on applicability of tests in this section, tests which are deemed not applicable shall be marked as such in the notes column.

| | | | |
|---|---|---|---|
| | | signal measured at the Point of Common Coupling. (Refer to Section 7.1.7.2) | |
| 28. | Peak Load Reduction (Per Section 7.2) | Successful demonstration | |
| 29. | Microgrid Resiliency for Emergency Conditions (Per Section 7.3) | Successful demonstration | |
| 30. | Load and Generation Following (Per Section 7.4) | Output must follow setpoint within +/-10% | |
| 31. | Low/High Voltage and Frequency Ride-Through Per Section 7.5) | Confirm settings per design | |
| 32. | Volt-VAR Regulation (Per Section 7.6) | Per pass criteria in 7.6.8 | |
| 33. | Autonomous Frequency Regulation (Per Section 8.1.1) | Result of Equation 8-2, Percent Difference is within +/-10% | |
| 34. | Autonomous Power Smoothing (Per Section 8.1.2) | Successful demonstration | |
| 35. | Price-Driven Control Functions (Per Section 8.1.3) | Successful demonstration | |

| | | | |
|---|---|---|---|
| 36. | Temperature Driven Control Functions (Per Section 8.1.4) | Successful demonstration | |
| 37. | Peak Power Limiting (Per Section 8.2) | Output tracks setpoint within +/-10% | |
| 38. | Black Start (Per Section 8.3) | Demonstrate black start capability – inverters function in grid forming mode and maintain load while setting frequency | |
| 39. | DER Settings to Manage Multiple Grid Configuration (Per Section 8.4) | Demonstrate that parameters are updated | |
| 40. | Maximum Generation Limit (Per Section 8.5) | Successful demonstration | |
| 41. | Other Smart Inverter Functions (Per Section 8.6) | Successful Demonstration | |
| 42. | Power Factor (Per Section 8.7) | Output tracks setpoint with +/-10% | |
| 43. | Monitoring and Scheduling Control Functions (Per Section 8.8) | Demonstrate parameters change | |
| 44. | Voltage Support (Per Section 8.9) | Successful demonstration, BESS follows the Volt/Var droop curve within +/-25% | |
| 45. | Overload Power (Per Section 8.10) | Successful demonstration | |

**Appendix 5: Buyer Provided Information**

Table 4: Application Types

| Item No. | Item | Value | Notes |
|---|---|---|---|
| 46. | Primary Application Type | | |
| 47. | Primary Operation days/year | | |
| 48. | Primary Cycles/day | | |
| 49. | Resting time before discharge (after fully charged) | | |
| 50. | Secondary Application Type | | |
| 51. | Secondary Operation days/year | | |
| 52. | Secondary Cycles/day | | |
| 53. | Resting time before discharge (after fully charged) | | |
| 54. | Tertiary Application Type | | |
| 55. | Tertiary Operation days/year | | |
| 56. | Tertiary Cycles/day | | |
| 57. | Resting time before discharge (after fully charged) | | |
| 58. | Quaternary Application Type | | |
| 59. | Operation days/year | | |
| 60. | Cycles/day | | |
| 61. | Resting time before discharge (after fully charged) | | |

# BESS BOT Scope Book
# Appendix 6
# Division of Responsibility (DOR)

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 5/19/2025 | All | Original Publication |
| 1 | 11/3/2025 | All | General Updates |
| | | | |
| | | | |

## Appendix 6: Division of Responsibility

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

| Ref. No. | Item | SELLER Responsibility | Scope Basis for SELLER | BUYER Responsibility |
|---|---|---|---|---|
| 1 | Equipment | | | |
| 2 | Battery and rack switchgear | S,E,I,C | Seller shall provide all external interface DC cabling to/from each BESS Enclosure. Internal BESS enclosure wiring within the BESS enclosures is furnished by the equipment OEM's. | — |
| 3 | BESS (including BMS) | S,E,I,C | Seller shall fully install the BESS Enclosures under the OEM Equipment Supply Contract. Installation includes all electrical, HVAC, fire protection, and foundation interfaces required by the OEM installation documents and specified by the Exhibit 1 – Scope Book. | — |
| 4 | ACC/DCC | S,E,I,C | The Seller shall design the DC collection system using a design philosophy typical for utility-scale BESS project in the United States. The DC collection system shall allow the power to be collected from the individual BESS enclosures, combined, and routed to the inverters, stepped-up in voltage and exported to the grid. | — |
| 5 | PCS | S,E,I,C | Seller shall fully install the PCS Equipment under the OEM Equipment Supply Contract. Installation includes all electrical, HVAC, and foundations interface required by the OEM installation documents and specified by the Exhibit 1 – Scope Book. | — |
| 6 | MVT | S,E,I,C | Seller shall fully install the MVT Equipment under the OEM Equipment Supply Contract. Installation includes all electrical, HVAC, and foundations interface required by the OEM installation documents and specified by the Exhibit 1 – Scope Book. | — |
| 7 | MV Switchgear | S, E, I, C | Seller shall provide and install Outdoor Switchgear necessary by Sellers detailed design to provide a means of disconnect between the PCS and the POI interface.<br>The switchgear shall be designed, manufactured, and tested in accordance with the latest IEC, ANSI, and NEMA standards. The MV and LV switchgear shall be of a design that has passed testing for arc-flash resistance according to Standard IEEE | — |

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

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|---|---|---|---|---|
| | | | C.37.20.7 or shall be provided with arc-flash mitigation if required.<br>The switchgear shall be adequately rated Per Appendix 2 of the Scope Book. | |
| 8 | BESS Plant Controller (and SCADA) | S, E, I, C | Seller shall install and commission Plant Controller (and SCADA) systems equipment per Exhibit 1 Scope Book Section 3.4. | — |
| 9 | Fiber conduit to POI | S, E, I, C | **Power** – Seller shall provide for allowance of [300 lineal feet of 6" conduit from the MV switchgear to the POI].<br>**Fiber** – Seller shall provide for allowance of [300 lineal feet of 2" PVC conduit to the POI]. | — |
| 10 | Fiber to POI Including Terms and Testing | C (support) | The Owner shall furnish and install fiber optic cabling from offsite to the POI. | S, E, I, C |
| 11 | Emergency Response Panel Interface | S, E, I, C | Seller shall provide and install one ERP measuring 4' wide x 5 feet tall x 1' deep (minimum). The ERP shall be installed on a 3' x 6' x 8" thick reinforced concrete pad with one 4" conduit dedicated for fiber communications cables and one 4" conduit dedicated for power cables.<br>Seller shall provide and install one area light fixture at emergency response panel. | — |
| 12 | Reserved. | — | --- | --- |
| 13 | Distribution Controller Interface to BESS SCADA | S, E, I, C | Excluded from EPC Contract | --- |
| 14 | Internet Access | S, E, I, C | Excluded from EPC Contract | --- |
| 15 | Auxiliary Power - Low voltage switchboard/transformers | S, E, I, C | Seller shall provide and install a complete LV auxiliary power system which shall include but not be limited to, 100% redundant auxiliary transformers and one low voltage switchboard. | — |
| 16 | Freight and Logistics to Site | S, E, I, C | Seller shall provide freight and on-site handling for all other equipment and material provided under the EPC Contract. | — |
| 17 | Site Work and Construction Management Services | | | |
| 18 | Structural foundations and anchoring for all equipment, panels, and enclosures | S, E, I, C | Seller shall provide reinforced concrete foundations for all BESS equipment, including but not limited to foundations for:<br>• BESS enclosures | — |

**Appendix 6: Division of Responsibility**

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

| | | | | |
|---|---|---|---|---|
| | | | • PCS<br>• MV Transformers<br>• MV switchgear<br>• Auxiliary Transformers<br>• LV distribution panels<br>• ERP – Emergency Response Panel<br>Concrete work shall, as a minimum, be designed, specified, and installed in accordance with applicable ACI requirements. Reinforced concrete structures and foundations shall be designed in accordance with the applicable provisions of ACI 318, "Building Code Requirements for Reinforced Concrete." Concrete work shall conform to the requirements of ACI 301, Specifications for Structural Concrete. | |
| 19 | Site/Safety and Equipment Identification Labels – NEC, Arc Flash, OSHA, and other code required labels for equipment and areas, as well as equipment identification | S, E, I, C | Seller shall apply all required labels to all equipment.<br>Instruction plates, nameplates and labels shall be provided for all items of the Plant giving particulars about rating, duty, size, model number, serial number and full information for identification and operation. Labels shall be of sufficient size to carry a full description of the Plant item and its complete identifier. | — |
| 20 | BESS Equipment Labels | S, E, I, C | Seller shall provide all required Labels to all BESS equipment, including ARC flash labels.<br>Instruction plates, nameplates and labels shall be provided for all items of the Plant giving particulars about rating, duty, size, model number, serial number and full information for identification and operation. Labels shall be of sufficient size to carry a full description of the Plant item and its complete identifier. | — |
| 21 | Trenching, Raceway, and Conduit | S, E, I, C | Seller shall provide raceways for all below grade cable in conduits or duct banks (use of direct buried cabling is prohibited). | — |
| 22 | External Interface - Power and Instrument Cable | S, E, I, C | Seller shall provide for all external cable and wiring of all BESS equipment, including but not limited to:<br>• DC cable and connections<br>• Auxiliary Power cable and connections | — |

**Appendix 6: Division of Responsibility**

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

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|---|---|---|---|---|
| | | | • FO communications cable and connections<br>• Fire protection devices (if required)<br>• Grounding connections | |
| 23 | Site grounding and lightning protection systems | S, E, I, C | Seller shall provide a site ground grid and lightning protection system. | — |
| 24 | Site Security Fence and Gate System | S, E, I, C | Seller shall provide and install perimeter security chain link fencing. Chain-link fencing shall be a 7-foot-high chain link fence with a 1-foot top guard (total 8-foot high) of three strands of nine-gauge barbed wire and designed to meet NESC and IEEE standards. Barbed wire shall be on arms oriented at 45 degrees facing up and outward. Fence posts shall be spaced no more than 8 ft apart, set in concrete finished no more than 2 inches above finished grade, and shall be grounded to meet NESC and IEEE standards. If any portions of the fence are located under transmission lines, they shall be isolated and grounded according to Utility requirements and NESC standards.<br>One 24’ Motor operated slide gate shall be provided by Seller at the plant entrance.<br>One area light shall be provided by Seller at the plant entrance gate.<br>Seller shall provide conduit and poles set at two-opposite corners of BESS site for Owner supplied security cameras. | — |
| 25 | Grading and Drainage (Construction and Operation) | S, E, I, C | The civil works, including grading and drainage, provided by Seller shall incorporate the following criteria:<br>• The size of the developed BESS Site shall be determined by Seller’s detailed design including OEM layout and equipment access requirements<br>• The minimum equipment setback criteria shall be:<br>  ○ 20’ between containers<br>  ○ 100’ to fence line to any BESS enclosure<br>  ○ 20 MW-Hr limitation on a single enclosure | — |

**Appendix 6: Division of Responsibility**

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

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| | | | • All equipment shall be on foundations twelve-inch (12”) freeboard above the 100-year, 24-hour rainfall event<br>• BESS site shall be lime or Geotech stabilized with minimum 4’ deep rock | |
| 26 | Roads (Temporary and Permanent) | S, E, I, C | Seller shall design and construct a permanent entrance road to BESS plant; the road shall be 24’ wide consisting of compacted gravel road to/from entrance tie-in at the existing Old Gentilly Road.<br>All roads shall be designed to sustain the maximum loads from the vehicles likely to use them during construction and throughout the life of the Plant, including articulated vehicles, material handling equipment and transporters used for the removal and replacement of major pieces of equipment. All materials used in the permanent construction shall be of good quality and shall conform to the relevant Codes and Standards. | — |
| 27 | Site Management during construction | S, E, I, C | Seller shall provide all on-site management during construction. | — |
| 28 | Construction Permits | S, E, I, C | Seller will be responsible for preparing, submitting, and securing all required site and construction-related permits. Seller will also be required to prepare and submit all site compliance certifications regarding work completion to applicable agencies (e.g., as-built certification of storm water management system, if required). | — |
| 29 | Onsite Utility Owner Coordination | S, E, I, C | Seller shall provide all on-site coordination and management of construction and commissioning activities related to utility requirements, including but not limited to temporary and permanent electrical power tie-ins, water tie-ins, and stormwater management. | — |
| 30 | Site Specific Environmental, Health and Safety Program and Reporting | S, E, I, C | Seller shall provide a comprehensive Site Specific Environmental, Health and Safety Program in accordance with all applicable laws and policies. | — |
| 31 | Start-up & Commissioning and Testing Program | S, E, I, C | Seller shall provide a Commissioning Plan to cover all Project scope including all labor, equipment, activities, tests, and procedures required to comprehensively execute the Commissioning Requirements. Commission | — |

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

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| | | | Plan and Requirements shall cover the Project apparatus, equipment, devices and auxiliary systems and their associated protection, control, and instrumentation schemes/systems required prior to energization, energization and phase-in activities, subsequent in-service checks and testing, and commissioning close-out. All equipment, devices, components, and materials specific to the Project shall be included. | |
| 32 | Coordination of interconnection and back feed power from the transmission system | S, E, I, C | Seller shall coordinate the interconnection and back feed power from the transmission system.<br>All proper protection systems shall be installed, including fusing, relaying and lightning protection, as applicable, to ensure the safe and reliable operation of the collection system. Collection system grounding shall meet all applicable codes, standards, and guidelines (including NEC) and shall ensure the safe and reliable operation of the collection system. | — |
| 33 | Temporary Power for Construction and Commissioning | S, E, I, C | Seller shall provide all temporary power needed for construction, commissioning, and testing of the Project or performance of the Work in each case or any portion thereof. | — |
| 34 | Temporary Facilities (Offices, Parking, Security, Water, Trash Disposal) | S, E, I, C | Seller shall provide all utility interconnections needed for construction, commissioning, and testing of the Project or performance of the Work in each case or any portion thereof (e.g., offices, security, parking, potable and non-potable water, wastewater, sanitation (including sewage), temporary power, telecommunications, broadband internet, and fuel). | — |
| 35 | Engineering, Design, and Project Management Services | | | |
| 36 | Project Administration and Management | S, E, I, C | Seller shall provide overall project administration and management for the Project. The Seller's management team shall be technically competent, shall be adequately trained, shall have a minimum of four (4) years of experience (unless otherwise mutually agreed) in the construction and startup of BESS Equipment. The Seller's team shall be present onsite during all construction and | — |

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

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| | | | commissioning work and shall instruct the Seller's construction and commissioning personnel in the proper construction, initial operation, and maintenance of the BESS equipment consistent with Prudent Utility Practice. | |
| 37 | Project Equipment and Material Management | S, E, I, C | The Seller shall provide a material management plan for all procured items, consumables and construction, installation, and commission works. | — |
| 38 | Permits/Business License | S, E, I, C | Excluded from EPC Contract | — |
| 39 | Landowner Coordination | S, E, I, C | The Seller shall take all reasonable measures to reduce the impacts of vehicular traffic and dust on the neighboring villages, towns, and businesses. | — |
| 40 | Seller proposed schedule and list of submittals for each of the Preliminary and Final Design Submittal phases. | S, E, I, C | The Seller shall perform the work in accordance with the project schedule. Seller shall provide Owner the overall Project schedule along with an approximate start date, major milestones, and durations for Seller's work. Seller shall furnish a construction schedule, in a format acceptable to Owner as part of the bid package and in accordance with the project schedule. Upon approval by Owner, the construction schedule shall become part of the Contract and may be revised only with written approval of Owner in the form of a contract change order. | — |
| 41 | Engineering and Design of the complete Project including As-Builts | S, E, I, C | The Plant shall have a design life of minimum of 20 years. All equipment shall have a design life at least equal to the plant design life unless otherwise specified or required by applicable codes, standards, and regulations.<br>All equipment supplied and Work by Seller shall be designed to ensure satisfactory and reliable operation under the full range of seismic and ambient conditions and under all Plant operating conditions and variation ranges specified. The Seller shall provide sufficient access around all equipment in accordance with good industry practices and OSHA regulations to allow for safe and effective operation, monitoring, maintenance, and removal. | — |
| 42 | 30%, 60%, 90% Design Packages for Review | S, E, I, C | Submission of all documents shall be in electronic format through a mutually agreed- | — |

