Facility Connection Requirements

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TABLE OF CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

Southern Maryland Electric Cooperative, Inc. (SMECO) is a customer-owned electric cooperative providing electricity to over 170,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is currently registered with the North American Electric Reliability Council (NERC) within the ReliabilityFirst (RF) Region as a Distribution Provider (DP) and Transmission Owner (TO). SMECO has also executed the Consolidated Transmission Owners Agreement (CTOA) and, as such, is a TO whose transmission facilities are under the operational control of PJM Interconnection, L.L.C. (PJM). SMECO's transmission facilities are interconnected with the Potomac Electric Power Company (PEPCO) transmission system, and SMECO serves as a Transmission Owner Control Center (TOCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." (PJM Operating Agreement), the PJM Open Access Transmission Tariff (Tariff), the "Interconnection and Mutual Operating Agreement" between PEPCO and SMECO, and the PJM Manual 14 series documents. The PJM Manual 14 series contains information specific to the generation and transmission interconnection process, planning studies, and facility connection requirements specific to the PJM system.

1.2 DISCLAIMER

This document, the associated Exhibits, and all the material contained herein are developed for guidance purposes only. It is produced as an informational and illustrational aid for customers considering purchasing generation equipment and interconnecting that generation equipment with the SMECO system (the interconnected arrangement of lines, transformers and generators that comprise SMECO's electric system). The information herein is intended to be of a general and typical nature and does not pertain to a specific facility or site. Furthermore, the requirements and practices described herein are subject to change based upon several factors, such as changing regulations. Accordingly, SMECO makes no warranty of any nature whatsoever concerning the information contained in this document.

1.3 PURPOSE

SMECO has prepared this document, and the associated Exhibits, to establish the requirements for interconnection to the SMECO electric system for generation, transmission, and end-user facilities.

These requirements are intended to promote safe operation, system integrity and reliability of the SMECO and interconnected systems. These requirements are minimums to be used as a guide toward SMECO's processing of interconnection requests. A thorough review and understanding of these requirements will assist a requesting party in obtaining timely and mutually satisfactory responses.

Each request for an interconnection will be evaluated on a case-by-case basis and will be subject to meeting the reasonable needs of the requesting party. The requesting party may be an Independent Power Producer (IPP), another electric utility, a municipality, or a retail customer. Interconnections must meet electric utility standards, including but not limited to, applicable NERC reliability and cyber security standards, PJM standards, and SMECO standards. SMECO standards are available on the www.smeco.coop website. The review and approval requirements detailed here shall apply to all interconnected facilities regardless of which party performs the design, construction, or installation work. The requesting party must obtain final design and equipment approval from SMECO.

This document, and the associated Exhibits, will be revised as needed to meet current conditions and NERC Reliability Standards. SMECO shall make this document available within five business days to the users of the electric system, the Regional Reliability Organization, and NERC on request.

1.4 SCOPE/APPLICABILITY

This document, and the associated Exhibits, applies to any and all third parties wishing to interconnect to the SMECO electric system at any location or voltage level. The PJM Tariff and / or PJM Interconnection Service Agreement (ISA) requirements will supersede SMECO Facility Connection requirements in cases of inadvertent conflict. Interconnections that are not subject to the PJM Tariff may instead be subject to Maryland State regulations as specified in Code of Maryland Regulations (COMAR), COMAR Section 20.50.09.

2. SMECO RESPONSIBILITIES

Vice President System Planning & Distribution Engineering	Provides technical support with respect to interconnection operational requirements, monitoring, and project review.
Distribution Engineer	Maintains and approves this procedure. Provides technical support with respect to system studies and project review.
Vice President Transmission Engineering Operations	Provides technical support with respect to project management, construction, engineering, material procurement.

Reliability and Compliance Director	Acts as the Compliance Officer for regulatory matters.

3. PROCEDURE DETAIL

3.1 DOCUMENTATION OF FACILITY CONNECTION REQUIREMENTS

Interconnections to the SMECO electric system shall comply with NERC, Reliability First (RF), PJM, and, as applicable, Maryland State requirements. Proposed Interconnections must not degrade reliability, operating flexibility, or safety of the existing electric system. System Studies will be required to evaluate the potential impacts of any proposed interconnections. Any such studies will be entirely funded by the requesting entity. See Exhibit “A”, **Electric System Planning Criteria**, for additional details.

3.1.1 GENERATION FACILITIES[1]

Generation facility connection requirements described in this document are general overviews of functional requirements for connecting new generation to the SMECO electric system. Detailed, project specific requirements will be developed as part of coordinated Joint Studies, Interconnection Agreements, other applicable PJM, NERC or Regional Reliability Standards, applicable Regional Reliability Organization, Sub-regional, Power Pool planning criteria and facility connection requirements, or the National Electrical Safety Code (NESC).

3.1.2 TRANSMISSION FACILITIES[2]

Transmission facility connection requirements described in this document are general overviews of functional requirements for connecting new transmission facilities to the SMECO electric system. Detailed, project specific requirements will be developed as part of coordinated Joint Studies, Interconnection Agreements, other applicable PJM, NERC or Regional Reliability Standards, applicable Regional Reliability Organization, Sub-regional, Power Pool planning criteria and facility connection requirements, or the NESC. See Exhibit “B”, **Substation and Transmission Line Design Criteria, for additional details**.

3.1.3 END-USER FACILITIES[3]

In the event an end-user proposes to connect to the SMECO electric system, the facility connection requirements described in this document are general overviews of functional requirements for connecting as a Delivery Point. Detailed, project specific requirements will be developed as part of coordinated Joint Studies, Interconnection Agreements, other applicable PJM, NERC or Regional Reliability Standards, applicable Regional Reliability Organization, sub-regional, Power Pool planning criteria and facility connection requirements, or the NESC.

3.1.4 MARYLAND STATE PRESCRIBED DISTRIBUTED GENERATION

Maryland State law may regulate the application, review, and approval process for connections at distribution voltages, including distributed generation such as, but not limited to, net-meter interconnections, aggregated net-meter interconnections, and Community Solar Energy Generation System interconnections. In such instances, the COMAR may supersede other SMECO requirements stated herein. Refer to COMAR for other potential applicable references.

3.2 DETAILED INFORMATION ON FACILITY CONNECTION REQUIREMENTS

This document has been prepared to identify the technical requirements for connecting new facilities to the SMECO electric system. It applies to new connections or substantial modifications of the system. Rather than give detailed technical specifications, this document provides a general overview of the functional objectives and requirements to be met in the design of facility connections. These requirements are written to establish a basis for maintaining reliability, power quality, and a safe environment for the general public, power consumers, maintenance personnel and the equipment. See Exhibit “C”, **Interconnection Requirements, for additional details**.

3.2.1 INTERCONNECTION STUDIES – PJM PROCEDURES

It is the intent of SMECO to achieve the required system performance and comply with the relevant NERC or Regional Reliability Standards as such relate to connections to the SMECO electric system throughout the applicable planning horizon. SMECO will work directly with PJM toward this intent as summarized in subsequent sections of this document.

3.2.2 Coordination through PJM Processes

SMECO is registered as a TO with both NERC and PJM. PJM serves as the Transmission Service Provider, Planning Authority, Transmission Planner, Resource Planner, Reliability Coordinator, Balancing Authority, and Transmission Operator for SMECO. PJM operates its transmission system in compliance with NERC Reliability Standards, RFC standards, and PJM standards. Because PJM is the Transmission Service Provider for the SMECO transmission system, all entities requesting interconnection of a generating facility (including increases to the capacity of an existing generating unit or decommissioning of a generating unit) or requesting interconnection of a merchant transmission facility to the SMECO transmission system must do so within PJM's defined interconnection process. This process, in its entirety, ensures that all new or materially modified transmission facilities are within the metered boundaries of the PJM Balancing Authority Area[4]. See the PJM website http://www.pjm.com to obtain information about submitting requests for interconnecting to the transmission system. Part IV of the PJM Tariff discusses interconnections with the transmission system. The PJM Manual 14 series also addresses the interconnection process, planning study requirements, and facility connection requirements specific to the PJM transmission system:

PJM Manual 14A – New Services Request Process

PJM Manual 14A guides developers of generation and merchant transmission projects through the initial planning stage through the request for facility construction. This process ensures the successful, timely completion of PJM's planning, facility construction and operational and market infrastructure requirements. PJM Manual 14A explains how other parties are notified of new or modified facilities through the PJM RTEP process. [5]

PJM Manual 14B – PJM Region Transmission Planning Process

PJM Manual 14B focuses on the process for planning baseline expansion facilities under the PJM Region Transmission Planning Process. This planning process culminates in the Regional Transmission Expansion Plan (RTEP). The PJM RTEP process consists of baseline reliability reviews as well as analysis to identify the transmission needs associated with generation interconnection and merchant transmission interconnection.

PJM Manual 14C – Interconnection Facilities, and Network Upgrade Construction

PJM Manual 14C guides developers of generation and merchant transmission projects through the PJM RTEP queue project lifecycle from agreement execution to commercial operation and construction agreement closeout. In other words, this manual focuses on the requirements for interconnecting generating sources under PJM's RTEP and describes the engineering and construction process to complete the interconnection of new facilities with the PJM grid. Also, this manual depicts the process for tracking projects driven by reliability criteria.

PJM Manual 14D – Generator Operational Requirements

PJM Manual 14D focuses on the operational requirements for generating entities to connect to the PJM system and their responsibilities as signatories to the PJM Operating Agreement.

PJM Manual 14E – Upgrade and Transmission Interconnection Requests

Among other things, this manual focuses on the specific requirements for interconnecting merchant transmission facilities, proposing capacity increases to specific TO facilities, and making upgrade requests to obtain incremental auction revenue rights under PJM's RTEP process. This manual describes the various rights available and agreements needed to complete the transmission interconnection or upgrade planning process."

Part IV of the PJM Tariff contains procedures for generation interconnection requests and transmission interconnection requests. Generally, to initiate the Interconnection Planning Process for a generation interconnection request, the developer must submit a completed Interconnection Request to PJM. This is accomplished via the execution of a Feasibility Study Agreement. Typically, the procedures used to process the requests for generation interconnection with the transmission system include three analytical steps[6]:

1. Feasibility Study
   The Feasibility Study assesses the practicality and cost of incorporating the generating unit or increased generation or transmission capacity into the PJM system. The analysis is limited to short-circuit studies and load-flow analysis of probable contingencies. This study does not include stability analysis. The study also focuses on determining preliminary estimates of the type, scope, and lead time for construction of the Transmission Owner's facilities required to interconnect the project.

2. System Impact Study
   The System Impact Study is a comprehensive regional analysis of the impact of adding the new generation and/or transmission facility to the system and an evaluation of their impact on deliverability to PJM load in the particular PJM region where the generator and/or new transmission facility is located. This Study identifies the system constraints relating to the project and the necessary Attachment Facilities, Local Upgrades, and Network Upgrades. The study refines and more comprehensively estimates cost responsibility and construction lead times for facilities and upgrades.

3. Interconnection Facilities Study

   The Interconnection Facilities Study will document the engineering design work necessary to begin construction of any required transmission facilities. The Study also will provide a good-faith estimate of the cost to be charged to the applicant for Attachment Facilities, Local Upgrades and Network Upgrades necessary to accommodate the project and an estimate of the time required to complete detailed design and construction of the facilities and upgrades.

PJM Manual 14F – Competitive Planning Process

PJM Manual 14F focuses on the process to conduct competitive proposal windows consistent with FERC Order No. 1000 regarding Transmission Planning and Cost Allocation.

PJM Manual 14G – Generation Interconnection Requests

PJM Manual 14G is a division out of Manual 14A Revision 23 that guides developers of generation projects through the planning and study phase of their proposed project up to the request for facility construction. This manual is applicable to any new service request received prior to April 1, 2018.

PJM will coordinate with all impacted utilities any request for connections that impact the lines of other interconnected utilities. This document is intended to highlight the minimum SMECO requirements and is not intended to fully replicate or to replace the PJM documentation. The scope of this document is limited to the technical requirements for connected facility design and operation. Parties requiring transmission service should refer to the PJM Open Access Transmission Tariff (OATT) to reserve and secure transmission service for their generation.

PJM Manual 14H – New Service Requests Cycle Process

PJM Manual 14H guides developers of generation projects through the planning and study phase of their proposed project up to the request for facility construction. PJM summarizes the application process, study process and agreements tendered for any project developer that submits a new service request. This manual is applicable to any new service requests received on or after April 1, 2018.

3.2.3 Voltage Level and MW and MVAR Capacity at Point of Connection

Voltage level and Megawatt (MW) and Megavar (MVAR) capacity or demand at point of inter-connection shall be analyzed, as necessary and appropriate, during the study process. Notwithstanding, the following are voltage issues that need to be considered:

All synchronous generators connected to the SMECO electric system are to be equipped with automatic voltage regulators (AVR). Generators with megavolt-ampere (MVA) ratings larger than 20.0 MVA connected to the SMECO electric system shall operate with the generator's AVR enabled and in the automatic voltage control mode to the extent practicable, unless otherwise approved by the applicable system operator consistent with NERC Reliability Standard VAR-002-1.1a as may be amended from time to time.

Entities connecting their electric system with SMECO's electric system shall endeavor to supply the reactive power required on their own system, except as otherwise mutually agreed with SMECO. SMECO shall not be obligated to supply or absorb reactive power for the other party when it interconnects with SMECO's electric system.

For end-users, the installation of power factor correction capacitor banks that compensate for the reactive power demands of customer loads may be required. The end-user should design and operate its load connections so that the load power factor measured at the customer service point is between 98.5% lagging and unity at all times. Delivery point(s) connections to the SMECO electric system shall operate to meet the power factor requirements agreed to by the parties.

3.2.4 Breaker Duty and Surge Protection

Breaker duty and surge protection requirements are applicable to all generation facilities, transmission facilities, and end-user facilities connected to the SMECO electric system.

All circuit breakers and other fault interrupting devices shall be capable of safely interrupting fault currents for any fault they may be required to interrupt. AC high voltage circuit breakers are specified by operating voltage, continuous current, interrupting current and operating time in accordance with ANSI/IEEE Standards C37 series, "Symmetrical Current Basis." These ratings are displayed on the individual Circuit Breaker nameplate. Breakers will be scheduled for replacement when they exceed 100% of ANSI C37 Guidelines for breaker duty ratings. There may be cases where adding generation will increase the available fault current above the present interrupting ratings of the existing breakers at a substation or stations. When this occurs, breaker upgrades are to be considered as part of the interconnection project. See Exhibit "B", for additional details.

Application of circuit breaker duty rating shall be in accordance with ANSI/IEEE C37 standards.

Basic Surge Level (BSL) or Basic Insulation Level (BIL), surge arrester, conductor spacing and gap application, substation and transmission line insulation strength, protection, and shielding shall be documented and submitted for evaluation as part of the interconnection plan.

3.2.5 SYSTEM PROTECTION AND COORDINATION

Utility grade, transmission level protective relays and fault clearing systems are to be provided on the interconnected electric system. All protective relays should meet or exceed ANSI/IEEE Standard series C37.90. Current transformers used for protection must be designed and installed in accordance with IEEE Standards. Adjoining electric systems may share a common zone of protection between two parties. Compatible relaying equipment must be used on each side of the point of ownership within a given zone of protection. The design must provide coordination for speed and sensitivity in order to maintain electric system security, system reliability, and system stability. All applicable NERC Reliability Standards for design, coordination, settings, and testing must be met.

System Protection Requirements for Generation Facilities:

Generator facilities connecting to any SMECO transmission line or facility are responsible for protecting those facilities from electrical faults and other hazardous conditions. Generator interconnections must be equipped with circuit breakers or other appropriate interrupting devices to protect those facilities. The generator owner must provide and own the primary circuit breaker or other interrupting device that protects the facility and disconnects it from the SMECO transmission line. The primary purpose of this interrupting device is to protect the generating plant facility. The protection system design must provide coordination for speed and sensitivity in order to maintain electric system security and reliability. See Exhibit “D”, **Customer Generation Protective Relaying Requirements**, for additional details.

System Protection Requirements for Transmission Facilities and End-User Facilities:

All primary protective relaying must operate within a time that meets the performance criteria established under the NERC Transmission System Planning (TPL) series of Reliability Standards. Backup protective systems must provide additional coverage for breaker and relay failure. Backup systems should operate in a coordinated fashion for failures on either side of an interconnection point to the extent possible. Time and sensitivity coordination must be maintained to prevent mis-operations.

A power source for tripping and control must be provided at substations by a DC storage battery. The battery is to be sized with enough capacity to operate all tripping devices after eight hours without a charger and in accordance with IEEE Standards. An under-voltage alarm must be provided for remote monitoring by the facilities owners who shall take immediate action to restore power to the protective equipment. Dual independent communication schemes to the remote terminal(s) are required for many installations. It is used for communication assisted transmission line protection, backup protection and islanding schemes. Fiber optics is the preferred means of communication. Audio tone over phone line is the least preferred method because it may not meet requirements for speed and reliability. See Exhibit “B” for additional details.

End-users are responsible for providing a reliable protective relaying scheme for customer-owned power transformers connected to the electric system. All faults on the transformers, bushings and transformer high-side arresters must be isolated by tripping a transformer high side fault interrupting device. Faults on the transformer high-side windings, high-side bushings, and transformer high-side arresters must be cleared to coordinate with transmission protection systems. This is to assure that a permanent failure in this zone would not result in a permanent outage of a transmission line segment. Faults in this zone must be coordinated with any applicable SMECO remote relaying.

3.2.6 METERING AND TELECOMMUNICATIONS

General – Unless otherwise agreed by the parties, SMECO shall install the metering equipment required for the operation of the interconnecting facilities and shall own, operate, test and maintain such equipment. Power flows to and from the interconnecting facility shall be measured in analog and/or digital form as required by SMECO. The interconnecting party shall bear all reasonable documented costs associated with the purchase, installation, operation, testing and maintenance of the metering equipment.

Current transformers – current transformers (CTs) used for revenue metering circuits must meet the accuracy standards, as specified under the American National Standards Institute (ANSI) C57.13, for an accuracy class of 0.3 percent at all burdens. Current transformers shall have a thermal rating factor of at least 2.0. Dedicated CTs are required for revenue metering.

Voltage transformers – voltage transformers (VTs) used for revenue metering circuits must meet the accuracy standards, as specified under ANSI C57.13, of 0.3 percent accuracy with the following burdens:

6.3.1. “W” through “Y” burden for 5 kV through 25 kV; and
6.3.2. “W” through “Z” burden for 25 kV and above.

Dedicated VTs are required for revenue metering.

Check Meters - The interconnecting party, at its option and expense, may install and operate, on its premise, one or more check meters to validate SMECO's meters. Such check meters shall be for check purposes only and shall not be used for the measurement of power flows. The check meters shall be subject at all reasonable times to inspection and examination by SMECO or its designee. The installation, operation and maintenance thereof shall be performed entirely by the interconnecting party in accordance with Good Utility Practice.

Metering Standards - SMECO shall install, calibrate, and test revenue quality metering equipment in accordance with applicable ANSI standards. See Exhibit "F", **Revenue Metering Requirements**, for additional details.

Testing of the Metering Equipment - SMECO shall inspect and test all metering equipment upon installation and at least once every two (2) years thereafter. If requested to do so by the interconnecting party, SMECO, at the interconnecting party's expense, may inspect or test the metering equipment more frequently than every two (2) years. SMECO shall give reasonable notice of the time when any inspection or test shall take place, and the interconnecting party may have representatives present at the test or inspection. If at any time the metering equipment is found to be inaccurate or defective, it shall be adjusted, repaired or replaced at the interconnecting party's expense, in order to provide accurate metering, unless the inaccuracy or defect is due to SMECO's failure to maintain, then SMECO shall pay. If the metering equipment fails to register, or if the measurement made by the metering equipment during a test varies by more than two percent from the measurement made by the standard meter used in the test, SMECO shall adjust the measurements by correcting all measurements for the period during which the metering equipment was in error by using the interconnecting party's check meters, if installed. If no such check meters are installed or if the period cannot be reasonably ascertained, the adjustment shall be for the period immediately preceding the test of the metering equipment equal to one-half the time from the date of the last previous test of the metering equipment.

Metering Data - At the interconnecting party's expense, the metered data shall be telemetered to one or more locations designated by SMECO and one or more locations designated by the interconnecting party.

Voice Communications – The interconnecting party shall maintain satisfactory operating communications with SMECO's electric system dispatcher or other designated representative. The interconnecting party shall provide standard voice line, dedicated voice line (generator interconnections only) and facsimile communications at its control room or central facility through use of either the public telephone system or a separate voice communications system.

Data communications - The interconnecting party shall also provide the dedicated data circuit(s) necessary to provide interconnecting facility data to SMECO as required for reliable electric system operation. Any required maintenance of such data circuit(s) shall be the responsibility of the interconnecting party. Operational communications shall be activated and maintained under, but not be limited to, the following events: system paralleling or separation, scheduled and unscheduled shutdowns, equipment clearances, and hourly and daily load data. See Exhibit "E", **SCADA and Communications Requirements**, for additional details.

Remote Terminal Unit (RTU) – Prior to the operation of the interconnecting facilities, an RTU shall be installed by the interconnecting party, or by SMECO at the interconnecting party's expense, to gather accumulated and instantaneous data to be telemetered to SMECO. The communication protocol for the data circuit(s) shall be specified by SMECO. Instantaneous bi-directional analog real power and reactive power flow information must be telemetered directly to the location(s) specified by SMECO. Each party will promptly advise the other party if it detects or otherwise learns of any metering, telemetry or communications equipment errors or malfunctions that require the attention and/or correction by the other party. The party owning such equipment shall correct such error or malfunction as soon as reasonably feasible. See Exhibit "E", for additional details.

3.2.7 GROUNDING AND SAFETY ISSUES

Safety is of utmost importance for all facilities associated with SMECO. Strict adherence to established switching, tagging and grounding procedures is required at all times for the safety of personnel. Any work carried out within a facility shall be performed in accordance with all applicable laws, rules, and regulations and in compliance with Occupational Safety and Health Administration, NESC, and good utility practice. Automatic and manual disconnect devices are to be provided as a means of removing all sources of current to any particular element of the electric system. Only trained operators are to perform switching functions within a facility under the direction of the responsible dispatcher or designated person as outlined in the NESC. See Exhibit "I", **Operational and Tagging Requirements**, for additional details.

Grounding Requirements for Generation Facilities (Source Systems):
When various switching devices are opened on an energized circuit, its ground reference may be lost if all sources are not effectively grounded. This situation may cause over voltages that affect personnel safety and damage equipment. This is especially true when one phase becomes short circuited to ground. Therefore, the interconnected transmission power system is to be effectively grounded from all sources. This is defined as $X_0/X_1 < 3$ and $R_0/X_1 < 1$. Interconnected generators should provide for effective system grounding of the high side transmission equipment by means of a grounded high voltage transformer.

Under certain system configurations/situations, the system may not be grounded at the source. However, the electric system equipment insulation level in the area must be rated to withstand the amplitude and duration of all over voltages caused by neutral displacement. Also the source must be removed rapidly when any overvoltage condition occurs. This includes isolation of the ungrounded source for system faults simultaneously with other relaying systems within the protected zone. Since the source provides no ground fault current, relay protection devices typically operate for specific voltage conditions. Some switching operations may cause the loss of all remote ground sources by islanding a part of the system even under non-fault conditions. The protection scheme must also be able to quickly remove the generation under this situation before any adverse effects occur. Some form of communication with remote transmission stations is usually required in order to accomplish this.

Grounding Requirements for Transmission Facilities and End-User Facilities:
Each interconnection substation must have a ground grid that solidly grounds all metallic structures and other non-energized metallic equipment. This grid and grounding system shall be designed to meet the requirements of ANSI/IEEE 80, IEEE Guide for Safety in AC 10 Substation Grounding and ANSI/IEEE C2, National Electrical Safety Code. The transmission line overhead ground wire (OHGW) shall be connected to the substation ground grid. See Exhibit "B" for additional details.

If the interconnection substation is close to another substation, the two grids may be isolated or connected. Connected grids are preferred, since they are easier to connect than to isolate. If the ground grids are to be isolated, there may be no metallic ground connections between the two substation ground grids. There must also be sufficient physical separation to limit soil conduction. If the ground grids are to be interconnected, the interconnecting cables must have sufficient capacity to handle the fault currents, duration, and duty. SMECO must approve any connection to a SMECO ground.

All transmission line structures must be adequately bonded and grounded to control step and touch potential in compliance with the NESC, and to provide adequate lightning performance. All transmission lines should have a continuous ground wire, not relying on earth as the primary conductor, to transfer fault current between structures and to substations and plant switchyards. Any exceptions to a continuous ground wire shall be verified with a system study. All ground wires and bond wires must be adequately sized to handle anticipated maximum fault currents and duty without damage.

Transmission interconnections may substantially increase fault current levels at nearby substations and transmission lines. Modifications to the ground grids of existing substations and OHGWs of existing lines may be necessary. The interconnection studies will determine if modifications are required and the scope and cost of the modifications.

3.2.8 INSULATION AND INSULATION COORDINATION

Insulation and Insulation Coordination requirements are applicable to all generation facilities, transmission facilities and end-user facilities connected to the SMECO electric system. Insulation coordination is the selection of insulation strength. Insulation coordination must be done properly to ensure electrical system reliability and personnel safety. Basic Surge Level (BSL) or Basic Insulation Level (BIL), surge arrester, conductor spacing, and gap application, substation and transmission line insulation strength, protection, and shielding shall be documented and submitted for evaluation as part of the interconnection plan.

3.2.9 VOLTAGE, REACTIVE POWER, AND POWER FACTOR CONTROL

Voltage, reactive power and power factor control requirements will be considered on a case-by-case basis. In order to assess power factor, the end-user delivery point real (kW) and reactive demands (kVar) shall be recorded as agreed to with SMECO.

Voltage Schedule for Generation
The interconnecting generator shall maintain the following voltage schedule; however, the operating limits of the generator shall not be exceeded in an effort to follow the voltage schedule. SMECO reserves the right to specify a different voltage schedule depending on specific interconnection tie point requirements.

230kV interconnecting bus voltage – 240kV

Voltage for Loads
It is the responsibility of the interconnecting facility owner to incorporate appropriate voltage regulation equipment in their facility if the interconnecting facility's supply voltage requirements are more restrictive than a range from 92% to 105% of the nominal voltages, listed below.

230kV
69kV
12.47kV

Reactive Power/Power Factor for Generator
The interconnected generator shall be designed and operated to maintain a composite power delivery at the continuous rated power output at a power factor between 0.95 lagging and 0.95 leading.

Reactive Power/Power Factor for Load
The interconnected facility shall be responsible for providing their own reactive power needs in order to maintain a power factor between 0.9850 lagging and 0.9925 leading. All reactive resources must be capable of operating within the voltage limits stated in the current NERC Standards and RFC Criteria for normal and emergency conditions. Switched reactive resources must be designed to minimize voltage transients on the system.

3.2.10 POWER QUALITY IMPACTS

Power quality requirements are applicable to all generation facilities, transmission facilities and end-user facilities connected to SMECO. Generation of harmonics should be limited to values prescribed by IEEE Standard 519 when measured at the interconnection point of ownership. Additionally, a SMECO facility should not be subjected to harmonic currents in excess of 5% of a transformer's rated current as stated in ANSI/IEEE Standard C57.12.00.

Power Quality
Adequate design precautions must be taken by the interconnected facility owner to prevent excessive and harmful harmonic voltages and/or currents from occurring on the SMECO system. The interconnected facility must be designed to operate with normal harmonic voltage and currents. Voltage and current harmonic levels need to be below the stated values in the current IEEE Standard 519 document. Excessive harmonics originating from within the interconnected facility will be the responsibility of the interconnected facility owner to correct at their own expense.

Voltage Flicker
Voltage surges or flicker caused by the operation, synchronization, or isolation of the interconnected facility shall be within the standards set forth in the latest version of IEEE Std. 1453 voltage flicker curves. The interconnected facility shall provide suitable equipment to limit voltage flicker to below the "Border Line of Irritation" curve on the IEEE Std. 1453 voltage flicker chart at the point of interconnection, as well as the planning levels, per Tables 1 and 2.

Phase Imbalance
Imbalanced phase voltages and currents can affect coordination of protective relaying, create higher flows of current in neutral conductors, and cause thermal overloading of transformers and motors. The measurement of voltage imbalance, Negative Sequence Unbalance Factor (NSUF) is the ratio of the negative sequence voltage divided by the positive sequence voltage, expressed as a percentage. The NSUF limits listed herein applies to normal system operations. For connections at 30 kV and above, the voltage imbalance should not exceed 1%. For connections below 230 kV, the contribution at the interconnection point should not be allowed to cause a voltage imbalance greater than 1.3%. System problems such as a blown transformer fuse or open conductor on an electric system can result in extended periods of phase imbalance. It is the interconnecting facility owner's responsibility to protect all of its connected equipment from damage that could result from such an imbalanced condition.

3.2.11 Equipment Ratings

Equipment ratings shall be suitable for the ambient temperature range of -40° C to 50°C. Equipment ratings shall be sized for load and system expansion for the 15-20 year time frame. Equipment ratings shall comply with the latest ANSI, IEEE, NEMA, and NERC requirements and must be in accordance with the SMECO methodology for determining facility ratings.

3.2.12 Synchronizing of Facilities

Generation Facilities:

Prior to commercial operation, the owner of a synchronous generator with a rating larger than 20 MVA shall provide the identified SMECO contact with documentation that describes the functional operation and settings for the AVR's control functions. This documentation shall demonstrate the AVR's controls are coordinated with the generator protection and with the generator's short-term capabilities. In cases where the AVR has been set to regulate a voltage other than the generator's terminal voltage or it has been set to regulate a compensated terminal voltage, sufficient data shall be provided to allow the AVR to be modeled accurately.

Provision of Generator Test Data

One of the standard generator commissioning tests is to introduce a step change in the AVR's reference voltage with the generator running at synchronous speed but not connected to the electric system. This is referred to the open circuit, step in voltage test and is used to confirm the AVR is functioning properly. Prior to commercial operation, the owner of a synchronous generator with a rating larger than 20 MVA should provide SMECO with open circuit, step in voltage test results. Recordings of the generator terminal voltage and generator field voltage magnitudes should be provided together with any calibration data necessary to equate the recordings with actual voltages. In situations where it is impractical to measure the generator field voltage (*e.g.,* brushless excitation systems) alternate quantities with equivalent response characteristics can be provided. An estimate of the generator's field winding temperature during this test should also be provided.

Each generating facility shall provide a point of contact to SMECO. A point of contact shall be reachable and available through telephone or other agreed upon means of communication at all times when the generating facility is energized or in operation. Any synchronizing to, or disconnecting the facility from SMECO must be pre-approved by the SMECO contact.

Disconnection without prior approval is permitted only when necessary to prevent injury to personnel or damage to equipment. Permission to synchronize to the interconnected system must be requested of SMECO following any overhaul, unit trip or islanding. It is the responsibility of the generation facility owner to provide all devices necessary to protect the customer's equipment from damage by abnormal conditions and operations that might occur on the interconnected electric system. The facility owner shall protect its generator and associated equipment from overvoltage, undervoltage, overload, short circuits (including ground fault conditions), open circuits, phase unbalance, phase reversal, surges from switching and lightning, over and under frequency conditions, and other injurious electrical conditions that may arise on the interconnected system.

Transmission and End-User Facilities:
It is the responsibility of the facility owner to provide for the orderly re-energization and synchronizing of their high voltage equipment to other parts of the electric system. Appropriate operating procedures and equipment designs are needed to guard against out-of-synch closure or uncontrolled energization. Each owner is responsible for knowing and following all applicable regulations, industry guidelines, safety requirements, and accepted practice for the design, operation and maintenance of the facility.

3.2.13 MAINTENANCE COORDINATION

The maintenance of facilities is the responsibility of the owner of those facilities. Adjoining facilities on the interconnected power system are to be maintained in accordance with accepted industry practices and procedures. Each party is to have a documented maintenance program ensuring the proper operation of equipment. SMECO will have the right to review maintenance reports and calibration records of equipment that could impact SMECO; SMECO is to be notified as soon as practicable about any out of service equipment that might affect the protection, monitoring, or operation of interconnected facilities.

Obligations – SMECO and the interconnecting party shall maintain their facilities in a safe and reliable manner in accordance with Good Utility Practice.

Coordination - SMECO and the interconnecting party shall confer regularly to coordinate the planning, scheduling and performance of preventive and corrective maintenance on the interconnecting facilities.

Secondary Systems – SMECO and the interconnecting party shall cooperate with the other in the inspection, maintenance, and testing of control or power circuits that operate below 600 volts, AC or DC, including, but not limited to, any hardware, control or protective devices, cables, conductors, electric raceways, secondary equipment panels, transducers, batteries, chargers, and voltage and current transformers that directly affect the operation of the interconnecting facilities and equipment which may reasonably be expected to impact the other party. SMECO and the interconnecting party shall provide advance notice to the other party before undertaking any work on such circuits, especially on electrical circuits involving circuit breaker trip and close contacts, current transformers, or potential transformers.

3.2.14 Operational Issues

Generators connected to SMECO must be able to withstand certain temporary excursions in voltage, frequency, reactive and real power output without tripping. A waiver may be justified in certain special circumstances such as low adverse reliability consequences from generator tripping, if mutually agreed to by SMECO. See Exhibit "I", **Operational and Tagging Requirements**, for additional details.

Generating facilities must be designed to remain online for normally cleared three-phase and delayed clearing single-line-to-ground faults within the close proximity to the plant switchyard (on the high-side of the generator step-up transformer). The ability of the generating unit to stay connected and synchronized with the electric system during system disturbances is known as low voltage ride-through. Voltage may approach zero at the switchyard bus for four to nine cycles for some types of faults. Generating plants are required to remain in-service during three-phase faults with normal clearing (which is a time period of approximately 4 – 9 cycles) and single line to ground faults with delayed clearing (10 – 30 cycles), and subsequent post-fault voltage recovery to pre-fault voltage unless clearing the fault effectively disconnects the generator from the system except as allowed under the current NERC Standards.

Most synchronous generator AVRs are equipped with limiting controls that help protect the generator while also allowing the generator to support the grid during temporary excursions in transmission voltage. The AVR's control and limiting functions must coordinate with the generator's short time capabilities and protective relay settings. These limiting controls must be properly coordinated with generator protection and with the generator's short-term voltage/reactive capabilities. Two common examples of these controls are the maximum excitation limiter (coordinates with over excitation protection) and the minimum excitation limiter (coordinates with the loss of field protection). The generating equipment owner shall provide SMECO the AVR's control and limiter settings as well as the protection settings which coordinate with AVR control and limiting functions. All new synchronous generators connected to the SMECO electric system with a nameplate rating greater than 20 MVA shall be equipped with a speed/load governing control that has a speed droop characteristic in the 3 to 6% range. Notification of changes in the status of the speed/load governing controls must be provided to SMECO.

All new synchronous generators connected to the SMECO electric system with a nameplate rating greater than 100 MVA shall be equipped with a power system stabilizer. Technical evaluations of oscillatory stability will be conducted for the interconnection of new generating plants. New generators that cause a decrease in the damping of an existing mode of oscillation or cause a poorly damped mode of oscillation will be required to operate with the power system stabilizer in service. The determination of the power system stabilizer's control settings will be coordinated with SMECO. Typically, this coordination would be to provide SMECO with preliminary power system stabilizer settings prior to the stabilizer's field commissioning tests, with the final settings provided after the field commissioning tests are completed.

All operational issues shall be considered during the study phase. Prior approval from SMECO is required for any switching that energizes or de-energizes portions of the SMECO connection or that may adversely affect SMECO. Industry and OSHA switching and safety procedures shall be strictly adhered to when maintenance is being performed. Also, each party shall maintain its system and facilities so as to avoid or minimize the likelihood of disturbances that might impair or interrupt service to the customers of the other party.

Abnormal Frequency Conditions -- It shall be the responsibility of the interconnecting facility owner to provide adequate protection or safeguards to prevent damage to SMECO caused by over/under frequency originating in the interconnected facility. The interconnecting facility owner shall provide adequate protection and safeguards to protect the interconnected facility from inadvertent over/under voltage conditions originating from the SMECO electrical system. Steady-state voltages must be maintained within the normal and emergency limits as defined in the current NERC Standards and any applicable RFC criteria or standard.

Abnormal Frequency Conditions Specific for Generators – the electric system is designed to automatically activate a load shed program in the event of an under frequency system disturbance. The interconnected generator shall implement under and over frequency relay set points to endure ride-through capability of the electric system. The generator's response to frequency deviations of pre-determined magnitudes shall be studied and coordinated with SMECO. Per PJM Manual 14 requirements, generators may not be tripped for under frequency operation until 57.5 Hz with a 5 second delay.

Generator Frequency Control - A speed governor system is required on all synchronous generators. The governor regulates the output of the generator as a function of the system frequency. That function must be coordinated with the governors of other resources, all located within the same control area, to assure proper system response to frequency variations.

Abnormal Voltages - It shall be the responsibility of the interconnecting facility owner to provide adequate protection or safeguards to prevent damage to SMECO caused by over/under voltages originating in the interconnected facility. The interconnecting facility owner shall provide adequate protection and safeguards to protect the interconnected facility from inadvertent over/under voltage conditions originating from the SMECO electrical system. Steady-state voltages must be maintained within the normal and emergency limits as defined in the current NERC Standards and RFC criteria or standard.

3.2.15 INSPECTION REQUIREMENTS FOR EXISTING OR NEW FACILITIES

SMECO shall have access, at all times, to the disconnect switch of the Unit which isolates the Unit from the SMECO system. At reasonable hours and upon reasonable notice consistent with this Agreement, or at any time without notice in the event of an emergency (as defined in paragraph 4.1), SMECO shall have access to the Unit.

If necessary, for the purposes of this Agreement, the Customer shall allow SMECO access to SMECO's equipment and facilities located on Customer's property. To the extent that the Customer does not own all or any part of the property on which SMECO is required to locate its equipment or facilities to serve the Customer under this Agreement, the Customer shall secure and provide in favor of SMECO the necessary rights to obtain access to such equipment or facilities, including easements if the circumstances so require.

Pre In-service Operation Testing and Inspection - Prior to the new interconnection facilities being placed in service, SMECO shall inspect, test, or witness the testing of the interconnecting facilities to ensure their safe and reliable operation. Similar testing may be required after initial operation. SMECO and the interconnecting party shall make any modifications to its facilities that are found to be necessary as a result of such testing. The interconnecting party shall bear the cost of all such testing, inspection, and modifications.

Post In-service Operation Testing and Modifications – Both SMECO and the interconnecting party shall perform routine inspection and testing of its interconnecting facilities and equipment in accordance with Good Utility Practice as may be necessary to ensure the continued interconnection of the new facility in a safe and reliable manner. Both SMECO and the interconnecting party shall have the right, upon advance written notice, to request additional testing of the other's interconnecting facilities.

Advance Notice - Both SMECO and the interconnecting party shall notify the other party in advance of its performance of tests of the interconnecting facilities. The other party has the right, at its own expense, to observe such testing.

Right to Inspect – SMECO and the interconnecting party shall have the right, but shall have no obligation to:

- Observe the other party's tests and/or inspection of any of its system protection facilities and other protective equipment;
- Review the settings of the other party's system protection facilities and other protective equipment; and
- Review the other party's maintenance records relative to the interconnection facilities, the system protection facilities and other protective equipment.

Exercise rights - SMECO and the interconnecting party may exercise these rights from time to time as it deems necessary upon reasonable notice to the other party. The exercise or non-exercise by a party of any such rights shall not be construed as an endorsement or confirmation of any element or condition of the interconnection facilities or the system protection facilities or other protective equipment or the operation thereof, or as a warranty as to the fitness, safety, desirability, or reliability of same.

3.2.16 COMMUNICATIONS AND PROCEDURES FOR ALL OPERATING CONDITIONS

General -- Operational communications between the interconnected facility and the SMECO Operations Center shall be active and maintained under both normal and emergency conditions.

Normal Conditions -- include, but not limited to, the following events: system paralleling or separation, scheduled and unscheduled shutdowns, equipment clearances, and hourly and daily load data.

Emergency Conditions -- are events or scenarios in which immediate action must be taken to ensure safety, prevent equipment damage, or jeopardize the reliability of the SMECO or interconnected party's system.

Failure of Communications -- Emergency telecommunications conditions may develop that affect telecommunications equipment with or without directly affecting power electric system facilities. Therefore, the interconnecting facility owner shall provide equipment redundancy and telecommunications route redundancy to protect against certain kinds of failure and telecommunications path interruption. A repair team dedicated to the telecommunications of the interconnecting facility should be retained along with an adequate supply of spare components.

Backup Communications Strategy -- Where commercial, public telephone network facilities or services support important power system telecommunications, a backup strategy should always be developed by the Customer to protect against interruption of such services. Backup methods could include redundant services, self-healing services, multiple independent routes, carriers and combinations of independent facilities such as land-line and cellular, fiber and radio, etc. Backup telecommunications system equipment such as emergency standby power generators with ample on-site fuel storage and reserve storage battery capacity must be incorporated in critical telecommunications facilities. Backup equipment should also be considered for certain non-critical telecommunications to provide continued operation of telecommunications during interruption of transmission services.

3.2.17 ENGINEERING AND CONSTRUCTION DELIVERABLES

General – Guidelines for Engineering and Construction Deliverables for Contractors' construction projects being proposed and/or approved for connection to the SMECO Electric System shall be as outlined in Exhibit "G", **Engineering and Construction Deliverables**.

3.2.18 CONSTRUCTION MANAGEMENT REQUIREMENTS FOR INTERCONNECTION CUSTOMERS

General – Construction Management Requirements and Procedures will follow industry accepted best practices for all activities, including safety. See Exhibit "H", **Construction Management Requirements for Interconnection Customers**, for additional details.

3.2.19 APPROVED CONSULTANTS, MATERIAL SUPPLIERS AND CONTRACTORS

General – Only Approved Consultants, Material Suppliers and Contractors will be used for services and equipment for SMECO. Other companies may be permitted to bid on substation and transmission work, but they will need to go through the SMECO formal contractor qualification process. See Exhibit "J", **Approved Engineers, Contractors, and Equipment Manufacturers**, for additional details.

4. SUPPORTING INFORMATION

4.1 LIST OF EXHIBITS

These Exhibits provide additional details:
Exhibit "A" Electric System Planning Criteria
Exhibit "B" Substation and Transmission Line Design Criteria
Exhibit "C" Interconnection Requirements
Exhibit "D" Customer Generation Protective Relaying Requirements
Exhibit "E" SCADA and Communication Requirements
Exhibit "F" Revenue Metering Requirements
Exhibit "G" Engineering and Construction Deliverables
Exhibit "H" Construction Management Requirements for Interconnection Customers

Exhibit "I" Operational and Tagging Requirements
Exhibit "J" Approved Engineers, Contractors, and Equipment Manufacturers

4.2 Operationally Affected Parties

None Identified

4.3 Training

No required training has been identified.

4.4 References

References are as listed in the individual sections of this document.

4.5 Definitions

Transmission Owner Control Center	An entity that participates in the Operating Agreement of PJM Interconnection, L.L.C. (Agreement) and assists PJM in operating and controlling Designated Transmission Facilities establishes a Transmission Owner (TO) Control Center to facilitate its responsibilities regarding the security of the PJM RTO.

4.6 Maintenance and Updates of Facility Connection Requirements

SMECO will maintain its facility connection requirements as necessary or required. SMECO will make these documents available to users of the electric system, the Regional Entity and NERC upon request within five business days.

4.7 Version History

Version #	Change	By	Date
1	Initial Issue	H. Reigel	4/22/2013
2	Minor document revisions throughout.	H. Reigel	8/1/2016
3	Section 3.2.1.1 was updated with PJM Manuals, Previous section 3.2.1.1 (Procedures for Coordinated Joint Studies and Notifications) was removed and replaced. Other minor document revisions.	H. Reigel	1/17/2017
3.1	Minor document revisions to the Purpose section. Updates made throughout the document to reflect SMECO's change in status relative to PJM, NERC, and RFC.	H. Reigel	10/1/2017
3.2	PJM requirements supersede SMECO requirements statement added to section 1.4 SCOPE/APPLICABILITY	H. Reigel	10/18/2017
3.3	Annual Review	H. Reigel	12/31/2018
4.0	Minor revisions throughout the document. The addition of sections 3.2.17 - Engineering and Construction Deliverables and 3.2.18 – Construction Management Requirements for Interconnection Customers and the inclusion of Exhibit "A" through "J": • Exhibit "A" Electric System Planning Criteria • Exhibit "B" Substation and Transmission Line Design Criteria • Exhibit "C" Interconnection Requirements • Exhibit "D" Customer Generation Protective Relaying Requirements • Exhibit "E" SCADA and Communication Requirements • Exhibit "F" Revenue Metering Requirements • Exhibit "G" Engineering and Construction Deliverables • Exhibit "H" Construction Management Requirements for Interconnection Customers • Exhibit "I" Operational and Tagging Requirements • Exhibit "J" Approved Engineers, Contractors, and Equipment Manufacturers	J. Bredenkamp	2/28/2019
4.1	Review and updated references from Local Control Center (LCC) to Transmission Owner Control Center (TOCC) per PJM Manual. Added Transmission Owner Control Center (TOCC) definition to section 4.5.	H. Reigel	1/7/2020

4.2	Annual Review; Section 3.2.2 was updated to include new PJM Manuals 14F and 14G.	H. Peregoy	12/18/2020
4.3	Annual Review: Updated titles in "Section 2: SMECO Responsibilities"; Approval changed from Roger Schneider to Herb Reigel and Technical Review changed from Herb Reigel to Hannah Smyser.	H. Smyser	12/15/2021
4.4	Annual Review: Section 1.1 – updated number of customers within SMECO service territory; Section 2 – updated titles to reflect changes in SMECO organizational structure; Section 3.2.2 – updated PJM Manual 14E title	H. Smyser	12/1/2022
4.5	Annual Review: Section 3.2.2 – updated PJM Manual 14C title, updated effective date for PJM Manual 14G, included new PJM Manual 14H	H. Smyser	12/1/2023

TECHNICAL REVIEW

Reviewed By	Signature	Date
Hannah Smyser, Distribution Engineer	Hannah Smyser Hannah Smyser (Dec 19, 2023 08:55 EST)	12/19/2023

APPROVAL

Approved By	Signature	Date
Herb Reigel, Vice President System Planning & Distribution Engineering	Herbert D Reigel Herbert D Reigel (Dec 29, 2023 06:38 EST)	12/29/2023

[1] FAC-001-2, R1 PART 1.1
[2] FAC-001-2, R1 PART 1.2
[3] FAC-001-2, R1 PART 1.3
[4] FAC-001-3, R3 PART 3 and R4 PART 3
[5] FAC-001-2, R3 PART 3.2
[6] FAC-001-2, R3 PART 3.1

Exhibit A:

Electric System Planning Criteria

Revision Date: February 28, 2019

Version No: 1.0

Approved By: Roger Schneider

Technical Review: Herb Reigel

TABLE OF CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is interconnected to the Potomac Electric Power Company (PEPCO) transmission system and serves as a Local Control Center (LCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." tariff, the "Interconnection and Mutual Operating Agreement" between Potomac Electric Power Company (PEPCO) and SMECO, and the PJM Manual 14 series documents.

1.2. DISCLAIMER

This document and all the material contained herein are developed for guidance purposes only. It is produced as an informational and illustrational aid for customers operating generation equipment that is interconnecting with the SMECO electric system. The information herein is intended to be of a general and typical nature and does not pertain to a specific facility or site. Furthermore, the requirements and practices described herein are subject to change based upon several factors, such as changing regulations. Accordingly, SMECO makes no warranty of any nature whatsoever concerning the information contained in this document.

1.3 PURPOSE

This document is developed to provide guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

2. REGULATORY RESPONSIBILITIES

Congress enacted the Energy Policy Act of 2005 which formed a hybrid system for establishing national electric grid reliability and security standards. This act of Congress gives NERC the responsibility to create national electric grid standards for the Bulk Electric System (BES) with the Federal Energy Regulatory Commission (FERC) having the oversight authority to review and approve the NERC recommended standards. The BES includes facilities rated at 100 kV and above except as otherwise modified by the Inclusions and Exclusions listed within the NERC BES definition.

There are seven Regional Reliability Organizations (RRO) within NERC responsible for enforcing the NERC BES Reliability Standards. Reliability First (RF) is the RRO covering the northeast and mid-west region that encompasses the SMECO service area.

PJM is the main Regional Transmission Organization (RTO) for the RF area and is responsible for overseeing the BES planning and operation for the multi-state regional RF area. PJM manages the RF regional generation and transmission planning process to ensure continued BES reliability. PJM develops an annual Regional Transmission Expansion Plan (RTEP) to meet requirements for firm transmission service and load growth, generation interconnection and retirements, operational performance, and market efficiency. The RTEP generally covers networked facilities interconnected on a regional level as opposed to transmission and distribution facilities that only serve local load centers.

SMECO is one of many Transmission Owners (TO) and Distribution Providers (DP) within the PJM region. Each TO and DP is responsible for local system area planning and operation within their respective service territory. The local system generally refers to facilities rated less than 100 kV that serve local load centers. Where applicable and when it makes sense to do so, SMECO consistently applies the same PJM, RF, and NERC related Reliability Standards to its own local system planning and operation as is applied on the larger regional scale. SMECO includes local system planning needs within its 3-year capital improvement Construction Work Plan (CWP). PJM may include local system planning related project needs in its RTEP as supplemental projects.

3. STUDY METHODOLOGY

SMECO uses a Siemens vendor product called ***PSSE*** and an Aspen vendor product called ***Aspen One Liner*** to analyze its local 69 kV and 230 kV facilities. The PSSE product is used for power flow analysis with the Aspen product being used for short-circuit and ground fault protection analysis. New SMECO software models are created annually with representative SMECO loading included for the next seasonal model year as well as 3-year and 5-year load forecast seasonal years as deemed necessary. Seasonal models may include summer, winter, spring light load, and shoulder load periods.

SMECO 69 kV load busses and associated tie lines directly interconnected to the Pepco system, along with all SMECO 230 kV facilities, are coordinated with PJM through the Multiregional Modeling Working Group (MMWG) and RTEP model build processes for consequent PJM regional analysis. SMECO performs its own power flow and short-circuit analysis of its entire 69 kV and 230 kV facilities, similar to the PJM RTEP analysis, to identify any corrective actions necessary for the local SMECO electric system.

The PJM RTEP process involves a comprehensive review and analysis of transmission system facilities within the PJM regional area. The resultant analysis identifies any existing or forecasted NERC Reliability Standards violations and subsequent system reinforcements necessary to correct the violations and ensure reliable transmission service throughout the PJM regional area.

SMECO utilizes a DNV-GL vendor software product called ***Synergi Electric*** to analyze potential voltage profile, thermal load limit, short-circuit and ground fault contributions, sectionalizing ability, outage contingency switching analysis, large motor starting ability, distributed generation capacity limits, and proposed system improvement impacts for the local SMECO 12.47 kV electric system. New Synergi Electric summer and winter seasonal year models are created on an annual basis to evaluate local SMECO electric system performance. The modeled system performance is internally documented in SMECO's annual "Synergi Model Build Executive Summary" report. The resultant system model(s) and associated Executive Summary report help identify potential SMECO system improvement areas for consideration in SMECO's ongoing 3-year CWP.

SMECO may consider additional factors such as but not limited to: 1) the severity of potential consequences, 2) availability of emergency switching procedures, 3) contingency event occurrence probability, and 4) the cost of available remediation measures when applying stated section IV Study Criteria to non-BES system facilities.

4. STUDY CRITERIA

4.1 VOLTAGE

Available nominal SMECO bus voltages are 230 kV, 69 kV, and 12.47 kV. SMECO does maintain limited 13.8 kV and 13.2 kV facilities dedicated to the Patuxent River Naval Air Station and Calvert Cliffs plant facilities.

SMECO 230 kV rated facilities are typically part of the BES and under PJM operational control. The networked SMECO 230 kV rated facilities serve local area 69 kV switching station line load and do not typically move power to the interconnected Pepco utility system.

SMECO 69 kV rated facilities are not part of the BES and remain under direct SMECO operational control. SMECO 69 kV facilities distribute power from source switching stations to local SMECO distribution substations. The SMECO 69 kV facilities typically operate in a radial configuration and may have normal-open switch points to adjacent SMECO 69 kV lines for use in contingency switching operations.

SMECO 12.47 kV facilities originate at SMECO distribution substations and deliver local power to end-user customer-member load centers. The SMECO 12.47 kV system operates in a radial configuration with normal-open switch points between main feeder and tap line circuits for use in contingency switching operations where possible to do so.

SMECO electric facilities meet the steady-state and post contingency voltage limits specified in Table One. Specified voltage limits meet NERC TPL-001-4 reliability standard criteria where applicable. All SMECO 69 kV and 230 kV power transformers include either a load tap changer (LTC) or independent bus regulation capable of regulating transformer low-side bus voltage between +/- 10% of the nominal low side winding voltage. SMECO 69 kV substation power transformer low side windings are typically rated at 13.2 kV and provide an inherent additional 5.85% voltage rise for the SMECO 12.47 kV system. SMECO 69 kV source switching station busses are typically controlled as close to 1.0 per-unit as possible.

Table One – Voltage Limits			
Nominal Bus Voltage	**Allowable Per Unit Voltage Range**		**Max Allowable Voltage Change following a Switching Event**
	Normal	**Contingency**	
≤ 230 KV	0.95 to 1.05	0.92 to 1.05	≤ 8%
≤ 69 KV	0.92 to 1.05	0.90 to 1.05	≤ 5%
≤ 15 KV	1.02 to 1.05	1.02 to 1.05	≤ 3%
≤ 15 KV (end-of-line)	0.97 to 1.05	0.97 to 1.05	≤ 3%
≤ 600 V	0.95 to 1.05	0.95 to 1.05	≤ 3%

4.2 THERMAL LIMITS

Thermal limits establish the maximum electrical current that a facility can conduct, over a specified time period, before the facility sustains permanent damage due to overheating or before it violates public safety requirements. A given facility's thermal limit generally determines its associated loading limit. Facility loading limits assume the existing facility is in good condition with no noted defects. Facility loading limits are based on thermal limitations only and care should be taken to ensure voltage drop or other site-specific conditions are taken into consideration where necessary.

Software modeled thermal limit ratings are specified as: RATE 1 = normal, RATE 2 = long term emergency (LTE), RATE 3 = short term emergency (STE), and RATE 4 = load dump (LD). Ratings are also specified based on summer or winter seasonal conditions. SMECO thermal rating parameters and assumptions are detailed in its internal SMECO standard T-77 document for non-BES conductors and in its procedure 3030 "Transmission Facility Ratings Methodology" document for BES conductors. Document procedure 3030 complies with NERC reliability standard FAC-008-3 and determines the associated circuit's thermal rating according to the most limiting component factor.

Overhead conductor thermal ratings are based on IEEE standard 738-2011 methodologies. Bus conductor ratings are based on IEEE standard 605-2008 methodologies. Underground cable thermal ratings are typically based on manufacturer stated ratings or based on final circuit installation engineering calculations performed by the owner's engineer. Power transformer ratings are typically based on stated manufacturer nameplate information and should generally not be loaded beyond the stated normal rating without additional detailed engineering review. Listed power transformer LTE and STE ratings are typically identical and represent loading at 124% of the stated manufacturer nameplate normal rating.

Normal ratings generally assume no loss of facility life under continuous loading at the specified rating limit. No facility may exceed its normal rating in steady state pre-contingency operations or its associated LTE and STE ratings in post contingency operations as described below. Normal, LTE, and / or STE ratings may be the same for any given facility. Load dump ratings are generally only used in real time operations within the local or regional control centers where immediate action may be necessary to protect given electric facilities from catastrophic failure.

Emergency ratings may accept some loss of life or strength, over a defined time period, for operation at the rated loading level. Emergency ratings are categorized as LTE or STE ratings. The STE rating generally applies immediately following a contingency operation that removes a component facility from the associated electric system area and before any other system adjustments can be made. The LTE rating generally applies while remaining in a contingency operation event and after system adjustments have been made to redistribute load as necessary to stay within LTE load limits. For extended outage contingency situations, system adjustments should be made, where possible, to bring facility loading back to within normal ratings.

4.3 CONTINGENCIES

NERC reliability standard TPL-001-4 outage contingency events are listed in table two. Stated voltage and thermal limit criteria apply to each listed event type with each prescribed event being analyzed to determine reliability impacts to the SMECO electric system. Networked SMECO 230 kV facilities serve critical local load centers and should not result in loss of load during any of the prescribed P1 through P7 contingency events. Identified P2-2, P4-5, and P4-6 SMECO bus outage contingency events may interrupt all facilities within the given zone of protection that are solely dependent on the bus for system connectivity. In such circumstances, loss of local load may occur.

Only P1 through P7 contingency events deemed applicable to the local non- BES facilities will be analyzed. Local SMECO non-BES 69 kV and 15 kV rated facilities are not generally networked and may result in loss of load during P1 through P7 event analysis. In such case, stated voltage and thermal limit criteria will still apply to all remaining energized facilities within the contingency event case. Subsequent analysis may establish contingency switching opportunities to restore partial or entire load to affected facilities following outage contingency events.

Extreme contingency events are defined as having a low probability of occurrence and only apply to BES facilities. Such events usually involve a large-scale station outage, loss of an entire transmission right-of-way corridor, loss of all area generation units, and so on. These events may already overlap and be covered as part of the listed P1 through P7 contingencies or they may be a separate standalone extreme event. Corrective action plans are not required for noted issues associated with extreme event analysis.

Table Two - NERC TPL-001-4 Contingencies

Category	Initial Condition	Outage Event
P0 Normal System	Normal System	None
P1 Single Contingency	Normal System	P1-1: Generator
		P1-2: Transmission Line
		P1-3: Transformer
		P1-4: Shunt Device
P2 Single Contingency	Normal System	P2-1: Opening of Line Section without a Fault
		P2-2: Bus Section Fault
P3 Multiple Contingencies	One (P1-1) outage event followed by system adjustments	P3-1: Generator
		P3-2: Transmission Line
		P3-3: Transformer
		P3-4: Shunt Device
P4 Multiple Contingencies due to Stuck breaker during initial event	Normal System	P4-1: Generator & Stuck Breaker (Non-Bus Tie Breaker)
		P4-2: Transmission Line & Stuck Breaker (Non-Bus Tie Breaker)
		P4-3: Transformer & Stuck Breaker (Non-Bus Tie Breaker)
		P4-4: Shunt Device & Stuck Breaker (Non-Bus Tie Breaker)
		P4-5: Bus Section & Stuck Breaker (Non-Bus Tie Breaker)
		P4-6: Bus Section & Stuck Breaker (Bus Tie Breaker)
P6 Multiple Contingencies	One (P1-2, P1-3, or P1-4) outage event followed by system adjustments	P6-1: Transmission Line
		P6-2: Transformer
		P6-3: Shunt Device
P7 Multiple Contingencies due to a double-circuit tower event	Normal System	P7-1: Double-Circuit Transmission Line
Extreme Events	Normal System	Entire Station and /or Transmission right-of-way Loss

4.4 SHORT CIRCUIT AND GROUND FAULT

The purpose of a circuit breaker is to isolate and sectionalize a short circuit or ground fault from the rest of the electric system. Under normal power flow conditions, the current through a circuit breaker is limited to its maximum continuous ampere rating. Under short circuit or ground fault conditions the breaker must be capable of interrupting the much higher available symmetrical and asymmetrical fault current flowing through the breaker. Both the normal continuous and short circuit or ground fault currents must remain below the associated breaker stated continuous and interrupt current ratings.