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

| | | | | |
|---|---|---|---|---|
| | | | upon document manager. Documents shall be submitted for 30% design, 60% design, 90% design, issued for construction, and as built. A preliminary list of documents and drawings to be submitted to the Owner for review and approval is given below in the Submittals tab. The provided document list may not be inclusive of all documents that need to be submitted. The Seller shall be responsible for providing all documentation necessary to fully characterize the design, construction, and operation of the Plant. | |
| 43 | Project Document Preparation and Submittal | S, E, I, C | Seller is responsible for completing all engineering for the Plant. The Seller shall prepare and submit to the Owner for approval, general arrangement and detailed design drawings of the Plant and parts thereof; drawings shall be dimensioned and generally drawn to scale in accordance with good industry practice. A professional engineer of record in the state where the project shall be constructed shall seal all design drawings, specifications, and calculations. Drawings submitted shall comply with this Technical Specification, all applicable laws, regulations, and applicable permits. | — |
| 44 | Maintain Set of Red-lined IFC Drawings on Site | S, E, I, C | Seller shall provide to Owner 'Red-Lined' drawings with all 'as built' changes made by the Seller prior to Commissioning Team leaving site. A station copy shall remain in the Seller's trailer during the project phase and shall be stored in the substation control house once the Project is turned over to Owner as an accurate set for operations personnel. | — |
| 45 | Electrical Studies | S, E, I, C | Seller shall provide Electrical Studies specified in Section 6.2 of the Exhibit 1 Scope Book. | — |
| 46 | Protection and Control Relaying | S, E, I, C | After energization, Seller shall perform all relay phase in verifications shall be performed on all relays. This includes calculating expected magnitude and phase angles to compare to actual values. Phase in documentation shall be submitted upon successful verification. | — |
| 47 | Relay and Meter Programming | S, E, I, C | Seller shall inspect and test each protective relay in accordance with NETA-ATS section 7.9. | — |

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

| | | | | |
|---|---|---|---|---|
| | | | Seller shall program each device with the recommended relay settings provided by the engineer. | |
| 48 | Fire Protection and Detection Studies and Design Within BESS Equipment Enclosures | S, E, I, C | Excluded from BOP EPC Contract | — |
| 49 | Fire Protection System Outside BESS Equipment Enclosures, per AHJ Requirements | S, E, I, C | As required by AHJ Requirements | — |
| 50 | Geotechnical Engineering Investigation Report | S, E, I, C | The Seller shall provide the Geotechnical Report documenting the subsurface exploration of the site. The Geotechnical Report shall provide sufficient detail to adequately design all aspects of the Plant and shall be submitted to the Owner for review. All required geotechnical investigation(s) shall be carried out by personnel with specialized training and experience in soil mechanics and foundation engineering and are solely the responsibility of the Seller. The geotechnical investigation(s) shall be performed in accordance with relevant ASTM Standards. All geotechnical testing, analysis, evaluation, and design methodologies shall be published methods that are generally accepted. | — |
| 51 | ALTA and Topographical Survey | S, E, I, C | The Seller shall perform a survey suitable for establishing topographic mapping. The optimum Site elevation(s) for the most efficient and economical operation of the Plant shall be determined by the Seller and submitted to the Owner for approval along with detailed calculations on which the Seller has based its assumptions in determining the optimum level(s) and flood/drainage considerations. The Seller shall determine the final Site elevations during the detailed design of the Plant, and these shall be subject to the approval of the Owner. | — |
| 52 | Site Hydrology/Flood Study and Report | S, E, I, C | The Seller shall perform a Hydrology/Flood Study to identify storm water design recommendations to facilitate the design of stormwater requirements, including but not limited to detention ponds, grassy swales, and final grading. | — |

**Appendix 6: Division of Responsibility**

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

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|---|---|---|---|---|
| 53 | Lease, Site Control, Easements and Associated Agreements | S, E, I, C | Land Acquisition By Seller | — |
| 54 | Quality Assurance Program and Reporting | S, E, I, C | The Seller shall provide a quality plan and prepare inspection records for all procured items, consumables and construction, installation, and commission works.<br>Seller shall ensure that all material shall be new and of the proven quality and of the class meeting standards and purpose specified and shall withstand the variations of ambient conditions and other transient and abnormal working conditions within specified limits without distortion or deterioration or the setting up of undue strains in any part, such as to affect the efficiency and reliability of the Plant, and also without affecting the strength and suitability of the various parts for the work performed. | — |
| 55 | Project Controls Program and Reporting | S, E, I, C | Seller shall provide a Project Controls Program (schedule, commodity curves, etc.) upon which the Seller will execute the work.<br>Seller shall provide adequate methods and tools for budget control, scheduling, tracking, trending, and reporting of work in progress for the engineering, procurement and construction activities related to the Project. | — |
| 56 | Operation & Maintenance Manuals (excluding Owner provided equipment) | S, E, I, C | The Seller shall furnish to the Owner Operations & Maintenance Manuals for all equipment provided under Contract. | — |
| 57 | BESS Training | S, E, I, C | Excluded from EPC Contract | — |
| 58 | Balance of Plant and Substation Training | S, E, I, C | Seller shall provide a Training Plan for operation and maintenance of all Balance of Plant systems and equipment. | — |
| 59 | Emergency Response Plan (ERP) including furnishing and installing specified signage, literature, MSDS, etc. as required in accordance with the ERP. | S, E, I, C | Seller shall provide an Emergency Response Plan (ERP). The ERP shall establish procedures in place to prepare for and respond to an emergency at the BESS Project. The Plan delineates emergency response<br>responsibilities of personnel and identifies mutual aid resources available by off-site responders.<br>The plan identifies training provided to site personnel in responding to emergencies and | — |

Key: Supply (S), Engineering (E), Installation (I), Commissioning (C)

| | | | | |
|---|---|---|---|---|
| | | | identifies drill procedures and incident investigation procedures. | |
| 60 | Hazard Mitigation Analysis (HMA) | S, E, I, C | Seller shall provide a Hazard Mitigation Analysis in accordance with the requirements of IFC (2021). Seller shall adhere to any additional HMA requirements specified by NFPA 855 2023 Edition. | — |

# BESS BOT Scope Book
# Appendix 7
# Cyber Security Plan

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 5/19/2025 | All | Original Publication |
| 1 | 11/3/2025 | All | General Updates |
| | | | |
| | | | |

## Appendix 7: Cyber Security Plan

This CYBER SECURITY PLAN is broken into four sections.

- **Section 1 – Developer Scope of Work:** These are the items that shall be required before the site if fully handed over.
- **Section 2 – System Security Plan Template:**– Utilized by the Seller. This section provides a starting point on the Buyer's philosophy and overall design. They Seller can modify to their liking.
- **Section 3 – Project Appendix A(Security Controls) and B (Baseline Testing):** This is guidance on how the Buyer could audit the sites (regulatory and non-regulatory) once put into operation. The Seller is not strictly held account to these but the purpose is to inform them so they can understand the Buyer's desires.
- **Section 4 –Project Workbook Template:** This template provides guidance on how to maintain tracking to the plan, IP configuration of the site, and aids in delivery of inventory.

# Section 1 – Developer Scope of Work

This appendix describes the IT and Security deliverables that the Seller will provide to the Buyer. This information will be developed and delivered throughout the execution of the project. This information will be managed the Buyer.

| Deliverable | Project Phase | Artifact |
|---|---|---|
| Security Plan | Prior to Mechanical Completion | Derived from Entergy Template, submitted, approved and stored by project management |
| Physical Drawing (Fence, gates, lock locations) | Prior to Mechanical Completion | Autcad, KMZ |
| Inventory with Attributes (Password, Firmware Rev,Log Locations, Firewall Rules, Backup/Config, Manual etc) | Prior to Substantial Completion | Entergy Provided Project Workbook |
| Patch Attestation <35 days | Prior to Substantial Completion | Email referencing Entergy Provided Project Workbook |
| EAC IOT Device Identification and Rationalization Attestation<br>No LTE Modems behind the EAC Firewall<br>Zigbee<br>Wifi<br>Loran<br>Bluetooth | Prior to Substantial Completion | Email stating that the Security Plan section 2.3.3.4 is accurate. If any deviations exist they must be requested and accepted prior to acceptance. |
| No LTE Behind MSS FW Attestation | Prior to Substantial Completion | Email stating that there is no LTE Behind MSS FW |
| Equipment Backups/Configs<br><br>Control Building (located inside Collector Substation Fence)<br>Server Equipment including VMware<br>PPC<br>SCADA Systems<br>Relays<br>Substation RTU<br>Firewall<br>Switches<br>Serial to Ethernet Converters<br><br>BESS Yard Equipment<br>Batteries<br>Enclosure<br>Inverter<br>Remote Shutdown Panel | Prior to Substantial Completion | Secure Offsite location reachable by project team for bulk download.<br><br>Format of each deliverable is variable but based on best practice based on device type. This can include file backups from the source system to a document providing guidance on how to configure the platform. A few examples include:<br><br>SEL Relay → RDB<br>VM→Snapshot<br>PLC→ company format |

## Appendix 7: Cyber Security Plan

| Deliverable | Project Phase | Artifact |
|---|---|---|
| Miscellaneous | | |

## Section 2 - System Security Plan TEMPLATE

# Site Name Here

# City, State

# System Security Plan (SSP)

| | |
|---|---|
| CM Version | **1.0** |
| Date Issued | |
| Author | **Robert Lewis** |
| Program Manager | **Entergy Program Manager Name Here** |

# Appendix 7: Cyber Security Plan

**Approvals**

| Name | Position | Signature | Date |
|---|---|---|---|
| | Manager, Security Architecture | | |
| | Sr. Security Solution Architect | | |
| | Power Delivery Program Manager | | |
| | Project Asset Manager | | |
| | ROCC Director | | |
| | Sr. Manager Risk Advisory Services, CSO | | |
| | Director Regulatory Compliance IS | | |

**Revision History**

| Date | Version | Summary of Changes | Owner |
|---|---|---|---|
| 11/6/2022 | 0.1 | Initial Document Template | Robert Lewis |
| 10/15/2024 | 1 | Changed watermark from Draft to Template | Robert Lewis |
| | | | |
| | | | |

**File Location**

This document can be found at the following location:

This document is stored in Share Point under the project documents library.

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# 2. Introduction

## 2.1. Purpose of this document

The purpose of this document is to describe the System Security Plan (SSP) for the [Project Name] site. Per the scope book *"Seller shall design, build, and deliver a cyber security system and plan for the Project that conforms to applicable NERC CIP rules, regulations, standards, and Laws. Buyer shall provide Security Controls that will be required to be tested prior to site acceptance. Seller shall develop and provide to Buyer a cyber security plan that includes accommodations to test the defined security controls."*

Project sites are very large in size but require very few people to manage. Facilities at Entergy range in size from 500kw to over 100+ MWs in output power connecting from residential primary, 13.8 kv distribution voltages, to transmission interconnect voltages. The size of the physical sites ranges from less than 1 acre to more than 1,000 acres. Facilities are distributed throughout the Entergy service territory in densely populated metro as well as rural areas. Due to these varying configurations the Information Technology (IT), Operational Technology (OT), and security requirements vary.

It is understood that the Lifecycle of a Project Site (Design, Build, Transfer of Ownership, and Operation) are not always the same entity. This SSP defines the agreed to overall cyber architecture for the site in a manner that is necessary and sufficient for readers to understand how the site is to be configured and operated, the key security components of this system, ensuring upon delivery the site can be compliant with the Entergy Security Policies and NERC CIP Requirements.

Seller submits this plan acknowledging the collaborative effort that was required with Buyer with the expectation the Entergy Operational Run Team can meet the Entergy defined controls.

## 2.2. Scope

This document covers the Project site physical perimeter and electronic systems provided by Seller to Buyer.

# 3. Audience

The audience of this document is information technology/security professionals and organizational risk acceptors at Entergy who are looking for security-specific information regarding this system and context for how it is designed, deployed, and secured.

# 4. Requirements

The following sections describe the various requirements that Entergy has identified and that this System Security Plan addresses via direct delivery or by providing the capability to the Entergy Operational Run Team to readily deliver where technically feasible.

## 4.1. Business Requirements

Below are the general business requirements that shall be present and further defined in the Reference Architecture and Use Cases in Sections 6 and 7. These include:

- Site inventory with required information for site delivery and management by Entergy Operational Run Team
- Location of inventory
- Design that supports 3rd party access from 3rd parties to perform site operations and remote support
- Data exfiltration to defined cloud providers
- Connection back to Entergy systems that may include PI, SCADA, MV-90, Enterprise Ignition, etc

## 4.2. Risk and Compliance (NERC Designation)

The purpose is to identify and categorize BES Cyber Systems and their associated BES Cyber Assets for the application of cyber security requirements commensurate with the adverse impact that loss, compromise, or misuse of those BES Cyber Systems could have on the reliable operation of the BES. Identification and categorization of BES Cyber Systems support appropriate protection against compromises that could lead to mis-operation or instability in the BES.

Seller and Buyer have worked jointly to determine the CIP-002-5.1a -Cyber Security-BES Cyber System Categorization of “CIP Low” and have proceeded with all design and implementation of the site design and implementation with that determination.

## 4.3. Regulatory Compliance Requirements

Entergy has reviewed this Cyber Security Plan for approval to ensure that the delivery of the site addresses the following Regulatory Compliance Requirements and internal policies and procedures, and they are able to be met when put into production.

- CIP-002-5.1a -Cyber Security-BES Cyber System Categorization.
- Annual Process to the O&M operator
- CIP-007-5
- CIP-003-8
- Cyber Security Awareness Procedures- Entergy’s Program
- Physical Security Controls- Entergy’s Program
- Electronic Access Controls-Entergy’s Program
- Cyber Incident Response – O&M Operator
- Transient Cyber Assets and Removable Media Refer to RASCI
- CIP Exceptional Circumstance Process (e.g. controls have failed and an exception to above procedures)

## 4.4. Entergy Security Policy and Procedure Requirements

Entergy maintains a series of Policies that shall be implemented for the environments that have Entergy data and or capability to affect its operations. Seller has consulted with Buyer throughout the process to ensure compliance or future ability to comply with buyer's internal policies upon delivery. The assessment and enforcement of these policies is not the Seller's responsibility. Below are the Entergy items that Buyer has reviewed this plan against:

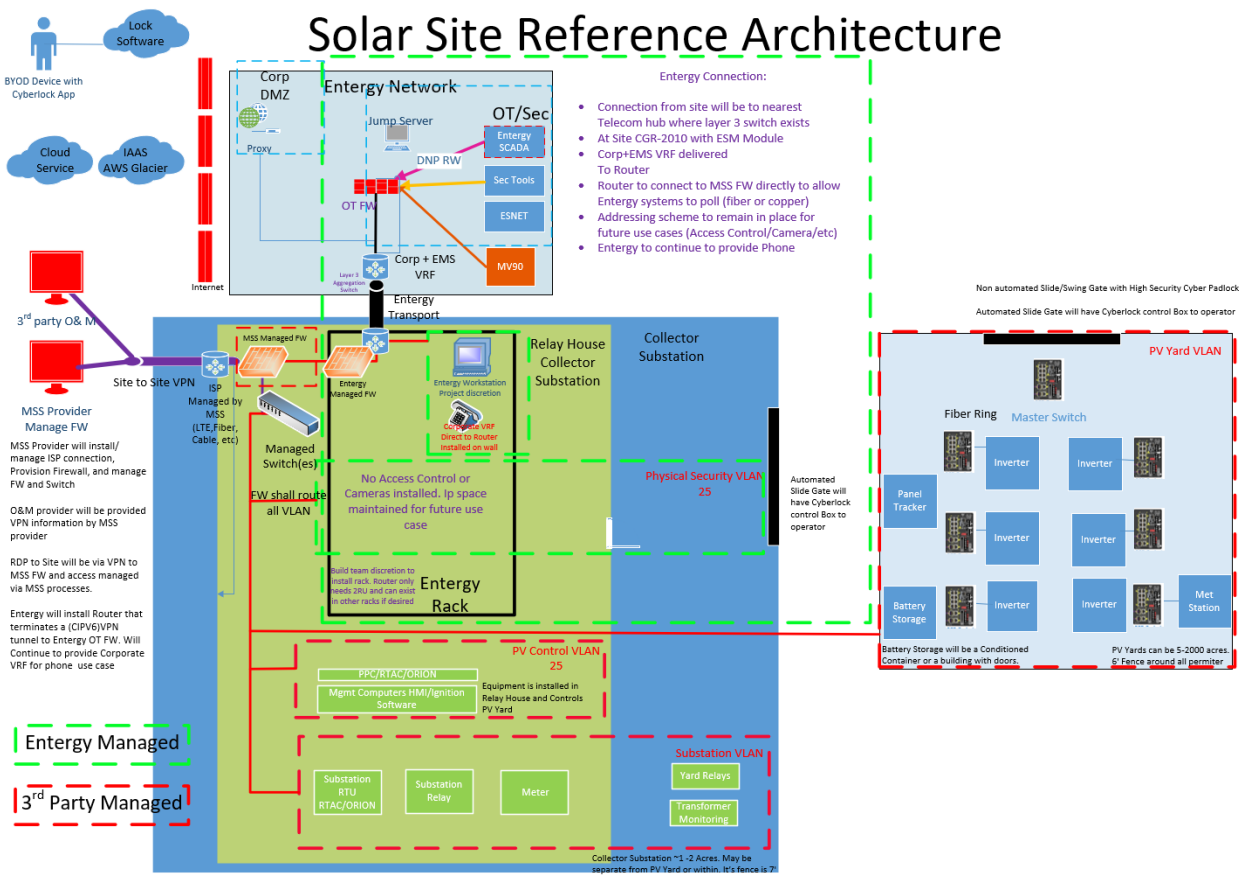
- Protection of Information
- Vulnerability Management
- Asset Management
- User Identify & Access Management Policy
- Network Segmentation
- Patch Management
- Physical Security
- Security Continuous Monitoring
- Cloud Security

# 5. Architecture

Text goes here.