Both single line-to-ground and three phase fault analysis will be evaluated under normal system configuration with all existing area generation in service. A 1.0 per unit pre-fault voltage will be used in the analysis.

4.5 STABILITY

The power system must remain stable, without cascading equipment outages or uncontrolled load loss, during sudden transient disturbances that have a reasonable probability of occurrence. There are numerous aspects to power system stability that include generator rotor angle stability and voltage stability. Generally speaking, stability focuses on transient system performance during the first few seconds following a disturbance before the system establishes a new steady state operating point.

Under normal conditions the system generator rotor angles are synchronized with each other; however, the rotor angle of one or more generators may become desynchronized with the other system generators immediately following a transient event. The electric system must be designed such that all area generators are quickly resynchronized following a given transient event. Similarly, under normal conditions area bus voltages remain steady within an acceptable range. A transient event can cause area bus voltages to fluctuate outside an acceptable range and must be promptly restored to acceptable levels to avoid equipment damage or voltage collapse.

PJM performs a regional system stability analysis, including the associated SMECO 230 kV facilities and 69 kV facilities directly interconnected with the Pepco electric system, during its annual RTEP process. The PJM stability analysis is performed in accordance with PJM Manual 14B Attachment G to ensure that the planned system can withstand NERC TPL 001−4 criteria disturbances and maintain stable operation throughout the PJM planning horizon. Stability studies are generally performed for light load and peak load scenarios to determine critical system conditions.

SMECO does not own any area generation and does not have any synchronous condensers, static Var compensators (SVC), flexible alternating current transmission

System (FACTS) devices, HVDC, or other dynamic reactive devices connected to its electric system that may affect the stability of the local SMECO electric system. SMECO does maintain a dynamic complex load model (CLOD) for its system that represents the local area load dynamics. The SMECO CLOD model is included within the PJM system stability analysis. SMECO will perform a stability analysis for its local area system on an as-needed basis dependent on any new system changes that might affect local system stability performance.

5. SERVICE QUALITY

Neither end-use customer member load nor interconnected customer generation shall cause any power quality related issues to the SMECO electric system or other SMECO end-use customer members. All interconnected end-use customer member load or interconnected customer generation shall comply with the latest edition of IEEE 519-1992 “IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems” Standard.

SMECO end-use customer member load power factor, as measured at the intertie point, must be between 0.9 lagging and 1.0 both with and without any associated customer member on-site generation in use. Generation customers interconnected to the SMECO electric system will operate in accordance with applicable PJM Tariff reactive power requirements. If not subject to PJM Tariff requirements, interconnected customer generation will hold a power factor between 0.95 leading (absorbing MVars) and 0.95 lagging (supplying MVars).

Exhibit B:

Substation and Transmission Line Design Criteria

Revision Date: February 28, 2019

Version No: 1.0

Approved By: John Bredenkamp

Technical Review: Hugh Voehl

TABLE OF CONTENTS

Exhibit B			
Substation and Transmission Line Design Criteria		SMECO People. Power. Progress.	
Distribution: Public		Procedure No: 3010 Exhibit B	
Version No: 1.0	Revision Date: February 28, 2019	Review Cycle: 5 Years	Effective Date: February 28, 2019

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is interconnected to the Potomac Electric Power Company (PEPCO) transmission system and serves as a Local Control Center (LCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." tariff, the "Interconnection and Mutual Operating Agreement" between Potomac Electric Power Company (PEPCO) and SMECO, and the PJM Manual 14 series documents.

1.2. DISCLAIMER

This document and all the material contained herein are developed for guidance purposes only. It is produced as an informational and illustrational aid for customers operating generation equipment that is interconnecting with the SMECO electric system. The information herein is intended to be of a general and typical nature and does not pertain to a specific facility or site. Furthermore, the requirements and practices described herein are subject to change based upon several factors, such as changing regulations. Accordingly, SMECO makes no warranty of any nature whatsoever concerning the information contained in this document.

1.3 PURPOSE

This document is developed to provide guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

2. OVERALL DESIGN PHILOSOPHY

The Transmission Network Facility connection designs must meet all applicable transmission planning standards, which are intended to:

- Minimize the magnitude and duration of system outages in the event of a component failure.
- Minimize widespread system effects on voltage, dynamic stability, etc., that occur as a result of an unplanned event.
- Facilitate the isolation of failed components(s) while maximizing the amount of transmission system equipment that can remain in service.
- Include plans for the expeditious restoration of failed facilities/components (dedicated spare/standard equipment, etc.)

3. DESIGN CONSIDERATIONS

3.1. SUBSTATION DESIGN CONSIDERATIONS

SMECO will own, operate and maintain the interconnection substation and associated equipment.

For customer's facilities that include transmission line relays for the protection of SMECO transmission lines, customer will own and maintain/test the applicable line relays at the customer's facility.

Ownership of communication equipment will be determined for each project.

The interconnection facility must provide a high level of reliability, operability and maintainability for the Transmission System. As a result, breaker-and-a-half or ring-bus, bus configurations are the required/preferred bus configurations for transmission substation switchyards. A ring bus configuration of more than 4 breakers should use the breaker-and-a-half design instead. Three terminal line configurations are generally not considered acceptable. For generation interconnection, a line tap is generally not considered acceptable.

Substation equipment design criteria have been established to assure acceptable reliability of the Bulk Electric System (BES) facilities. These set forth service conditions and establish electrical insulation levels and short circuit rating levels for substations.

Substation design criteria for SMECO existing facilities are detailed in section three through section seven. New facilities and interconnections shall meet equivalent requirements.

Please also note that SMECO is also referred to as owner and SMECO' s representation as owner's engineer or engineer.

See PJM documentation for the following Environmental parameters:

- Ambient Temperature Range
- Extreme Wind Loading
- Heavy Ice Loading
- Coincident Wind & Ice Loading
- Seismic Substation Requirements
- Flood Plan Requirements
- AC Station Service Requirements
- DC Supply Requirements
- Ground Grid Requirements

See PJM documentation for the following Electrical parameters:

- Continuous Current Rating
- 3 Second Current Rating
- Operating Voltage Range
- RIV Level
- Lightning BIL
- Switching BIL
- Surge Arrester Rating
- Breaker Closing
- System Grounding

- Lightning Trip Performance
- Fault Performance

3.2. FUNCTIONAL CRITERIA

Physical as well as electrical characteristics must be considered when evaluating proposed electrical interconnections by evaluating the following criteria:

- Clearing of faulted Interconnection Customer-Owned facility equipment, including synchronizing breakers and interconnection Customer transmission lines, should not adversely affect any Transmission Owner (TO) transmission circuits. This generally means that there could be one more intertie breaker required.
- Two circuits that supply a common facility should not be supplied from a common breaker-and-a-half bay or a common bus configuration, such that a single breaker failure operation would trip both circuits.
- Multiple ties between buses should be provided for all conditions to ensure network continuity with at least one transmission breaker open/out of service.
- The arrangements of lines and breakers owned by the Interconnection Customer and NOT under control of PJM shall not allow transmission network load current to flow through the Interconnection Customer's interconnection facilities.
- A generator radial line shall include a synchronizing breaker or line isolation switch.
- A transmission line phase conductor or a static wire that drops within the substation switchyard should not cause the tripping of another transmission circuit.
- Electrical equipment with in the substation must be adequately spaced to facilitate equipment maintenance/replacement; and minimize the likelihood that catastrophic failure of an item of equipment will adversely impact adjacent equipment.

3.3. SUBSTATION ARRANGEMENT

Substations need to be designed to meet the applicable NESC, IEEE, NERC and CIP requirements and take into account the follow areas as specified in PJM documentation.

- Accessibility and Layout
- Grounding and Fence
- Lighting
- Lightning/Surge/Noise Protection
- Raceways
- Security
- Control House
- Auxiliary Facilities

Substation designs will include all disconnect switches and devices required to permit maintenance of all transmission lines and breakers without the loss of the ability to use the customer owned generation when available and required.

3.4. SYSTEM PROTECTION AND COORDINATION

The Customer is responsible for providing a properly designed and tested protection system which will protect their equipment from disturbances on SMECO's system and will minimize the effects of disturbances on their equipment/facilities on SMECO's electric system. The protection system shall adhere to the latest IEEE C37 & C57 guidelines and standards for protective relaying and meet all applicable NERC and PJM standards related to system protection.

The protection system shall be adequately sensitive to detect all faults and abnormal conditions, provide coordination between protection zones and have an operating time to maintain system stability/reliability.

The protection system shall protect against/minimize the effects of abnormal conditions, including, but not limited to, short circuits, over/under frequency, over/under voltage, open phases, phase unbalance, harmonics, overload, lightning/switching surges, and other harmful electrical conditions.

Utility grade protective relays and fault clearing devices shall be used. All protective relays shall meet or exceed latest ANSI/IEEE Standard C37.90.

The protection system, including protective relays, voltage and current sensing devices, associated communication equipment/system, station batteries and DC control circuits shall be compatible with SMECO's standard design for common equipment and zones of protection. Compatibility includes protective relaying application, redundancy, speed of operation, communication type and communication medium.

For reliability of the protection system, it shall be battery powered. The battery(ies) shall be sized to power the continuous loads for a minimum of 8 hours, and power the maximum momentary tripping load (typically the tripping of multiple breakers due to a breaker failure scheme operation) without a battery charger available. The battery sizing calculation shall be in accordance with the latest IEEE 485 standard. A DC undervoltage alarm may need to be provided for remote monitoring of the facility. Dedicated Disturbance Monitoring Equipment (DME) for the protection system may need to be installed to meet NERC requirements for BES facilities.

The customer's Engineering/Operations staff shall investigate all protection system operations/mis-operations, affecting the interconnected facility and provide SMECO with the findings of their investigation upon request. Likewise, SMECO will cooperate with the customer and will provide any necessary findings related to operations/mis-operations of the protection system affecting the interconnected facility.

4. SUBSTATION DESIGN CRITERIA

4.1. CLIMATOLOGICAL DATA

• Ambient Temperature:	-30 °C to +40 °C
• Wind loading Substations (no ice):	Per ASCE 7-10, Figure 6-1 depending on location [typically 90 to 110 mph]
• Wind loading Lines (no ice) 138kV or less: • Wind loading Lines (no ice) Greater than 138 kV:	Per NESC Extreme Wind 25 psf or NESC Extreme Wind (whichever is greater)
• Ice load 765 kV or less lines (no wind):	38 mm radial ice
• Ice load 500 kV, 345 kV, 230 kV lines (no wind):	38 mm radial Ice
• Ice load 138 kV or less lines (no wind):	38 mm radial ice
• Ice load substations (no wind):	25 mm radial Ice
• Wind Coincident with 13 mm radial Ice:	64 km/h (40 mph)
• Seismic Substation:	Per ASCE 7-10 0.2 s and 1.0 s Spectral Response Acceleration (5% of Critical Damping), Site Class B. (Figure 9.4.1.1 (a) & (b)) Equipment Qualification per IEEE 693-2005. [Typically, 0.2g Some as High as 0.04 g]
• Line Design:	NESC Heavy Loading (latest edition)
• Flood Plain:	Structure ground line above 100-year flood where possible

4.2. SYSTEM ELECTRICAL PARAMETERS

The switching station is designed for the following voltage, current, and fault current ratings as described in the following subsections.

4.2.1 230KV YARD

• Maximum Phase-to-Phase Voltage:	242	kV
• Maximum Phase-to-Ground Voltage:	139.7	kV

• Nominal Phase-to-Phase Voltage:	230	kV
• Nominal Phase-to-Ground Voltage:	132.8	kV
• Basic Impulse Level (BIL):	900	kV
• Maximum system three phase available fault current:	50	kA
• Maximum system single phase to ground available fault current:	50	kA
• Maximum continuous current carrying capacity:	3,000	A
• Nominal System Operational Frequency:	60	Hz
• Minimum Leakage Distance:	152.4	in.
• Fault clearing time:	Worst case remote ends 18 cycles, best case (bolted) clears at substation 6 cycles	
• System Grounding:	Solidly grounded	

4.2.2 69KV YARD

• Maximum Phase-to-Phase Voltage:	72.5	kV
• Maximum Phase-to-Ground Voltage:	41.9	kV
• Nominal Phase-to-Phase Voltage:	69	kV

• Nominal Phase-to-Ground Voltage:	38.1	kV
• Basic Impulse Level (BIL):	350	kV
• Maximum system three phase available fault current:	40	kA
• Maximum system single phase to ground available fault current:	40	kA
• Maximum continuous current carrying capacity:	2000	A
• Nominal System Operational Frequency:	60	Hz
• Minimum Leakage Distance:	45.67	in.
• Fault clearing time:	Worst case remote ends 18 cycles, best case (bolted) clears at substation 6 cycles	
• System Grounding:	Solidly grounded	

4.3. CLEARANCES AND SPACING'S

The switching station is designed to maintain clearances and spacing's as described in the following subsections.

4.3.1. 230KV YARD

• Rigid bus center-to-center phase spacing:	132	in.
• Minimum phase-to-phase, metal-to-metal distance from ANSI C37.32, 2002:	89	in.
• Minimum phase-to-ground, from ANSI C37.32, 2002:	71	in.

• Recommended phase-to-ground clearance, from ANSI C37.32, 2002:	71	in.
• Minimum vertical clearance, from NESC:	165	in.
• Low bus height above bottom of baseplate:	18	ft.
• High bus height above bottom of baseplate:	26	ft.
• Minimum bottom of insulator or bushing porcelain to top of finished grade:	8.5	ft.
• Minimum clearance to fence from live parts:	16	ft.

4.3.2. 69KV YARD

• Rigid bus center-to-center phase spacing:	84	in.
• Minimum phase-to-phase, metal-to-metal distance from ANSI C37.32, 2002:	31	in.
• Minimum phase-to-ground, from ANSI C37.32, 2002:	25	in.
• Recommended phase-to-ground clearance, from ANSI C37.32, 2002:	29	in.
• Minimum vertical clearance, from NESC:	125	in.
• Low bus height above bottom of baseplate:	14	ft.
• High bus height above bottom of baseplate:	19	ft.
• Minimum bottom of insulator or bushing porcelain to top of finished grade:	8.5	ft.
• Minimum clearance to fence from live parts:	12	ft.

4.4. CIRCUIT BREAKERS

The circuit breakers are as described in the following subsections.

4.4.1. 230KV GAS CIRCUIT BREAKERS

- Nominal Voltage (Phase-to-Phase): 230 kV

- Continuous Current: 3000 A
- Short Circuit Interrupting Current: 63[1] kA
- Maximum Voltage (Phase-to-Phase): 245 kV
- Basic Impulse Level (BIL): 900 kV
- Nominal Operation Frequency: 60 Hz
- Interrupting Time: 3 Cycles
- Type: SF6 Gas Insulated Dead Tank
- Construction: Ganged 3-Pole Operation on a Common Frame
- Current Transformers: 3000:5 MR
- Quantity: 6
- Manufacturer P/N: MEPPI 200-SFMT-63F
- Contract Number: 146028.66.0800

[1] Note: The 63 kA rating for 90 percent short line faults requires 3000 pF line-to-ground capacitance per phase, located on the line side of the breaker and within 300 feet from the junction of the line circuit with the station bus.

4.4.2. 69KV GAS CIRCUIT BREAKERS

- Nominal Voltage (Phase-to-Phase): 69 kV
- Continuous Current: 2000 A
- Short Circuit Interrupting Current: 40 kA
- Maximum Voltage (Phase-to-Phase): 72.5 kV
- Basic Impulse Level (BIL): 350 kV
- Nominal Operation Frequency: 60 Hz
- Interrupting Time: 3 Cycles
- Type: SF6 Gas Insulated Dead Tank
- Construction: Ganged 3-Pole Operation on a Common Frame

- Current Transformers: 2000:5 MR
- Quantity: 6
- Manufacturer P/N: MEPPI 70-SFMT-40E
- Contract Number: 146028.66.0800

4.5. BREAKER/TRANSFORMER DISCONNECT SWITCHES

The breaker/transformer disconnect switches are as described in the following subsections.

4.5.1. 230KV BREAKER-ISOLATING DISCONNECT

- Nominal Voltage (Phase-to-Phase): 230 kV
- Type: Vertical Break, Ganged 3-pole
- Continuous Current: 3000 A
- Maximum Voltage (Phase-to-Phase): 245 kV
- Basic Impulse Level (BIL): 900 kV
- Operator: Manual
- Quantity: 12
- Manufacturer P/N: USCO “Type AVR” Switch
- Contract Number: 146028.66.4000

4.5.2. 230KV TRANSFORMER-ISOLATING DISCONNECT

- Nominal Voltage (Phase-to-Phase): 230 kV
- Type: Vertical Break, Ganged 3-pole
- Continuous Current: 3000 A
- Maximum Voltage (Phase-to-Phase): 245 kV

- Basic Impulse Level (BIL): 900 kV
- Operator: Motor
- Quantity: 2
- Manufacturer P/N: USCO "Type AVR" Switch with SEECO MNM1 Motor Operator
- Contract Number: 146028.66.4000

4.5.3. 69KV BREAKER-ISOLATING DISCONNECT

- Nominal Voltage (Phase-to-Phase): 69 kV
- Type: Center Break, Ganged 3-pole
- Continuous Current: 2000 A
- Maximum Voltage (Phase-to-Phase): 72.5 kV
- Basic Impulse Level (BIL): 350 kV
- Operator: Manual
- Quantity: 10
- Manufacturer P/N: USCO "Type AGCH-5" Switch
- Contract Number: 146028.66.4000

4.5.4. 69KV TRANSFORMER-ISOLATING DISCONNECT

- Nominal Voltage (Phase-to-Phase): 69 kV
- Type: Vertical Break, Ganged 3-pole
- Continuous Current: 2000 A
- Maximum Voltage (Phase-to-Phase): 72.5 kV
- Basic Impulse Level (BIL): 350 kV

- Operator: Motor
- Quantity: 2
- Manufacturer P/N: USCO "Type AVR" Switch with SEECO MNM1 Motor Operator
- Contract Number: 146028.66.4000

4.5.5. 69/15KV YARD DISCONNECTS

- Nominal Voltage (Phase-to-Phase): 69 kV
- Type: Vertical Break, Ganged 3-pole
- Continuous Current: 2000 A
- Maximum Voltage (Phase-to-Phase): 72.5 kV
- Basic Impulse Level (BIL): 350 kV
- Operator: Manual
- Quantity: 4
- Manufacturer P/N: USCO "Type AVR" Switch
- Contract Number: 146028.66.4000

4.6. LINE DISCONNECT SWITCHES

The line disconnect switches are as described below:

- Nominal Voltage (Phase-to-Phase): 230 kV
- Type: Double-end Break, Ganged 3-Pole
- Continuous Current: 3000 A
- Maximum Voltage (Phase-to-Phase): 245 kV
- Basic Impulse Level (BIL): 900 kV

- Operator: Motor
- Grounding switch: 100 kA Momentary Rating
- Quantity: 3
- Manufacturer P/N: Southern States "RDA-1" Switch, SEECO MNM1 Motor Operator, and Southern States Ground Switch "EPG"
- Contract Number: 146028.66.4000

4.7. SURGE ARRESTERS

The surge arresters are as described in the following subsections.

4.7.1. 230KV SURGE ARRESTERS

- Type: Metal-Oxide (MOV)
- Arrester Duty Cycle: 180 kV
- Arrester MCOV: 144 kV
- Class: Station
- Material: Polymer
- Quantity: 9
- Manufacturer P/N: Ohio Brass PVN 314144-3001
- Contract Number: 146028.66.4000

4.7.2. 69KV SURGE ARRESTERS

- Type: Metal-Oxide (MOV)
- Arrester Duty Cycle: 72 kV
- Arrester MCOV: 57 kV
- Class: Station
- Material: Polymer
- Quantity: 9

- Manufacturer P/N: Ohio Brass PVN 314057-3001
- Contract Number: 146028.66.4000

4.8. CAPACITOR VOLTAGE TRANSFORMERS

The capacitor voltage transformers are utilized only in the 230kV yard. The capacitor voltage transformers are as described below:

- Primary Voltage (Phase-to-Phase): 230 kV
- Basic Impulse Level (BIL): 1050 kV
- Secondary Voltage:
  - X Winding 115/69 V
  - Y Winding 115/69 V
- Ratio: 1200/2000:1
- Accuracy Class:
  - X Winding 0.3WXYZ
  - Y Winding 0.3WXYZ
- Thermal Burden Rating: 1000 VA
- Total Capacitance: 5000 pF
- Quantity: 18
- Manufacturer P/N: ABB Kuhlman – DFK-245
- Contract Number: 146028.66.4000

4.9. POTENTIAL TRANSFORMERS

The potential transformers are utilized only in the 69kV yard. The potential transformers are as described below:

- Primary Voltage (Phase-to-Phase): 69 kV
- Basic Impulse Level (BIL): 350 kV
- Secondary Voltage:
  - X Winding 115/67 V
  - Y Winding 115/67 V

- Ratio: 350/600:1
- Accuracy Class:
  - X Winding 0.3ZZ
  - Y Winding 0.3ZZ
- Thermal Burden:
  - X Winding 5000 VA
  - Y Winding 2500 VA
- Quantity: 12
- Manufacturer P/N: ABB Kuhlman POF-350
- Contract Number: 146028.66.4000

4.10. POWER TRANSFORMERS

The power transformers are as described in the following subsections.

4.10.1. TRANSFORMER 1

- Type: Autotransformer
- Cooling: OA/FA/FA
  (Self-cooled)/(Forced air)/(Forced air)
- Configuration: Primary - 220kV GRY
  Secondary – 69kV GRY
  Tertiary – 13.2kV Delta (buried)
- Rating: 120/160/200/224 MVA
  @ 55ºC/65ºC
- Percent Impedance: 14.5 (200MVA base)
- Serial Number: ABB ALM30652

4.10.2. TRANSFORMER 2

- Type: Autotransformer

- Cooling: OA/FA/FA
  (Self-cooled)/(Forced air)/(Forced air)
- Configuration: Primary - 220kV GRY
  Secondary – 69kV GRY
  Tertiary – 13.2kV Delta (buried)
- Rating: 120/160/200/224 MVA
  @ 55ºC/65ºC
- Percent Impedance: 14.6 (200MVA base)
- Serial Number: Pauwels 61-08-6A674

4.11. POWER LINE DESIGN CRITERIA

The following mechanical loading conditions were used for the design of transmission and distribution line structures. Loads are applied with all wires intact for tangent, angle, and dead-end structures. Loads are applied to one side only for dead-end structures. New designs should be equivalent.

For Circuit 2345/2340/2330/6791/6789 structure calculations, refer to Calc. No. 146026.51.2400.

For Circuit 2345/2340/2330/6791/6789 foundation calculations, refer to Calc. No. 146026.51.2300

4.11.1. SMECO CIRCUIT 2340

- Nominal Voltage: 230 kV
- Power Line Conductor

Cable Size/Type: 1590 MCM AAC (Coreopsis)
Design Tension: 5000 pounds at NESC Heavy
Pull-off Elevation: 50 feet

- Shield Wires

Wire Size/Type: 7#9 Alumoweld
Design Tension: 2500 pounds at NESC Heavy
Pull-off Elevation: 60 feet
Quantity per Circuit: 1

- Fiber Optic Cable

Cable Type: Optical ground wire (OPT-GW)
Fiber Type: Single-mode, 48 fibers

Manufacturer P/N: Alcoa CC-60/48/610 (Specification No. DNO-5465)
Design Tension: 2500 pounds at NESC Heavy

Quantity per Circuit: 1

4.11.2. SMECO CIRCUIT 2345

- Nominal Voltage: 230 kV
- Power Line Conductor

Cable Size/Type: 1590 MCM AAC (Coreopsis)
Design Tension: 5000 pounds at NESC Heavy
Pull-off Elevation: 50 feet

- Shield Wires

Wire Size/Type: 7#9 Alumoweld
Design Tension: 2500 pounds at NESC Heavy
Pull-off Elevation: 60 feet
Quantity per Circuit: 2

4.11.3. SMECO CIRCUIT 2330

- Nominal Voltage: 230 kV
- Power Line Conductor

Cable Size/Type: 1590 MCM AAC (Coreopsis)
Design Tension: 5000 pounds at NESC Heavy
Pull-off Elevation: 50 feet

- Shield Wires

Wire Size/Type: 7#9 Alumoweld
Design Tension: 2500 pounds at NESC Heavy
Pull-off Elevation: 60 feet
Quantity per Circuit: 1

- Fiber Optic Cable

Cable Type: Optical ground wire (OPT-GW)
Fiber Type: Single-mode, 48 fibers
Manufacturer P/N: Alcoa CC-60/48/610 (Specification No. DNO-5465)
Design Tension: 2500 pounds at NESC Heavy

Quantity per Circuit: 1

4.11.4. SMECO CIRCUIT 6791

- Nominal Voltage: 69 kV
- Power Line Conductor

Cable Size/Type: 1590 MCM AAC (Coreopsis)
Design Tension: 2500 pounds at NESC Heavy
Pull-off Elevation: 35 feet

- Shield Wires

Wire Size/Type: 7#9 Alumoweld
Design Tension: 1500 pounds at NESC Heavy
Pull-off Elevation: 40 feet
Quantity per Circuit: 2

4.11.5. SMECO CIRCUIT 6789

- Nominal Voltage: 69 kV
- Power Line Conductor

Cable Size/Type: 1590 MCM AAC (Coreopsis)
Design Tension: 2500 pounds at NESC Heavy
Pull-off Elevation: 35 feet

- Shield Wires

Wire Size/Type: 7#9 Alumoweld
Design Tension: 500 pounds at NESC Heavy
Pull-off Elevation: 40 feet
Quantity per Circuit: 2

4.12. SUBSTATION STRUCTURES

Equipment support steel structures are designed using hot-rolled structural steel shapes such as wide flange, tubing, channels, and angles or as folded plate tapered tubular structures. All yard structures are hot-dip galvanized for corrosion protection. Galvanizing thickness is in accordance with ASTM 123.

For the complete structure point load calculations, refer to “Structure Point Loads, Calc. No. 146028.51.2202”.

4.13. WIND AND ICE LOADING COMBINATIONS

The line and equipment support structures are designed to withstand the following wind and ice loads.

4.13.1. LINE SUPPORT STRUCTURES (DEAD-ENDS)

NESC Heavy
Wind Velocity: 40 mph
Ice Thickness: 0.5 inch
Safety Factor: NESC OLF

Extreme Wind
Wind Velocity: 100 mph
Ice Thickness: 0 inch
Safety Factor: 1.3

Extreme Ice
Wind Velocity: 0 mph
Ice Thickness 1.5 inch
Safety Factor: 1.3

4.13.2. EQUIPMENT SUPPORT STRUCTURES

NESC Heavy
Wind Velocity: 40 mph
Ice Thickness: 0.5 inch
Safety Factor: NESC OLF

Extreme Wind
Wind Velocity: 100 mph
Ice Thickness: 0 inch
Safety Factor: 1.0

Short Circuit with Extreme Wind
Short Circuit Force: 35 lb./ft @ 230kV
55lb/ft @ 69kV
Wind Velocity: 110 mph
Ice Thickness: 0 inch
Safety Factor: 1.0

4.14. LINE SUPPORT STRUCTURES (DEAD-ENDS)

Dead-ends are designed to the following criteria:

4.14.1. 230KV LINE SUPPORT STRUCTURES (DEAD-ENDS)

Conductors: 5000 pounds per conductor at 15°line angle
Shield Wires: 2500 pounds per cable at 15°line angle

Equipment Weight:	400 pounds per surge arrestor 500 pounds per underhung insulator
Wind and Ice Loads:	See Section 3.13
Deflection Limits:	The horizontal deflection of vertical members is limited to 1/50th of the span. The vertical deflection of horizontal members is limited to 1/200th of the span. The horizontal deflection of horizontal members is limited to 1/100th of the span. The span is defined as the distance between supporting members or the length of the cantilever (see NEMA SG6, Part 36).

4.14.2. 69KV LINE SUPPORT STRUCTURES (DEAD-ENDS)

Conductors:	2000 pounds per conductor at 15° line angle
Shield Wires:	1500 pounds per cable at 15° line angle
Equipment Weight:	400 pounds per surge arrestor 500 pounds per underhung insulator
Wind and Ice Loads:	See Section 3.13
Deflection Limits:	The horizontal deflection of vertical members is limited to 1/50th of the span. The vertical deflection of horizontal members is limited to 1/200th of the span. The horizontal deflection of horizontal members is limited to 1/100th of the span. The span is defined as the distance between supporting members or the length of the cantilever (see NEMA SG6, Part 36).

4.15. EQUIPMENT SUPPORT STRUCTURES

Equipment support structures are designed to the following criteria:

Short Circuit Force:	35 lb./ft
Wind and Ice Loads:	See Section 3.13
Seismic:	Zone 1
Deflection Limits:	NEMA SG6, Part 36
Rigidity Considerations:	NEMA SG6, Part 36

<u>230kV Equipment Weight</u>

High Switch Stand:	6000 lb.
Low Switch Stand:	6000 lb.

3PH High Bus Support:	1800 lb.
3PH Low Bus Support:	1800 lb.
1PH High Bus Support:	600 lb.
1PH CCVT Stand:	1000 lb.

<u>69kV Equipment Weight</u>

High Switch Stand:	1600 lb.
Low Switch Stand:	1600 lb.
3PH High Bus Support:	900 lb.
3PH Low Bus Support:	900 lb.
1PH High Bus Support:	300 lb.
1PH Bus & Fuse Stand:	600 lb.
3PH PT Stand:	1800 lb.
1PH PT Stand:	600 lb.

4.16. FOUNDATION DESIGN

The foundation design conforms to the current issue of the “Building Code Requirements for Reinforced Concrete,” ACI 318, county and state codes, and is in accordance with the following general criteria listed below.

Concrete Strength: fc = 4000 psi at 28 days
All Reinforcing Bars: fy = 60,000 psi
ASTM A615 Gr 60

Safety factor against soil failure:

Drilled Pier	
Lateral Load Analysis (Ultimate Condition)	1.5
Uplift or Compression Capacity	2.0
Slab-on-Grade Foundations	
Overturning	1.5
Sliding	1.5
Bearing	3.0

Deflection criteria for drilled piers for switching station structures, the allowable top of pier deflection under working loads, is limited to the following:

Switch Support Structures	$\leq$ 1/4 inch
Non-Switch Support Structures	$\leq$ 1/2 inch

Dead-end and Lightning Mast $\leq$ 3 inches
(Ultimate loads used to evaluate the pier deflection.)

4.17. CONTROL HOUSE

4.17.1. DIMENSIONS

The Control House dimensions are as follows:

- Length: 40 feet exterior
- Width: 30 feet exterior
- Height: 10 feet interior

4.17.2. HEATING, VENTILATING, AND AIR CONDITIONING

The following subsection provides information about the equipment used in the heating, ventilating, and air conditioning (HVAC) of the control house.

4.17.3. HEAT PUMP

- Model: Bard Wall-Mount Model No. W36H1-A05XXXXXO with Heater No. EHWH36-A05
- Quantity: 2

4.17.4. WALLS

Walls for the control house meet the following requirements:

- Wind Load: 130 mph
- Insulation: R-11 Polystyrene
- Interior Walls: Fire Rated Particle Board (FRP)
- Exterior Finish: Exposed aggregate

4.17.5. ROOF/CEILING

Roof/ceiling of the control house meets the following requirements:

- Distributed Roof Load: 60 psf
- Insulation: R-19 Polystyrene
- Ceiling: FRP

4.18. SWITCHING STATION BUS

The following subsections provide general design information about both the rigid and strain bus.

4.18.1. RIGID BUS

The tubular bus is designed to meet bus ratings at a 35ºC ambient temperature, a wind of 2 fps, and a bus operating temperature of 90ºC, and can withstand appropriate mechanical as defined in the PJM Substation Conductor Ratings. The tubular bus system is comprised of both Schedule 40 and Schedule 80 aluminum alloy (6063-T6).

<u>230kV High Bus Design Parameters</u>

Bus Size/Type:	4 in, Schedule 80
Short Circuit Current:	50 kA rms
Load Cases:	Case 1 – 0.50 in ice & 40 mph wind
	Case 2 – no ice & 100 mph wind
	Case 3 – seismic & short circuit
Max Vertical Deflection:	4.5 in
Aeolian Vibration Damper:	556.5 MCM ACSR "DOVE"
Insulator Overload Factors:	Wind Forces (K_1) = 1.25
	Short Circuit Forces (K_2) = 1.00
	Gravitational Forces (K_3) = 1.25

<u>230kV Low Bus Design Parameters</u>

Bus Size/Type:	4 in, Schedule 80
Short Circuit Current:	50 kA rms
Load Cases:	Case 1 – 0.50 in ice & 40 mph wind
	Case 2 – no ice & 100 mph wind
	Case 3 – seismic & short circuit
Max Vertical Deflection:	4.5 in
Aeolian Vibration Damper:	556.5 MCM ACSR "DOVE"
Insulator Overload Factors:	Wind Forces (K_1) = 1.25
	Short Circuit Forces (K_2) = 1.00
	Gravitational Forces (K_3) = 1.25

<u>69kV High Bus Design Parameters</u>

Bus Size/Type:	4 in, Schedule 40
Short Circuit Current:	40 kA rms
Load Cases:	Case 1 – 0.50 in ice & 40 mph wind
	Case 2 – no ice & 100 mph wind
	Case 3 – seismic & short circuit
Max Vertical Deflection:	4.5 in
Aeolian Vibration Damper:	556.5 MCM ACSR "DOVE"
Insulator Overload Factors:	Wind Forces (K_1) = 2.50

Short Circuit Forces (K_2) = 1.00
Gravitational Forces (K_3) = 1.50

69kV Low Bus Design Parameters

Bus Size/Type:	3 in, Schedule 40
Short Circuit Current:	40 kA rms
Load Cases:	Case 1 – 0.50 in ice & 40 mph wind Case 2 – no ice & 100 mph wind Case 3 – seismic & short circuit
Max Vertical Deflection:	3.5 in
Aeolian Vibration Damper:	336.4 MCM ACSR “LINNET”
Insulator Overload Factors:	Wind Forces (K_1) = 2.50 Short Circuit Forces (K_2) = 1.00 Gravitational Forces (K_3) = 1.50

4.18.2. JUMPER CONDUCTOR

Substation stranded jumper conductor is designed to meet the ampacities for bare conductor based on a 35° C ambient temperature, a wind of 2 fps, and a conductor operating temperature of 105° C per PJM Substation Conductor Ratings.

The outdoor jumper conductors will be sized to meet the connected load.

	Size	Current Rating
Substation Line Conductor:	1-1590 MCM AAC, 61 Strand conductor “COREOPSIS”	1612A
Substation Jumper Conductor:	2-1590 MCM AAC, 61 Strand conductor “COREOPSIS”	3060A (PJM required derating of conductor ratings for proximity effect.)
Substation Shield Wire:	7 #9 Alumoweld	
230kV CCVTs and Surge Arresters:	1-556.5 MCM ACSR, 26/7 Strand conductor “DOVE”	862A
69kV PTs and Surge Arresters:	1-336 MCM ACSR 26/7 strand conductor “LINNET”	624A

4.19. INSULATORS

4.19.1. STATION POST

Porcelain station post insulators are used on all termination structures and disconnect switches.

Insulators are selected to meet all electrical and mechanical ratings for their application in accordance with ANSI C29 series for porcelain insulators.

The station post insulators meet the following criteria:

230kV Yard

Nominal Voltage:	230 kV
BIL:	900 kV
ANSI Number:	T.R. 308 EHS
Cantilever Strength:	2750 lb.
Manufacturer P/N:	Newell 47818-7001

69kV Yard

Nominal Voltage:	69 kV
BIL:	350 kV
ANSI Number:	T.R. 278
Manufacturer P/N:	Newell 41530-7001

4.19.2. SUSPENSION INSULATORS

Suspension insulators are a polymer insulator designed to meet the following criteria:

230kV Yard

Nominal Voltage:	230 kV
Quantity per String:	1 (Polymer)
Combined M-E Strength:	25,000 lb.
ANSI Class:	52-5
Manufacturer P/N:	NGK Locke 251-SS640-YJ-08

69kV Yard

Nominal Voltage:	69 kV
Quantity per String:	1 (Polymer)
Combined M-E Strength:	25,000 lb.
ANSI Class:	52-5
Manufacturer P/N:	NGK Locke 251-SS260-YJ

4.20. INSULATED CABLE

Criteria for the insulated cables are selected to satisfy SMECO requirements, and standard operating procedure.

4.20.1. K1 COLOR CODE

The requirements for K1 color coded insulated cables are as follows:

Application:	AC Supply
Voltage Rating:	600 V
Conductor:	Class B copper, stranded
Insulation:	XLPE
Jacket:	PVC
Shield:	None

4.20.2. K2 COLOR CODE

The requirements for K2 color coded insulated cables are as follows:

Application:	Control, dc supply, CTs	
Voltage Rating:	Control, dc supply, CTs:	600 V
	RTU indication:	300 V
Conductor:	Class B copper, stranded	
Insulation:	XLPE	
Jacket:	PVC	
Shield:	Control, dc supply, CTs:	5 mil copper
	RTU Indication:	1 mil aluminum/mylar

4.21. YARD LIGHTING

Yard lighting utilizes quartz flood lights. Because of their instant-on characteristic, they are suitable for emergency and temporary lighting applications. High color rendition aids in distinguishing different colors.

4.21.1. LUMINAIRES

Fixture:	500 W quartz flood light, GE No. QF50DB
Replacement Bulbs:	Q500T3/CL or Q500T3

4.21.2. SWITCHING

230kV Lighting Contactor	12-pole, Square D No. 8903 LG1200V02
69kV Lighting Contactor	6-pole, Square D No. 8903 LG60V02

4.22. CABLE TRENCH

All cable trench is drivable, and has the following properties:

Material:	High Density Polymer Concrete (HDPC)
Load Rating:	H20; Drivable
Size:	20 inches (wide) x 12 inches (deep)
Manufacturer P/N:	Plastibeton Model 2012

4.23. LIGHTNING SHIELDING DESIGN

The shielding design is performed using the “rolling sphere method” as described in IEEE 998, Guide for Direct Lightning Stroke Shielding of Substations.

The lightning protection system is designed to provide protection for new equipment within the substation fence such that the probability of failures of insulation is less than once in 100 years. Structure lightning masts and finials provide this protection.

4.24. SECURITY FENCE

The security fence is a galvanized chain link fence with three strands of barbed wire at the top. The fence meets the following criteria:

Height:	10 feet of fabric and 1 foot of barbed wire
Depth of fence post footing holes:	3.25 feet
Depth of gate post footing holes:	4.25 feet

4.25. PURPOSE OF GROUND GRID

The substation ground grid provides the means to carry electric currents into the earth under normal and fault conditions without exceeding any operating and equipment limits or adversely affecting continuity of service and ensures that a person in the vicinity of grounded facilities is not exposed to the danger of critical electric shock.

The final design objective is to limit touch and step voltages under fault conditions to be below allowable levels for personnel touching (touch voltage) any grounded facilities up to 3 feet beyond the perimeter fence and the east transmission tower base and step voltages up to 20 feet beyond the perimeter fence and the east transmission tower base. All computations were done using version 13.4.28 of the CDEGS Integrated Software Package developed by Safe Engineering Services & Technology LTD. The analyses are based on guidelines defined in the ANSI/IEEE Standard 80-2000, Guide for Safety in AC Substation Grounding. New designs should also be based on CDEGS integrated software package.

4.26. GROUND GRID DESIGN CRITERIA

The existing ground grid is designed to the following criteria:

Total Ultimate Fault Current:	63 kA
Shock Duration (Fault Clearing Time):	18 cycles
Fault Current Distribution (Split Factor):	84.98 percent
Grid Conductor:	500 MCM (19 No. 5) Copperweld, 40 percent conductivity
Grid Conductor Burial Depth:	24 inches below unfinished grade
Ground Rods:	3/4 inch, 30 feet long
Calculated Ground Grid Impedance:	0.059 Ohms

Soil Model [Taken by SMECO on 4/19/2011]

Resistivity (Ohm-meter)	Thickness (feet)
39.6	5.23
18.3	infinite

4.27. ALLOWABLE VOLTAGES BASED ON 50 KG BODY CURRENT

3 Inch Crushed Rock

Surface Layer Resistivity (Ohm-M)	Fault clearing time = 0.3 second	
3000	Step Voltage (V)	Touch Voltage (V)
	2443	757

Safety criteria within and up to 3 feet beyond perimeter fence.

Native Soil

Surface Layer Resistivity (Ohm-m)	Fault clearing time = 0.3 second	
Native soil	Step Voltage (V)	Touch Voltage (V)
	244	208

Safety Criteria 20 feet beyond perimeter fence and transmission tower crushed rock surface.

4.28. CALCULATED TOUCH AND STEP VOLTAGES

Touch voltage (main ground grid with 3 inches of 3000 ohms of crushed rock): 711 V.
Step voltage (main ground grid up to 3 feet beyond fence): 221 V.
Step voltage (main ground grid up to 20 feet beyond fence): 68 V.

4.29. AC SYSTEM APPROACH

The AC system is composed of three separate AC sources. The AC system contains two station service transformers and a standby propane generator. The two station service transformers interface via Automatic Transfer Switch 1. Each transformer is capable of supplying both AC Panel 1 and 2. The generator supplies loads for only AC Panel 2. The generator and AC Panel 2 interface via Automatic Transfer Switch 2.

4.30. AUXILIARY TRANSFORMERS

The following subsections provide information on auxiliary transformers used at the switching station.

4.30.1. STATION SERVICE TRANSFORMER 1

- Rating: 100 kVA
- Voltage: 67 kV to 120/240 V

4.30.2. STATION SERVICE TRANSFORMER 2

- Rating: 100 kVA
- Voltage: 67 kV to 120/240 V

4.31. TRANSFER SWITCHES

The following subsections provide information on transfer switches used at the switching station.

4.31.1. AUTOMATIC TRANSFER SWITCH 1

- Type: ASCO 7000 series, P/N: J07ATSA20600F50C
- Rating: 600 amperes, 1ø, 120/240 V
- Normal Source: Station Service Transformer 1
- Emergency Source: Station Service Transformer 2
- Enclosure: NEMA 1

4.31.2. AUTOMATIC TRANSFER SWITCH 2

- Type: ASCO 7000 series, P/N: J07ATSA20260F50C
- Rating: 260A, 1ø, 120/240 V
- Normal Source: Automatic Transfer Switch 1
- Emergency Source: Standby propane generator
- Enclosure: NEMA 1

4.32. PROPANE GENERATOR

The propane generator meets the following criteria:

- Rating: 40 kW, 1ø, 120/240 V, 3 wire
- Remote Start: From Automatic Transfer Switch 2
- Propane Tank Capacity: 499 gallons

4.33. AC POWER PANELS

The following subsection provides information on AC power panels used at the switching station.

4.33.1. AC PANEL 1 AND 2

- Type: Siemens, Panel Type P1, P/N: P1A42QJ225CTS
- Main: 225A main breaker
- Voltage Rating: 120/240 V, 1ø, 3 wire
- Branch Breakers: BQD, BL, and BF(GFCI)
- Circuits: 42

4.34. DC SYSTEM APPROACH

The 125 VDC system consists of two batteries and two chargers. Each charger and battery set are capable of providing emergency operation and continuous load for the substation facility, and breaker operating power at the end of the 8 hour duty cycle, providing 100 percent redundancy. The redundancy will be achieved by providing a battery tie switch.

4.35. DC BATTERIES 1 AND 2

Criteria for the DC batteries are as follows:

- Nominal Voltage: 125 VDC
- Number of Cells: 60
- Capacity: 410 Ah
- Manufacturer P/N: Alcad, LSe400

4.36. BATTERY CHARGERS 1 AND 2

Criteria for the battery chargers are as follows:

- Charger Rating: 50A and 130 VDC
- Input Voltage: 240 VAC
- Alarm Contacts: High DC, Low DC, Ground Detection, DC Output Failure, AC Output Failure, Charger Failure
- Manufacturer P/N: Alcad, AT10-130-050-240-0101030000

4.37. DC POWER PANELS

Criteria for DC Panel 1, 2, 3, and 4 are as follows:

- Type: Siemens, Type P2, P/N: P2N60FX225FTS
- Main: 225A main breaker
- Voltage Rating: 125 VDC
- Branch Breakers: BQD
- Circuits: 30 (2 wire circuits)

4.38. CONTROL AND RELAY PANELS

The control and relay panels are designed to the following criteria:

- Panel Construction: #11 galvanized steel

• Relay Panel Width:	32 inches
• Panel Height:	80 inches
• Interior Color:	High Gloss White
• Exterior Color:	ANSI-70 Gray
• Control Leads:	No. 14 AWG stranded copper, 600 V, SIS type
• Current and Potential Leads:	No. 10 AWG stranded copper, 600 V, SIS type
• Terminal Blocks:	Similar to 12-point Marathon 1600 series
• Ground Bus:	Copper, (5mm) x(25mm) x(750mm)

4.39. CONTROL AND PROTECTION

For a complete treatment of the Control and Protection, see drawings:

- D-3611 Typical Interconnection 69kv Functional One Line – Four Breaker Ring
- D-3613 Typical Interconnection 230kv Functional One Line – Six Breaker Ring
- D-3610 Typical Interconnection Block Diagram – Four Breaker Ring

For references purposes, the following sections document relays and protection schemes that have been previously installed at SMECO.

4.39.1. TRANSMISSION LINE

Transmission line protection is summarized below:

• Lines:	2340, 2345, 2330
• Nominal Voltage:	230 kV
• Protection Scheme:	Line differential (87L), distance permissive to timer (21/62), stub bus (50STB) enabled only on loss of comms.
• Relays:	ABB RED670, GE L90, ABB REC670

4.39.2. DISTRIBUTION LINE

- Lines: 6791, 6789
- Nominal Voltage: 69 kV
- Protection Scheme: Directional overcurrent (67)
- Relays: ABB REC670, ABB REF550

4.39.3. POWER TRANSFORMER

- Transformers: TR1(ABB), TR2(Pauwels)
- Nominal Voltages: 220/69kV (buried tertiary)
- Protection Scheme: Transformer differential (87, 87W1, 87W2), high impedance 230kV bus differential (87B), sudden pressure & high winding temperature
- Relays: ABB RET670, ABB TPU2000R

4.39.4. 69KV BUS PROTECTION

- Bus: Bus1, Bus2
- Nominal Voltage: 69 kV
- Protection Scheme: Low impedance bus differential (87B)
- Relays: ABB REB670, GE B30

4.39.5. 230KV BUS PROTECTED

- 230kV bus protected by 87B in ABB RET670

5. SUBSTATION CONSTRUCTION CRITERIA

5.1. SUBSTATION GENERAL REQUIREMENTS

5.1.1. GENERAL

This section specifies the general technical requirements applicable to the technical specifications' sections, including furnishing and installing materials for and documenting the construction of substations. The requirements of this section are intended as an addition to and not to conflict with any specific requirements included in any other section of the technical specifications.

5.1.2. CODES AND STANDARDS

The Contractor shall construct the Work specified in accordance with applicable requirements of the latest versions of the codes and standards referenced in this section. Codes and standards applying to a specific portion of the work will be referenced in the technical section applicable to that portion of the Work.

5.1.2.1. STANDARD VERSION

All references to codes and standards shall be the current version of the code or standard in effect (including all amendments) unless otherwise stated.

5.1.2.2. CONFLICTS

The Contractor shall comply with the requirements of the referenced federal, state and local code or standards as well as standards specified by association, or trade. Where codes and standards conflict with each other, the most stringent requirements apply. If specified reference codes and standards conflict with technical specification sections, the Contractor shall request clarification from the Owner before proceeding.

5.1.2.3. CODES

The Work shall comply with relevant portions of the following codes:

- National Electrical Safety Code (ANSI C2).
- Federal and State Occupational Safety and Health Act (OSHA).

5.1.2.4. STANDARDS

The Work shall comply with relevant portions of the industry accepted standards published by the following institutes, associations, and societies:

- American Concrete Institute.
- American Institute of Steel Construction.
- American Iron and Steel Institute.
- American Institute of Timber Construction.
- American National Standard Institute.
- American Society of Civil Engineers.
- American Society of Mechanical Engineers.
- American Society for Testing and Materials.
- American Welding Society.
- Concrete Reinforcing Steel Institute.
- Institute of Electrical and Electronics Engineers, Inc.
- National Electrical Manufacturer's Association.
- Underwriters' Laboratories, Inc.

5.1.3. EXISTING UNDERGROUND INSTALLATIONS

The Contractor shall call Miss Utility (1-800-257-7777) at least 48 hours in advance of any excavation to have the appropriate underground utilities located. Each underground facility encountered shall be accurately located on the drawings, indicating the original location and relocation, if any. When all Work is completed, the marked copy of the drawings shall be submitted to the Owner and Engineer as part of the field records.

5.2. SITE CONDITIONS

5.2.1. SITE INVESTIGATION AND CONTRACTOR'S REPRESENTATION

Contractor acknowledges that the Specification and Documents have been thoroughly reviewed and is satisfied as to the nature and location of the Work, the general and local conditions. The Contractor is aware of the bearing on the project of the following: availability of transportation; disposal, handling and storage of materials; availability of labor, water, and roads; the uncertainties of weather, water levels, or similar physical conditions at the project site; the conformation and condition of the ground; the character of equipment and facilities needed during the execution of the Work; and all other matters that can in any way affect the scope of Work or the Contract Price.

Contractor further acknowledges that the Soil Boring Report has been thoroughly reviewed and is satisfied as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspection of the project site and from reviewing any available records of exploratory work furnished by the Owner or included with these Documents. Failure by the Contractor to understand the physical conditions of the project site and all available information will not relieve Contractor from responsibility for properly estimating the difficulty or cost of successfully performing the Work.

Contractor warrants that, as a result of examination and investigation of all the aforesaid data, Contractor can perform the Work to the satisfaction of the Owner. Owner assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this Contract, unless (1) such representations are expressly stated in the Contract and (2) the Contract expressly provides that the responsibility thereof is assumed by the Owner.

5.3. MODIFICATIONS AND REMOVAL OF EXISTING FACILITIES

5.3.1. GENERAL

During construction, existing facilities may require modification or removal in order to properly execute project construction. The Contractor shall make such modifications and removals as indicated on the drawings and as required by these Specifications.

The Contractor shall coordinate all Work regarding modifications and removal of existing facilities with the Owner to minimize interruptions on the Owner's system. Prior to starting the modification and/or removal Work, the Contractor will prepare and submit to the Owner a proposed detailed schedule for such Work. The Contractor shall not proceed with the modification and/or removal Work until the schedule has been approved by the Owner.

The Contractor shall protect from damage all existing structures and materials that are to remain in place. Existing facilities that are damaged during modification Work shall be restored to their original condition to the Owner's satisfaction. The Contractor shall pay all costs in connection with repairing damages to existing facilities resulting from this Work.

5.3.2. EQUIVALENT MATERIAL AND EQUIPMENT

Where one or more manufacturers are listed in the Contract Documents for a material item, without the words "or equal," the Contractor shall provide the product of one of the manufacturers listed. Where one or more manufacturers are listed followed by the words "or equal," "or approved equal," "or equivalent," and "or acceptable equal," the Contractor shall provide the product of one of the manufacturers listed, or an equivalent material item may be proposed as a substitute for the one specified. The proposed substitution must be a product of equal quality; must meet or exceed the attributes, performance, or other standards of the specified product; and must be approved by the Owner.

When an equivalent material or equipment item is approved by the Owner, all costs associated with changes required to incorporate the equivalent item into the Work shall be borne by the Contractor without increase in the Contract Price.

5.3.3. ENGINEERING DATA

The Contractor shall submit data to the Engineer covering all equipment and fabricated materials to be furnished under these Specifications.

5.3.4. CORRECTION OF ERRORS

Equipment and materials shall be complete in all respects within the limits herein outlined. All errors or omissions required to be corrected in the field shall be done by the manufacturer or their duly authorized representative at the Contractor's expense. All corrective measures shall be subject to the approval of the Engineer.

5.4. MATERIAL AND EQUIPMENT

5.4.1. SALVAGED MATERIALS

Contractor shall deliver all salvaged poles, structures, equipment, conductors, and materials to the Owner's storage area and unload as directed by the Owner. Contractor shall dispose of all materials not being salvaged.

Contractor shall obtain a signed voucher from the Owner's storekeeper for all returned material.

The Contactor shall disassemble, sort, and store all structures and materials. Wood and concrete poles removed shall be freed of dirt and other debris and inspected for damage. The Contractor shall Identify and inform Owner of any wood poles that may need treatment to prevent further deterioration and notify Owner of any damage needing repair.

Contractor shall spool and tag all conductors, shield wires, fiber optic cables, and guy wires with information concerning the type and approximate length of conductor or wire in feet contained in each spool. The Contractor shall remove all splices and connectors and identify and inform Owner of any damaged sections of wire.

The Contractor shall provide all reels, shoring, and crating required for the storage of salvaged structures, equipment, and materials.

5.4.2. DISPOSAL OF RAZED ITEMS

All electrical equipment, materials, wire, conduit and miscellaneous items removed shall be disposed of by the Contractor unless otherwise indicated on the drawings or specified herein. Conduit and wire, which have been removed from the existing installation, shall not be reinstalled at other locations as part of the Work under these Specifications.

5.4.3. NAMEPLATES

The Contractor shall furnish and install nameplates for all equipment installed including Owner-furnished equipment. Nameplates for mounting inside equipment or in the control buildings shall be made of laminated white phenolic engraving stock with black core. Nameplates to be installed outdoors in the switchyards shall be assembled from replaceable letter/number blocks or Engineer approved equal consisting of black characters on a white or yellow background. The blocks shall be fade resistant and shall be assembled in galvanized steel or aluminum frames.

All items of equipment shall have nameplates. In addition, nameplates shall be provided for all panelboards, cabinets, junction boxes, etc. Transmission line and feeder termination structures and riser poles shall be labeled with the appropriate line and feeder numbers and phase designations. Phase designations shall also be installed on the load side of all disconnect switch structures and at all CCVT, PT, and line-trap structures.

Engraved nameplate lettering for indoor nameplates shall not be less than 1-inch square, bold engraved through the outside layer so that the letters are the color of the core.

The letter blocks shall be approximately 3 inches square.

All nameplates shall be attached to the equipment or structures with stainless steel hardware.

5.4.4. SPARE PARTS

In addition to spare parts identified elsewhere in these specifications or on the drawings, the Contractor shall furnish the following spare parts for each item of equipment Contractor furnishes:

- 100 percent replacement of fuses for each type and size of fuse.
- 100 percent replacement of each type of lamp, bulb, etc., for each type of indicating light and light fixture.
- 100 percent replacement of each type of blown fuse indicators.
- 2 fuse pullers for each type of fuse.

All spares shall be strictly interchangeable with the parts for which they are intended to be replacements and shall be treated and packed for long storage under the climatic conditions prevailing at the site. Each spare shall be clearly marked or labeled on the outside of its packing with its description and purpose. All spare parts shall be turned over to the Owner.

5.5. PROTECTION OF THE ENVIRONMENT

5.5.1. GENERAL

The Contractor shall observe the rules and regulations of the Owner and the state, local, and federal agencies having jurisdiction over the protection of the environment.

5.5.2. TRAFFIC CONTROL

Traffic control shall be the responsibility of the Contractor and shall be in accordance with applicable state, county, and municipality statutes and guidelines.

5.6. SEDIMENT AND EROSION CONTROL

5.6.1. GENERAL

Soil erosion and sediment control devices shall be constructed and installed by the site preparation contractor. The control devices shall be left in place to prevent sediment and soil erosion at those areas not protected by either existing vegetation or natural barriers. The Contractor shall be responsible for maintaining these existing devices. The Contractor shall be responsible for maintaining the existing Sediment and Erosion Control plan throughout the duration of the project.

The spoil removed from the foundation excavations shall be disposed of offsite. The Contractor shall be responsible for installing necessary sediment and erosion control devices around this area. Topsoil, soil containing roots, rootmat or other coarse material, shall not be used as base material in constructing berms, storm water retention ponds or other sediment and erosion control devices.

Sediment and erosion control plan as presented and approved by Maryland Department of the Environment (MDE), Maryland Department of Natural Resources, County Dept. of Public Works and/or Land Use and County Conservation Service shall hereby be made a part of the contract.

All sediment and erosion control shall be subject to inspection by the Natural Resources, Conservation Service and MDE as to compliance with appropriate rules, ordinances and regulations.

5.7. SEEDING

5.7.1. GENERAL

The Contractor is responsible for repairing any vegetation damaged during the station construction. To remedy vegetation damage by the Contractor, seed bed preparation and seeding shall be done by the Contactor.

5.8. EXCAVATION, TRENCHING AND BACKFILLING

5.8.1. GENERAL

The station site has been graded to its design level. Any changes to this level as a result of excavating for installation of raceway and grounding shall be corrected prior to installing the aggregate surfacing. The excavations shall conform to the dimensions and elevations indicated on the drawings, except as specified below. Where unsuitable bearing is encountered at the elevations indicated on the drawings, the Engineer may direct, in writing, that the excavation be carried to elevations below those shown on the drawings. Unless so directed by the Engineer, excavation shall not be carried below the elevations indicated on the drawings. Where the excavation is made below the elevations indicated, the excavations, if under slabs, shall be restored to the proper elevation in accordance with the procedure specified for backfill, or if under footings, the heights of the walls or footings shall be increased, as may be directed by the Engineer. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, and for inspection, except where the concrete for footings is authorized to be deposited directly against excavated surfaces. Undercutting will not be permitted.

5.8.2. DRAINAGE IN VICINITY OF BUILDING AND OTHER STRUCTURES

The Contractor shall control the grading in the vicinity of buildings and other structures so that the surface of the ground will be properly sloped to prevent water from running into the excavated areas. Any water that accumulates in the excavation shall be promptly removed

5.8.3. EXCESS MATERIAL

Excess material from excavation shall be disposed of off site.

5.8.4. BACKFILLING

Where backfill is required, such backfill shall consist of broken stone, sand, gravel, or other material approved by the Owner. Where broken stone, sand or gravel is used for backfill, it shall be placed in layers not exceeding twelve (12) inches in thickness and thoroughly compacted. When earth is used for fill, it shall be placed in layers not exceeding eight (8) inches in thickness. Each layer shall be moistened during compaction to a moisture content such that the required degree of compaction may be obtained. (Where there is a conflict MDE, Natural Resources Conservation Service or County Regulations shall be used.)

5.9. AGGREGATE SURFACING

5.9.1. GENERAL

This section covers the materials and construction for station aggregate surfacing.

All new and existing aggregate surfaced areas constructed under these Specifications or separate contract shall be maintained by the Contractor until final acceptance of the Work by the Owner.

The Contractor shall be responsible to provide a finished subgrade after all underground facilities are installed. This includes any rough site conditions from previous contracts.

5.9.2. PROTECTION OF SUBGRADE

Ditches and drains along the subgrade shall be maintained to provide effective drainage. Whenever ruts are formed, the subgrade shall be brought to grade, reshaped, and recompacted. In no case shall aggregate surfacing be placed on a muddy subgrade. Storage or stockpiling of materials on the subgrade will not be permitted.

5.9.3. SUBGRADE PREPARATION

Immediately prior to surfacing, the subgrade shall be shaped to the grade and cross section indicated on the drawings and compacted. This operation shall include any scarifying, reshaping, and wetting required to obtain a firm, dense surface. Soft, organic, and otherwise unacceptable material shall be removed from the subgrade and replaced with acceptable material.