# 6. Entergy Reference Architecture

The Project Site Reference Architecture (an example for Solar below) provides the framework in which a project shall be architected and executed against through the lifecycle of the facility. This includes the design, build, and operation of the facility as it relates to the IT, OT, and Security groups. Overall requirements are driven by various factors requirements as described above.




Seller agrees to review the reference architecture and implement design that meets the reference architecture use cases and underlying security controls where applicable that will be required upon commissioning. The information used and results of the coordination and outcome shall reside in this section.

The Solar Site Reference Architecture represents the high-level overview of the Project site and systems that are typically present at a facility. This drawing is used to facilitate the various discussions around how the site is configured and addresses the requirements as described above.

The drawing represents the primary focus areas, Collector Substation and PV Yard, where both physical and electronic design considerations are made but also addresses how the site connects to the various networks. The decisions in regards to network design and VLAN designation is further elaborated below and memorialized in the inventory artifact.

This site does not contain any Battery Storage devices (BESS) and is an artifact of the reference architecture provided by Entergy.

# 7. Use Cases to Support

Entergy has requested that the site shall support the various use cases as described below. Entergy has provided this as a way to discuss and solution the various interaction. Seller has reviewed with Entergy the applicable use cases to support in delivery of the site. Of note are:

Interface 3,4, and 5 represent SCADA Interfaces. A SCADA Edit sheet has been agreed to by the parties represented by SCADA Edit Sheet artifact.

Interface 7 MV-90 Use Case: there will be no need for MV-90 to read any meters at the site as that is accomplished with a meter in the adjacent substation.

Interface NOTES

Each Interface is a connection on a specific IP and Port over dedicated fiber path which will require FW rules when Entergy takes over.

Interface #1: O&M Operator utilizes defined VPN approach. Preference is Scenario #3.

Interface #2: These communications will leave via proxy or approved storage connection at Entergy. Proxy connections to cloud will exit via CORP VRF. This will require a FW rule with a static route. HTTPS Required.

Interface #3: Serial Connections over Dark Fiber

Interface #4: PI Data will include specific site data wishing to be stored in historian

Interface #5: MISO connection has 2 potential patterns: 1. MISO→GMS→ Solar site Direct or 2. MISO→GMS→ Interface #3 RTU directly or from EMS SCADA.

Interface #6: Security Tools will be deployed as needed. To date no AD integration or other tools to be deployed.

Interface #7: MV-90 will poll POI metering devices as required.

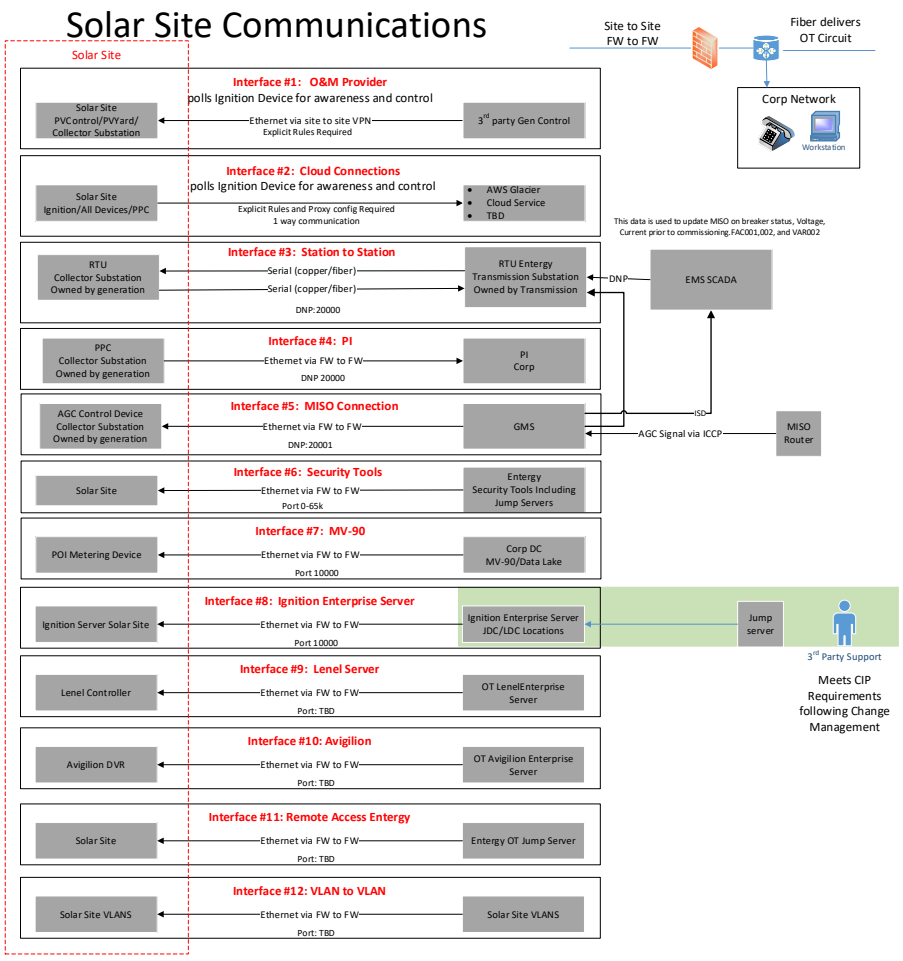
Interface #8: Ignition Enterprise Server will connect to the site and pull information back. Maturity over time will provide more control to Entergy. This includes camera feeds into the tool.

Interface #9: Lenel Server opens and closes doors

Interface #10: Avigilion Enterprise Server allows connection to the local NVR. When requested video recordings are uploaded to the Avigilion Enterprise Server.

Interface #11: RDP/SSH from Entergy OT server to 3rd party managed devices.

Interface #12: VLAN to VLAN. This allows all VLANS at the site to communicate. Explicit FW rules are required to enable this.




# 8. Design Discussion and Mapping to Requirements:

The below sections will describe the design. Each section will provide a quick reference to the sections of the Security Controls Appendix that they map to. It is understood that all controls in the Security Controls Appendix will not map to a specific deliverable of Seller. These references are typically after the header and may have headers such as PSC or EAC.

## 8.1. Project Information

The Seller shall provide a general description of the site. This includes the physical location, the applicable project parameters, etc. Other information about the project that may materially affect the SSP and its alignment with the Reference Architecture. In this section the Seller is providing the relevant information as it applies:

| | |
|---|---|
| **1.1** | Project Name(s) (Common) |
| **1.2** | Project Legal Entity Name (if different) |
| **1.3** | Project Type |
| **1.4** | Project Legal Address |
| **1.5** | Project E911 Address or GPS coordinates |
| **1.6** | Does this Facility require NERC registration? |
| **1.7** | Project NERC Compliance Registry Number (NCR # - If Applicable) For the avoidance of doubt, Buyer will be responsible for registering site with NERC and obtaining the Compliance Registry Number. |
| | |
| **1.8** | Are there multiple phases to this project? |
| **1.9** | Substantial Completion Date, if applicable |
| **1.10** | Commercial Operation Date, if applicable |
| **1.11** | MW/MVA |
| **1.12** | BESS (Battery Energy Storage System) Substantial Completion Date, if applicable |
| **1.13** | BESS (Battery Energy Storage System) Commercial Operation Date, if applicable |
| **1.14** | MW/MVA |

## 8.2. Physical Security Design

Seller has provided a physical security design as part of the requirements of the agreed to Scope Book. The site has a regulatory requirement CIP LOW which requires definition of a physical security plan. The combination of permitter fencing and locking of devices is the foundation of the physical security plan. This primarily includes Fencing and Gates as part of the permitter control. The following shows a map of the site. The site is located at the following coordinates AB°CD'EF.7GH"N, AB°CD'EF.GH"W with a physical address of Physical Address. The Fence and Access Control of the physical security solution is further defined below. For the avoidance of doubt, the perimeter fence is provided and installed by the Seller and the gate locks are provided and installed by the Buyer.

Seller has agreed per BOT scope book XYX to provide a map in both CAD and KMZ file to Buyer of all fences, gates, equipment locations including locations with electronics with connectivity (ethernet) to

Seller prior ot Substantial completion. This artifact is in the list of delivery items that will be provided prior to Substantial Completion.

### 8.2.1. Fence and Gates:

The site design calls for a fence that will comply with section 3.2.11 of the BOT scope book. The location of the fencing, gates, and operators are shown in the CAD and KMZ files provided.

For the avoidance of doubt, the perimeter fence is provided and installed by the Seller and the gate locks (padlocks) are provided and installed by the Buyer after substantial completion.

### 8.2.2. Physical Access Control

As a point of reference Entergy has a robust system utilizing a combination of Lenel System for Substations and select gates and Cyber Lock System for locations that are not technically or economically feasible. The following sections will describe the utilization of each. For the avoidance of doubt, the perimeter fence is provided and installed by the Seller and the gate locks are provided and installed by the Buyer at or about Substantial Completion.

Seller has worked with Entergy to understand their desires with regards to Access Control to the physical site and their desire to have a margin of compliance by further locking electronics devices inside the physical permitter on identified devices. This includes inverters, substation, weather stations, etc. This is above and beyond a typical CIP Low Physical security but agree it is a best practice and is able to be document and deliver in compliance with Lock Locations as described in BOT (section 3.9-3.12). Some devices are not technically feasible to lock including the Inverter platform. Seller has worked with Buyer to identify such cases and reflect appropriately on the delivery KMZ and CAD Deliverables.

It was agreed that during the build and up to Substantial Completion the Seller Access Control system will be used at which point a transition to Entergy managed system will be put into place.

#### 8.2.2.1. Lenel System (Connected via Network)

*PSC-01, PSC-02, PSC-05*

Entergy has a corporate access system that connects to doors and allows use of company provided identification cards to open doors. The system is typically installed in office and high value operational sites such as substations. Entergy has chosen not to use Lenel at the xxxx Site and will connect a lock as described in section 2.3.2.2.2

Per the scope book an electronic door system was to be provide. It has been determine that the Lenel or equivalent is not to be installed and only the conduit to implement automated gate controls and door access solutions to the Relay house will be fitted but nothing installed.

#### 8.2.2.2. Electronic Lock System (Non-Connected)

*PSC-01, PSC-02, PSC-05*

Entergy has a robust lock program defined for non-digitally connected physical sites. The program is based on a digital lock product with various form factors that support many different lock use cases. It provides an advanced system that allows for electronic controlled access controls with logging versus a brass key program. This includes padlock style, Puck Lock, and classical cylinder-based locks. Entergy has advised that the physical permitter and selected components will be secured using Entergy provided Digital locks after substantial completion Entergy has a pre-existing relationship with reseller who defines, sells and installs the required digital locks at the site.

Seller has reviewed with Entergy the physical security layout drawing that indicates the location where installations will occur and has worked on locations that do not have a drop in lock solution. . This is in compliance with Lock Locations as described in BOT (section 3.9-3.12). These locations include gates, any device with ethernet, and substation buildings. Seller will provide to Entergy “Artifact name” by “Agreed upon date” so that Entergy may timely procure and schedule installation after substantial completion.

Review of layout drawing will submitted by Seller 2 months prior to Substantial Completion. Buyer will provide timely feedback.

### 8.2.3. Cyber Asset Management

The below requirements are what the seller will provide prior to SC. Entergy has provided an example Spreadsheet, Appendix A and Appendix B to aide in the delivery of these requirements.

#### 8.2.3.1. Inventory

*EAC-01*

A full inventory of all physical and cyber assets will be included in the Master Spreadsheet.

Asset management is a foundational item in the execution of the cyber security plan. Seller will provide in separate artifact containing a full inventory of all digital/cyber assets at the site. This has coordinated with Entergy and has decided to include all inventory on a Master Spreadsheet that contains all of the inventory by name, description, firmware/software revision, IP address, and user IDs,Passwords, Logging Configuration, TVM, and location to configuration and for each device type will have at a minimum the OEM manuals. This includes all electronic equipment inside of the Substation permitter including substation and Project Site control equipment. Seller has worked on an agreed upon format that aligns the hardware and software assets with the IP inventory as defined. Specifically in alignment with the Security Controls Entergy will test the O&M provider against the system delivered will comply with the following:

| VLAN INFO | | | | SUBNET INFO | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ID | VLAN Name | VLAN Description | Subnet | Mask | Inverse Mask | Subnet | Address Size | Host Range | Broadcast |
| 1450 | XYZ-OTNET | OTNET | 10.ABC.DEF.0 | 255.255.255.248 | | /29 | 8 | | |
| 1455 | XYZ-OTN-MGMT | OTNET Management | 10.ABC.DEF.8 | 255.255.255.248 | | /29 | 8 | | |
| 1454 | XYZ-PROD-NON-ESP | Entergy Substation VLAN | 10.ABC.DEF.16 | 255.255.255.240 | | /28 | 16 | | |
| 1453 | XYZ-FAC | Physical Security VLAN | 10.ABC.DEF.32 | 255.255.255.224 | | /27 | 32 | | |
| 1457 | XYZ-SOLAR-SUB | 3rd Party Substation VLAN | 10.ABC.DEF.64 | 255.255.255.224 | | /27 | 32 | | |
| 1458 | XYZ-PV-CONTROL | PV Control VLAN | 10.ABC.DEF.96 | 255.255.255.224 | | /27 | 32 | | |
| 1459 | XYZ-PV-YARD | PV Yard VLAN | 10.ABC.DEF.128 | 255.255.255.128 | | /25 | 128 | | |
| Entergy Specified | | | | | | | 256 | | |
| Seller Specified | | | | | | | | | |

Site Name: Solar Site XYZ

| IP | Mask | Vlan | VLAN Name | Description | Additional Notes | Physical Location | Firmware Revision | Device Type | ID | Password | Logging | TVM | Config Link | Manual Link |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.ABC.DEF.64 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | Network | 3rd Party Substation /27 | | | | | | | | | |
| 10.ABC.DEF.65 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | FW | VRRP | | | | | | | | | |
| 10.ABC.DEF.66 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | XYZFWAP4001 | Firewall | | | | | | | | | |
| 10.ABC.DEF.67 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | XYZFWAP4002 | Firewall | | | | | | | | | |
| 10.ABC.DEF.68 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | | | | | | | | | |
| 10.ABC.DEF.69 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | | | | | | | | | |
| 10.ABC.DEF.70 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | | | | | | | | | |
| 10.ABC.DEF.71 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | | | | | | | | | |
| 10.ABC.DEF.72 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | RTU (OrionLX) | | | | | | | | | | |
| 10.ABC.DEF.73 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | COMM 1 (OrionLX) | | | | | | | | | | |
| 10.ABC.DEF.74 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | Meter (SEL-735) | | | | | | | | | | |
| 10.ABC.DEF.75 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 87T1P (SEL-487E) | | | | | | | | | | |
| 10.ABC.DEF.76 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 87T1S (SEL-3311A) | | | | | | | | | | |
| 10.ABC.DEF.77 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 87L1P (SEL 411L) | | | | | | | | | | |
| 10.ABC.DEF.78 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 87L1S (SEL-411L) | | | | | | | | | | |
| 10.ABC.DEF.79 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 50-51/F1 (SEL-751A) | | | | | | | | | | |
| 10.ABC.DEF.80 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | RTU-NTIO1 (Orion I/O) | | | | | | | | | | |

### 8.2.3.2. Authentication

*EAC-17, EAC-18, EAC-19, EAC-20, EAC-21, and EAC-22*

Seller will provide all username and passwords to digital assets where default passwords have been changed. This information will be included in the Asset Inventory as described in 2.3.3.1.1.