5.9.4. MATERIALS

Materials for the aggregate surfacing shall be as stated on the drawings and comply with all applicable sections of the State Highway Administration Standard Specification.

A job mix formula shall be established by the Contractor and shall be acceptable to the Owner prior to the start of Work. This mix shall not be changed without prior authorization from the Owner.

5.9.5. APPLICATION

Aggregates shall be handled and spread in a manner that will prevent segregation of sizes. The surfacing shall be uniformly spread and compacted with vibratory rollers or tampers. Care shall be taken to prevent damage to any structures with the rolling or tamping equipment.

Surface of the completed aggregate layer shall not deviate more than ½ inch when tested with a 10-foot straightedge. The completed compacted thickness of any course shall be within plus ¾ inch and minus ½ inch of indicated thickness, and the average thickness shall not be less than the design thickness indicated.

5.9.6. WEED ERADICATOR AND SOIL FUMIGANT

After subgrade preparation and prior to applying the final aggregate layer, areas to receive aggregate surfacing shall be treated with a weed eradicator and soil fumigant.

Weed eradicator and soil fumigant shall be applied in strict accordance with the manufacturer's instructions. The weed eradicator and soil fumigant shall be Allied Chemical "UROX" or "URAB"; Du Pont "Hyvar-X" or "Hyvar XL"; or U.S. Borax "Ureabor".

5.9.7. MAINTENANCE

Maintenance of aggregate surfacing shall consist of periodic maintenance operations by the Contractor throughout the period utilized to complete the Work under these specifications. Maintenance operations shall include loosening, adding, and removing material, grading, reshaping, and recompacting as required to keep the surfaced areas in first-class condition.

5.10. GROUNDING SYSTEM

5.10.1. GENERAL

This section covers the furnishing and installation of a complete grounding system in accordance with these specifications and the drawings. The Contractor is responsible to install the below grade ground grid including ground rods and structure and equipment stingers as well as the above grade grounding as shown in the grounding details on the drawings.

5.10.2. GROUNDING MATERIALS

All grounding materials required shall be furnished new and undamaged in accordance with these Specifications and the drawings

5.10.2.1. GROUND GRID

Ground Bus Conductor shall consist of 500 MCM copper weld with 40% conductivity as indicated on the drawings.

5.10.2.2. GROUNDING RODS

Copper cladding shall be electrolytically bonded to the steel rod or bonded by a molten welding process. Cold rolled copper cladding is not acceptable.

5.10.2.3. COMPRESSION CONNECTORS

Connectors, crimps, and dies shall be furnished by the same manufacturer.

5.10.2.4. CONNECTION HARDWARE

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

5.10.3. GROUNDING INSTALLATION

Grounding system materials shall be installed according to the drawings and the requirements which follow.

5.10.3.1. GROUND GRID

Ground bus conductor shall be buried not less than 24 inches below finished grade as indicated on the drawings.

5.10.3.2. GROUNDING RODS

All ground rods shall be located and installed to the depth as indicated on the drawings. Where the required ground rod length exceeds 10 feet, standard sections shall be joined together with threadless connections to provide an extended rod with one true center line and a minimum of joint resistance.

5.10.3.3. ABOVE GRADE CONDUCTORS

Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to dominant surfaces.

Conductors routed over concrete, steel, or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not to exceed 3 feet.

Damaged ground system conductors shall be repaired or replaced by the Contractor as directed by the Owner.

5.10.3.4. CONNECTIONS

All below grade connections shall be made with compression connectors except where otherwise indicated on the drawings or in the specifications. The manufacturer’s instructions on the use of compression connectors shall be followed in all details. All surfaces to be joined by the connectors shall be thoroughly cleaned. Connectors and dies shall be kept dry, clean, and free of debris.

All connections shall successfully resist moderate hammer blows. Any connection which fails such test or which, upon inspection, indicates a defective or noncompliant connection, shall be remade.

All bolted and screwed connections shall be securely tightened.

5.10.3.5. TRAY GROUNDING

A bare grounding conductor shall be installed the entire length of cable trays where indicated on the drawings. The grounding conductor shall be connected to each tray section and the tray grounding system shall be connected to the station ground grid as indicated on the drawings.

5.10.3.6. STRUCTURE AND EQUIPMENT GROUNDING

All electrical equipment and structures shall be connected to the ground grid with the same size and type of conductor as the ground grid, or as shown on the drawings. Most equipment and structures will be furnished with grounding pads and/or grounding lugs which the Contractor shall connect to the ground grid. The Contractor shall furnish all grounding material required but not furnished with equipment. All ground connection surfaces shall be cleaned immediately prior to connection.

Where ground grid extension stingers are indicated on the drawings to be provided for connection to electrical equipment, the Contractor shall connect the bare grounding conductor to the equipment ground bus, pad, or lug. Where a grounding conductor is included with the phase conductors of power circuits, the grounding conductor shall be connected to the equipment grounding facilities and to the source ground bus. Where a grounding conductor is not included with the phase conductors, the equipment shall be grounded by connecting a separate ground cable to the equipment grounding facilities and to the tray ground cable or source ground bus. Except where otherwise indicated on the drawings, all equipment grounding conductors which are not an integral part of a cable assembly shall be sized in accordance with the requirements of the NEC. All ground conductors installed in conduit shall be insulated.

No grounding conductor shall be smaller in size than 12 AWG unless it is a part of an acceptable cable assembly.

5.10.3.7. SWITCH OPERATOR – GROUNDING PLATFORM

A ground platform shall be installed for all new switch operators as indicated on the drawings. Ground platforms shall be approximately 3 feet by 4.5 feet and located on top of the crushed rock surface. The platform shall be connected to the station ground system and to the switch operating mechanism as indicated on the drawings.

5.10.3.8. FENCE GROUNDING

The perimeter fence shall be grounded in accordance with these Specifications and the drawings. The Contractor is responsible for performing all the fence grounding as shown on the fence grounding details.

5.11. RACEWAY

5.11.1. GENERAL

This section covers furnishing and installation of a complete raceway system in accordance with these Specifications and the drawings.

The Contractor shall install all above and below grade conduit from all electrical devices to the cable trench. The Contractor shall terminate all riser conduits with appropriate adapters, locknuts, and bushings into equipment enclosures

5.11.2. CODES AND STANDARDS

Raceway system materials and devices furnished shall be in accordance with applicable standards of ANSI, NEMA, and UL. Raceway system components shall be installed in accordance with applicable requirements of the NEC. In case of conflict between the requirements of any of the above-referenced codes and standards and the requirements of these Specifications, the requirements of these Specifications shall govern. All materials and devices shall be in accordance with the applicable requirements of the Federal "Occupational Safety and Health Standards."

5.11.3. CONDUIT MATERIAL

Electrical conduit and associated materials shall conform with the requirements of the articles which follow.

5.11.3.1. PLASTIC CONDUIT

Non-encased schedule 40 PVC conduit shall be used for station service and for housing conductors for control and power relay systems. Conduit shall be complete with bushing, fitting, and couplings. Joints shall be made with solvent cement. Couplings shall have a center stop to ensure proper seating.

5.11.3.2. SPECIAL FITTINGS

Conduit sealing, explosion proof, dustproof, and other types of special fittings shall be provided as required by the drawings and these specifications and shall be consistent with the area and equipment with which they are associated. Fittings installed outdoors or in damp locations shall be sealed and gasketed. Outdoor fittings shall be of heavy cast construction.

5.11.3.3. BUSHINGS

Insulated bushings with insulating inserts in metal housings shall be provided for the termination of all conduit not terminated in hubs and couplings. Standard bushings shall be galvanized.

5.11.3.4. LOCKNUTS

One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

5.11.3.5. RAINTIGHT CONDUIT HUBS

Raintight conduit terminating hubs shall be used where indicated on the drawings or required by these Specifications

5.11.3.6. CONDUIT CLAMPS

Supports for conduits in single runs or groups of two shall be one-hole cast metal clamps and clamp-backs. They shall be galvanized malleable iron or acceptable equal.

Supports for banks of three or more conduits shall be constructed of support channels with associated conduit clips. Support channels shall be steel hot-dip galvanized after fabrication.

5.11.4. CONDUIT INSTALLATION

Conduit installation shall be as indicated on the drawings and as described in these specifications.

Conduit deformed or crushed in any way shall not be installed.

Conduit shall be bedded in a graded 3-inch-deep soft bedding of sand or finely divided job excavated material free from debris, organic material, and stones. Backfill, to approximately 6 inches above the conduit, shall be the same as bedding material.

Conduit which is stubbed up shall be plugged and shall remain plugged until the conduit is extended later.

No conductors shall be installed until Work, which might cause damage to the conductors or conduit, has been completed.

5.11.4.1. ROUTING

The Contractor shall field route conduit according to the general routing indicated on the drawings and shall coordinate conduit locations with equipment and structures. Conduit which will be visible above the finished grade shall be straight and plumb. Routing not acceptable to the Owner shall be rerouted and replaced without expense to the Owner.

5.11.4.2. BENDS AND OFFSETS

A run of conduit shall not contain more than the equivalent of four quarter bends, including those immediately at outlets or fittings. Bends in conduit shall be made without reducing the internal diameter of the conduit.

Bends shall be made from straight conduit lengths or shall be factory fabricated. Bend radii shall be in accordance with the NEC.

The conduit length for field bending shall be heated to approximately 275 F by radiant heat, hot air, or hot liquid immersion. Open flame heating will not be permitted. Special mandrels or forms shall be used to provide a smooth bend without reduction of the conduit diameter. Conduit discolored by prolonged heating will not be acceptable.

5.11.4.3. CUTTING

The plane of all conduit ends shall be square with the center line. The ends of all conduit shall be reamed to remove all rough edges and burrs.

5.11.4.4. CONNECTIONS TO BOXES AND CABINETS

Conduit shall be securely fastened to all boxes and cabinets. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. All conduit entering enclosures outdoors or in wet areas shall enter through watertight hubs or threaded openings.

5.11.4.5. SLEEVES AND OPENINGS

The Contractor shall be responsible for all required openings. Required openings not provided during equipment fabrication shall be provided by the Contractor using a hacksaw, a hole saw, or a core drill subject to acceptance by the Owner.

5.11.4.6. CLEANINGS

The Contractor shall exercise necessary precautions to prevent the accumulation of water, dirt, or concrete in the conduits during the execution of the Work. Conduits in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or the conduit run replaced where such accumulation cannot be removed by methods approved by the Owner.

5.11.4.7. CONDUIT JOINTS

Expansion joints for exposed conduit or buried conduit which will be exposed to temperature variations shall be provided as recommended by the manufacturer.

Joints shall be unthreaded solvent cement type as recommended by the conduit manufacturer. The contact surfaces of the conduit and fitting socket shall be cleaned with Stoddard solvent, methyl ethyl ketone, or acetone, liberally coated with solvent cement, promptly and fully engaged, and either conduit or fitting rotated approximately l/4 turn to dispel air and evenly distribute solvent cement over contact surfaces. For proper connection, total elapsed time between the start of the cement application to the surfaces being joined and final assembly of the joint should not exceed 60 seconds. The initial strength of the joint will permit continuous conduit installation; however, additional stress at the joint shall be avoided for at least 24 hours after joining.

5.11.4.8. SPACING AND ATTACHMENTS OF SUPPORTS

All conduit runs shall be rigidly supported. Each conduit shall be supported within one foot of junction boxes and fittings. Support spacing along conduit runs shall be as follows.

Conduit Size	Maximum Distance Between Supports
l/2 inch through l-l/4 inch	5 feet
l-l/2 inch and larger	l0 feet

Conduit clamps shall be bolted to steel using drilled and tapped screw holes. Support channels for three or more conduits shall be bolted using drilled and tapped screw holes.

The use of wooden plugs inserted in masonry or concrete as a base to fasten conduit supports shall not be permitted.

5.11.5. BOXES AND CABINETS

All boxes and cabinets required throughout the electrical raceway system shall be furnished and installed in accordance with these Specifications and as indicated on the drawings.

5.11.5.1. JUNCTION BOXES AND CABINETS

Junction boxes, pull boxes, and cabinets shall be constructed in accordance with UL 50 for their intended service. Junction boxes, pull boxes, and cabinets shall not have knockouts.

Enclosure type, material, and dimensions shall be as indicated on the drawings and as specified in these Specifications. Where no type or size is indicated elsewhere for junction boxes, pull boxes, or cabinets, they shall be in accordance with the requirements of the NEC, Article 370.

Unless indicated otherwise on the drawings or in these Specifications, electrical enclosures shall be as follows:

Location	Enclosure Type
Indoor	NEMA 12
Outdoor	NEMA 4X

5.11.5.2. OUTLET BOXES AND SWITCH BOXES

All outlet boxes, switch boxes, and associated fittings shall be constructed in accordance with UL 514.

All surface mounted outlet boxes, switch boxes, and associated fittings shall be galvanized malleable iron or acceptable equal.

5.11.5.3. INSTALLATION

Cabinets and boxes shall be rigidly mounted. Mounting on concrete shall be secured by self-drilling anchors. Mounting on steel shall be by drilled and tapped screw holes. Cabinets shall be leveled and fastened to the mounting surface with not less than ¼ inch air space between the enclosure and mounting surface. All mounting holes in the enclosure shall be used.

Except as prevented by the location of other Work, all junction boxes and outlet boxes shall be centered on structures.

Conduit openings in boxes shall be made with a hole saw or shall be punched.

5.11.5.4. JUNCTION BOX IDENTIFICATION

A nameplate with the identification number of each junction box indicated on the drawings shall be installed on the box in accordance with Section 4.4.3 NAMEPLATES.

5.12. PRECAST UNDERGROUND CABLE TRENCH SYSTEM

A precast underground cable trench system shall be installed in accordance with the drawings and these Specifications.

5.12.1. GENERAL

A precast underground trench system with removable covers installed in earth trenches shall be constructed per the manufacturers recommendations at the locations indicated on the drawings.

Construction shall be to grades as indicated on the drawings.

5.12.2. MATERIAL

A precast high-density polymer concrete trench system as manufactured by Synertech, 332 South Michigan Ave, Suite 1143, Chicago, Illinois 60604, shall be furnished by the Owner.

The dimensions of the trench shall be as indicated on the drawings.

The precast sections of the trench system shall be furnished in standard 10-foot lengths, except that special lengths shall be furnished where required by the layout on the drawings.

The trench system shall be designed for an H20 load rating.

The Owner will approve all necessary special fittings, offsets, terminations, or other designated fittings as required.

5.12.3. EXCAVATION

All excavation and backfill shall conform to Section 4.8 EXCAVATION, TRENCHING AND BACKFILLING.

5.12.4. INSTALLATION

Installation shall be as indicated on the drawings and Manufacturer's recommendations.

A ground cable shall be installed in the trench system over its entire length using manufacturer's non-corrosive metal cable clips. The ground cable shall be sized as indicated on the drawings.

Conduits shall be terminated in the bottom or side of the cable trench. The Contractor shall cut holes as required in the cable trench to accommodate the conduit entrance.

Covers shall be placed on trenches after installation of cables is completed.

The cable trench system shall be protected against entrance of construction debris, rock, and earth during the construction. The Contractor shall clean out trenches of any such foreign material prior to placing cables and just before final placing of covers.

5.13. CAST-IN-PLACE CONCRETE

5.13.1. GENERAL

Foundations, footings, concrete slabs, and duct line shall be installed as indicated on the drawings, and in undisturbed earth. Dimensions indicated for anchor bolt settings shall be checked against the steel and/or equipment to be installed prior to construction of forms.

5.13.1.1. STRENGTH

Concrete shall be of Type IIA. Concrete shall have a compressive strength of 4000 pounds per square inch after 28 days when tested in accordance with ASTM C 39-86 or latest revision. (Refer to "Testing" below.)

5.13.1.2. AIR CONTENT

All concrete shall have "air-entraining agent" of no less than four (4) percent nor more than six (6) percent. The strength shall be a minimum of 4000 pounds per square inch with the "air entraining agent" added. (Refer to section 4.13.2, Testing.)

5.13.1.3. REINFORCING STEEL

All reinforcing steel bars shall be grade 60 deformed billet-steel per ASTM A-615. All welded wire fabric shall conform to ASTM A-185.

Welded wire fabric reinforcement in slabs shall be continuous, shall have joints lapped at least one full mesh plus two inches, and shall be supported at proper elevations by standard accessories. Lapping of sheets shall be staggered to avoid continuous lap in either direction.

Accessories such as high chairs, ties, bolsters, spacers, etc., shall be sufficient in number and strength to carry properly the reinforcing steel they support, and shall be secured against displacement. All reinforcement shall be tied.

5.13.1.4. STORAGE

Storage accommodations, accessible for inspection and identification of shipments shall be subject to approval by the Owner and/or Engineer.

5.13.1.5. CEMENT

Immediately upon receipt at the project site, bagged cement shall be stored in a dry, weather tight structure.

5.13.1.6. AGGREGATE

Aggregate shall be piled with facilities for good drainage and the exclusion of foreign matter.

5.13.1.7. FORMS

Forms shall be constructed to the shape, form, line and grade required and shall be maintained sufficiently rigid to prevent deformation under the load imposed by supported inserts or by wet concrete.

5.13.1.8. COATING

Forms shall be coated with form oil before reinforcement is placed.

5.13.1.9. REMOVAL

Forms shall not be removed until permission of the Owner and/or Engineer has been obtained. Any void in concrete shall be repaired using non-shrink grout.

5.13.1.10. CHAMFER STRIPS

Chamfer strips shall be placed in forms to bevel all salient edges and corners except where otherwise noted. Bevel dimensions shall be 3/4 by 3/4-inch unless otherwise indicated on the drawings.

5.13.2. TESTING

Consistency will be determined in the field by the slump test, in accordance with ASTM Specification C143. Slump for concrete shall be 2 to 3 inches for footing construction and 3 to 5 inches for other construction. Air content shall be four to six percent by on-site testing using the pressure method in accordance with ASTM C231.

The Contractor shall provide equipment and labor to make slump and air entrainment tests. All slump tests shall be made at the time of the pour and as directed by the Owner. Test cylinders shall be placed, and strength tested by the Contractor as directed by the Owner for each shipment of concrete. Test results shall be sent to the Owner. All costs for tests shall be the Contractor's responsibility.

The Contractor shall take three (3) test cylinders for breakage testing. The first shall be broken after seven (7) days, the second after twenty-eight (28) days, and the third kept as a spare.

5.13.3. JOB-MIXED CONCRETE

Concrete mixed at the job site shall be mixed in a batch mixer and in a manner subject to the approval of the Owner.

5.13.4. READY-MIXED CONCRETE

Concrete mixed off-site and transported to the job site shall be used in lieu of job-mixed concrete, provided it meets previous specifications for strength and slump at the time of delivery. All ready-mixed concrete shall be in compliance with ASTM C94-86a, "Standard Specification for Ready-Mixed Concrete."

5.13.5. ANCHORAGE ITEMS

Installation of anchorage items, including bolts, dowels, and other similar devices, shall be accurately positioned and securely anchored. Embedments shall be clean when they are installed. After installation, surfaces not in contact with concrete shall be cleaned of all concrete spatter and other foreign substances.

5.13.6. BOLT PROTECTION

Prior to setting, the threads of each anchor bolt shall be given a light coating of oil or grease to prevent the adherence of concrete. When installed, the bolts shall be clean and the portions to be embedded in concrete shall be free of heavy scale, oil or other deleterious substances that would adversely affect the bond between the bolts and concrete. During the concrete finish and clean-up, the Contractor shall remove concrete adhering to the portions of anchor bolts extending above finished concrete grade. No pipe sleeves are to be installed with the anchor bolts. The bolts shall be accurately positioned. It will be the Contractor’s responsibility to accurately set the bolts initially and to maintain the required accuracy of their positioning to the time of final acceptance.

5.13.7. ASSEMBLY TOLERANCE

Deviations from specified positions of anchor bolts, after concrete has set, shall not exceed the following:

Horizontal distance between centers of adjacent anchor bolts shall be within 1/16-inch of the specified distance, measured at the top of concrete.

The elevation of the top of the lowest anchor bolt in a set shall not be less than specified, and that of the highest bolt shall not exceed the specified elevation by more than ¼-inch.

Angular deviation of the installed anchor bolt set from specified alignment relative to center line shall not exceed one (1.0) degree.

5.13.8. PREPARATION FOR PLACING

Water shall be removed from excavations before concrete is deposited. Hardened concrete, debris, and other foreign materials shall be removed from the interior of forms and from the inside of mixing and conveying equipment; reinforcement secured in position will be subject to inspection and approval by the Owner. Runways for buggies or wheelbarrows shall not be supported on reinforcement.

5.13.8.1. CONVEYING

Concrete shall be conveyed from mixer to forms as rapidly as practicable without segregation or loss of ingredients.

5.13.8.2. PLACING CONCRETE

Concrete having attained its initial set or having contained its water content for more than 1-1/2 hours shall not be used in the Work. Concrete shall not be dropped freely more than 5 feet in unexposed Work and not more than 3 feet in exposed Work. Unless approved by the Owner, concrete shall be mixed and placed only when the temperature is at least 40° F. Concrete footings shall be placed upon surface free from frost, ice, mud, loose or unsound rock and other detrimental substances.

5.13.8.3. VIBRATING

All concrete shall be vibrated thoroughly with mechanical devices designed for the purpose while pouring into forms. Stirring or settling with shovels only will not be accepted. The vibrator is to be inserted only straight down into the concrete. The vibrator is not to be used to move the concrete after it is dumped into the form.

5.13.8.4. SLAB ON GRADE

The subgrade shall be brought to an even plane and compacted solid. Concrete shall be deposited to the required thickness and finished monolithically to a smooth, level surface by floating and troweling.

5.13.8.5. FINISHES OF CONCRETE OTHER THAN FLOORS AND SLABS

Slight honeycomb and minor defects shall be patched with cement mortar made with non-shrinking grout. Exposed surfaces shall be given a rubbed finish. Fins and other projections shall be carefully removed, offsets leveled, and surface damage repaired. The surfaces then shall be rubbed with cement or Carborundum bricks and water, leaving the surface uniformly smooth and clean and concrete sealer applied.

5.13.9. PROTECTION AND CURING

5.13.9.1. PROTECTION AGAINST MOISTURE LOSS

Immediately after placing or finishing, concrete surfaces not covered by forms shall be protected against moisture loss for not less than 7 days by covering with Kraft paper, mats, or burlap, lapped 4 inches at edges and ends. Burlap may be used only for unexposed concrete surfaces and shall be in at least 2 layers. Surfaces from which forms are removed before the curing period has elapsed shall be protected as specified for surfaces not covered by forms. All materials used for prevention of moisture loss shall be in accordance with ASTM C-171-69.

5.13.9.2. CURING

Curing shall be done by keeping the forms and other protective material thoroughly wet.

5.13.9.3. CLEANING- UP

All forms shall be completely removed. All materials and equipment and rubbish shall be removed, and the premises left in a neat condition.

5.14. SURVEYING AND STAKING

5.14.1. GENERAL

The Owner will provide the construction baselines as shown on the drawings, and an elevation bench mark on the substation pad. The Contractor shall be responsible for the surveying and staking throughout the project duration.

5.15. STRUCTURAL STEEL ERECTION

5.15.1. GENERAL

This section covers the installation of steel structures.

5.15.2. INSTALLATION

The Contractor shall exercise care in the handling of the steel in order to avoid damaging the galvanizing or straining or bending the members. Structure members, pending erection, shall be neatly piled off the ground. Structure member shall not be used as unloading or loading skids. Galvanized surfaces, which are damaged for any reason, shall be given one spot coat of a zinc-rich paint containing a minimum of 92% zinc content by weight, such as ZRC's Galvanox paint.

All steel shall be plumb and level. Bolts shall not be tightened until all parts are installed in place. After steel is completely installed, bolts shall then be installed to final torque levels.

Turn-of-nut tightening shall be used. Hardened washers are not required except where the outer face of the bolted parts has a slope greater than 1:20 with respect to a plane normal to the bolt axis, a hardened beveled washer shall be used to compensate for the lack of parallelism.

Bolts shall be installed in all holes of the connection and brought to a snug-tight condition. "Snug tight" is defined as "the tightness that exists when the plies of the joint are in firm contact." This may be attained by a few impacts of an impact wrench or by the full effort of a man using an ordinary spud wrench. Snug tightening shall progress systematically from the most rigid part of the connection to the free edges, and then the bolts of the connection shall be re-tightened in a similar systematic manner as necessary until all bolts are simultaneously snug tight and the connection is fully compacted. Following this initial operation all bolts in the connection shall be tightened further by the applicable amount of rotation or torque. During the tightening operation there shall be no rotation of the part not turned by the wrench. Tightening shall progress systematically from the most rigid part of the joint to its free edges.

If any mis-fabrications or incorrectly drilled holes are encountered in structure components, the Owner shall be notified, and redrilling or other corrections shall be undertaken by the Contractor as directed. Imperfect holes may be corrected by reaming, punching, drilling or filling and drilling, as directed by the Owner or Engineer. Additional holes required or missing shall be the responsibility of the Contractor at no additional cost to the Owner.

No field welding of the structure shall be permitted unless specifically approved by the Owner or Engineer.

5.15.3. REUSE OF BOLTS

A490 bolts and galvanized A325 bolts shall not be reused. Other A325 bolts may be reused if approved by the Owner or Engineer. Toughing up or re-tightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as reuse provided the snugging up continues from the initial position and does not require greater rotation, including the tolerance, than that required.

5.15.4. BOLTING

The bolts will be furnished by the Owner, except as otherwise indicated on the drawings.

All connections shall be bearing type connections with threads excluded from the shear planes of the connected materials. Bolt length shall be selected in accordance with the Research Council specification and commentary specified hereinafter. Bolt length shall provide for washers, nuts, and locking devices. Where clearance permits, nuts shall be placed so they will be on the least visible side of each connection.

High strength bolts and their installation and bolting tools and equipment shall conform to all requirements for A325 bolts of the "Specifications for Structural Joints Using ASTM A325 or A490 Bolts" including the commentary given therewith, as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation and endorsed by AISC, except as otherwise modified or supplemented herein. The

Research Council specification is dated August 14, 1980. All methods, tools, and equipment shall be subject to the acceptance of the Owner or Engineer. The work shall be done by competent and experienced bolting crews.

Tightening of galvanized high strength bolts shall be done by the "turn-of-nut" method only. A washer shall be used under the element turned in tightening. Smooth beveled washers shall be used when the bearing faces of the bolted parts have a slope of 1:20 or greater with respect to a plane normal to the bolt axis.

ASTM A394 and machine bolt length shall be selected to provide for nut and locknut, plus a 1/4 inch to 1/2-inch projection beyond the locknut. Each connection bolt shall be securely wrench tightened. "Wrench tightened" is defined as 50 to 75 foot-pounds of torque on 5/8-inch bolts and finger tightened to contact the nut, then wrench tightened against the nut an additional one-half to one full turn.

Bolted connections shall be drifted to proper position and the holes inspected to ensure that bolt threads will not be damaged by forcing the bolts in place. Connections shall be tightly drawn together using two bolts or 25 percent of the total number of bolts in the completed joint, whichever is greater. Bolts for initial tightening shall be distributed uniformly about the joint. Either fitting-up bolts or high strength bolts may be used for this purpose.

The Contractor shall make a thorough inspection to ensure that all bolts are tightened and that a locknut has been installed and tightened on each bolt.

Any ASTM A325, A394, or machine bolt, which has been tightened more than one-half turn beyond "snug tight", shall not be loosened and retightened. All such bolts shall be discarded and new bolts shall be used in their place.

The tightened A325 bolts shall be checked at random as directed by and in the presence of the Owner. Calibrated hand torque wrenches and the necessary platforms, equipment, and personnel shall be provided for the random check.

The torque wrench shall be constructed so that it will visually or audibly indicate when the proper torque is reached. The wrench shall be calibrated to indicate a torque equivalent to bolt tension of 28,000 pounds for 3/4-inch bolts. The number of A325 bolts checked shall be acceptable to the Owner based upon observance of the quality and completeness of the tightening operations. A minimum of 10 /4percent of the bolts in each connection, but not less than two bolts in each connection, shall be checked.

5.16. ELECTRICAL EQUIPMENT INSTALLATION

5.16.1. GENERAL

This section covers the installation of electrical equipment.

Erection Work shall include receiving, unloading, storage, removal from storage, hauling, cleaning, erection on foundations and other Work necessary to place all equipment into successful operation. In addition, erection Work shall include complete assembly of equipment shipped unassembled, dismantling and re-assembly of equipment to make adjustments, and provision of personnel, equipment, and assistance to the Owner in testing and placing the equipment in operation.

Erection procedures not specified herein shall be performed in a workmanlike manner and shall be in accordance with the recommendations and drawings of the equipment manufacturer.

Defective materials and equipment or materials and equipment damaged in the course of installation or test shall be replaced or repaired in a manner meeting the approval of the Owner.

All equipment shall be properly and securely mounted and connected. Proper clearances shall be maintained. All bus and lead connections shall be electrically sound. Switches shall be adjusted as necessary for proper operation. Equipment shall be suitably protected from weld spatter during construction.

The major items of materials and equipment for the substation structure are to be furnished by the Owner. To properly install this equipment, it may be necessary for the Contractor to furnish certain materials and/or tools and equipment. Refer to list of Owner furnished materials.

The Contractor shall also be responsible for equipment installations onto concrete pads, steel columns or poles. These items include area lights, 120/240 Volt outlets, junction boxes, station service transformer, and assorted conduits. Field drilling may be required in some instances at no additional cost to the Owner.

5.16.2. DANGER SIGNS

“Danger High Voltage” signs will be provided for the station by the Owner. These shall be securely attached to the substation fence in an approved manner, at the locations shown on the drawing.

5.16.3. CABLE BUS AND LEADS

Cable bus and leads shall be sized and installed as indicated on the drawings. All conductors shall be brushed and a suitable compound used on the conductors when connections are made. All compression tools shall utilize dies approved by the connector manufacturer. Connectors shall have all bolts tightened to torque levels specified by the connector manufacturer or the Owner.