### 8.2.3.3. Logging

*EAC-15 and EAC-16*

Seller will Identify the source of logs on all systems and provide as part of the handoff. This includes logs that are created native to the equipment or installation specific. Include location and available methods for extraction (syslog, Database Query, etc). This can be met with a link to documentation that provides this information in the asset list or may be included in operations manual.

### 8.2.3.4. Patch Management

*EAC-10, EAC-11, EAC-12, and EAC-13*

Seller shall be responsible for patch management of the devices that they manage until substantial completion. Seller attest via the Device inventory handoff that no published CVEE over 35 days exists. If there are any exceptions seller shall inform Entergy and agree to a mitigation plan.

### 8.2.3.5. Backup

*EAC-22*

Seller has provided as part of the Inventory the configuration file, backup file, or configuration guide for identified assets. It is understood there are certain systems where this is not achievable. If so, seller will describe which pieces of equipment and point them to the RISK section to describe. It is understood that this will evolve over time but will be complete prior to SC.

### 8.2.3.6. Segmentation Strategy

*EAC-17, EAC-18*

Entergy provided Seller a high-level reference architecture. The architecture described a segmentation strategy that shows various sections of the plant to be logically segmented and routed via a local firewall with defined rules for enforcement. Seller has gained agreement with Entergy on the segmentation strategy for site and Buyer has provided the network vlan definition for ease of integration into Entergy network. Seller will configure and route the segments via the MSS Firewall (Seller provided) for distribution onto the managed switches. Make a reference to Spreadsheet?

### 8.2.3.7. Firewall

*EAC-04, EAC-17, EAC-18,*

The Solar Reference Architecture has two firewalls installed back-to-back. There is an Entergy Corporate Managed Firewall and a Managed Security Service (MSS) Firewall. The Entergy Corporate Firewall will be installed prior to substantial completion to ensure all end to end acceptance testing is able to be performed. The MSS Firewall make, model, and features was mutually agreed to by Entergy and Seller and was installed as part of the build process. As part of the engagement Seller configured the MSS firewall to communicate via a public telecom circuit of their choosing. This was set as the default gateway and is where all primary traffic for the site is to be routed. This allowed Seller to configure the MSS firewall to readily communicate with the site during the build process and allows Entergy MSS provider to perform on boarding with nominal changes to configuration to quickly facilitate transition from Seller to Buyer.

The MSS Firewall will be additionally configured to allow communications to and from the Entergy Firewall. Entergy will provide a firewall ruleset that was mutually agreeable by both parties that would allow systems such as Entergy's PI Historian, various RDP Servers, Security tools, and Ignition Enterprise System to communicate with the site.

The firewall will be configured to only allow defined firewall rules utilizing the segmentation as described in the Segmentation section below. Between each segment Explicit firewall rules were written where interactions between each segment where required. Those rules are shown below.

| Interface Name | Source | IP | Destination | IP | Port | udp/tcp | Service | Description |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
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Table ABC: Example Firewall Rules

#### 8.2.3.8. Wireless IOT Protocols

The use of IOT protocols are typically defined as non-wifi protocols and offer an ability for the devices to be deployed and managed at a low cost. Each can be deployed securely if configured correctly. IOT protocols create an opportunity for an EAC and potential violation if not configured correctly. The following sections provide the context in which they are used at these sites.

##### 8.2.3.8.1. Zigbee Wireless

*EAC-04*

The use of Zigbee at the Project sites is fairly typical for control of Arrays.

Explanation of Zigbee at the site is required including use case and the technical security configuration. If no Zigbee is present at the site the following is adequate: Seller confirms this site contains no Zigbee as all controllers are… .

##### 8.2.3.8.2. LoRa

*EAC-04*

The use of LoRa is becoming more popular at Project sites by some manufactures of trackers and is the method used to communicate between controllers in the PV Yard.

Explanation of LoRa at the site is required including use case and the technical security configuration. If no LoRa is present at the site the following is adequate: Seller confirms this site contains no LoRa as all controllers are… .

##### 8.2.3.8.3. Bluetooth

*EAC-04*

The use of Bluetooth is becoming more popular at Project sites. Specifically connecting to inverters and tracker control units in the PV Yard. Blue tooth introduces a TCA risk as many of the use cases involve the techs connecting from Ipads or phone devices creating a TCA risk.

Explanation of Bluetooth at the site is required including use case and the technical security configuration. If no Bluetooth is present at the site the following is adequate: Seller confirms this site contains no Bluetooth as all controllers are… .

### 8.2.3.9. Cellular/LTE At Site

*EAC-04*

The use of a cell modem as a WAN link (connected to the WAN interface on the MSS firewall) for either primary and/or back up WAN connectivity is expected and acceptable.

Project sites have a history for equipment manufacturers installing/embedded cell(LTE) modems within equipment in the PV Array that create an Electronic Access Point Concern. Seller guarantees that no Cellular/LTE modems or equivalent will present at the site beyond the one connected to the MSS firewall. If any other LTE modems are found Entergy will be notified and they will be physically removed from the devices prior to Substantial Completion.

### 8.2.3.10. VLAN Segmentation

*EAC-03, EAC-04, EAC-05*

The overall segmentation strategy has been normalized by Entergy. All Project sites will be segmented in the same convention as described by Entergy. Seller has coordinate with Entergy Data Network Team to identify the VLAN, VLAN Segment and Addressing that is acceptable to Buyer. Seller received the Segment in Table 1 and has deployed the XYZ-Project-SUB, XYZ PV-CONTROL, AND XYZ PV-YARD segments (Green) back to Buyer.

| VLAN INFO | | | SUBNET INFO | | |
|---|---|---|---|---|---|
| ID | VLAN Name | VLAN Description | Subnet | Mask | Invers |
| 1450 | XYZ-OTNET | OTNET | 10.ABC.DEF.0 | 255.255.255.248 | |
| 1455 | XYZ-OTN-MGMT | OTNET Management | 10.ABC.DEF.8 | 255.255.255.248 | |
| 1454 | XYZ-PROD-NON-ESP | Entergy Substation VLAN | 10.ABC.DEF.16 | 255.255.255.240 | |
| 1453 | XYZ-FAC | Physical Security VLAN | 10.ABC.DEF.32 | 255.255.255.224 | |
| 1457 | XYZ-SOLAR-SUB | 3rd Party Substation VLAN | 10.ABC.DEF.64 | 255.255.255.224 | |
| 1458 | XYZ-PV-CONTROL | PV Control VLAN | 10.ABC.DEF.96 | 255.255.255.224 | |
| 1459 | XYZ-PV-YARD | PV Yard VLAN | 10.ABC.DEF.128 | 255.255.255.128 | |
| Entergy Specified | | | | | |
| Seller Specified | | | | | |

Table 1: VLAN Definition and Address space Default VLAN configuration

### 8.2.3.11. Managed Switches

*EAC-03, EAC-23*

The Project site consists of many switches. The VLANs that consist as part of the segmentation policy will be delivered by the firewall and assigned physical ports on the managed switches. This may consist of 1 or many ports that connects to downstream switches. The switch shall follow the normal configuration that no VLAN to VLAN communications occur on the switch but are routed via the Firewall and if allowed via ruleset are then routed back to the managed switch.

#### 8.2.3.12. Remote Access

*EAC-04, EAC-05,EAC-08, EAC-09*

Interactive remote access is a key element to performing the O&M function of the site. There is a need to connect to the site and manage the devices. The design supports various patterns to accomplish this task either from a 3rd party separate to Entergy or from within Entergy. The MSS firewall has been configured with a site to site VPN with defined source and destination addresses during the build process. Upon competition Entergy will be able to configure the firewall to allow connections from trusted parties in a similar manner as well as configure the MSS firewall to allow further connections from the Entergy managed firewall.

# 9. Security Controls and Testing

The security control baseline is based upon the guidance in *CIP-003-8 – Cyber Security – Security Management Controls*

As this is more closely aligned to a Low Impact asset there are minimum controls. However, in line with best practices the site design and delivery has more restrictive controls capabilities that allow alignment with best practice and Medium CIP site and applicable Entergy controls, where financially and operationally feasible.

Buyer by acceptance of this document acknowledges Seller has provided a security Plan/Design that allows/enables the identified Security Controls in Appendix A and Test in Appendix B to to be met by Buyer or its assigned provider at COD.

# 10. Controls

Appendix A has been provided by Entergy as a requirement to be met by the responsible party (Entergy Operational Run Team) and list each of the discrete security controls in each of the following sections that shall be tested by the Entergy Operational Run Team.

1. Cyber Security Awareness
2. Physical Security Controls
3. Electronic Access Controls
4. Cyber Security Incident Response
5. Transient Cyber Asset and Removable Media Malicious Code Risk Mitigation

# 11. Testing

Appendix B has been provided by Entergy as a document to help document the Controls identified in Appendix A Security Controls. Seller has reviewed and submits this template with confidence that the design and deliverables can be readily met by the Entergy Operational Run Team.

Entergy description of Testing:

> *The test plan is designed to take each security significant requirement and to demonstrate due diligence in testing to ensure the control is adequately implemented. Se  Each test will capture the following information:*
>
> - Requirement # (from ID)
> - Expected Setting(s) and Test Plan - expected security outcome
> - Test Evidence – steps taken to test, screenshots, and logs
> - Test Result –Pass, Fail, Partial Pass, N/A
> - Tested By – person who tested
> - Date Tested – Date the person tested
>
> *For each test, documentation should be attached as evidence to include log files, screen shots, or other information relevant to providing assurance to risk acceptance officials that the system is adequately secured or configured as documented.  The appendixes provide the test plan for the security baselines. It is expected that before the site is turned over via Generation Operation Ready Assessment (ORA) that these artifacts be completed.*

# 12. Risk Assessment

Entergy has provided this section. Seller has included it to help normalize any risk identified through the design that the Entergy Operational Run Team may have meeting.

Entergy description of Risk Assessment:

> *The risk assessment evaluates possible negative events and/or threats that could occur, the possibility of occurring (likelihood), and the impacts of them occurring (consequence).  Mitigations are then applied based on the controls, architecture, and baselines documented in the security plan to calculate the residual risk if the prescribed controls in Appendix A are not fully met.  The residual risk allows Entergy decision makers to make an informed decision to authorize a new system or major change to an existing system based on the cyber and information security risks that it presents.  An explanation of the risk evaluation methodology is provided below:*
>
> - **Risks** – Identify the new risks introduced by this technology and any known threats that would be able to exploit this risk
> - **Consequence** – Identify the “so-what” of this risk occurring
>   - Low – minor or insignificant damage
>   - Medium – measurable impact but recoverable
>   - High – significant impact and/or unrecoverable
> - **Likelihood** – Identify the likelihood of the risk actually occurring

  - Low – unlikely to happen in the immediate future
  - Moderate – reasonable possibility of happening in the immediate future
  - High – near certainty of happening in the immediate future
- **Mitigations** – Identify the mitigations already in place or being put in place to minimize or eliminate this risk
- **Residual Risk/Risk Score** – Identify the residual risk score after the mitigations are in place
  - Low – risk is acceptable low after mitigation
  - Medium – risk level is not acceptable long-term but should not impact short-term operations; additional mitigations should be funded over time
  - High – risk level is not acceptable short-term and the system should not be authorized to operate

*The following risks were evaluated as applicable to this system:*

*This should be a list of each controls the Seller feels will not be able to be met due to technical feasibility. This could include a Zigbee reference, LTE, or say a clasp on an inverter where Entergy would have to add a clasp o accomplish locking.*

*An O&M PROVIDER responds with their implementation, this table should be populated*

| Risk/Threat | Consequence | Likelihood | Mitigations | Residual Risk |
|---|---|---|---|---|
| Risk/Threat 1 | Medium | Low | Mitigation 1<br>Mitigation 2 | Low |
| Risk/Threat 2 | Medium | Low | Mitigation 1<br>Mitigation 2 | Low |

# Section 3 - Project Appendix A(Security Controls) and B (Baseline Testing)

## 12.1. Cyber Security Awareness / Personnel and Training

Each Responsible Entity shall reinforce, at least once every 15 calendar months, cyber security practices (which may include associated physical security practices).

***CSA-01***

- **Description**: Ensure all users receive cyber security awareness training at least once every 15 calendar months
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-003-8 – Appendix 1
    - CIP-004-6 R2

***CSA-02***

- **Description**: Ensure all users are identified and meet Entergy's requirements for accessing data/systems
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-003-8 – Appendix 1
    - CIP-004-6 R3
    - IT-PR-007 "IT Vendor Resource On-Boarding Procedure"

***CSA-03***

- **Description**: Ensure all users with electronic and unescorted physical access are documented
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-003-8 – Appendix 1
    - CIP-004-6 R4
    - IT-PR-518 "Access Management"

***CSA-04***

- **Description**: Ensure access is revoked when users/contractors are terminated

- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-003-8 – Appendix 1
    - CIP-004-6 R5
    - IT-PR-007 “IT Vendor Resource On-Boarding Procedure”

## 12.2. Physical Security Controls

Each Responsible Entity shall control physical access, based on need as determined by the Responsible Entity, to (1) the asset or the locations of the Cyber Systems within the asset, and (2) the Cyber Asset(s), as specified by the Responsible Entity, that provide electronic access control(s) implemented in the *Electronic Access Controls* section, if any.

***PSC-01***

- **Description**: Utilize at least one physical access control to allow unescorted physical access into each applicable Physical Security Perimeter to only those individuals who have authorized unescorted physical access
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-006-6 1.2

***PSC-02***

- **Description**: Log (through automated means or by personnel who control entry) entry of each individual with authorized unescorted physical access into each Physical Security Perimeter, with information to identify the individual and date and time of entry.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-006-6 1.8

***PSC-03***

- **Description**: Restrict physical access to cabling and other nonprogrammable communication components used for connection between applicable Cyber Assets within the same Electronic Security Perimeter in those instances when such cabling and components are located outside of a Physical Security Perimeter. Where physical access restrictions to such cabling and components are not implemented, the Responsible Entity shall document and implement one or more of the following:
    - encryption of data that transits such cabling and components;

    - monitoring the status of the communication link composed of such cabling and components and issuing an alarm or alert in response to detected communication failures to the personnel identified in the BES Cyber Security Incident response plan within 15 minutes of detection; or
    - an equally effective logical protection.
- **Implementation:**
- **Implementation Status:**
- **Responsible Party:**
- **References:**
    - CIP-006-6 1.10

***PSC-04***

- **Description**: Require continuous escorted access of visitors (individuals who are provided access but are not authorized for unescorted physical access) within each Physical Security Perimeter, except during CIP Exceptional Circumstances.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-006-6 R1, 2.1

***PSC-05***

- **Description**: Require manual or automated logging of visitor entry into and exit from the Physical Security Perimeter that includes date and time of the initial entry and last exit, the visitor's name, and the name of an individual point of contact responsible for the visitor, except during CIP Exceptional Circumstances.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-006-6 R1, 2.2

## 12.3. Electronic Access Controls

For each asset that is a Cyber System(s), the Responsible Entity shall implement electronic access controls to:

1. Permit only necessary inbound and outbound electronic access as determined by the Responsible Entity for any communications that are:
    a. between a Cyber System(s) and a Cyber Asset(s) outside the asset containing low impact BES Cyber System(s);
    b. using a routable protocol when entering or leaving the asset containing the low impact BES Cyber System(s); and
    c. not used for time-sensitive protection or control functions between intelligent electronic devices (e.g., communications using protocol IEC TR- 61850-90-5 R-GOOSE).

### 12.3.1. Asset Management

***EAC-01***

- **Description**: Identify each Cyber Asset and update inventory list whenever changes are made and review/update it at least every 15 months.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-002-5.1a R1, R2

***EAC-02***

- **Description**: When replacing/retiring a system validate sensitive information is destroyed according to NIST data destruction guidance
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - NIST Special Publication 800-88

***EAC-22***

- **Description**: System configuration shall be backed up/stored and readily accessible for restoration.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - NIST Special Publication 800-88

### 12.3.2. Electronic Security Perimeter and Electronic Access Points

***EAC-03***

- **Description**: All applicable Cyber Assets connected to a network via a routable protocol shall reside within a defined ESP.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-005-5 1.1

***EAC-04***

- **Description**: All External Routable Connectivity must be through an identified Electronic Access Point (EAP).
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-005-5 1.2

***EAC-05***

- **Description**: EAPs Require inbound and outbound access permissions, including the reason for granting access, and deny all other access by default.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-005-5 1.3

***EAC-06***

- **Description**: EAPs must have one or more methods for detecting known or suspected malicious communications for both inbound and outbound communications.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-005-5 1.5

***EAC-07***

- **Description**: Utilize an Intermediate System such that the Cyber Asset initiating Interactive Remote Access does not directly access an applicable Cyber Asset.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-005-5 2.1

***EAC-08***

- **Description**: For all Interactive Remote Access sessions, utilize encryption that terminates at an Intermediate System.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-005-5 2.2

***EAC-09***

- **Description**: Require multi-factor authentication for all Interactive Remote Access sessions.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-005-5 2.3

### 12.3.3. Patch Management

***EAC-10***

- **Description**: A patch management process for tracking, evaluating, and installing cyber security patches for applicable Cyber Assets. The tracking portion shall include the identification of a source or sources that the Responsible Entity tracks for the release of cyber security patches for applicable Cyber Assets that are updateable and for which a patching source exists.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-007-6 2.1
    - IT-PR-506 “Security Patch Management”
    - IT-PR-513 “Threat and Vulnerability Management”

***EAC-11***

- **Description**: At least once every 35 calendar days, evaluate security patches for applicability that have been released since the last evaluation from the source or sources identified in EAC-10.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-007-6 2.2
    - IT-PR-506 “Security Patch Management”
    - IT-PR-513 “Threat and Vulnerability Management”

***EAC-12***

- **Description**: For applicable patches identified in EAC-11, within 35 calendar days of the evaluation completion, take one of the following actions:
    - Apply the applicable patches; or
    - Create a dated mitigation plan; or
    - Revise an existing mitigation plan.

  Mitigation plans shall include the Responsible Entity’s planned actions to mitigate the vulnerabilities addressed by each security patch and a timeframe to complete these mitigations.
- **Implementation:**

- **Implementation Status:**
- **Responsible Party**
- **References:**
    - CIP-007-6 2.3
    - IT-PR-506 “Security Patch Management”
    - IT-PR-513 “Threat and Vulnerability Management”

***EAC-13***

- **Description**: For each mitigation plan created or revised in EAC-12, implement the plan within the timeframe specified in the plan, unless a revision to the plan or an extension to the timeframe specified in EAC-11 is approved by Entergy Security Compliance.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-007-6 2.4
    - IT-PR-506 “Security Patch Management”
    - IT-PR-513 “Threat and Vulnerability Management”

### 12.3.4. Malicious Code

***EAC-14***

- **Description**: Where technically feasible, deploy method(s) to deter, detect, or prevent malicious code
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-007-6 R3

### 12.3.5. Logging

***EAC-15***

- **Description**: All applicable systems within the scope of this procedure shall be configured to generate system access logs, audit trails, and security status alerts for the identification of Cyber Security Incidents per Cyber Asset or Cyber System capability. At a minimum, this includes the following types of events: 1) Detected successful login attempts; 2) Detected failed access attempts and failed login attempts; 3) Detected malicious code
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-007-6 R4

***EAC-16***

- **Description**: A Centralized Monitoring, Logging, and Alerting Platform (CMLAP) should perform the logging and monitoring of devices, where technically feasible
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-007-6 R4

### 12.3.6. Authentication and System Access Controls

***EAC-17***

- **Description**: Have a method(s) to enforce authentication of interactive user access, where technically feasible.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP 007-6 5.1

***EAC-18***

- **Description**: Identify individuals who have authorized access to shared accounts.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP 007-6 5.3

***EAC-19***

- **Description**: Change known default passwords, per Cyber Asset capability
- **Implementation**:
- **Implementation Status**:
- **Entergy**:
- **DEPCOM**:
- **Responsible Party**:
- **References**:
    - CIP 007-6 5.4

***EAC-20***

- **Description**: For password-only authentication for interactive user access, either technically or procedurally enforce the following password parameters: 1) Password length that is, at least, the lesser of eight characters or the maximum length supported by the Cyber Asset; and 2)

Minimum password complexity that is the lesser of three or more different types of characters (e.g., uppercase alphabetic, lowercase alphabetic, numeric, non- alphanumeric) or the maximum complexity supported by the Cyber Asset.

- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References:**
    - CIP 007-6 5.5

***EAC-21***

- **Description**: Where technically feasible, either: 1) Limit the number of unsuccessful authentication attempts; or 2) Generate alerts after a threshold of unsuccessful authentication attempts.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP 007-6 5.6

***EAC-22***

- **Description**: Where technically feasible, include a warning banner for notifying those logging into a system that they are logging into a sensitive system and access is restricted/monitored.
- **Implementation**:
    - **Entergy**: "Warning! Legal Notice. This system is the property of Entergy and is for the use of authorized users only. Personal use should only be occasional, incidental, and infrequent. Individuals using this system or otherwise accessing the Entergy network waive any expectation of privacy. Use of this system is express consent to monitoring, and users are advised that if unauthorized activities, including but not limited to theft, tampering, misuse, creation, or dissemination of malicious software (e.g., computer viruses), destruction, or loss have occurred, appropriate action will be taken, such as disciplinary action up to and including termination. Entergy retains the right, exercisable in its sole discretion, at any time and from time to time, to monitor, intercept, search, and record any and all activities on this system, and undertaken through any pc or other device connected to the Entergy network, and disclose information, as Entergy deems appropriate, to others such as the U.S. Government to help ensure information security and protect the Entergy network. Entergy further reserves the right, without the consent of or liability to any user or third party, to record, screen, edit, curtail, or remove any content on this system at any time and for any reason, including because it believes such content to be harmful, harassing, abusive, offensive, or in violation of this notice or any other terms, conditions, and policies applicable to this system. Entergy shall have no liability to any user or third party for the performance or non-performance of monitoring or other actions taken to protect the Entergy network. Additionally, the unauthorized activity may be reported to government authorities including law enforcement. Clicking I ACCEPT or LOG ON, or continuing to use this computer or accessing the Entergy network constitutes an acknowledgement and acceptance of the

terms of this notice, and Entergy's Communications Systems policy and the Electronic Information Security policy."
    - **Third Party**: Similar language as above
- **Implementation Status:**
- **Responsible Party:**
- **References:**

## 12.4. Cyber Security Incident Response

Each Responsible Entity shall have one or more Cyber Security Incident response plan(s), either by asset or group of assets, which shall include:

1. Identification, classification, and response to Cyber Security Incidents;
2. Determination of whether an identified Cyber Security Incident is a Reportable Cyber Security Incident and subsequent notification to the Electricity Information Sharing and Analysis Center (E-ISAC), unless prohibited by law;
3. Identification of the roles and responsibilities for Cyber Security Incident response by groups or individuals;
4. Incident handling for Cyber Security Incidents;
5. Testing the Cyber Security Incident response plan(s) at least once every 36 calendar months by: (1) responding to an actual Reportable Cyber Security Incident; (2) using a drill or tabletop exercise of a Reportable Cyber Security Incident; or (3) using an operational exercise of a Reportable Cyber Security Incident; and
6. Updating the Cyber Security Incident response plan(s), if needed, within 180 calendar days after completion of a Cyber Security Incident response plan(s) test or actual Reportable Cyber Security Incident.

***CIR-01***

- **Description**: Have a documented Cyber Security Incident response plan, which includes identification, classification, and response to Cyber Security Incidents
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-003-8 Attachment 1
    - CIP-008-5 1.1
    - *IT-PR-502 "Security Incident Response Procedure"*

***CIR-02***

- **Description**: Have a documented Cyber Security Incident response plan, which includes determination of whether an identified Cyber Security Incident is a Reportable Cyber Security Incident and subsequent notification to the Electricity Information Sharing and Analysis Center (E-ISAC), unless prohibited by law
- **Implementation**:
- **Implementation Status**:

- **Responsible Party**:
- **References**:
  - CIP-003-8 Attachment 1
  - CIP-008-5 1.2
  - *IT-PR-502 "Security Incident Response Procedure"*

***CIR-03***

- **Description**: Have a documented Cyber Security Incident response plan, which includes identification of the roles and responsibilities for Cyber Security Incident response by groups or individuals
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
  - CIP-003-8 Attachment 1
  - CIP-008-5 1.3
  - *IT-PR-502 "Security Incident Response Procedure"*

***CIR-04***

- **Description**: Have a documented Cyber Security Incident response plan, which includes incident handling for Cyber Security Incidents
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
  - CIP-003-8 Attachment 1
  - CIP-008-5 1.4
  - *IT-PR-502 "Security Incident Response Procedure"*

***CIR-05***

- **Description**: Have a documented Cyber Security Incident response plan, which includes testing the Cyber Security Incident response plan(s) at least once every 36 calendar months by: (1) responding to an actual Reportable Cyber Security Incident; (2) using a drill or tabletop exercise of a Reportable Cyber Security Incident; or (3) using an operational exercise of a Reportable Cyber Security Incident
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
  - CIP-003-8 Attachment 1
  - CIP-008-5 2.1
  - *IT-PR-502 "Security Incident Response Procedure"*

***CIR-06***

- **Description**: Have a documented Cyber Security Incident response plan, which includes updating the Cyber Security Incident response plan(s), if needed, within 180 calendar days after completion of a Cyber Security Incident response plan(s) test or actual Reportable Cyber Security Incident
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
- CIP-003-8 Attachment 1
- CIP-008-5 R3
- *IT-PR-502 "Security Incident Response Procedure"*

***CIR-07***

- **Description**: Third parties which operate, maintain, or have ongoing electronic access to the site must appoint an Incident Response contact. Additionally, require immediate (within 12 hours of discovery) notification to Entergy for any suspected or actual cyber events on the third party's computer systems. This should be required through contractual language of the third party's O&M agreement with Entergy.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
  - CIP-003-8 Attachment 1
  - CIP-008-5 1.3

## 12.5. Transient Cyber Asset and Removable Media Malicious Code Risk Mitigation

Responsible Entity shall implement, except under CIP Exceptional Circumstances, one or more plan(s) to achieve the objective of mitigating the risk of the introduction of malicious code to low impact BES Cyber Systems through the use of Transient Cyber Assets or Removable Media. The plan(s) shall include:

1. For Transient Cyber Asset(s) managed by the Responsible Entity, if any, the use of one or a combination of the following in an ongoing or on-demand manner (per Transient Cyber Asset capability):
   a. Antivirus software, including manual or managed updates of signatures or patterns;
   b. Application whitelisting; or
   c. Other method(s) to mitigate the introduction of malicious code.
2. For Transient Cyber Asset(s) managed by a party other than the Responsible Entity, if any:
   a. Use one or a combination of the following prior to connecting the Transient Cyber Asset to a low impact BES Cyber System (per Transient Cyber Asset capability):
      i. Review of antivirus update level;
      ii. Review of antivirus update process used by the party;
      iii. Review of application whitelisting used by the party;

iv. Review use of live operating system and software executable only from read-only media;
v. Review of system hardening used by the party; or
vi. Other method(s) to mitigate the introduction of malicious code.

b. For any method used pursuant to above, Responsible Entities shall determine whether any additional mitigation actions are necessary and implement such actions prior to connecting the Transient Cyber Asset.

3. For Removable Media, the use of each of the following:
   a. Method(s) to detect malicious code on Removable Media using a Cyber Asset other than a BES Cyber System; and
   b. Mitigation of the threat of detected malicious code on the Removable Media prior to connecting Removable Media to a low impact BES Cyber System.

***TCA-01***

- **Description**: For Transient Cyber Asset(s) managed by the Responsible Entity, if any, the use of one or a combination of the following in an ongoing or on-demand manner (per Transient Cyber Asset capability): 1) Antivirus software, including manual or managed updates of signatures or patterns; 2) Application whitelisting; or 3) Other method(s) to mitigate the introduction of malicious code.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
  - CIP-003-8 Attachment 1
  - *IT-PR-517 "Transient Cyber Asset and Removable Media Security Plan"*

***TCA-02***

- **Description**: For Transient Cyber Asset(s) managed by a party other than the Responsible Entity, if any, use one or a combination of the following prior to connecting the Transient Cyber Asset to a Cyber System (per Transient Cyber Asset capability): 1) Review of antivirus update level; 2) Review of antivirus update process used by the party; 3) Review of application whitelisting used by the party; 4) Review use of live operating system and software executable only from read-only media; 5) Review of system hardening used by the party; or 6) Other method(s) to mitigate the introduction of malicious code. For any method used pursuant to above, Responsible Entities shall determine whether any additional mitigation actions are necessary and implement such actions prior to connecting the Transient Cyber Asset.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
  - CIP-003-8 Attachment 1
  - *IT-PR-517 "Transient Cyber Asset and Removable Media Security Plan"*

***TCA-03***

- **Description**: For Removable Media, the use of each of the following: 1) Method(s) to detect malicious code on Removable Media using a Cyber Asset other than a Cyber System; and 2) Mitigation of the threat of detected malicious code on the Removable Media prior to connecting Removable Media to a BES Cyber System.
- **Implementation**:
- **Implementation Status**:
- **Responsible Party**:
- **References**:
    - CIP-003-8 Attachment 1
    - *IT-PR-517 "Transient Cyber Asset and Removable Media Security Plan"*

# 13. Appendix B – Baseline Testing

Text goes here.