5.16.4. BOLTED ELECTRICAL CONNECTIONS

Where bolted connections are made to aluminum, the aluminum surface shall be thoroughly cleaned with a wire brush, then coated with joint compound and thoroughly brushed again through the compound. Additional compound shall then be added and the joint bolted together. Joint compound shall be Alcoa No. 2 or acceptable equal approved by the Owner.

A bi-metallic transition plate shall be used between all aluminum pad to copper or bronze pad connections unless the copper or bronze pad is tinned.

Where bolted connections are made between copper or brass surfaces, the metal surfaces shall be thoroughly cleaned and coated with Penetrox A as manufactured by Burndy Corp., Norwalk, Connecticut or No-Ox-Id A compound as manufactured by Sanchem Inc., Chicago, Illinois.

The tightness of each bolt in each factory made bolted electrical connection shall be checked during erection and connection of the equipment.

It shall be the Contractor's responsibility to certify that the tightness of each bolt in all bolted electrical connections, factory or field, is in accordance with the manufacturer's recommendations.

Bolted electrical connections shall be tightened with manual torque wrenches. Torque wrenches shall be so constructed that they will visually or audibly indicate when the proper torque is reached. The accuracy of each torque wrench shall be checked by a testing laboratory acceptable to the Owner immediately prior to its use on equipment erected under these Specifications.

Bolted electrical connections made with Belleville washers shall be made in accordance with manufacturer’s recommendations.

5.16.5. TORQUE VALUES

If the equipment manufacturer's erection instructions do not include recommended torque values for bolt tightening or specify an alternate method for tightening bolted electrical connections, torque values shall be in accordance with those listed in the table which follows. This table is not to be used when Belleville washers are used.

<u>TORQUE VALUES FOR DRY, UNPLATED, NONLUBRICATED BOLTS</u>

Bolt Size	18-8 Stainless Steel	Brass	Silicon Bronze	Aluminum 24ST-4	316 Stainless Steel
	in.-lb.	in.-lb.	in.-lb.	in.-lb.	in.-lb.
1/4”-20	75.2	61.5	68.8	45.6	78.8
1/4”-28	94.0	77.0	87.0	57.0	99.0
5/16”-18	132	107	123	80	138
5/16”-24	142	116	131	86	147
3/8”-16	236	192	219	143	247
3/8”-24	259	212	240	157	271
7/16”-14	376	317	349	228	393
7/16”-20	400	327	371	242	418
1/2”-13	517	422	480	313	542
1/2”-20	541	443	502	328	565
9/16”-12	682	558	632	413	713
9/16”-18	752	615	697	456	787
5/8”-11	1,110	907	1,030	715	1,160
5/8”-18	1,244	1,016	1,154	798	1,301
3/4”-10	1,530	1,249	1,416	980	1,582
3/4”-16	1,490	1,220	1,382	958	1,558

Bolt Size	18-8 Stainless Steel	Brass	Silicon Bronze	Aluminum 24ST-4	316 Stainless Steel
	in.-lb.	in.-lb.	in.-lb.	in.-lb.	in.-lb.
7/8”-9	2,328	1,905	2,140	1,495	2,430
7/8”-14	2,318	1,895	2,130	1,490	2,420
1”-8	3,440	2,815	3,185	2,205	3,595
1”-14	3,110	2,545	2,885	1,995	3,250

5.16.6. CONNECTION BOLT TIGHTNESS CHECK

The tightened bolts in electrical connections shall be checked at random as selected by and in the presence of the Owner. The Contractor shall provide calibrated hand torque wrenches and the necessary platforms, equipment, and personnel for the random check.

The number of bolts checked shall be acceptable to the Owner based upon observance of the equality and completeness of the tightening operations. A minimum of 10 per cent of the bolts in each connection, but not less than two bolts in each connection, shall be checked.

The Contractor shall be responsible for coordinating the checking of bolt tightness so that minimum interference with equipment erection and connection will be experienced. Removal of covers and similar dismantling of equipment to permit the Owner to witness the testing of bolt tightness of enclosed connections shall be part of the Work included under these Specifications.

Checking of tightness of electrical connections in the presence of the Owner is intended to assist the Contractor in avoiding the expense of repairing costly connection failures. This check shall not relieve the Contractor of complete responsibility for the integrity of the electrical connections.

5.16.7. STATION POWER AND CONTROL CABLES

Station power and control cables for interconnection to AC and DC supply panels, and for AC and DC supply to equipment are included in this scope of Work. The control cable between the equipment and the relay panels are also included in this scope of Work. The cable for the yard lighting is included in this scope of Work.

The Contractor shall be responsible for installing all the power and control cables including the terminations. Conduit ends shall be sealed with duct seal after cable installation.

5.16.8. MEGGER TEST

The Contractor shall megger all 600 V power and control cable with a 1000 V megger for one minute after installation. Values at the end of one minute must be as follows:

Conductor Capacity Amperes	Minimum Resistance Ohms
0-24	1,000,000
25-50	250,000
51-100	100,000
101-200	50,000
201-400	25,000
501-800	12,000
Over 800	5,000

5.16.9. CODES

The installation shall comply with the applicable rules of the latest editions and amendments of the National Electrical Safety Code, the National Electrical Code, the Occupational Safety and Health Act and other federal, state and local codes as required. The Owner will have the authority to stop the Work without cost or liability whenever such stoppage is necessary to ensure proper compliance with the construction standards, project drawings/specifications, or safety requirements.

5.16.10. MISCELLANEOUS MATERIAL

All miscellaneous materials except those specified to be furnished by the Owner or other contractors shall be furnished as required for the complete erection of the switching station. These materials shall include, but shall not be limited to, shims, wedges, dowels, anchors, supports, bolting, gaskets, packing, welding rod, and consumable gases.

5.16.11. EQUIPMENT PROTECTION

All equipment shall be protected from damage of any kind from the time it is unloaded until it is ready for initial operation.

During the erection period, all equipment having drive motors or rotating parts shall be protected with a weatherproof flame-resistant sheeting which completely covers the exposed parts of the equipment.

Equipment shall be suitably protected from weld spatter during construction.

Equipment housed or covered with glass or equipped with easily broken components shall be protected as required to prevent damage throughout the construction period.

Machine finished surfaces, polished surfaces, or other bare metal surfaces which are not to be painted, such as machine shafts and couplings, shall be provided temporary protection during storage and construction periods by a coating of rust preventive compound.

5.16.12. CLEANING

The exterior and interior surfaces of each equipment item shall be cleaned of sand, dirt, and other foreign materials after its removal from storage and immediately before its movement to its final location.

Before initial operation of individual items of equipment, the Contractor shall remove all dirt and other material which has been spilled or otherwise has been allowed to mar the surface finish. The interior of all electrical equipment, including relays and electrical contacts, shall be thoroughly wiped and vacuumed clean before the equipment is energized. All debris shall be removed from the site and disposed of as directed by the Owner.

5.16.13. MAINTENANCE TOOLS

The Contractor shall not use special tools furnished with equipment except as directed by the Owner. All special tools furnished with equipment for maintenance shall be stored as directed by the Owner. These tools shall become the property of the Owner upon completion of the erection of the equipment.

5.16.14. MANUFACTURERS' INSPECTION AND SUPERVISION

The services of a trained manufacturer's representative to inspect and advise during the installation of Owner-furnished equipment may be supplied by the Owner.

The Contractor shall furnish all necessary labor to perform tests or inspections as required by the manufacturer's representative.

When field labor is needed to correct errors in Owner-furnished equipment, the Contractor shall furnish such labor when so requested by the manufacturer or the manufacturer's representative. The cost of such labor shall not be included in the Contract Price for the Work to be performed under these Specifications. The Contractor shall obtain payment for this labor from the manufacturer who requests the labor.

The presence of a manufacturer’s representative shall not relieve the Contractor of responsibility for the Work under these Specifications. The Contractor shall be responsible for the coordination of Work with the availability of the manufacturer’s representative.

5.16.15. LOCATION TOLERANCE

Equipment shall be located within I/8 inch of the dimensional location indicated on the drawings unless otherwise permitted by the Owner.

5.16.16. ALIGNMENT

Rigid components such as bus and enclosures shall be aligned and connected with special care to prevent excessive stress in joints, supports, and connections.

Equipment with moving parts such as switches, circuit breakers, and switch operating mechanisms shall be carefully aligned to assure free mechanical operation.

5.16.17. LUBRICATION

The Contractor shall furnish all oils, greases, and other lubricants required to place equipment in operation. The Contractor shall apply lubricants in accordance with the manufacturer's recommendations. The lubricants used shall be acceptable to the Owner.

5.16.18. EQUIPMENT FINISH

Surfaces of most electrical equipment, such as panels, switchgear, transformers, and circuit breakers, are finished at the factory. Great care shall be exercised to prevent damage to this original finish during installation of the equipment and during construction Work.

If the factory finish is damaged during the course of construction, the entire surface of the damaged component shall be refinished by and at the expense of the Contractor.

The refinished surface shall be equivalent in every respect to the original surface, including color, texture, and smoothness. Refinishing paint, if furnished with the equipment, may be used; otherwise, the paint shall be obtained from the equipment manufacturer.

5.16.19. GALVANIZED SURFACE COATINGS

All galvanized surfaces on which the galvanizing is removed by cutting, drilling, or by any other operation shall be regalvanized with "Galvanizing Powder M- 32l" as manufactured by the American Solder and Flux Company of Philadelphia, Pennsylvania; with "Zincilate 8l0" as manufactured by Industrial Metal Protectives, Inc., of Dayton, Ohio; with "Zinc Rich" coating as manufactured by ZRC Chemical Products Company, Quincy, Massachusetts; or acceptable equal. The Contractor shall furnish this protective material and shall apply it in the field to any surface where the galvanized coating is broken or removed.

5.16.20. INSULATION OIL

The Contractor shall accept all insulating oil for oil insulated equipment from the carriers at the jobsite and shall transport, store, filter, and install the oil in the equipment in accordance with the manufacturer's recommendations and in the presence of the manufacturer's representative.

As soon as possible after insulating oil is received at the jobsite, the Contractor shall withdraw a test sample of oil from each individual shipping container and from each equipment tank which contains insulating oil. Samples shall be withdrawn and tested in the presence of the equipment supplier or the supplier's representative.

Sampling shall be in accordance with the requirements of ASTM D923. Oil samples shall be tested by the Contractor in accordance with ASTM D877 for dielectric acceptance under these specifications and with ASTM Dll7 if other oil tests are required by the Owner.

Oil dielectric strength shall not be less than 28 kV prior to acceptance from the equipment supplier. If oil fails to meet dielectric requirements specified prior to acceptance, it will be dried by and at the expense of the supplier.

The Contractor shall be responsible for preservation of the dielectric strength of insulating oil received at the jobsite and accepted.

The Contractor shall again test the insulating oil from each container immediately before it is transferred into the equipment. A sample of oil shall be taken from each container and tested according to the procedures previously specified. Oil which does not test at least 28 kV shall be dried by and at the expense of the Contractor. Oil tested and found satisfactory and oil dried until it is satisfactory may then be installed in equipment.

Apparatus and material required for transferring oil to equipment shall include a filter and oilproof synthetic rubber hose with black iron fittings as required. Natural rubber hose shall not be used. Equipment shall be clean and dry to prevent contamination of the oil. Oil shall not be transferred during inclement weather. Where vacuum filling is recommended by the equipment manufacturer, a vacuum pump and fittings of the proper capacity shall be furnished by the Contractor.

The Contractor shall exercise care in determining the filling requirements of Owner-furnished equipment provided for installation under these Specifications since these requirements may vary according to manufacturer. The Contractor shall furnish and install all nitrogen gas required to maintain recommended internal pressure within power transformers during storage, erection, and filling with oil. This responsibility will end when each transformer is successfully placed in service.

Nitrogen gas in cylinders furnished with the transformer or by the Owner shall be installed and connected to the transformer by the Contractor after erection and filling are complete and the absence of nitrogen leaks is verified.

Equipment shall be filled in accordance with the manufacturer's recommendations. After the oil has been in the equipment at least 8 hours, a sample of oil shall be taken from the sampling valve at the bottom of the tank and tested as above. If the oil fails to test at least 26 kV, the oil shall be dried and refiltered until it will meet this test. Another dielectric test shall be made on the oil immediately prior to placing the equipment in service. Should the oil fail this test, it shall be dried, refiltered, sampled, and tested by the Contractor until it does test at least 26 kV.

All apparatus and material required for filtering, handling, testing, and transferring insulating oil from containers to equipment shall be furnished by the Contractor. Equipment used to transport the oil shall be subject to the acceptance of the Owner.

The following safety precautions shall be observed during oil filling operations:

- Ground all tanks, storage drums, pumping and filtering equipment, shielded hoses, and receiving vessels to a solid common ground.

- Ground all exposed terminals and conductors on transformers and circuit breakers to the same ground. Where transformers are to be partially filled before the bushings are installed and where there are no exposed terminals or conductors, install a temporary metallic ground from one side of each winding to a bolt on the case.

- Wait 8 hours after filling before removing these grounds.

- After vacuum filling a transformer, relieve the vacuum with nitrogen to prevent air from mixing with the oil vapor and creating an explosive atmosphere.

- All tanks (such as circuit breaker and tap changer compartments not blanketed with nitrogen) which may have an accumulation of arc byproduct gases must be purged thoroughly, prior to filling or recirculating operations.

5.16.21. CONTROL PANELS

Control Panels shall be installed in accordance with the drawings and per manufacturer's recommendations.

5.16.22. BATTERIES AND BATTER CHARGES

The Contractor shall install and connect the batteries and battery chargers and prepare them for operation as soon as possible after their arrival at the jobsite.

A temporary power supply shall be connected to each battery charger and shall be maintained in service until permanent power supplies are installed and ready for continuous energization.

5.16.23. ASSEMBLY

The assembly of each battery and battery rack shall be in accordance with the manufacturer's recommendations and assembly instructions.

Prior to installing intercell connectors, the Contractor shall inspect all terminal posts and connecting hardware. Any area showing evidence of leaking acid shall be reported to the Owner. A thin film of corrosion inhibiting grease shall be applied to all contact surfaces. Intercell connections shall be completed with connectors and associated hardware supplied by the battery manufacturer. The connection bolts shall be tightened to the manufacturer's recommended torque values.

All individual battery cells or containers shall be cleaned. A water moistened clean wiper shall be used for the removal of dust and dirt. A bicarbonate of soda and water moistened wiper shall be used for cleanup of electrolyte spillage. All wipers used shall be free of oil distillates. Explosion resistant vent plugs shall be installed where provided. Individual cell numbers in sequence with No. 1 at the positive end of the battery shall be applied for permanent identification of flooded-cell batteries.

The voltage of the battery shall be measured to ensure that individual cells are connected correctly. If the measured voltage is less than approximately the number of cells multiplied by the measured voltage of one cell, the individual cell polarities shall be rechecked.

Intercell connection resistance shall be measured and recorded. Any connection with a resistance measurement exceeding 10 percent above the average shall be remade and remeasured.

Final connections from the battery to the charger and dc system shall be installed after assembly of the battery has been completed. The battery shall be protected from construction dirt and debris.

5.16.24. FRESHENING CHARGE AND TESTING

A freshening charge shall be applied to each battery after installation. Freshening charges shall be applied in accordance with the manufacturer's instructions and recommendations.

5.16.25. RECORDS

Data obtained from receiving, storage, and assembly are pertinent to the maintenance and operational life of the battery. Listed below, as applicable, are the data that shall be recorded and submitted to the Owner.

- Date of receipt of battery. Cells should not be stored for more than the time period recommended by the manufacturer without applying a charge to the battery. In all cases, a period of 3 months storage is allowable between charges if the cells are stored in a clean, dry, cool location without exposure to extremely low ambient temperatures or localized sources of heat.
- Initial resistance values of the intercell connections measured as specified in this section under Assembly.
- Individual cell specific gravity (corrected to a temperature of 25 C).
- The voltage of each cell.
- The temperature of one cell on each tier of the rack.

5.17. SUBSTATION ALUMINUM BUS

5.17.1. GENERAL

The Contractor shall unpack, clean, and check all aluminum bus immediately upon receipt from the carrier. Bus delivered by the carrier with unsatisfactory finish shall be rejected. The Contractor shall remove all materials which might damage the bus finish and shall store the bus in such a manner that the finish will be protected. Contractor shall be responsible for maintaining the finish on bus accepted from the carrier. Defective bus finish discovered after initial unpacking and inspection shall be the responsibility of the Contractor. All costs associated with the cleaning of minor black marks, abrasions, and scratches shall be included in the Contractor's bid. Any stored or erected bus found to have unsatisfactory finish shall be refinished or replaced by the Contractor at the option of the Owner. All expense for such refinishing or replacement shall be borne by the Contractor.

All bus shall be carefully handled and erected to provide a complete bus system without dents, abrasions, discolorations, or other structural or surface damage. Any bus so damaged shall be replaced by the Contractor at Contractor's expense.

Prior to the installation of fittings for the bus, conductors for vibration dampening, as required by the drawings, shall be installed within all horizontal buses for the full length of each bus. The conductors for this application will be furnished by the Owner unless indicated otherwise on the drawings or in these Specifications.

5.17.2. FIELD BENDS

All field bends of bus shall be made with a hydraulic type bender which is acceptable to the Owner. Each bend shall be smooth and uniform and shall retain the original inside bus diameter.

Bend radii shall be as indicated on the drawings. Each bend in 2-inch bus shall have a center line radius of at least 9-1/2 inches. Each bend in bus larger than 2 inches shall have a center line radius of at least five times the inside diameter of the bus.

5.17.3. ALIGNMENT

All bus components shall be aligned and supported prior to and during the welding operation. Support and alignment shall be as required to provide a finished bus arrangement with center lines of adjacent sections coincident. Bus shall be aligned for welding in such a manner that the welded bus remains essentially straight after removal of erection supports.

During splicing operations, each piece of bus shall be supported at not less than three points in approximately equal spans of 12 feet or less.

5.17.4. FITTINGS

The joint components to be welded shall be fitted to allow for expansion and contraction during welding without loss of alignment. The joint design shall be in accordance with manufacturers' recommendations. Connections shall be positioned and located to prevent the retention of water or drainage from copper or copper alloys to aluminum surfaces. Drain holes shall be provided as required. The location and size of drain holes shall be acceptable to the Owner.

The Contractor shall locate bus splices in locations that will not impose a moment on the splice hence damaging the splice. The location of maximum bending moment usually exists at the midspan and at the bus support. The Contractor shall not locate a bus splice within a distance of 10 percent of the total span length from the bus midspan or from the bus support. Only one bus splice is allowed within one bus span.

5.17.5. CLEANING

Immediately prior to welding, all materials to be welded shall be thoroughly cleaned with a hydrocarbon solvent. Degrease with the solvent, then remove the oxide film prior to welding. Oxide films must be removed from the surface of the aluminum by a suitable abrading process and brushing with a clean, stainless steel wire brush immediately prior to welding.

5.17.6. WELDING

Welding processes and methods shall be subject to code qualification and acceptance by the Owner. Only the following welding methods will be permitted for joining bus sections and fittings:

Gas metal arc welding. MIG DC Power, sources, reverse polarity, constant current (drooping characteristic), or constant voltage (constant potential) unit.

Gas tungsten arc welding. TIG AC Power Source

The TIG process is preferred for material less than 1/8 inch in thickness.

The MIG process shall be used for material thicker than 1/8 inch in thickness.

Shielding gas for each process shall be welding grade argon when welding material is less than 3/4 inch thick. A combination of helium and argon shall be used for each process when the welding material is 3/4 inch thick and greater.

Welding energy and filler material requirements shall be as recommended by AWS D10.7-86, "Recommended Practices for Gas Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe."

5.17.7. WELDING QUALIFICATIONS

All welded connections on aluminum bus or structural elements shall be made by AWS certified welders. A copy of the AWS certificate shall be provided to the Owner by the Contractor prior to commencement of welding.

To determine compliance with these Specifications, all welds shall be visually inspected by the Owner. Regardless of the method of inspection, the acceptance or rejection of welds shall be determined by the following:

- Cracks in welds or adjacent base metal will not be acceptable.
- Copper inclusions will not be acceptable.
- Porosity in excess of that permitted by Appendix IV, Section VII of the ASME Boiler and Pressure Vessel Code will not be acceptable.

5.17.8. WELD QUALITY

Preheating of heavy sections and removal of moisture is permitted, provided the metal temperature does not exceed 150°F. Caution: Welding on overheated metal shall be avoided. Large grain size may reduce mechanical properties and result in intergranular cracking.

Welding shall not be attempted during rain, snow, fog or windy conditions, unless area of welding is protected by an appropriate covering. Moisture shall not be allowed to contaminate the shielding gas as this will create porosity in the weld during the initial weld period.

Sequence of welding to minimize distortion is to be established by the Contractor in consultation with the Owner.

Undercut shall not be more than 1/32" deep when its direction is transverse to the primary stress in the part that is undercut. Undercut shall not be more than 1/32" deep when its direction is parallel to the primary stress in the part that is undercut and shall not be more than 2" in length.

All craters shall be filled to the full cross section of the welds by reversing direction of travel before terminating the arc.

Welds having defects greater than the levels of acceptance specified above shall be considered as rejected unless corrected in accordance with Section 9, ASME.

If a water supply is not available, a small water tank and pump shall be used to re-circulate water from the tank to torch and return. Antifreeze shall be added if conditions warrant and soluble oil is added to water circulating units.

The electrode will extend beyond the gas cup slightly further than its diameter for fillet welding.

Multiple pass welds shall be wire brushed after each pass.

In most cases, welding for this project will require multiple pass welds. The first pass shall be applied so as to create a vertical weld in an upward direction whenever possible. Starts and stops of subsequent passes shall be staggered.

In starting a MIG weld, strike the arc about one-inch ahead of the weld starting point and quickly drag it back to the starting point before beginning to weld forward at normal speed to preheat the joint and produce adequate penetration.

In starting a TIG weld, the tungsten electrode shall not touch the aluminum work piece.

The filler rod or wire shall always be placed within the inert gas shield and at the leading edges of the weld pool. The proper size rod or wire shall always be used.

Safe welding practices shall always be observed as outlined in “Aluminum Welders Training Manual, First edition, January 1972,” or other county, state, or federal safety practices.

The bus shall be beveled before the welding bus splices.

All welds shall be ground smooth.

5.17.9. REPAIR OF DEFECTIVE WELDS

In lieu of rejection of an entire piece or member containing welding which is unacceptable, the corrective measures listed below may be permitted by the Owner, whose approval shall be obtained prior to making each repair.

Defective welds shall be corrected by removing and replacing the entire weld, or as follows:

Cracks in welds: determine full extent of crack by dye penetrant method or other positive means. Drill ¼” hole at start and end of crack and chip out. Remove crack throughout is length and depth, and reweld.

Excessive porosity, lack of fusion: remove defective portions and reweld.

Copper or tungsten inclusions: remove defective portions and reweld.

Excessive concavity of crater, undercut, undersize weld: clean and deposit additional weld metal.

Overlap: reduce by removal of excess weld metal.

The defective areas shall be removed by chipping or machining. Before rewelding, the joint shall be inspected to assure that the entire defective weld has been removed.

5.18. CONDUCTORS

5.18.1. GENERAL

Insulated cable, conductors, and conductor accessories shall be installed in accordance with the requirements of this section of these Specifications.

Cable reels shall be stored and handled in a manner which will prevent physical damage to the cable. Cable reels shall be stored on a hard surface to prevent contact between cable insulation and earth due to sinking of the reel.

Installation shall be defined to include placement, terminating conductors, coiling and taping of spare conductors, identification, testing, and verification of each circuit, cable, and conductor. Installation of cable in existing trays or cable trench shall also include removal and replacement of existing cable tray or cable trench covers.

Terminating a conductor shall include installing cable termination kits for shielded cable, attaching the conductor at its designated location and insulating the entire connection where specified or required by the application.

5.18.2. CONDUCTOR ACCESSORIES

All conductor accessories including connectors, terminations, insulating materials, support grips, markers, and cable ties shall be furnished and installed.

Supplier's installation instructions shall be obtained for cable accessories. These instructions shall be in the possession of the craftsmen while installing the accessories and shall be available to the Owner for reference.

5.18.2.1. TERMINAL CONNECTORS FOR CONDUCTORS 8 AWG 0 AND LARGER

Terminal connectors for conductors 8 AWG and larger shall be pressure or bolted clamp type, Burndy Qiklug, Varilug, or acceptable equal; or compression type, Burndy Type YAV or YA (long barrel), Panduit Type LCA or LCC, or acceptable equal. Acceptable connectors included with Owner-furnished equipment may be used.

5.18.2.2. TERMINAL CONNECTORS FOR CONDUCTORS SMALLER THAN 8 AWG

Terminal connectors for conductors smaller than 8 AWG shall be compression type connectors properly sized for the conductor and the terminal. The connectors shall be constructed of fine grade high conductivity copper in accordance with QQ-C-576 and shall be tin plated in accordance with MIL T I0727. The interior surface of the connector wire barrel shall be serrated, and the exterior surface of the connector wire barrel shall be provided with crimp guides.

Noninsulated terminal connectors shall be provided on conductors terminated on devices equipped with individual fitted covers, such as General Electric Type SB-I control switches and General Electric Type HEA lockout relays. Preinsulated ring type terminal connectors shall be used on all current and potential transformer circuits. All other terminal connectors for conductors smaller than 8 AWG shall be preinsulated ring type or preinsulated spade type.

Preinsulated terminal connectors shall include a vinyl insulating sleeve, color coded to indicate conductor size. Preinsulated terminal connectors shall include a metallic support sleeve bonded to the vinyl insulating sleeve and designed to grip the conductor insulation.

Ring type connectors shall be manufactured by AMP, 3M, Panduit, or acceptable equal. Spade type connectors shall be AMP slotted spring spade, 3M Scotchlok Series 61 snap spade, or Panduit locking fork terminal connectors.

5.18.2.3. TERMINAL BLOCKS

Terminal blocks for conductors rated 600 volts or less shall be strap screw type, rated 600 volts, shall have 20 percent more terminal points than the quantity of conductors requiring termination, and shall have white marking strips. Terminal blocks shall be sized for the conductor being terminated except that terminal blocks for all conductors 10 AWG and smaller shall be Marathon 1500 Series or acceptable equal.

5.18.2.4. CRIMPING TOOLS

Crimping tools used to secure conductors in compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tools shall accurately crimp the connector barrel and shall accurately crimp the conductor insulation support sleeve where provided. Crimping tools shall be provided with guides to position connectors in the tool, shall be provided with stops to prevent overcrimping, and shall be of a type which prevents the tools from opening until the crimp action is completed. Crimping tools shall be a product of the connector manufacturer or shall be as recommended by the connector manufacturer and acceptable to the Owner or Engineer for use with the connectors. The

Contractor shall establish and maintain a tool certification program to ensure that crimping tools are kept in accurate operating condition.

5.18.3. INSULATING MATERIALS

Insulating materials for termination insulation shall be in accordance with the following.

5.18.3.1. 600 VOLT CABLE

Insulating materials for terminal connectors or compression type connectors shall consist of varnished cambric tape, rubber tape, and vinyl tape. Taping materials shall be as listed below or acceptable equal.

Varnished Cambric Tape--3M Company Irvington 2520
Rubber Tape--3M Company Scotch 130C
Vinyl Tape--3M Company Scotch 33+

5.18.4. SUPPORT GRIPS

Cable support grips shall be either split or closed woven wire type as manufactured by The Kellems Division, Harvey Hubbell Incorporated, Stonington, Connecticut.

5.18.5. WIRE AND CABLE MARKERS

Markers for wire and cable circuits shall be of an opaque nylon material arranged to include a marker board, no releasing holding device, and cable fastening tail. The marker board shall not be less than 3/4-inch-wide, 2-1/2 inches long, and 15 mils thick and shall be Panduit Corp. Part No. MP250 marker plates or acceptable equal. One side shall be roughened to hold black nylon marking ink from a fine tip pen similar to Thomas & Betts Company "TY-RAP" marking pen, Catalog No. WTI63M-I, or Panduit Corp. Part No. PFX-0 marking pen. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device and prevent the removal of the tail without cutting it loose from the marker.

5.18.6. CABLE TIES

Lacing materials for field installed cable shall be nonreleasing weather-resistant black nylon ties manufactured by Thomas & Betts Company, Elizabeth, New Jersey; Panduit Corp., Tinley Park, Illinois; 3M Company; or acceptable equal.

5.18.7. ARC PROOFING MATERIAL

Material for arc proofing cable shall be an unsupported intumescent self-extinguishing elastomer tape, 3M Company Scotch Brand No. 77 or acceptable equal, and a pressure sensitive silicone adhesive backed glass cloth holding tape, 3M Company Scotch Brand No. 69 or acceptable equal.

5.18.8. CABLE SHIELD BONDING CONNECTORS

Cable shield bonding connectors for use with shielded power, control, and instrumentation cable shall be Scotchlock 4460, manufactured by the 3M Company; Nicopress Shield Connector B-2974, manufactured by National Telephone Supply Company; Surgegard Shield Bond Connector, manufactured by Brand-Rex Company; or acceptable equal,approved by owner.

Cable shield bonding connectors shall be installed on one end of each shielded power, control, and instrumentation cable listed in the circuit lists.

5.18.9. INSTALLATION

Conductor installation shall be in accordance with the cable manufacturer's recommendations and the articles which follow.

5.18.9.1. CABLE PLACEMENT

All cable described in the circuit lists shall be routed as indicated therein. Routing of other cable shall be as indicated on the drawings.

Cable shall not be handled when the cable temperature is below the minimum temperature recommended by the manufacturer. If cable heating is required prior to placement, the cable shall be stored in a heated building in accordance with the manufacturer's recommendations for at least 24 hours. Cable shall be placed the same day it is removed from heated storage.