# 14. Cyber Security Awareness Testing

| CSA-01 – Ensure all users receive cyber security awareness training at least once every 15 calendar months | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate each of the site users has received cyber security awareness training in the last 15 months. Evidence can be a sign-in sheet, training log, or electronic records. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CSA-02 – Ensure all users are identified and meet Entergy's requirements for accessing data/systems | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate each of the SITE users is identified and meet Entergy's requirements. Evidence can be electronic records or manual validation. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CSA-03 – Ensure all users with electronic and unescorted physical access are documented | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate each of the users that have electronic or physical access are documented. Evidence can be a log on a central repository or electronic records. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CSA-04 – Ensure access is revoked when users/contractors are terminated | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure all users are still valid and have not been terminated. Evidence can be a full or random audit. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

## 15. Physical Security Testing

| PSC-01 – Utilize at least one physical access control to allow unescorted physical access into each applicable Physical Security Perimeter to only those individuals who have authorized unescorted physical access | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate at least one physical access control mechanism is in use at the Physical Security Perimeter. Evidence can be a picture showing this. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| PSC-02 – Log (through automated means or by personnel who control entry) entry of each individual with authorized unescorted physical access into each Physical Security Perimeter, with information to identify the individual and date and time of entry. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure a log exists for access to the site. Evidence should be a picture of a paper log or attachment of electronic records | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| **PSC-03 – Restrict physical access to cabling and other nonprogrammable communication components used for connection between applicable Cyber Assets within the same Electronic Security Perimeter in those instances when such cabling and components are located outside of a Physical Security Perimeter. Where physical access restrictions to such cabling and components are not implemented, the Responsible Entity shall document and implement one or more of the following:**<br>• **encryption of data that transits such cabling and components;**<br>• **monitoring the status of the communication link composed of such cabling and components and issuing an alarm or alert in response to detected communication failures to the personnel identified in the BES Cyber Security Incident response plan within 15 minutes of detection; or**<br>• **an equally effective logical protection.** |
|---|
| Tested By |
| Date Tested |
| Expected Setting(s) and Test Plan |
| Ensure all cabling that is outside of the Electronic Security Perimeter is encrypted. Evidence should be a screen capture of configuration settings or a packet capture showing these are encrypted. Additionally, if physical access restrictions are in use, evidence should be a picture showing this. |
| Testing Evidence |
| Testing Result — Pass / Fail |

| **PSC-04 – Require continuous escorted access of visitors (individuals who are provided access but are not authorized for unescorted physical access) within each Physical Security Perimeter, except during CIP Exceptional Circumstances.** |
|---|
| Tested By |
| Date Tested |
| Expected Setting(s) and Test Plan |
| Ensure signage and training are present for those escorting visitors. Evidence can be pictures of signs and/or training logs |
| Testing Evidence |
| Testing Result — Pass / Fail |

| **PSC-05 – Require manual or automated logging of visitor entry into and exit from the Physical Security Perimeter that includes date and time of the initial entry and last exit, the visitor's name, and the name of an individual point of contact responsible for the visitor, except during CIP Exceptional Circumstances.** |
|---|
| Tested By |

| PSC-05 – Require manual or automated logging of visitor entry into and exit from the Physical Security Perimeter that includes date and time of the initial entry and last exit, the visitor's name, and the name of an individual point of contact responsible for the visitor, except during CIP Exceptional Circumstances. | |
|---|---|
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure a log exists for visitor access to the site. Evidence should be a picture of a paper log or attachment of electronic records | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

## 16. Electronic Access Testing

| EAC-01 – Identify each Cyber Asset and update inventory list whenever changes are made and review/update it at least every 15 months. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate the Cyber Asset list is up to date. Evidence can include an inventory list compared to actual assets at the site. This assessment can be a full or random sampling of devices. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-02 – When replacing/retiring a system validate sensitive information is destroyed according to NIST data destruction guidance | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Look for evidence of destruction process. If possible, randomly sample a device that was supposed to be sanitized. If not possible, interview SMEs to see if this is being done. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-03 – All applicable Cyber Assets connected to a network via a routable protocol shall reside within a defined ESP. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Compare the inventory list to the network diagram; ensure all networked assets are within the ESP. If any are not, they should be documented as an exception. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-04 – All External Routable Connectivity must be through an identified Electronic Access Point (EAP). | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure there are no out of band internet/external network connections to the site assets. All connectivity should utilize the connections detailed above. This will require a site visit or interview to attest that there are no other connections. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-05 – EAPs Require inbound and outbound access permissions, including the reason for granting access, and deny all other access by default. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Get a list of firewall rules. Ensure there is a Deny All at the end of the Access Control List. Ensure there are no Allow Any/Any rules unless explicitly documented. Ensure rules/exceptions are documented as part of Entergy's existing processes. Evidence should be a screenshot or list of rules. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-06 – EAPs must have one or more methods for detecting known or suspected malicious communications for both inbound and outbound communications. |
|---|
| Tested By |

| EAC-06 – EAPs must have one or more methods for detecting known or suspected malicious communications for both inbound and outbound communications. | |
|---|---|
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure the SITE firewall has Intrusion Detection enabled and logging. Evidence should be a screenshot or firewall configuration settings. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-07 – Utilize an Intermediate System such that the Cyber Asset initiating Interactive Remote Access does not directly access an applicable Cyber Asset. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure that all interactive access to the site is through the Jump Servers or the RTAC. Evidence could be firewall rules. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-08 – For all Interactive Remote Access sessions, utilize encryption that terminates at an Intermediate System. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Verify encryption is turned on for both the Jump Server/Citrix as well as the VPN tunnel. Evidence could be screenshots or configuration settings. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-09 – Require multi-factor authentication for all Interactive Remote Access sessions. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Test the interactive login to the Jump Server and ensure it requires MFA. Evidence can be a screenshot. | |
| Testing Evidence | |

| EAC-09 – Require multi-factor authentication for all Interactive Remote Access sessions. |
|---|
| Testing Result Pass / Fail |

| EAC-10 – A patch management process for tracking, evaluating, and installing cyber security patches for applicable Cyber Assets. The tracking portion shall include the identification of a source or sources that the Responsible Entity tracks for the release of cyber security patches for applicable Cyber Assets that are updateable and for which a patching source exists. |
|---|
| Tested By |
| Date Tested |
| Expected Setting(s) and Test Plan |
| Ensure a patch management process exists for the assets. Evidence should be the process. |
| Testing Evidence |
| Testing Result Pass / Fail |

| EAC-11 – At least once every 35 calendar days, evaluate security patches for applicability that have been released since the last evaluation from the source or sources identified in EAC-10. |
|---|
| Tested By |
| Date Tested |
| Expected Setting(s) and Test Plan |
| View the last patch evaluation and a current scan. Ensure all patches > 35 days old are installed or evaluated. |
| Testing Evidence |
| Testing Result Pass / Fail |

| EAC-12 – For applicable patches identified in EAC-11, within 35 calendar days of the evaluation completion, take one of the following actions:<br>• Apply the applicable patches; or<br>• Create a dated mitigation plan; or<br>• Revise an existing mitigation plan.<br>Mitigation plans shall include the Responsible Entity's planned actions to mitigate the vulnerabilities addressed by each security patch and a timeframe to complete these mitigations. |
|---|
| Tested By |

| **EAC-12 – For applicable patches identified in EAC-11, within 35 calendar days of the evaluation completion, take one of the following actions:**<br>• **Apply the applicable patches; or**<br>• **Create a dated mitigation plan; or**<br>• **Revise an existing mitigation plan.**<br>**Mitigation plans shall include the Responsible Entity's planned actions to mitigate the vulnerabilities addressed by each security patch and a timeframe to complete these mitigations.** | |
|---|---|
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| View the last patch evaluation and a current scan. Ensure all patches > 35 days old are installed or evaluated. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| **EAC-13 – For each mitigation plan created or revised in EAC-12, implement the plan within the timeframe specified in the plan, unless a revision to the plan or an extension to the timeframe specified in EAC-12 is approved by Entergy Security Compliance.** | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| View all mitigation plans and ensure all are up to date and have been implemented within the timeframe specified or that an extension is in place. If the number of mitigation plans is more than 10, randomly sample 10 plans. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| **EAC-14 – Where technically feasible, deploy method(s) to deter, detect, or prevent malicious code** | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure endpoint protection is installed, updated, and functioning for all systems that technically support it. Evidence can be a screenshot. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-15 – All applicable systems within the scope of this procedure shall be configured to generate system access logs, audit trails, and security status alerts for the identification of Cyber Security Incidents per Cyber Asset or Cyber System capability. At a minimum, this includes the following types of events: 1) Detected successful login attempts; 2) Detected failed access attempts and failed login attempts; 3) Detected malicious code | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure all systems are generating logs that meet the events specified. Ideally this should be centrally logged, but if not, ensure the logs at least exist locally. Testing should include a screenshot of the logs or the actual logs, including testing for the three types of logs mentioned. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-16 – A Centralized Monitoring, Logging, and Alerting Platform (CMLAP) should perform the logging and monitoring of devices, where technically feasible | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure all systems are generating logs that meet the events specified. This should be centrally logged. Testing should include a screenshot of the logs or the actual logs in the CMLAP, including testing for the three types of logs mentioned. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-17 – Have a method(s) to enforce authentication of interactive user access, where technically feasible. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure all devices require authentication for interactive user access. This could be a random sampling of at least one of each type of device, showing a screenshot of the required authentication. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-18 – Identify individuals who have authorized access to shared accounts. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Ensure a list exists of all users that have access to shared accounts. For testing, view the accounts on devices, identify shared accounts, and ensure the match the documentation provided. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-19 – Change known default passwords, per Cyber Asset capability | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Provide evidence that default passwords have been changed. Testing should also include research and trial of the default password on each type of device to ensure it has truly been changed. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-20 – For password-only authentication for interactive user access, either technically or procedurally enforce the following password parameters: 1) Password length that is, at least, the lesser of eight characters or the maximum length supported by the Cyber Asset; and 2) Minimum password complexity that is the lesser of three or more different types of characters (e.g., uppercase alphabetic, lowercase alphabetic, numeric, non- alphanumeric) or the maximum complexity supported by the Cyber Asset. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Provide a configuration setting or screenshot showing this policy is enabled. If that is not possible, try to set a password without meeting the requirements and validate if the system will let you. If this is strictly an administrative control, show evidence where the user is made aware of this requirement (user agreement, training, warning banner, etc) | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-21 – Where technically feasible, either: 1) Limit the number of unsuccessful authentication attempts; or 2) Generate alerts after a threshold of unsuccessful authentication attempts. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Provide a configuration setting or screenshot showing this policy enabled, if technically feasible. Testing should also include testing this by providing bad credentials to verify the user is either locked out or alerts are generated. If not technically feasible for a system, this should be documented. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-22 – Where technically feasible, include a warning banner for notifying those logging into a system that they are logging into a sensitive system and access is restricted/monitored. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Provide a configuration setting or screenshot showing the warning banner or where this policy enabled, if technically feasible. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| EAC-23 – System configuration shall be backed up/stored and readily accessible for restoration. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Provide a mapping to each inventory Item of configuration or backup file location. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

# 17. Cyber Security Incident Response Testing

| CIR-01 – Have a documented Cyber Security Incident Response Plan, which includes identification, classification, and response to Cyber Security Incidents | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate the Cyber Security Incident Response Plan exists and is current. Provide a screenshot of the front of Incident Response Plan. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CIR-02 – Have a documented Cyber Security Incident response plan, which includes determination of whether an identified Cyber Security Incident is a Reportable Cyber Security Incident and subsequent notification to the Electricity Information Sharing and Analysis Center (E-ISAC), unless prohibited by law | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate the Cyber Security Incident Response Plan exists and is current. Provide a screenshot of the page that shows the process for Reportable Cyber Security Incidents. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CIR-03 – Have a documented Cyber Security Incident response plan, which includes identification of the roles and responsibilities for Cyber Security Incident response by groups or individuals | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate the Cyber Security Incident Response Plan exists and is current. Provide a screenshot of the page that shows the roles and responsibilities. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CIR-04 – Have a documented Cyber Security Incident response plan, which includes incident handling for Cyber Security Incidents | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate the Cyber Security Incident Response Plan exists and is current. Provide a screenshot of the page that shows the incident handling details. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CIR-05 – Have a documented Cyber Security Incident response plan, which includes testing the Cyber Security Incident response plan(s) at least once every 36 calendar months by: (1) responding to an actual Reportable Cyber Security Incident; (2) using a drill or tabletop exercise of a Reportable Cyber Security Incident; or (3) using an operational exercise of a Reportable Cyber Security Incident | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate the Cyber Security Incident Response Plan exists and is current. Provide a screenshot or other evidence that shows when it was last tested. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CIR-06 – Have a documented Cyber Security Incident response plan, which includes updating the Cyber Security Incident response plan(s), if needed, within 180 calendar days after completion of a Cyber Security Incident response plan(s) test or actual Reportable Cyber Security Incident | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate the Cyber Security Incident Response Plan exists and is current. Provide a screenshot or other evidence that shows it was updated within 180 days of the last incident or test. Additionally, if the plan was updated less than 180 days prior to the evaluation of this control, that is considered a pass. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| CIR-07 – Third parties which operate, maintain, or have ongoing electronic access to the site must appoint an Incident Response contact. Additionally, require immediate notification to Entergy for any suspected or actual cyber events on the third party's computer systems. This should be required through contractual language of the third party's O&M agreement with Entergy. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Provide evidence that DEPCOM has provided an Incident Response contact in either this plan or another document. Additionally, provide evidence that there are the above requirements in the third party's contract with Entergy. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

## 18. Transient Cyber Asset & Removable Media Malicious Code Risk Mitigation Testing

| TCA-01 – For Transient Cyber Asset(s) managed by the Responsible Entity, if any, the use of one or a combination of the following in an ongoing or on-demand manner (per Transient Cyber Asset capability): 1) Antivirus software, including manual or managed updates of signatures or patterns; 2) Application whitelisting; or 3) Other method(s) to mitigate the introduction of malicious code. | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate that one of the above methods is in use on any transient cyber assets. As these are transient, in nature, take credit for assessments of this control whenever they take place. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| **TCA-02 – For Transient Cyber Asset(s) managed by a party other than the Responsible Entity, if any, use one or a combination of the following prior to connecting the Transient Cyber Asset to a Cyber System (per Transient Cyber Asset capability): 1) Review of antivirus update level; 2) Review of antivirus update process used by the party; 3) Review of application whitelisting used by the party; 4) Review use of live operating system and software executable only from read-only media; 5) Review of system hardening used by the party; or 6) Other method(s) to mitigate the introduction of malicious code. For any method used pursuant to above, Responsible Entities shall determine whether any additional mitigation actions are necessary and implement such actions prior to connecting the Transient Cyber Asset.** | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate that one of the above methods is in use on any third party transient cyber assets. As these are transient, in nature, take credit for assessments of this control whenever they take place. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

| **TCA-03 – For Removable Media, the use of each of the following: 1) Method(s) to detect malicious code on Removable Media using a Cyber Asset other than a Cyber System; and 2) Mitigation of the threat of detected malicious code on the Removable Media prior to connecting Removable Media to a BES Cyber System.** | |
|---|---|
| Tested By | |
| Date Tested | |
| Expected Setting(s) and Test Plan | |
| Validate that one of the above methods is in use on any third party transient cyber assets. As these are transient, in nature, take credit for assessments of this control whenever they take place. | |
| Testing Evidence | |
| Testing Result | Pass / Fail |

# Section 4 - Project Workbook Template

## MASTER IP LIST

| VLAN INFO | | | SUBNET INFO | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ID | VLAN Name | VLAN Description | Subnet | Mask | Inverse Mask | Subnet | Address Size | Host Range | Broadcast |
| 1450 | XYZ-OTNET | OTNET | 10.ABC.DEF.0 | 255.255.255.248 | | /29 | 8 | | |
| 1455 | XYZ-OTN-MGMT | OTNET Management | 10.ABC.DEF.8 | 255.255.255.248 | | /29 | 8 | | |
| 1454 | XYZ-PROD-NON-ESP | Entergy Substation VLAN | 10.ABC.DEF.16 | 255.255.255.240 | | /28 | 16 | | |
| 1453 | XYZ-FAC | Physical Security VLAN | 10.ABC.DEF.32 | 255.255.255.224 | | /27 | 32 | | |
| 1457 | XYZ-SOLAR-SUB | 3rd Party Substation VLAN | 10.ABC.DEF.64 | 255.255.255.224 | | /27 | 32 | | |
| 1458 | XYZ-BESS-CONTROL | BESS Control VLAN | 10.ABC.DEF.96 | 255.255.255.224 | | /27 | 32 | | |
| 1459 | XYZ-BESS-YARD | BESS Yard VLAN | 10.ABC.DEF.128 | 255.255.255.128 | | /25 | 128 | | |
| 1460 | XYZ-BESS-YARD | BESS Yard VLAN extension | 10.ABC.XYZ.0 | 255.255.255.224 | | | 223 | | |
| 1461 | XYZ-MSS-Security | MSS Security VLAN | 10.ABC.XYZ.224 | 255.255.255.224 | | | 27 | | |
| Entergy Specified | | | | | | | 506 | | |
| Seller Specified | | | | | | | | | |

| Site Name: | Solar Site XYZ | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IP | Mask | Vlan | VLAN Name | Description | Additional Notes | Physical Location | Firmware Revision | Device Type | ID | Password | Logging | TVM | Config Link | Manual Link |
| 10.ABC.DEF.0 | 255.255.255.248 | 1450 | XYZ-OTNET | Network | | OTNET /29 | | | | | | | | |
| 10.ABC.DEF.1 | 255.255.255.248 | 1450 | XYZ-OTNET | Router | VRRP | | | | | | | | | |
| 10.ABC.DEF.2 | 255.255.255.248 | 1450 | XYZ-OTNET | XYZRTRP4001 | CGR-2010 | | | | | | | | | |
| 10.ABC.DEF.3 | 255.255.255.248 | 1450 | XYZ-OTNET | | | | | | | | | | | |
| 10.ABC.DEF.4 | 255.255.255.248 | 1450 | XYZ-OTNET | FW | VRRP | | | | | | | | | |
| 10.ABC.DEF.5 | 255.255.255.248 | 1450 | XYZ-OTNET | XYZFWAP4001 | Firewall | | | | | | | | | |
| 10.ABC.DEF.6 | 255.255.255.248 | 1450 | XYZ-OTNET | XYZFWAP4002 | Firewall | | | | | | | | | |
| 10.ABC.DEF.7 | 255.255.255.248 | 1450 | XYZ-OTNET | Broadcast | | | | | | | | | | |
| 10.ABC.DEF.8 | 255.255.255.248 | 1455 | XYZ-OTN-MGMT | Network | | OT Mgmt /29 | | | | | | | | |
| 10.ABC.DEF.9 | 255.255.255.248 | 1455 | XYZ-OTN-MGMT | Router | VRRP | | | | | | | | | |
| 10.ABC.DEF.10 | 255.255.255.248 | 1455 | XYZ-OTN-MGMT | XYZRTRP4001 | CGR-2010 | | | | | | | | | |
| 10.ABC.DEF.11 | 255.255.255.248 | 1455 | XYZ-OTN-MGMT | | | | | | | | | | | |
| 10.ABC.DEF.12 | 255.255.255.248 | 1455 | XYZ-OTN-MGMT | XYZSW2P4003 (ESM) | RWIC-D-ES-2S-8PC | | | | | | | | | |
| 10.ABC.DEF.13 | 255.255.255.248 | 1455 | XYZ-OTN-MGMT | | | | | | | | | | | |
| 10.ABC.DEF.14 | 255.255.255.248 | 1455 | XYZ-OTN-MGMT | unassigned | | | | | | | | | | |
| 10.ABC.DEF.15 | 255.255.255.248 | 1455 | XYZ-OTN-MGMT | Broadcast | | | | | | | | | | |
| 10.ABC.DEF.16 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | Network | | Prod NON-ESP /28 | | | | | | | | |
| 10.ABC.DEF.17 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | FW | VRRP | | | | | | | | | |
| 10.ABC.DEF.18 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | XYZFWAP4001 | Firewall | | | | | | | | | |
| 10.ABC.DEF.19 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | XYZFWAP4002 | Firewall | | | | | | | | | |
| 10.ABC.DEF.20 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | XYZSW2P4001 | Non-ESP Switch | | | | | | | | | |
| 10.ABC.DEF.21 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.22 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.23 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.24 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.25 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.26 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.27 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.28 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.29 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.30 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.31 | 255.255.255.240 | 1454 | XYZ-PROD-NON-ESP | | | | | | | | | | | |
| 10.ABC.DEF.32 | 255.255.255.224 | 1453 | XYZ-FAC | Network | | Facility / Phys Sec /27 | | | | | | | | |
| 10.ABC.DEF.33 | 255.255.255.224 | 1453 | XYZ-FAC | FW | VRRP | | | | | | | | | |
| 10.ABC.DEF.34 | 255.255.255.224 | 1453 | XYZ-FAC | XYZFWAP4001 | Firewall | | | | | | | | | |
| 10.ABC.DEF.35 | 255.255.255.224 | 1453 | XYZ-FAC | XYZFWAP4002 | Firewall | | | | | | | | | |
| 10.ABC.DEF.36 | 255.255.255.224 | 1453 | XYZ-FAC | | | | | | | | | | | |
| 10.ABC.DEF.37 | 255.255.255.224 | 1453 | XYZ-FAC | | | | | | | | | | | |
| 10.ABC.DEF.38 | 255.255.255.224 | 1453 | XYZ-FAC | XYZCACP4001 | rd Access Controller | | | | | | | | | |
| 10.ABC.DEF.39 | 255.255.255.224 | 1453 | XYZ-FAC | | | | | | | | | | | |
| 10.ABC.DEF.40 | 255.255.255.224 | 1453 | XYZ-FAC | XYZCACP4002 | rd Access Controller | | | | | | | | | |
| 10.ABC.DEF.41 | 255.255.255.224 | 1453 | XYZ-FAC | XYZBESSOITP4001 | -3355 VMS Video Svr | | | | | | | | | |
| 10.ABC.DEF.42 | 255.255.255.224 | 1453 | XYZ-FAC | XYZBESSOITP4002 | -3355 VMS Video Svr | | | | | | | | | |
| 10.ABC.DEF.43 | 255.255.255.224 | 1453 | XYZ-FAC | Cluster (OS) Client Access | -3355 VMS Video Svr | | | | | | | | | |
| 10.ABC.DEF.44 | 255.255.255.224 | 1453 | XYZ-FAC | Cluster (App) | -3355 VMS Video Svr | | | | | | | | | |
| 10.ABC.DEF.45 | 255.255.255.224 | 1453 | XYZ-FAC | | | | | | | | | | | |
| 10.ABC.DEF.46 | 255.255.255.224 | 1453 | XYZ-FAC | | | | | | | | | | | |
| 10.ABC.DEF.47 | 255.255.255.224 | 1453 | XYZ-FAC | XYZENCP4001 | Encoder | | | | | | | | | |
| 10.ABC.DEF.48 | 255.255.255.224 | 1453 | XYZ-FAC | XYZENCP4002 | Encoder | | | | | | | | | |
| 10.ABC.DEF.49 | 255.255.255.224 | 1453 | XYZ-FAC | XYZENCP4003 | Encoder | | | | | | | | | |
| 10.ABC.DEF.50 | 255.255.255.224 | 1453 | XYZ-FAC | XYZENCP4004 | Encoder | | | | | | | | | |
| 10.ABC.DEF.51 | 255.255.255.224 | 1453 | XYZ-FAC | | | | | | | | | | | |
| 10.ABC.DEF.52 | 255.255.255.224 | 1453 | XYZ-FAC | | | | | | | | | | | |

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|---|---|---|---|---|---|---|
| 10.ABC.DEF.64 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | Network | 3rd Party Substatio | |
| 10.ABC.DEF.65 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | FW | VRRP | |
| 10.ABC.DEF.66 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | XYZFWAP4001 | Firewall | |
| 10.ABC.DEF.67 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | XYZFWAP4002 | Firewall | |
| 10.ABC.DEF.68 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | |
| 10.ABC.DEF.69 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | |
| 10.ABC.DEF.70 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | |
| 10.ABC.DEF.71 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | |
| 10.ABC.DEF.72 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | RTU (OrionLX) | | |
| 10.ABC.DEF.73 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | COMM 1 (OrionLX) | | |
| 10.ABC.DEF.74 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | Meter (SEL-735) | | |
| 10.ABC.DEF.75 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 87T1P (SEL-487E) | | |
| 10.ABC.DEF.76 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 87T1S (SEL-3311A) | | |
| 10.ABC.DEF.77 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 87L1P (SEL 411L) | | |
| 10.ABC.DEF.78 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 87L1S (SEL-411L) | | |
| 10.ABC.DEF.79 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 50-51/F1 (SEL-751A) | | |
| 10.ABC.DEF.80 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | RTU-NTIO1 (Orion I/O) | | |
| 10.ABC.DEF.81 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | 50BF/T1 (SEL-352-2) | | |
| 10.ABC.DEF.82 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | |
| 10.ABC.DEF.83 | 255.255.255.224 | 1457 | XYZ-SOLAR-SUB | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10.ABC.DEF.96 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Network | Vendor BESS Contro | |
| 10.ABC.DEF.97 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | FW | VRRP | |
| 10.ABC.DEF.98 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | XYZFWAP4001 | Firewall | |
| 10.ABC.DEF.99 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | XYZFWAP4002 | Firewall | |
| 10.ABC.DEF.100 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | | | |
| 10.ABC.DEF.101 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | | | |
| 10.ABC.DEF.102 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Development for Ignition | | |
| 10.ABC.DEF.103 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Top Server | | |
| 10.ABC.DEF.104 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Ignition SCADA Server | | |
| 10.ABC.DEF.105 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Ignition Historian | | |
| 10.ABC.DEF.106 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | M340 PLC CPU | | |
| 10.ABC.DEF.107 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.108 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.109 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.110 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.111 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.112 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.113 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.114 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.115 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.116 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | Dell VM Admin IP | | |
| 10.ABC.DEF.117 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | | | |
| 10.ABC.DEF.118 | 255.255.255.224 | 1458 | XYZ-BESS-CONTROL | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10.ABC.DEF.128 | 255.255.255.128 | 1459 | XYZ-BESS-YARD | Network | | BESS Yard /25 |
| 10.ABC.DEF.129 | 255.255.255.128 | 1459 | XYZ-BESS-YARD | FW | VRRP | |
| 10.ABC.DEF.130 | 255.255.255.128 | 1459 | XYZ-BESS-YARD | XYZFWAP4001 | Firewall | |
| 10.ABC.DEF.131 | 255.255.255.128 | 1459 | XYZ-BESS-YARD | XYZFWAP4002 | Firewall | |
| 10.ABC.DEF.132 | 255.255.255.128 | 1459 | XYZ-BESS-YARD | | | |
| 10.ABC.DEF.133 | 255.255.255.128 | 1459 | XYZ-BESS-YARD | | | |

## Appendix 7: Cyber Security Plan

SOFTWARE

| **Software Name** | **Present at Site (Y/N)** | License Transfer |
|---|---|---|
| | | |
| VMWARE | | |
| Windows | | |
| Ignition | | |
| ModBus SCADA | | |
| Software Toolbox | | |
| TOPS Server | | |

FIREWALL RULES

| Rule Name | Source | IP | Destination | IP | Port | udp/tcp | Service | Description (provide interface to interface description and reason why) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

# BESS BOT Scope Book

# Appendix 8

# Project Site Map

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 9/14/2023 | All | Original Publication |
| 1 | 6/6/24 | All | Added Site Physical Address |
| 25-1 | 11/3/2025 | Cover | Added BESS Cover Page |
| | | | |

## Appendix 8: Project Site Map

Appendix 8 cannot be updated without approval of Buyer.

[INSERT SITE MAP HERE]

Site Physical Address:

*** **END OF APPENDIX 8** ***

# BESS BOT Scope Book

# Appendix 9

# Approved Manufacturers and EPC Contractors List

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 9/14/2023 | All | Original Publication |
| 1 | 6/6/2024 | All | • Updated module manufacturers to reflect approved AML from February 2024<br>• Added Fixed-Tilt manufacturers<br>• Deleted Schneider and ABB from inverters as they only make string inverters |
| 25-1 | 11/3/2025 | All | Added BESS Cover Page<br>Removed Powin, Added Hithium to BESS Suppliers<br>Added Wanzek, WHC to EPC Contractors |
| | | | |
| | | | |

## Appendix 9: Approved Manufacturers and EPC Contractors List

A vendor appearing in the list below as an Approved Vendor for a particular type of equipment, system, or item shall not be an Approved Vendor for the manufacture of any other type of equipment, system, or item unless it is also identified therein as an Approved Vendor for such other type of equipment, system, or item. The inclusion of an entity on the list does not mean that such entity has been determined to satisfy or been pre-approved with respect to the requirements in, and other terms of, this Scope Book or the Agreement that apply, directly or indirectly, to EPC Contractors, vendors, manufacturers, or providers of equipment, systems, or items on (or not on) the list. Nothing in this Appendix is intended to or shall limit the application of such requirements or terms, directly or indirectly, to any entity on the list.

Vendors or EPC Contractors not included in the list shall be considered and permitted upon Buyer's approval in its sole and absolute discretion. Vendors and EPC Contractors submitted for approval shall be evaluated based on a combination of installed capacity of largest facilities, total installed capacity of all facilities, bankability of product, company net worth, legal standing of the company, safety record and policies, quality assurance/quality control procedures, and other factors.

| **Approved Manufacturers List** | | | | | |
|---|---|---|---|---|---|
| **Major Equipment – Excludes major equipment covered in Appendix 1 - Collector Substation and Appendix 2 - High Voltage Overhead Transmission Line** | | | | | |
| **Battery Energy Storage Systems** | EKS Energy | Fluence Energy | LG Energy Solution Vertech Inc. | Sungrow | Tesla |
| | Wartsila North America | Prevalon | Hithium | | |
| **Inverters** | GE | TMEIC | Sungrow | SMA | Ingeteam |
| | Chint | | | | |
| **LV/MV Transformer** | ABB | Central Maloney | ERCOM | Virginia Transformer with external surge arrestor | Cooper/ Eaton |
| **Balance of Plant** | | | | | |
| **SCADA Platforms** | Ignition | | | | |
| **Disconnects** | Square D | Siemens | Eaton | ABB | SMA |
| **Data Logger** | Campbell Scientific | Kipp and Zonen | | | |
| **Network Equipment** | CheckPoint | Palo Alto | Cisco | SEL | |

## Appendix 9: Approved Manufacturers and EPC Contractors List

| EPC Contractors | | | | | |
|---|---|---|---|---|---|
| Blattner | IEA | Moss | White Construction | Boldt | Kiewit |
| Aristeo | Rosendin | Depcom | RES | SOLV Energy | McCarthy |
| Primoris | Mortenson | Cupertino | Premier Builders | Wood | Granite |
| Henkels and McCoy | Aldridge Electric | Bowen Engineering | Conductor Power | Barton Malow | Rachel Contracting |
| J. Ranck | Black & Veatch | MYR Group | WHC | Wanzek | |

# BESS BOT Scope Book

# Appendix 10

# North American Electric Reliability Corporation (NERC) Requirements

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 9/14/2023 | All | Original Publication |
| 1 | 6/6/2024 | PRC-023-4 | Added “or evidence of compliance” |
| 25-1 | 11/3/2025 | Cover | Added BESS Cover Page |
| | | | |
| | | | |

## Appendix 10: North American Electric Reliability Corporation (NERC) Requirements

### 10: NERC REQUIREMENTS - EFFECTIVE DATE[1]

| NERC Standard | Title | Deliverable | Due Date |
|---|---|---|---|
| CIP-002-5.1a | Cyber Security - BES Cyber System Categorization | 1)Provide real MW power capability of generator<br>2) Provide MVAR nameplate rating capability of generator | At FNTP |
| CIP-003-8 | Cyber Security — Security Management Controls | 1)Provide Physical Security Controls<br>2) Provide Electronic Access Controls<br>3) Provide Transient Cyber Assets and Removeable Media if required | 60 Days Prior to Substantial Completion |
| COM-001-3 | Communications | Documentation showing the interpersonal communications channels (phones, backup systems) exist and are functioning. | 30 Days Prior to Substantial Completion |
| FAC-002-2 | Facility Interconnection Studies | Evidence of the coordination/communication with the TO as port of GIA development | 120 Days Prior to Substantial Completion |
| FAC-008-5 | Facility Ratings | Facility Rating Report with supporting documentation supporting each equipment rating | 150 Days Prior to Substantial Completion |
| MOD-032-1 | Data for Power System Modeling and Analysis | Evidence that all required data has been provided. | 30 days prior to Substantial Completion<br><br>Final updates (if required) within 90 days of Post Substantial Completion |
| PRC-002-2 | Disturbance Monitoring and Reporting Requirements | Provide the required Dynamic Disturbance Recording equipment if required by the Generator Interconnection Agreement | 60 Days Prior to Substantial Completion |
| PRC-005-6 | Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance | 1) List of equipment that must be in the PSMP plan. Must include all facility equipment generation and substation. (Entergy uses a PRC-005 Component list).<br><br>2) Test reports or documentation that all listed equipment has been tested. | List of equipment and test documentation: 90 days prior to Substantial Completion |
| PRC-006-5<br>PRC-006-PRC-006-SERC-3 | Automatic Underfrequency Load Shedding | Attestation that no UFLS is included in facility design<br>OR<br>Specific documentation for under frequency/over frequency of protection and control devices included in the facility (including the control systems). | 90 Days Prior to Substantial Completion |
| PRC-012-2 | Remedial Action Schemes | Attestation that no RAS is included in facility design.<br>OR<br>Specific documentation for remedial action scheme settings of protection and control devices included in the facility (including the control systems). | 30 Days prior to Substantial Completion |