If at any time during the progress of the work the Contractor finds raceways which appear inadequate to accommodate the assigned cable, Contractor shall notify the Owner at once and shall discontinue any further work on the questionable raceway until advised by the Owner as to how Contractor shall proceed.

Immediately prior to the placement of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cable assigned to a particular duct or conduit shall be grouped and pulled in simultaneously using cable grips and acceptable lubricants.

All cable shall be carefully checked both as to size and length before being pulled into conduits or ducts. Cable pulled into the wrong conduit or duct or cut too short to rack, train, and splice as specified herein shall be removed and replaced by and at the expense of the Contractor. Cable removed from one conduit or duct shall not be pulled into another conduit or duct.

5.18.9.2. CABLE IN TRAY

All cable shall be carefully laid in or pulled through the tray system so that neither the cable nor the trays are damaged. Cable may be laid along the side of the tray system during placement provided it is protected from dirt, water, oil, or other detrimental materials and from mechanical injury. Cable shall be cut sufficiently long to conform to the contour of the trays, with particular attention paid to vertical inside bends. All excessive slack shall be removed from the cable so that it lies parallel to the sides of the trays. Multiple single conductor cable which constitutes a single power circuit shall be grouped together to minimize magnetic influence on other cable in the area. The cable shall be tied to the trays with nylon ties at I0 foot intervals to hold it in place. Cable clamps designed for holding the cable inside the trays shall be installed at all vertical bends.

5.18.9.3. CABLE IN MANHOLE

Cable shall be supported at all times without short bends or excessive sags and shall not be permitted to lie on the manhole floor. Cable ends must not be submerged. Cable racks or trays shall be provided for permanent support. Temporary support required during placement shall be with rope slings, timbers, or alternate method acceptable to the Owner.

5.18.9.4. CABLE PULLING

Fishing and pulling shall be done with flexible round metal tape, CO^2 propelled polyethylene cord, nylon rope, or manila rope.

Unless specified otherwise or acceptable to the Owner, cable shall not be pulled in a single pull through two sections of Engineer-designed raceway connected by a manhole or pull box. Cable shall be pulled out at each manhole and pull box to the length required for termination. Prior to repulling of the pulled-out cable, the cable shall be thoroughly inspected, cleaned, and relubricated. Damaged cable shall be removed and replaced by and at the expense of the Con-tractor.

Cable may be pulled in a single pull through two sections of Engineer-designed raceway connected by a manhole or pull box only if it can be determined by calculation to the satisfaction of the Owner, that the pulling tension will not exceed the maximum tension allowed by the cable manufacturer.

5.18.9.5. CABLE GRIPS

Factory installed pulling eyes shall be used for pulling cable where they are available. Woven wire cable grips shall be used to pull all single conductor cable 2/0 AWG and larger, where pulling eyes are not available, and all multi-conductor cable. Pulling loops shall be used to pull single conductor cable smaller than 2/0 AWG. All sharp points and edges on the hardware attaching the pulling rope to the cable shall be taped to prevent snagging or damaging the raceway.

When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal plus 6 inches shall be cut off and discarded when the pull is completed. When pulling loops are used, the entire loop shall be cut off and discarded when the pull is completed.

As soon as the cable is pulled into place, the pulling eyes, cable grips, or pulling loops shall be removed and any cable which was sealed shall be resealed.

5.18.9.6. SWIVELS

A reliable nonfreezing type of swivel, or swivel connection, shall be inserted between the pulling rope and the cable pulling eye, grip, or loop to prevent twisting under strain.

5.18.9.7. FEEDING TUBES

A 4 inch or larger flexible feeding tube, with a removable nozzle sized to fit the ducts, shall be used in pulling all underground cable. The feeding tube shall be long enough to extend from the duct entrance to the outside of the manhole and shall be so arranged that it will be impossible for the cable to drag across the edge of the manhole ring or any other damaging surface. The bending radius of the tube shall not be less than the minimum bending radius of the cable specified in this section under the article titled Section 4.18.9.12 Cable Bends.

5.18.9.8. PULLING LUBRICANTS

Only lubricants recommended by the cable manufacturer and acceptable to the Owner shall be used. Lubricants shall be applied liberally and continuously during the pull.

5.18.9.9. INSPECTION

The outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced by and at the expense of the Contractor.

5.18.9.10. PULLING TENSION

The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Contractor shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to show the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected.

5.18.9.11. SIDEWALL PRESSURE

To avoid insulation damage from excessive sidewall pressure at bends, the pulling tension in pounds at a bend shall not exceed 300 times the radius of the bend in feet.

5.18.9.12. CABLE BENDS

Tape shielded, flat tape armored, and wire armored cable shall not be bent to a radius of less than 12 times the overall cable diameter. All other cables shall not be bent to a radius of less than eight times the cable diameter.

5.18.9.13. SUPPORTS

All cable supports and securing devices shall have bearing surfaces located parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation.

Adequate cable end lengths shall be provided and properly placed in junction boxes and manholes to avoid longitudinal strains and distorting pressures on the cable at conduit bushings and duct end bells.

Final inspection shall be made after all cable is in place and, where supports or raceway fittings deform the cable jacket, additional supports shall be provided as directed by the Owner. Additional cable protection such as a wrapping of light rubber belting, friction tape, or similar material shall be provided where required.

Cable in vertical runs shall be supported by woven wire grips in accordance with the NEC requirements, except that the distance between supports shall conform to the following:

Vertical Cable Support Spacing

Conductor Size	Aluminum Conductor	Copper Conductor

1/0 AWG and smaller	150 feet	100 feet
2/0 AWG thru 500 Mcm	100 feet	50 feet
Larger than 500 Mcm	70 feet	30 feet

5.18.9.14. CABLE RACKS

Where cable trays are not specified in man-holes, cable racks shall be furnished and installed according to the drawings and as required to provide the proper cable support. Cable racks shall be installed on spacings of not greater than 36 inches and shall be bolt secured to permanent wall surfaces with self-drilling anchors or continuous slot concrete inserts.

5.18.9.15. SPARE CONDUCTORS

All spare conductors of a multi-conductor cable shall be left at their maximum lengths for possible replacement of any other conductors in the cable. Each spare conductor shall be neatly coiled and then taped to the conductors being used

5.18.9.16. LACING

Nylon ties shall be used to neatly lace together conductors entering switchboards and similar locations after the conductors have emerged from their supporting raceway and before they are attached to terminals.

5.18.9.17. CABLE IDENTIFICATION

The Contractor shall identify the ends of all circuits listed in the circuit lists.

Each marker shall bear the number of the circuit according to the circuit lists and drawings.

At terminations, the Contractor shall identify each conductor of power circuits, each multi-conductor cable, and each conductor of circuits consisting of multiple single conductors where the conductors are not otherwise identified. Markers shall be attached where the first individual conductor is routed away from the assembly. Each phase of multiphase power circuits shall be individually identified.

One end of each marker board shall remain free of the fastening tail, and the entire marker shall be so attached that it is readily visible for circuit identification.

5.18.9.18. MOISTURE SEALS

Each cable with an aluminum conductor shall be kept sealed except when termination and splicing work is being performed.

The ends of all cables shall be sealed with heat shrinkable caps. Cap sizes shall be as recommended by the cap manufacturer for the cable OD and insulation. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive water-tight seal capable of withstanding complete immersion or total exposure without permitting the entrance of moisture. Heat shrinkable caps shall be "Thermofit" as manufactured by Raychem Corporation or acceptable equal.

Before and after pulling, the leading end seal of each length of cable shall be examined and repaired if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated immediately.

5.18.10. SPLICES

No splices shall be made in conductors for instrument circuits or control circuits. Shields may be spliced where necessary to permit connection to the station ground.

Power cable circuits may be spliced only by methods and at locations acceptable to the Owner.

5.18.11. TERMINATIONS

Cable shall be terminated in accordance with the following requirements:

Train cable in place and cut squarely to required length. Avoid sharp bends.

Remove necessary amount of cable jacket and insulation without damage to the conductor.

Install terminals or terminal connectors as required, ensuring a firm metal-to-metal contact.

Insulate each connection of cable to an insulated conductor (whether cable, bus, or equipment bushing). The insulation shall cover all exposed surfaces of the conductors; the insulation voltage level of the completed termination shall be not less than the insulation voltage level of the connected conductors.

5.18.11.1. INSULATION OF 600 VOLT CABLE CONNECTIONS

Where connections of cable rated 600 volts or less require insulation, all exposed conductor and connector surfaces shall be covered with tape in accordance with the following:

One half-lapped layer of varnished cambric tape.

A minimum of three half-lapped layers of rubber tape, elongated not more than 20 percent, applied over the varnished cambric tape.

A minimum of three half-lapped layers of vinyl tape applied over the rubber tape. The vinyl tape shall extend a minimum of two cable diameters over the cable jacket and a similar distance over the insulation of the conductor to which the cable is connected.

5.18.12. TEST AFTER PLACEMENT

All insulated conductors shall be electrically tested after placement.

All circuits, including lighting circuits, shall be tested with the circuit complete except for connections to equipment. All splices, stress cones on shielded cable, and terminal connector attachments shall be complete prior to testing.

In addition to the tests performed after cable placement is complete, continuity tests and insulation tests shall be performed on all supervisory and communication cable before and after each splice is made.

Any circuit failing to test satisfactorily shall be replaced or repaired and then retested.

5.18.13. CONTINUITY AND IDENTIFICATION TESTS

All insulated conductors shall be tested for continuity and conductor identification.

5.18.14. CONTINUITY TESTS

Continuity tests shall include all tests necessary to confirm that each conductor is continuous throughout its entire length.

5.18.15. IDENTIFICATION TESTS

Identification tests shall include all tests necessary to confirm that the conductor being investigated originates and terminates at the locations designated in the circuit lists or indicated on the drawings.

5.18.16. INSULATION TEST

Resistance from ground provided by the insulation on all field installed insulated conductors shall be measured.

5.18.16.1. CABLE RATED 600 VOLTS AND BELOW

All insulated conductors except supervisory and communication cable, rated 600 volts and below shall be tested with a 1000-volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptable resistance values shall be approximately 500 megohms.

5.18.16.2. SUPERVISORY AND COMMUNICATION CABLE

All insulated conductors of supervisory and communication cable shall be tested with a 500-volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and the cable shielding tape and between the two conductors in each pair. Minimum acceptable resistance values shall be 500 megohms divided by the actual cable length in miles.

6. TRANSMISSION LINE DESIGN CRITERIA

6.1. 230KV TRANSMISSION LINE RELAYING PHILOSOPHY

To meet the overall design philosophy, SMECO's high level philosophy for 230kV transmission line relaying is dual, fully redundant, fully independent line relay schemes, including dual independent communications to remote substations and independent DC control circuits with dual station batteries. All of SMECO's 230kV breakers are also equipped with dual, fully redundant stuck breaker/breaker failure schemes. One-line relay scheme is designated as Line Relays #1 and the other is designated as Line Relays #2. The zone of protection, selectivity and operating speed are essentially the same for both schemes. For any in zone line fault, it is expected that both schemes will operate to initiate the clearing of the fault. With this approach, one set of relays can be taken out of service for testing/maintenance without any degradation in line protection. Line relay scheme and manufacturer diversity is also achieved by deploying line relays with different operating characteristics (i.e., current differential & impedance) and different manufacturers for Line Relays #1 and Line Relays #2. Most SMECO 230kV transmission lines are terminated with a dedicated breaker, or with a breaker and a half substation configuration. Where appropriate, separate breaker currents, instead of summed currents are being connected to the line relay current inputs.

Presently, Line Relays #1 applications are being deployed with GE's UR-L90 microprocessor relays, either in a direct under-reaching and permissive over-reaching impedance scheme; or in a line current differential scheme, with over-reaching impedance back up if communications with the remote relay(s) is lost.

Presently, Line Relays #2 applications are being deployed with SEL's 411L microprocessor relays, either in a direct under-reaching and permissive over-reaching impedance scheme; or in a line current differential scheme, with over-reaching impedance back up if communications with the remote relay(s) is lost.

Legacy 230kV line relay installations were almost exclusively dual direct under-reaching and permissive over-reaching impedance schemes with Line Relays # 1 typically connected to line side VTs, and Line Relays # 2 typically connected to bus VTs. Where necessary, separate dead line/close into fault/ switch on to fault protection was deployed as part of the line relay schemes connected to the line side VTs. Presently, line side VTs are connected to both sets of line relays. VTs with dual secondary windings are considered independent voltage circuits and meet industry standards. Leveraging the capability of the 411L relay to accommodate and utilize two independent 3-phase sets of voltage inputs, the 411L relay will be connected to both line side and bus VTs where applicable.

This high level of line relay scheme redundancy and independence meets or exceeds all industry accepted best practices and the applicable line relay requirements specified in the following documents. (or superseded by PJM & IEEE)

- PJM Manual 07, Effective Date: 11/16/2011
- Protective Relaying Philosophy and Design Guide – PJM Relay Subcommittee, August 15, 2013
- IEEE Transmission Line Relay Guide C37.113 Draft #8

6.2. MECHANICAL LOADING CRITERIA

The following mechanical loading conditions will be used for the design of transmission line structures. Abbreviations used are as follows: overload capacity factor (OCF), transverse loads (T), vertical loads (V), longitudinal loads (L). Transverse, vertical and longitudinal loads will be applied simultaneously unless noted otherwise. Loads will be applied with all wires intact for tangent, angle and dead-end structures, unless noted otherwise in the load cases below. Loads will also be applied to one side only for dead-end structures.

6.2.1. LOADING CASE I - NESC HEAVY

4 psf (40 mph) wind and 0.5-inch radial ice at 0oF, initial condition.
Steel OCF: T=2.5, L=1.65, V=1.5
(For sag-tension analysis, a constant (k) of 0.3 lbs/ft will be added to the resultant wire load)
Deflection of the structure top shall be limited to 10% of total structure height above ground. Does not apply to switch structures.

6.2.2. LOADING CASE II - EXTREME WIND (NESC 2007)

25.6 psf (100 mph) wind and no ice at 60oF, initial condition.
Steel OCF: T, L, V = 1.1

6.2.3. LOADING CASE III - CONCURRENT ICE & WIND (NESC 2007)

4 psf (40 mph) wind and 0.5-inch radial ice at 0oF, initial condition.
Steel OCF: T, L, V = 1.0

6.2.4. LOADING CASE IV – EXTREME ICE (PJM)

No wind, 1.5 inches radial ice at 0°F, initial condition.
Steel OCF: T, L, V = 1.0

6.2.5. LOADING CASE V - DEFLECTION LOADING

No wind, no ice at 60oF, final condition.
Steel OCF: T, L, and V = 1.0
Deflection of the structure top shall be limited to the greater of 1% of total structure height or 40% of the base diameter. Does not apply to switch structures.

6.2.6. LOADING CASE VI - BROKEN WIRE (NESC HEAVY) (TANGENT AND ANGLE STRUCTURES)

4 psf (40 mph) wind and 0.5-inch radial ice at 0oF, initial condition.
Steel OCF: T, L, and V = 1.1
One sub conductor or static wire broken in any one phase position, all other wires intact. More than one load case may be necessary if the highest stress inducing location is not apparent.

6.2.7. LOADING CASE VII – DIFFERENTIAL ICE (TANGENT AND ANGLE STRUCTURES)

4 psf (40 mph) wind at 0°F, initial condition.
OCF: T, L, and V = 1.1
One span with 0.5-inch radial ice and the other span with no ice. This will result in unbalanced longitudinal loads at all conductor and static wire attachment points and a reduction in transverse and vertical loads resulting from the absence of ice on the shorter span.

6.2.8. LOADING CASE 1A-7A- ONE 69 KV CIRCUIT UNLOADED (TANGENT AND ANGLE STRUCTURES)

All loads same as described in load cases I through VII above, except one 69 kV circuit is not loaded

6.2.9. LOADING CASE 1A-4A- DEADEND

All shield wires and conductor phases deadened on one side using NESC Heavy, Extreme Wind, Concurrent Ice and Wind, and Extreme Ice Loading Cases.

6.2.10. LOADING CASE 1B-9B- ONE 69 KV CIRCUIT UNLOADED (DEADEND)

All loads same as described in load cases I through V and load cases 1A through 4A above, except one 69 kV circuit is not loaded.

6.3. ELECTRICAL CLEARANCES

The clearances used in the design of the transmission lines will meet or exceed the requirements of the National Electrical Safety Code (NESC), 2007 Edition. The clearances pertain to vertical clearances, horizontal clearances, lateral clearances, and air gap clearances. Lateral clearances are included in the horizontal clearance subsection.

6.3.1. VERTICAL CLEARANCES

Vertical clearances will be designed to accommodate the design AAC conductor at a maximum operating temperature of 100°C (212°F), unless otherwise specified. The vertical clearances indicated below meet the requirements of the NESC for 69 kV and 230 kV line voltage and include additional clearance to allow for construction and survey tolerances.

Description of Crossing	69 kV Clearance	230 kV Clearance
1. Tracks of railroads, except electrified trolleys (except as specified by the affected Railroad)	30.5 ft	33.5 ft
2. Roads, streets, driveways parking lots, alleys, and all other areas subject to truck traffic	22.5 ft	25.5 ft
3. Spaces and ways subject to pedestrians or restricted traffic less than 8 feet in height	22.5 ft	25.5 ft
4. Pedestrian Traffic (According to PJM section 5.2: “All areas beneath the line shall be assumed to allow vehicle access.”)	22.5 ft	25.5 ft
5. Water areas not suitable for sailboating or where sailboating is prohibited	21 ft	24 ft
6. Water areas suitable for sailboating including lakes, ponds, reservoirs, rivers, streams, and canals with an unobstructed surface area of:		
a. Less than 20 acres	24.5 ft	27.5 ft
b. Over 20 to 200 acres	32.5 ft	35.5 ft
c. Over 200 to 2000 acres	38.5 ft	41.5 ft
d. Over 2000 acres	44.5 ft	47.5 ft
7. Public or private land and water areas posted for rigging or launching sailboats:		
a. Less than 20 acres	29.5 ft	32.5 ft
b. Over 20 to 200 acres	37.5 ft	40.5 ft
c. Over 200 to 2000 acres	43.5 ft	46.5 ft
d. Over 2000 acres	49.5 ft	52.5 ft
8. Communication lines	10 ft	10 ft
9. Overhead ground wires and guy wires	10 ft	10 ft
10. Open supply conductors over or under subject line:		
a. 22 kV and below	5 ft	8 ft
b. 69 kV	6 ft	10 ft
c. 230 kV	10 ft	13 ft
d. 500 kV	15 ft	18 ft

Description of Crossing	69 kV Clearance	230 kV Clearance
11. Buildings:		
a. Over roofs or projections not readily accessible to pedestrians	16.5 ft	19.5 ft
b. Over roofs or projections readily accessible to pedestrians	17.5 ft	20.5 ft
c. Over roofs accessible to vehicles but not trucks 8 ft high	17.5 ft	20.5 ft
d. Over roofs accessible to truck traffic	22.5 ft	25.5 ft
12. Bridges: Over (not attached)	16.5 ft	19.5 ft
13. Installations not classified as buildings or bridges:		
a. Over or under catwalks and other surfaces upon which personnel walk	17.5 ft	20.5 ft
b. Over or under other portions of such installations	12 ft	15 ft
14. Another supporting structure	8.5 ft	11.5 ft
15. Top of rail cars	10.5 ft	13.5 ft
16. Swimming Pool	29 ft	32 ft
17. Diving Platform	21 ft	24 ft

6.3.2. HORIZONTAL CLEARANCES

Horizontal clearances are based on a maximum operating temperature of 100°C (212°F) with the conductor in the final maximum sag condition with no wind, unless otherwise specified. The horizontal clearances indicated below meet the requirements of the NESC for 69 kV and 230 kV line voltage and include additional clearance to allow for construction and survey tolerances.

Description of Obstacle	69 kV Clearance	230 kV Clearance
1. Buildings, signs, chimneys, billboards, radio & TV antennas, tanks & other installations not classified as buildings or bridges (wires not attached):		
a. With no wind displacement	11.5 ft	14.5 ft
b. With 6 psf wind displacement	8.5 ft	11.5 ft
2. Lighting supports, traffic signals, or supporting structures of another line:		
a. With no wind displacement	8 ft	11 ft
b. With 6 psf wind displacement	8.5 ft	11.5 ft

3.	Bridges (unattached):		
	a. With no wind displacement	11.5 ft	14.5 ft
	b. With 6 psf wind displacement	8.5 ft	11.5 ft
4.	Swimming Pool	29 ft	32 ft
5.	Diving Platform	21 ft	24 ft

6.3.3. AIR GAP CLEARANCES

Air gap clearances are indicated below.

Voltage	Air Gap	Clearance Description
69 kV	30 in	Full Impulse
	17 in	6 psf Wind Displacement
	4 in	60 Hertz Extreme Wind Operating Clearance
230 kV	80 in	Full Impulse
	50 in	6 psf Wind Displacement
	20 in	60 Hertz Extreme Wind Operating Clearance

6.3.4. GALLOPING

An elliptical analysis will be performed to investigate the potential for galloping throughout the transmission line. The analysis will consider the conductor operating at either of two conditions; either a 2 psf wind, ½" radial ice, at 32°F loading condition; or a no wind, ½" radial ice, 32°F loading condition. A single loop calculation will be performed for spans of 600 feet or less, and a double loop calculation will be performed for spans in excess of 600 feet. For 69 kV and 230 kV operations, the conductor ellipses will be allowed to overlap up to 1 foot.

6.4. CONDUCTORS, STATIC WIRES, AND FIBER OPTIC CABLES

The following sub-sections will describe the physical properties of the conductor, static wire, and fiber optic cables to be used for this project.

6.4.1. CONDUCTOR

The transmission conductor for both 69 kV and 230 kV to be used for this project is as follows:

Code Word	Class Type	Size	Stranding	Area (sq in)	Diameter (in)	Weight (lbs./ft)	Ultimate Strength (lbs.)
COREOPSIS	AAC	1590	61	1.25	1.454	1.493	27,000

6.4.2. STATIC WIRE

The static wire to be used for this project is as follows:

Description	Class Type	Size	Stranding	Area (sq. in)	Diameter (in)	Weight (lbs./ft)	Ultimate Strength (lbs.)
7 #9 Alumoweld	AW	#9	7	0.0720	0.343	0.208	12,630

6.4.3. FIBER OPTIC CABLES

The fiber optic conductor to be used is as follows:

Description	Type	Fibers	Fault Current ((kA)^2*sec)	Area (sq in)	Diameter (in)	Weight (lbs./ft)	Ultimate Strength (lbs.)
AFL CC-60/48/610	OPGW	48	175	0.2233	0.61	0.4057	17,314

6.4.4. CONDUCTOR TENSION LIMITS

The following maximum tension limits will be used in the determination of conductor sag and tension values. The first set of limits meet NESC code requirements, and the second set of limits are SMECO tension controls and will normally be the controlling limitation in non-slack tension spans.

Load Case	**NESC Limits**
NESC Heavy	60% Initial
Extreme Wind	75% Initial
Heavy Ice	75% Initial
60°F	35% Initial
60°F	25% Final
Load Case	**SMECO Limits**

NESC Heavy	10,000 lbs., Initial @ 230KV, 10,000 lbs., Initial @ 69KV (1590 AAC Only)
-20°F	25% Initial (1590 AAC Only)
-20°F	20% Initial
0°F	33% Initial
0°F	25% Final

The static wire tension is based on 80% of the conductor sag at 60°F, no ice, no wind, final sag condition, and must also meet the same criteria as a conductor. This 80% sag criteria will apply to both full tension and slack tension spans.

7. TRANSMISSION LINE CONSTRUCTION CRITERIA

7.1. TRANSMISSION LINE GENERAL REQUIREMENTS

7.1.1. GENERAL

This section specifies the general technical requirements applicable to the technical specifications' sections, including furnishing and installing materials for and documenting the construction of overhead electric transmission lines.

The requirements of this section are intended as an addition to and not to be in conflict with any specific requirements included in any other section of the technical specifications.

7.1.2. CODES AND STANDARDS

The Contractor shall construct the work specified in accordance with applicable requirements of the latest versions of the codes and standards referenced in this section. Codes and standards applying to a specific portion of the work will be referenced in the technical section applicable to that portion of the work.

7.1.2.1. STANDARD VERSION

All references to codes and standards shall be the current version of the code or standard in effect (including all amendments) unless otherwise stated.

7.1.2.2. CONFLICTS

The Contractor shall comply with the requirements of the referenced federal, state and local code or standards as well as standards specified by association, or trade. Where codes and standards are in conflict with each other, the most stringent requirements apply. If specified reference codes and standards conflict with technical specification sections, the Contractor shall request clarification from the Owner before proceeding.

7.1.2.3. CODES

The work shall comply with relevant portions of the following codes:

- National Electrical Safety Code (ANSI C2).
- Federal and State Occupational Safety and Health Act (OSHA).

7.1.2.4. STANDARDS

The work shall comply with relevant portions of the industry accepted standards published by the following institutes, associations, and societies:

- American Concrete Institute.
- American Institute of Steel Construction.
- American Iron and Steel Institute.
- American Institute of Timber Construction.
- American National Standard Institute.
- American Society of Civil Engineers.
- American Society of Mechanical Engineers.
- American Society for Testing and Materials.
- American Welding Society.
- Concrete Reinforcing Steel Institute.
- Institute of Electrical and Electronics Engineers, Inc.
- National Electrical Manufacturer's Association.

- Underwriters' Laboratories, Inc.

7.1.3. EXISTING UNDERGROUND INSTALLATIONS

The Contractor shall be solely responsible for locating all existing underground installations in advance of any required excavations. The Contractor shall use Contractor's own information and shall not rely upon any information indicated on the drawings concerning existing underground installations.

The Contractor will be held responsible for any interruption in the service of underground facilities resulting from Contractor's operations, unless the facilities owner has given specific approval for the interruption in each case.

Except where the damaged parties desire to conduct their own repair and restoration work, the Contractor shall repair and fully restore any underground facility damaged during the construction period to a condition equal to or better than that which existed at the time of damage. All repair and restoration work shall be done to the complete satisfaction of the damaged parties and the Owner and Engineer.

The Contractor shall make arrangements with any jurisdictional authority requiring inspection of repaired or reconditioned utility facilities. The Contractor shall pay all applicable inspection fees.

Where the damaged parties desire to conduct their own repair and restoration work, the Contractor shall render all assistance to facilitate this corrective work. The Contractor shall assume all just and reasonable expenses thus incurred by the damaged parties.

The Contractor shall call Miss Utility (1-800-257-7777) at least 48 hours in advance of drilling to have the appropriate underground utilities located.

Each underground facility encountered shall be accurately located on the drawings, indicating the original location and relocation, if any. When all work is completed, the marked copy of the drawings shall be submitted to the Owner and Engineer as part of the field records.

7.2. SITE CONDITIONS

7.2.1. SITE INVESTIGATION AND CONTRACTORS' REPRESENTATION

Contractor acknowledges that he has satisfied himself as to the nature and location of the work, the general and local conditions. The Contractor is aware of the bearing on the project of the following: availability of transportation; access to the transmission line right-of-way; disposal, handling and storage of materials; availability of labor, water, and roads; the uncertainties of weather, water levels, or similar physical conditions along the transmission line right-of-way; the conformation and condition of the ground; the character of equipment and facilities needed during the execution of the work; and all other matters that can in any way affect the scope of work or the Contract Price.

Contractor further acknowledges that Contractor is satisfied as to the character, quality, and quantity of surface and subsurface materials to be encountered from Contractor's inspection of the transmission line right-of-way and from reviewing any available records of exploratory work furnished by the Owner or included with these Documents. Failure by the Contractor to acquaint himself with the physical conditions of the transmission line right-of-way and all available information will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the work.

Contractor warrants that, as a result of his examination and investigation of all the aforesaid data, he can perform the work to the satisfaction of the Owner. Owner assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this Contract, unless (1) such representations are expressly stated in the Contract and (2) the Contract expressly provides that the responsibility thereof is assumed by the Owner.

7.3. MODIFICATION AND REMOVAL OF EXISTING FACILITIES

7.3.1. GENERAL

During construction, existing facilities may require modification or removal in order to properly execute project construction. The Contractor shall make such modifications and removals as indicated on the drawings and as required by these Specifications.

The Contractor will coordinate all work regarding modifications and removal of existing facilities with the Owner to minimize interruptions on the Owner's system. Prior to starting the modification and/or removal work, the Contractor will prepare and submit to the Owner a proposed detailed schedule for such work. The Contractor shall not proceed with the modification and/or removal work until the schedule has been approved by the Owner.

The Contractor shall protect from damage all existing structures and materials that are to remain in place. Existing facilities that are damaged during modification work shall be restored to their original condition to the Owner's satisfaction. The Contractor shall pay all costs in connection with repairing damages to existing facilities resulting from this work.

7.4. EASEMENTS AND PERMITS

Where portions of the work will be located on public or private property, easements and/or permits will be obtained by the Owner. Copies of the easements and permits are available from the Owner for review.

It is anticipated that all required easements and permits will be obtained by the Owner before the start of construction. However, should the procurement of any easement or permit be delayed, the Contractor will schedule the work in such a way that construction can continue confined to areas where easements or permits have been obtained or are not required, until the delayed easement or permit is secured.

The Contactor shall comply with restrictions on limitations listed in the easement or permit documents.

7.5. PRESERVATION, RESTORATION AND CLEANUP

7.5.1. SITE RESTORATION AND CLEANUP

7.6. EQUIVALENT MATERIAL AND EQUIPMENT

Approval of equivalent material and equipment shall be as specified in the Special Conditions.

Where one or more manufacturers are listed in the Contract Documents for a material item, without the words "or equal," the Contractor shall provide the product of one of the manufacturers listed. Where one or more manufacturers are listed followed by the words "or equal," "or approved equal," "or equivalent," and "or acceptable equal," the Contractor shall provide the product of one of the manufacturers listed, or an equivalent material item may be proposed as a substitute for the one specified. The proposed substitution must be a product of equal quality; must meet or exceed the attributes, performance, or other standards of the specified product; and must be approved by the Owner.