[1] NTD: Items to be updated and current as of the Effective Date of the Agreement.

| NERC Standard | Title | Deliverable | Due Date |
|---|---|---|---|
| PRC-017-1 | Remedial Action Scheme Maintenance and Testing | Attestation that no RAS is included in facility design.<br>OR<br>Specific documentation for remedial action scheme settings of protection and control devices included in the facility (including the control systems). | 30 Days prior to Substantial Completion |
| PRC-019-2 | Coordination of Generating Unit or Plant Capabilities, Voltage Regulating Controls, and Protection | Relay setting documentation and a specific report showing that all limiters operate before protection and control devices including the control systems and the protective system limits damage to equipment. | 90 Days Prior to Substantial Completion |
| PRC-023-4 | Transmission Relay Loadability | Attestation that PRC-023-4 does not apply or evidence of compliance | 90 Days Prior to Substantial Completion |
| PRC-024-2 | Generator Frequency and Voltage Protective Relay Settings | Relay setting documentation and a specific report showing the frequency and voltage responsive relays and control function device comply with the setting requirements of PRC-024 by not tripping in the "No-Trip" zone. | 90 Days Prior to Substantial Completion |
| PRC-025-2 | Generator Relay Loadability | Relay setting documentation and a specific report showing the load responsive relays comply with the setting requirements of PRC-025. | 90 Days Prior to Substantial Completion |
| PRC-026-1 | Relay Performance During Stable Power Swings | Relay Setting Documentation and analysis showing the load responsive relays will not trip during power swings. | 90 Days Prior to Substantial Completion |
| PRC-027-1 | Coordination of Protection Systems for Performance During Faults | Complete package of relays setting documents including analysis to support review by Entergy Transmission. Documentation should include varication of electrical coordination for expected fault currents. | Should be provided before equipment is energized. |
| VAR-002-4.1 | Generator Operation for Maintaining Network Voltage Schedules | 1) Report showing facility design must include alarms for AVC mode off, PSS off, and out of voltage schedule.<br><br>2) Report showing pop-up notification in the HMI telling the operator that changing the AVR/controller from AVR to any other mode (PF, VAR control) MUST have documented/written approval from the TCC before changing modes. | 60 Days Prior to Substantial Completion |

# BESS BOT Scope Book
# Appendix 11
# Project Controls

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 9/14/2023 | All | Original Publication |
| 1 | 6/6/2024 | All | Added required witness and hold points to QA/QC Plan<br>Added 60-day deadline for PEP submission<br>Added flow diagram to document control plan |
| 25-1 | 11/3/2025 | Cover | Added BESS Cover Page |
| | | | |
| | | | |

# 1 Project Controls

Our mutual goal is to have a safe construction environment in which we deliver a quality plant, on time, at the agreed upon cost, that can be safely, timely and efficiently operated for the next several decades by the Owner Operating Company. ***A key element of successful project delivery is having execution plans that clarify roles, responsibilities, and expectations for the various companies and persons managing the execution effort.*** It is presumed that Owner is contracting with companies experienced in executing the work and that our partners already have their own set of plans. Owner's execution team will then review our partners' plans to establish a confidence-level that the work will be executed safely, efficiently and to scope, and also offer suggestions based on lessons learned.

Owner will not be providing templates of the required plans, because if we were to do so, we risk diminishing the ownership that a partner would have if the plan wasn't developed by their company with their own subject matter experts. However, the below guidelines may help provide context as to Owner's minimum information expectations.

Owner is not requiring its partners to rewrite or reformat their existing plans, we just want to confirm that our partners have established a methodical approach that serves as a roadmap for their internal management and their contractors to ensure successful project execution. Some plans might be stand-alone due to their complexity or importance, i.e. Environmental, Health and Safety or Quality plans, while other information may be embedded in an overall Project Execution Plan, as contemplated below.

## 1.1 Health, Safety, and Environmental Plan

Purpose: Protocols to safeguard the health and safety of all persons who visit/work on the site, as well as environmental protections for the site, as well as adjacent land owners/public/communities.

- Seller's Corporate HSE policy, setting forth minimum expectations and confirmation that all subcontractors' plans meet the minimum expectations
- Safety Programs

  - ✓ General Safety plan
  - ✓ Responsibilities of Contractors, Employees and Visitors
  - ✓ Subcontractor safety plans
  - ✓ Site specific safety protocols, including, but not limited to: drug testing, surveillance, on-site training/orientation, stop work authority, hazardous materials, LOTO-High Energy, emergency response, record retention, incident follow-up, commitment to action if a safety protocol and/or safeguard is violated, etc.
  - ✓ Reporting information: Timeline for reporting severe incidents between the contractors (sub to EPC to Seller) and to the Buyer, statistics information, incident investigations/lessons learned
  - ✓ Describe the steps that will be taken to educate and inform local law and EMS personnel about the site to increase their efficiency should their assistance be needed

- Extreme Weather / Hurricane Plan

  - ✓ Guidelines for protecting the workers and preparing the project site and loose materials for extreme weather i.e. hurricanes, tornadoes, freeze/ice snow,
  - ✓ Establishing management communication before, during and after severe weather events, and
  - ✓ Assessing the site after an extreme weather event

- Environmental

  - ✓ Protection of the project land and biodiversity, as well as adjacent land/communities/public
  - ✓ Permitting: SWPPP, SPCC, Waters of the US, et al
  - ✓ Protocols for monitoring adherence to Best Management Practices listed in the permitting
  - ✓ Protocols for ensuring compliant disposal of damaged modules or other e-waste or haz waste
  - ✓ Protocols for preventing any new ENV issues from happening

- If a Seller's intention is to submit *their EPC's Environmental and/or Safety plan*, then articulate how the Seller will oversight their EPC's compliance with their plan

## 1.2 Quality Assurance/Quality Control Plan

Purpose: Protocols for verification that the project is built in compliance with the Agreement, IFC drawings, the Scope of Work, and that the installation will meet the Performance Standard for a plant that can be safely maintained, and timely and efficiently operated.

- Seller's and/or EPC's Corporate QA/QC policy, setting forth minimum expectations and confirmation that all subcontractors' plans meet the minimum expectations
- Accountability of contractors
- Process control
- Design Control
- Document Control
- Reporting
- Training
- Materials Quality
- Installation Quality Assurance (PV: civil, mechanical, electrical and HV: Collector Sub, transmission, distribution)
- Equipment calibration
- Identifying and managing nonconformance
- Articulate the process for tiered inspection oversight, i.e. Subs QA their work, the EPC then QAs the subs' work, the Seller then QAs the sub's work
- If a Seller's intention is to submit their EPC's QA/QC plan, then articulate how the Seller will oversight that EPC's compliance with their stated protocols
- Include information on the onsite inspection process/program that will be conducted by the major materials OEMs' QA/QC teams, i.e. for trackers, inverters, modules, major Collector Substation components, etc.

- Required Witness Points – The following inspection points, at a minimum, shall be included in the plan. Project Inspection presence at the "Event" is required. The contractor may proceed past the point, provided, the agreed notice of "Event" is given, and the Project Manager elects not to be present at the time of "Event".
    - SWPP compliance and initial road cut
    - Medium voltage cable installation
    - Pile pull test
    - Inverter skid / MV rough in
    - Inverter set
    - DC cable / combiner box / CAB installation
    - PV wire harness management
    - Main step up (MSU) transformer pit
    - MSU transformer set
    - Backfeed
- Required Hold Points – The following hold points, at a minimum, shall be included in the plan. No work is to proceed beyond this point without Buyer's Engineer inspection witness and acceptance of the "Event" activity. Waiver of the Project presence at a hold point can only be given in writing by the Project Manager.
    - Golden Row
    - Mechanical Completion
    - Substantial Completion
    - Final Acceptance

## 1.3 Project Execution Plan (PEP) Overview Guidance

Purpose: A Project Execution Plan (PEP) is a governing document that establishes the means and methods to execute, monitor and control projects. In the context of the business partners working with Owner to execute renewable projects, the PEP should contain high-level information about the project, discuss stakeholders and provide an organizational chart of the entities and people that will manage the project. The PEP may include Design, Engineering and Construction management protocols, articulate the approach for contracting and procurement, intended methods for security of the site, people and material, how project performance will be monitored with scheduling and installation velocity tracking, identification of risks and risk-monitoring, and how documentation and required information will be transmitted. A completed PEP document shall be provided 60 days after FNTP with the final draft being provided 4 months prior to site mobilization.

The following plans can be stand alone or grouped as one over-arching document:

### 1.3.1 Project Organization Plan

- Project Organization and Roles/Responsibilities
- Include primary companies (Seller and EPC), could also include Owner's primary contacts
- Meeting and Report Distribution Matrix (listing of personnel to be included in mtgs/reports/etc.)

### 1.3.2 Engineering Plan

Purpose: Acknowledge requirements in the Agreement and the Scope of Work (SOW) by communicating the plan to meet key deliverables and expectations.

- Articulates the engineering strategy, identify who is performing the engineering tasks
- Discuss Basis of Design document development (PV and HV)
- Provide a submittal list of ENG documents that correlates with the SOW and the engineering phase
- Design review cycle, i.e. 30-60-90 or Phase A/B/C, RFIs/tracking

  - ✓ List the deliverables that will be in each phase
  - ✓ Define what constitutes achieving IFC drawings

- Dates and Milestones for Engineering deliverables

  - ✓ PV Engineering, including civil, mechanical, electrical, Cx, et al
  - ✓ HV/Substation Engineering
  - ✓ Drawings, etc.

- Approach for developing plans defined in the Agreement/SOW, i.e. the Hot Commissioning Plan, the Performance Testing Plan, Harmonics Studies, etc.
- Establishing, implementing, and adhering to NERC-CIP requirements (as will be further detailed in the
  stand-alone Cyber Security Plan)

## 1.4 Document Control Plan

- Describe the method for transmitting documentation deliverables to Owner
- Articulate the process for tracking review comments and resolution of comments (ball-in-court process) including flow diagram showing the document issue and revision / comment process to ensure alignment
- Ensure that the external team members are aware of Owner's >10MB email attachment restrictions

## 1.5 Contracting Plan

- Articulates the contracting strategies, identify primary suppliers, discuss long-lead times
- List of anticipated contractors for major services
- Key supply risks and mitigating actions
- Narrative on actively pursuing qualified/capable local and diverse suppliers and labor resources, and sharing this information with Owner

## 1.6 Procurement Plan

- Articulates the procurement strategies and approach used to purchase equipment and materials for the project
- Narrative of how procurement functions through contracts and responsibilities
- Estimated start and end delivery dates of equipment
- Key supply risks and mitigating actions

## 1.7 Construction Plan

- Narrative of how the work will be managed and by whom, include titles and corresponding roles and responsibilities
- Articulate the planned approach to constructing the plant, from initial grading to cold and hot commissioning
- Due to the importance of commissioning (Cx), as well as the increased safety focus that is required, include discussion on the Cx plan
- Reference applicable project plans, i.e. Safety/ENV, QA/QC, Procurement, Performance Monitoring, and how the Seller/EPC will provide engagement and oversight to ensure plans are being followed
- Include specific discussion acknowledging the challenges for building in the Deep South, including weather, terrain, labor availability - list construction practices that will be implemented to ensure safety and schedule optimization
- Describe the plan to minimize items that can/will be addressed during the construction cycle to minimize elongated periods to achieve Mechanical Completion, Substantial Completion and Final Acceptance (drainage and water conveyance, high vegetation, Pre-Punch List items with the EPC, rut remediation, trash/litter, damaged components, etc.)
- Describe the oversight and communications that will occur between all entities to ensure continued focus of safety, environmental, and quality when personnel changes occur and/or conditions change on site, for example the transformation that often occurs on the site when transitioning to the Substantial Completion through Final Acceptance phase

## 1.8 Site Security Plan (Project Custody)

- Explain how the site will be secured to protect the people on site as well as the project's assets
- Ensure how the site will restrict unauthorized access
- Describe the signage for the site that will communicate authorized access requirements, i.e. project signage, main gate(s) descriptor signage, directional signs, Site Rules and Required PPE signage, explanation of authorized access / badging if applicable, speed limit signs, muster locations, Hot Cx / LOTO signage/roping (i.e. Red Rope process)

## 1.9 Project Risk Register

- Identify, track and manage risks, i.e.:

  - ✓ Safety, environmental, weather, labor/contractor resources
  - ✓ Design/Engineering progressing to IFC
  - ✓ Supply chain issues
  - ✓ PV Installation: Civil, mechanical/electrical/civil work, electrical
  - ✓ HV Installation: Collector substation, transmission lines, etc.
  - ✓ Handover requirements/readiness
  - ✓ Political changes

- Ensure risks are listed with potential schedule and/or cost impacts
- Articulate with what frequency the Risk Matrix will be reviewed, updated and shared with Owner, i.e. included in the monthly Report

- Request Owner to share lessons learned from previous projects
- Please provide an example of your risk matrix for review

## 1.10 Schedule and Performance Management

Purpose: Planning the work involves having a project schedule that shows a sophisticated approach to planning the work, including demonstrating an understanding of the resources that will be required (Man Hours, equipment, subcontractors), weather, procurement, labor availability, etc. Communicating the plan to all supervisors, managers, and project leaders is critical in establishing universal and unified performance. Ensuring that the plan is being worked involves tracking progress and updating the schedule and plan when challenges or changes occur; to accomplish this, frequent reporting to all project leadership is critical.

### 1.10.1 Schedule Management Plan

- Articulate the schedule strategy, control requirements, software tool selection, frequency of updates, etc. Refer to the detailed expectations in the Scope of Work document
- Describe how installation velocity will be tracked
- Articulate how often the velocity reporting and schedules will be reviewed and updated and how the information will be shared with Owner, i.e. Weekly for Velocity, monthly for P6 schedule updates, etc.
- Refer to the detailed expectations in the Scope of Work document
- Please provide an example of your weekly velocity tracker for review

### 1.10.2 Preliminary Baseline Level I and Level II Project Schedules and WBS

- Baseline schedules – provide the initial baseline schedule for the project
- Refer to the detailed expectations in the Scope of Work document

### 1.10.3 Performance Measurement Baseline

- Describe how performance will be tracked, managed and reported, i.e. in the monthly report
- Describe key commodities that will be tracked via Velocity Installation Curves
- Refer to the detailed expectations in the Scope of Work document
- Articulate the information that will be shared in the Monthly Reporting/Weekly Reporting
- Please provide an example of your Monthly Reporting / Weekly Reporting

# BESS BOT Scope Book
# Appendix 12
# Equipment Warranties

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 25-1 | 11/3/2025 | Cover | Original Publication |
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| | | | |

# 1 Major Equipment Warranties

Building or Special Built Enclosure Battery (to include battery modules, battery management system, thermal management system if integrated, safety elements if integrated, and power conversion system if integrated) – Shall have a warranty of 3 Years from Mechanical Completion with Original Equipment Manufacturer (OEM) responsible for all maintenance costs during warranty period.

Building or Special Built Enclosure Power Conversion System – 5 Years from Mechanical Completion with Original Equipment Manufacturer (OEM) responsible for all maintenance costs.

Containerized Battery (to include battery modules, racking and container, thermal management system, safety elements, battery management system, and power conversion system) – 3 Years from Mechanical Completion with Original Equipment Manufacturer (OEM) responsible for maintenance costs.

Medium Voltage Transformer – 3 Years from Mechanical Completion with OEM responsible for all maintenance costs.