When an equivalent material or equipment item is approved by the Owner, all costs associated with changes required to incorporate the equivalent item into the work shall be borne by the Contractor without increase in the Contract Price.

7.7. MATERIAL AND EQUIPMENT

7.7.1. GENERAL

A Bill of Material is shown on the drawings and segregates Owner-furnished material items from Contractor-furnished material items.

Material items are specified on the transmission line construction assembly drawings and in the Bill of Material with specific manufacturers' names and catalog numbers. Where material is so specified, and not furnished by the Owner, the Contractor shall furnish the material item as specified, or an equivalent item as approved by the Owner and shall match exactly any Owner-furnished material item when furnishing additional units of those items.

7.7.2. OWNER-FURISHED MATERIAL

Owner-furnished materials are listed and identified in the Bill of Material. The Contractor shall obtain Owner-furnished material items from the Owner's designated storage area and transport them to the jobsite.

Contractor will receive, unload, inspect, and properly protect Owner-furnished material at the jobsite and will immediately report and return to the Owner any material found damaged or unsuitable for use.

Owner-furnished material damaged by the Contractor shall be promptly replaced or, if approved by Owner, satisfactorily repaired.

The costs for handling, installing, adjusting, and integrating in the project all Owner-furnished material shall be included in the Contract Price.

7.7.3. CONTRACTOR- FURBISHED MATERIALS

The Contactor shall provide all material items designated on the Bill of Material as Contractor-furnished materials and also provide all incidental material items, connections, and other items that are not specified on the drawings or Bill of Material, but are necessary to complete the work as specified as though such material items, connections and other items were shown on the drawings and/or the Bill of Material. Contractor-furnished materials shall be in accordance with the drawings and Specifications.

7.7.4. SALVAGED MATERIALS

Contractor shall deliver all salvaged poles, structures, equipment, conductors, and materials to the Owner's storage area and unload as directed by the Owner. Dispose of all materials not being salvaged.

Contractor shall obtain a signed voucher from the Owner's storekeeper for all returned material.

The Contactor shall disassemble, sort, and store all structures and materials. Wood and concrete poles removed shall be freed of dirt and other debris and inspected for damage. The Contractor shall Identify and inform Owner of any wood poles that may need treatment to prevent further deterioration and notify Owner of any damage needing repair.

Contractor shall spool and tag all conductors, shield wires, fiber optic cables, and guy wires with information concerning the type and approximate length of conductor or wire in feet contained in each spool. The Contractor shall remove all splices and connectors and identify and inform Owner of any damaged sections of wire.

The Contractor shall provide all reels, shoring, and crating required for the storage of salvaged structures, equipment, and materials.

7.8. PROTECTION OF THE ENVIRONMENT

The Contractor shall observe the rules and regulations of the Owner and the state, local, and federal agencies having jurisdiction over the protection of the environment.

7.9. TRAFFIC CONTROL

Traffic control shall be the responsibility of the Contractor and shall be in accordance with applicable state, county, and municipality statutes and guidelines. Owner shall be provided a copy of the approved traffic control permit.

7.10. TRANSMISSION LINE RIGHT OF WAY CLEARING

7.10.1. GENERAL

This section covers general procedures and requirements for right-of-way clearing for construction of the associated transmission line. See Section 6.12, Access Road Construction, for information not included in this section. The following shall be performed:

Trim or remove and dispose of trees, shrubs, and underbrush along the right-of-way as specified herein and as indicated on the drawings.

Do not begin clearing work on any right-of-way section until that section has been released in writing by the Owner.

Perform right-of-way clearing with minimum disturbance to the natural surroundings. Existing grades shall not be modified without Owner approval.

Use only workers who are experienced in tree trimming and clearing work for right-of-way clearing.

Perform clearing work within street, road, or highway rights-of-way in accordance with the requirements of the municipal, county, or state authority having jurisdiction over the right-of-way in each case.

Clearing performed on private right-of-way shall comply with all provisions and limitations in the Owner's easements and agreements.

Do not use equipment that may leave ruts or track marks in wetland areas.

7.10.2. STAKING

The right-of-way limits shall be staked before starting clearing or trimming. Right-of-way stakes shall be clearly visible and of sufficient size and spacing to define the right-of-way limits. If left unattended overnight or over the weekend, stake locations shall be checked to the latest drawings to ensure accuracy before starting clearing or trimming.

7.10.3. CLEARING

On right-of-way portions that are designated on the drawings to be cleared, all vegetation, including stumps and roots, shall be removed to ground line to allow the Owner to perform future right-of-way maintenance using conventional mowing equipment.

Environmentally sensitive areas shall be protected. Owner will delineate sensitive areas prior to start of clearing and construction. Prior to the start of clearing and construction, it shall be verified with Owner that delineation activities are complete.

Where existing fences, gates, and/or any other such facilities must be removed to carry out the clearing, or are damaged during clearing, they shall be restored to their original condition or replaced.

7.10.4. TRIMMING

Portions of the right-of-way may be designated to be trimmed as indicated by the "Trim Line" on the drawings. In these areas, the existing trees shall be trimmed to provide the horizontal and vertical clearances indicated on the drawings. Where trees require significant trimming that would destroy the overall symmetry of the tree, the entire tree shall be trimmed to provide an overall symmetrical appearance.

7.10.5. SELECTIVE CLEARING

Portions of the right-of-way designated as "Selective Clearing Area" shall be cleared as specified herein.

Shrubs and underbrush shall be cleared only near structure locations and at construction lay-down areas. Areas to be cleared should be the minimum required to successfully and safely complete construction activities at the specific site. Prior to clearing, Owner's approval shall be obtained for the size of the clearing area required for the construction lay-down areas.

In upland areas designated as "Selective Clearing Area," the entire tree length to groundline, of all trees shall be removed, including the removal of stumps and roots larger than 2 inches in diameter.

In wetland areas designated as "Selective Clearing Area," all trees shall be removed to within 4 inches of the groundline or waterline (as measured during the wet season). Stumps of felled trees in wetlands shall be left in place to retain the integrity of the wetland and bottom soils and to maintain the hydraulic characteristics of the area. Shrubs and underbrush shall not be removed. In addition, a meandering line shall be used for vehicle access so that long visible vehicle trails are not created.

7.10.6. DANGER TIMBER

Dead, diseased, or leaning timber outside the right-of-way that could fall into the transmission line shall be designated as danger timber. The height of timber that could fall into the transmission line is indicated as the "Danger Timber Line" on the drawings. All danger timber shall be marked. Owner shall be notified when danger timber has been marked. Owner will inspect and approve danger timber removal. Danger timber shall be cut or trimmed in a manner that will minimize damage to trees that are not to be cut.

7.10.7. DISPOSAL

Cleared vegetation shall be disposed of in accordance with the following items.

7.10.7.1. URBAN AREAS

Cleared or trimmed vegetation shall be hauled away, and the material disposed of at an acceptable disposal site.

7.10.7.2. UPLAND RURAL AREAS

Cleared or trimmed vegetation shall be hauled to a suitable disposal site. With Owner's approval, and if allowed by local and state regulations, cleared and trimmed vegetation may be chipped, burned, scattered, windrowed, or stacked on the right-of-way. All local and state permits shall be obtained required for burning. No burning shall take place without Owner's approval.

7.10.7.3. WETLAND AREAS

Cleared or trimmed vegetation shall be hauled to a suitable disposal site, or to adjacent upland areas only if vegetation removal is allowed by permit. Cleared and trimmed vegetation may be left if authorized by the appropriate state or federal regulatory agency. Vegetation removed from wetlands to upland areas may be chipped, burned, scattered, windrowed, or stacked as specified above.

7.10.8. INJURY REPAIR

Damage to trees that are not to be cut or trimmed shall be avoided. If a tree is injured during the construction period, it shall be repaired as soon as possible. Such repair, to be completed by a licensed arborist, shall minimize the possibility of disease to the injured tree and shall be in accordance with accepted tree surgery practices

7.10.9. SEEDING AND SODDING

Areas indicated on the drawings shall be seeded or sodded in accordance with Section 6.11, Transmission Line Seeding and Sodding. In general, once construction is complete, all established areas that were disturbed during clearing or construction shall be seeded or sodded.

7.11. TRANSMISSION LINE SEEDING AND SODDING

7.11.1. GENERAL

This section covers seeding and sodding of transmission line rights-of-way, access roads, and work platforms to stabilize disturbed soil and embankments and control erosion. The contractor is responsible for repairing any vegetation damage during construction. See Section 6.23, Access Road Construction, for additional information not included in this section.

7.11.2. SODDING

Sodding shall include preparation of the soil surface, fertilizing, laying the sod, rolling, and watering. Sod shall be placed only when the soil is moist and in proper condition to induce growth.

Sod shall be placed after preparing the soil and applying fertilizer as specified. The native soil on the roots of the sod shall be retained during placement. Dumping sod from vehicles will not be permitted. Sod shall be transplanted within 24 hours from the time of stripping, unless stored in a satisfactory manner. After delivery and while in stacks, sod shall be kept moist and protected from exposure to the air and sun and from freezing. During periods of high temperature, after all unevenness in the soil surface has been corrected, the soil shall be lightly moistened immediately prior to laying the sod.

As sodding is completed in any one section, sod shall be pressed into contact with the sod bed by tamping or rolling to eliminate air pockets. A true and even surface shall be provided to ensure knitting without displacement of the sod or deformation of the surface of sodded areas. Following compaction, good quality screened soil shall be used to fill all cracks. Work excess soil into the grass with rakes or other suitable equipment. Adjust the quantity of fill soil so that it will not smother the grass. The sod shall be watered to a depth such that both the underside of the new sod and the soil immediately below the sod are thoroughly wet.

7.11.3. SEEDING

Seeding shall include preparation of the soil surface, fertilizing, seeding, compacting, mulching, and watering. Areas indicated on the drawings shall be seeded or sodded in accordance with Section 6.10.9 and 6.11.5 Seeding, Sodding and Mulch.

Mulch, seed, and fertilizer may be applied simultaneously with a hydraulic applicator manufactured specifically for this purpose. The hydraulic applicator shall be capable of applying the mulch, seed, and fertilizer slurry in the proper proportions under its own power to slopes at least as steep as 2 feet horizontal for 1 foot vertical.

Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 15 miles per hour. Seeds shall be sown only when the soil is moist and in proper condition to induce growth. Areas to be seeded shall be scarified by disc or cultivated by other approved method to a depth of 4 inches prior to seeding.

Seeding shall be conducted under favorable weather conditions during seasons that are normal for such work as determined by accepted practice in project locality. Seeding operation shall proceed on moist soil, but only after free surface water has drained away. Seeding mixtures shall be as shown in Sections 6.23.2.46-48.

7.11.4. FERTILIZER

Commercial fertilizers shall comply with state and local laws regulating the use of fertilizers and shall be approved for use in the area being seeded.

7.11.5. MULCH

Mulch shall be either vegetative mulch consisting of stalks of oats or wheat or a wood cellulose fiber mulch. Mulch shall be free of noxious weeds. Mulch shall be spread at a rate of 1,500 pounds per 10,000 square feet.

7.11.6. SEED

Seed shall be labeled in accordance with the latest US Department of Agriculture Rules and Regulations under the Federal Seed Act and shall comply with all applicable state and local laws and regulations. Sealed standard containers, plainly labeled as to variety, percentage of germination, purity, and the date tests were made shall be provided. Seed that has become wet, moldy, or otherwise damaged will not be acceptable.

The balance of material in an acceptable seed mixture (other than pure live seed) shall, for the most part, consist of nonviable seed, chaff, hulls, live seed of crop plants, and harmless inert matter. The percentage of weed seed shall not exceed 1 percent by weight for the mixture.

7.11.7. GUARANTEE

If, at the end of 8 weeks following seed planting or sodding, a satisfactory stand of grass has not been produced, unsatisfactory portions thereof shall be renovated and reseeded or resodded immediately or during the next planting season. A satisfactory stand of grass is defined as an area of 1,000 lineal feet of right-of-way that has the following:

No bare spots larger than 9 square feet.

Not more than 10 percent of total area with bare spots larger than 4 square feet.

7.11.8. WATERING

Watering will be required to promote the establishment of healthy turf. Water areas that have been seeded or sodded such that water will penetrate 1 inch into the soil.

Additional applications of water will be required until the grass is well established after planting.

Water and all pipes, pumps, hoses, sprinklers, and all other necessary materials shall be supplied to apply water.

7.11.9. MAINTENANCE

All planted areas shall be maintained and protected until final acceptance of the work. Final acceptance will not be made until an acceptable uniform stand of grass is obtained, except that, at the Owner's sole discretion portions of the seeding or sodding may be accepted at various times. Upon acceptance by the Owner of a planted area, the Owner will assume responsibility for maintenance of that portion.

Any portions of the areas of planting that fail to show a uniform stand of grass shall be replanted as before, except commercial fertilizer shall be applied at one-half the original rate. Planting shall be repeated until an acceptable stand of grass is provided.

Over watering shall be avoided on the sloped areas to prevent erosion. Any areas that have become eroded shall be regraded and replanted. Organic soil shall be added, if required.

7.12. TRANSMISSION LINE RIGHT OF WAY ACCESS

7.12.1. GENERAL

This section covers providing access roads, construction trails, and maintenance roads along the transmission line right-of-way. See Section 6.23, Access Road Construction, for additional information not included in this section.

Access to the transmission line right-of-way shall be from county roads or state roads wherever possible. Access along the transmission line right-of-way shall be limited to the right-of-way as indicated on the drawings.

The requirements of this section in no way restrict the Contractor's operation as an independent contractor to obtain written agreements for any additional access required. File copies of both the execution and termination of such agreements must be submitted to the Owner. The Owner will not be liable for any expenses related to the acquisition, use, misuse, and expiration of said agreements.

Access roads or working platforms shall not be constructed in any areas along the right-of-way, unless otherwise indicated on the drawings or in these Specifications. Where access roads along the transmission line right-of-way are not allowed, all necessary construction methods or special construction equipment shall be used to perform the line construction work without additional roads or pads

7.12.2. MATERIALS

7.12.2.1. FILL MATERIAL

All fill material required for the construction of new access roads and/or working platforms shall be provided.

7.12.2.2. CRUSHED ROCK

Crushed rock for backfill shall be clean, moist, graded aggregate meeting the state department of transportation specifications indicated on the drawings or, if not indicated, the following requirements:

Sieve Size	Percent Passing by Weight
1-1/2 inch	100
1 inch	95-100

1/2 inch	25-60
No. 4	0-10
No. 8	0-5

7.12.2.3. GEOTEXTILE FABRIC

Geotextile fabric shall be provided as shown on the drawings.

7.12.2.4. TURBIDITY BARRIERS

Turbidity barriers composed of silt fences and stacked hay bales shall be provided as approved by the Owner.

7.12.2.5. CORRUGATED METAL PIPES CULVERTS

Corrugated metal pipe culverts shall conform to AASHTO M36 and shall be galvanized, Type I. Corrugated metal pipe shall be 16 gauge for 18 inch and 24-inch diameters, 14 gauge for 30 inch and 36 inch diameters, and 12 gauge for 42 inch and 48 inch diameters.

7.12.2.6. SOIL STERILANT

Soil sterilant shall be composed of a finely divided wettable powder containing a minimum of 80 percent active ingredients. Soil sterilant shall consist of a mixture containing not less than 25 percent of sodium chlorate, not less than 45 percent of boron trioxide, and not more than 2 percent inert ingredients. The mixture shall have a minimum water solubility of 1 pound per gallon at 75° F plus or minus 5° F.

7.12.3. EXECUTION

7.12.3.1. GENERAL

Access to all structure locations shall be as indicated on the drawings. Any proposed modifications to the right-of-way access as described on the drawings shall be submitted to the Owner for approval. In order of priority, access to structure locations shall be obtained by the following:

Using existing access roads indicated on the drawings.

Driving across designated areas indicated as new access roads on the drawings.

Fill, blading, and grading new access roads that require earthwork modifications.

Before grading, the roadbed shall be stripped of sod to whatever depth is necessary to remove roots of grass and other vegetation.

Side slope of access roads shall be as indicated on the drawings.

7.12.3.2. FILL

Fill required for the construction of access roads, culverts, and working platforms shall be provided in compliance with all requirements of the authorities having jurisdiction in such areas. The amount of fill required shall be determined and, all fill shall be provided as necessary. Any quantities of fill indicated in these Specifications and associated documents are for informational purposes only and shall not relieve the Contractor from determining the quantity of fill required.

The amount of fill used shall be limited as much as possible during construction and maintenance of the roads and/or platforms by using geotextile fabric to enhance stability where needed.

Fill material in layers not to exceed 24 inches in uncompacted thickness and compacted using compaction techniques approved by the Owner.

7.12.3.3. CRUSHED ROCK

Crushed rock shall be placed in 12-inch layers and compacted to 90 percent of the maximum dry density as determined by ASTM 1557. Compaction techniques shall be approved by the Owner.

7.12.3.4. TURBIDITY BARRIERS

Prior to placement of fill, turbidity barriers shall be installed in accordance with local environmental regulations and as approved by the Owner. Turbidity barriers shall remain in place until the Owner authorizes their removal.

7.12.3.5. GEOTEXTILE FABRIC

Geotextile fabric shall be provided where necessary to stabilize fill for access road and/or working platform construction.

7.12.3.6. CORRUGATE METAL PIPE CULVERTS

Corrugated metal pipe culverts shall be provided along the access roads where indicated on the drawings. The length of culverts shall be determined so that they are long enough to ensure proper flow from end to end without interference from debris washed down the side slope of access roads.

Culverts shall be spaced as indicated on the drawings. Culverts shall be set perpendicular to roadway, except in areas where flow dictates otherwise. Additional corrugated metal pipe culverts shall be installed as directed by the Owner.

7.12.3.7. FINAL PREPARATION

Upon completion of all construction work, the access roads and working platforms shall be regraded and compacted. Fills, embankments, and backfills that have settled or eroded shall be repaired. Settled or eroded areas shall be refilled, compacted, and graded to conform to the elevation indicated on the drawings. Damaged facilities shall be repaired in a manner acceptable to the Owner.

Finished road shall be smooth and uniform and shall be maintained in this condition throughout the construction period.

7.13. TRANSMISSION LINE FENCES AND GATES

7.13.1. GENERAL

This section covers repairing, modifying, furnishing, and installing fences, gates, associated posts, bracing, and associated hardware to control access to the transmission line right-of-way.

7.13.2. FENCING

New fences shall conform to the alignment and finish grades shown on the drawings.

With Owner's approval, ground surface irregularities may be graded to eliminate frequent changes in vertical alignment and to provide a smooth profile for the fence.

All fencing along the transmission line route that is damaged during construction shall be replaced or restored to original condition.

Existing fences crossing existing or proposed access roads shall be cut to allow access to the structure sites. The existing tension in fences shall be maintained by installing additional supports or struts. Any fencing and supports to be removed shall be properly disposed of.

In livestock areas, existing fencing shall be maintained, and new fencing installed in these areas to ensure that the livestock do not stray. A complete fence shall be maintained at all times. There will be no exceptions to this requirement.

New fencing shall match the quality and construction standards of the existing fencing unless otherwise approved by the Owner.

7.13.2.1. FENCE POSTS

Fence posts shall be set in earth at least 24 inches deep. If bedrock is encountered, post excavation shall be continued to the 24-inch depth or 12 inches into the rock, whichever is less.

Backfill shall be compacted around fence posts to at least the density of the adjacent undisturbed earth.

Wood fence posts shall be treated with preservative and shall be a minimum of 4 inches in diameter.

Fence posts shall be plumb and spaced no more than 10 feet apart.

7.13.3. GATES

Gates shall be installed in accordance with the drawings and the requirements of this section.

Steel gates shall be installed at all locations along the right-of-way where they are necessary for access to the transmission line right-of-way during line construction.

Gate posts shall be set at least 3 feet below grade. If bedrock is encountered, post excavation shall be continued to the 3-foot depth or 18 inches into the rock, whichever is less. All gate posts shall be braced. Gate posts shall be set for each gate so that their tops are at the same elevation. All posts shall be plumb. Backfill shall be compacted around posts to at least the density of adjacent undisturbed earth. Wood posts shall be treated with preservative and shall be a minimum of 6 inches in diameter.

A brace panel shall be installed on each side of each gate. Brace panels shall have double diagonal tension wires. Wires shall be tensioned tightly.

Gates shall be nominal 4-foot-high safety panel farm gates designed for a 16-foot opening width. Gates shall be braced using diagonal and vertical panels. Gate manufacturer's specifications shall be provided, and data cataloged to Owner for review.

Gates shall be installed so that they swing freely in accordance with manufacturer's instructions and recommendations.

Each gate shall be installed on heavy galvanized hinges so that it cannot be removed without disassembly of the hardware. Hardware attachment bolts shall be peened so that removal will be difficult.

A padlock shall be provided for each gate during construction. Owner will provide padlocks after construction is complete.

7.14. ERECTION OF WOOD AND DIRECT-EMBEDDED STEEL STRUCTURES

7.14.1. GENERAL

This section covers erection work for wood and direct-embedded steel transmission line structures. All structure components, including those fabricated of metal, shall be handled with care to prevent damage to the components, their preservative treatment, or their protective coatings.

7.14.2. STRUCTURE FRAMING AND ASSEMBLY

All structures shall be framed and assembled as indicated on the drawings.

Structures shall be completely assembled prior to setting the poles.

The Contractor shall field drill all bolt holes, which are not factory drilled, but which are required for a complete installation. Field drilled bolt holes shall be drilled using a bit with a diameter 1/16-inch larger than the diameter of the bolt to be inserted. All holes drilled by the Contractor or factory, which will not be used, shall be plugged and sealed to the satisfaction of the Owner and the Engineer.

All bolts shall extend not less than 1/2 inch nor more than 2-1/2 inches past the locknut; all bolts shall be tightened so that the bearing surfaces of hardware, insulators, etc., are properly seated to the poles and arms. If necessary, gaining of poles, not shimming, may be used to achieve proper seating.

Each completed structure shall have all washers, locknuts, and other hardware properly installed and tightened. Ground conductors shall be installed when framing the structure.

7.14.3. BOLTING

The bolts will be furnished by the Owner, except as otherwise indicated on the drawings.

All connections shall be bearing type connections with threads excluded from the shear planes of the connected materials. Bolt length shall be selected in accordance with the Research Council specification and commentary specified hereinafter. Bolt length shall provide for washers, nuts, and locking devices. Where clearance permits, nuts shall be placed so they will be on the least visible side of each connection.

High strength bolts and their installation and bolting tools and equipment shall conform to all requirements for A325 bolts of the "Specifications for Structural Joints Using ASTM A325 or A490 Bolts" including the commentary given therewith, as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation and endorsed by AISC, except as otherwise modified or supplemented herein. The Research Council specification is dated August 14, 1980. All methods, tools, and equipment shall be subject to the acceptance of the Engineer. The work shall be done by competent and experienced bolting crews.
Tightening of galvanized high strength bolts shall be done by the "turn-of-nut" method only. A washer shall be used under the element turned in tightening. Smooth beveled washers shall be used when the bearing faces of the bolted parts have a slope of 1:20 or greater with respect to a plane normal to the bolt axis.

ASTM A394 and machine bolt length shall be selected to provide for nut and locknut, plus a 1/4 inch to 1/2-inch projection beyond the locknut. Each connection bolt shall be securely wrench tightened. "Wrench tightened" is defined as 50 to 75 foot-pounds of torque on 5/8-inch bolts and finger tightened to contact the nut, then wrench tightened against the nut an additional one-half to one full turn.

Bolted connections shall be drifted to proper position and the holes inspected to ensure that bolt threads will not be damaged by forcing the bolts in place. Connections shall be tightly drawn together, using two bolts or 25 percent of the total number of bolts in the completed joint, whichever is greater. Bolts for initial tightening shall be distributed uniformly about the joint. Either fitting-up bolts or high strength bolts may be used for this purpose.

The Contractor shall make a thorough inspection to ensure that all bolts are tightened and that a locknut has been installed and tightened on each bolt.

Any ASTM A325, A394, or machine bolt that has been tightened more than one-half turn beyond "snug tight" shall not be loosened and retightened. All such bolts shall be discarded, and new bolts shall be used in their place.

The tightened A325 bolts shall be checked at random as directed by and in the presence of the Engineer. Calibrated hand torque wrenches and the necessary platforms, equipment, and personnel shall be provided for the random check.

The torque wrench shall be constructed so that it will visually or audibly indicate when the proper torque is reached. The wrench shall be calibrated to indicate a torque equivalent to bolt tension of 28,000 pounds for 3/4-inch bolts. The number of A325 bolts checked shall be acceptable to the Engineer based upon his observance of the quality and completeness of the tightening operations. A minimum of 10 percent of the bolts in each connection, but not less than two bolts in each connection, shall be checked.

7.14.4. POLE STORAGE

Poles received from the vendor shall be set on the ground and stacked with a minimum of four stakes, so that the poles cannot be rolled.

Poles stored along the right-of-way near future setting locations shall be located away from residential areas, on the ground, and secured against rolling with a minimum of four stakes.

7.14.5. POLE SETTING

Except as otherwise indicated herein or on the drawings, or as otherwise required by the Engineer, each structure shall be set within +/- 6 inches transversely of the location indicated on the drawings and minimum pole setting depths shall be in accordance with the following table:

MINIMUM POLE SETTING DEPTHS

Pole (feet)	Depth of Setting (feet)
50	7.0
55	7.5
60	8.0
65	8.5
70	9.0
75	9.5
80	10.0
85	10.5
90	11.0
95	11.5
100	12.0

Each pole shall be set within 3 inches of the depth specified in the preceding table. The butt or top of a new pole shall not be cut off.

Poles shall be set in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they shall be set and raked against the strain so that the conductors are in line.

Poles shall be raked against the conductor strain not less than 1 inch for each 10 feet of pole length, nor more than 2 inches for each 10 feet of pole length, after conductors are installed at the required tension.

Poles shall be set so that alternate crossarm gains face in opposite directions, except at terminals and dead ends where the gains of the last two poles shall be on the side facing the terminal or dead end. On unusually long spans, the poles shall be set so that the crossarm comes on the side of the pole away from the long span.

7.14.6. POLE HOLE EXCAVATION

The diameter of each pole hole shall be as required for tamping of earth or select backfill around the pole, but not less than the pole diameter at the butt plus 12 inches.

Pole hole excavation shall include removal of stumps, roots, and other obstructions as necessary to provide a clean vertical hole to the required depth. Where necessary, the Contractor shall use split drums to prevent the earth from caving in or spilling into the pole holes.

Excavated pole holes shall be covered with plywood not less than 3/4 inch thick where the associated poles will not be set during the same working day. Under no circumstances shall pole holes be left uncovered overnight.

Unusable spoil removed from the hole shall be spread evenly over the right-of-way except in areas designated as wetlands. All spoil shall be spread outside the wetland area.

Pole hole excavation in earth shall be performed with a power driven auger; pole hole excavation in rock shall be performed by hand excavation or power driven rock auger. Blasting will not be permitted.

7.14.7. POLE HOLE BACKFILL

Pole hole crushed rock backfill shall be provided in accordance with Section 6.12, Transmission Line Right-of-Way Access.

Earth for backfill shall be finely divided excavated earth free from debris, organic material, and stones, and shall have a moisture content which will ensure good compaction. No mud will be permitted.

All pole holes shall be 12” larger on each side of the butt of the pole and shall extend a minimum of 18” below the pole embedment depth shown on the drawings unless indicated otherwise on the drawings.

Pole holes shall be backfilled and tamped at vertical intervals not to exceed 12 inches. Tamping shall be done with air tampers only, using methods acceptable to the Engineer. Tamped backfill shall be placed to the natural ground elevation. Water shall be pumped from all holes during the setting and tamping operations.

The Contractor shall dispose of all excess materials such as dirt, rock, sand, etc., after backfilling operations are completed. Holes from removal of old poles shall be backfilled with dirt and tamped.

7.14.8. ANCHORS AND GUYS

Each anchor rod shall be aligned with its connected guy and shall extend not less than 3 inches nor more than 9 inches above the ground surface after the connected structure has been loaded.

The Contractor shall base his bid on installing helical anchors at each guy location indicated on the drawings. The unit adjustment prices stated in the proposal shall be used for additions to or deletions from the quantity of helical anchors specified.

The multi-helix anchor shall be installed with a minimum of one (1) five-foot extension. The lead section shall extend no more than 12 inches above the ground. Installation of multi-helix anchors shall be performed using torque-indicating devices recommended by the anchor manufacturer and acceptable to the Owner or Engineer. Each torque-indicating device shall be calibrated before use. Results of the calibration shall be submitted to the Owner and the Engineer. Minimum installation torques of 5,000 foot-pounds for the TA-7S anchor shall be achieved. An alternative method of checking the anchor installation torque is the wrap-of-the-shaft method. A minimum of one full wrap in each four feet of the 1-½ inch square shaft length is required.

All guys shall be installed prior to loading the structures. Guys shall be installed in accordance with the guying details indicated on the drawings. Guy dead-end units shall be installed in accordance with the manufacturer's recommendations.

If, after loading the structures, the Engineer determines that final adjustments to the guys are necessary, the Contractor shall make such adjustments to the satisfaction of the Owner or Engineer.

7.15. ERECTION OF TUBULAR STEEL POLE STRUCTURE

7.15.1. GENERAL

This section covers the installation of tubular steel pole structures.

Tubular steel poles shall be erected in strict accordance with the manufacturer's instructions.

Erection procedures not specified herein or shown on the drawings shall be in accordance with the structure manufacturer's drawings and recommendations and IEEE Std. 951, "Guide to the Assembly and Erection of Metal Transmission Structures."

7.15.2. STRUCTURE ASSEMBLY

All structure components shall be handled carefully to prevent damage to the finish. Padded cradles and nylon slings shall be used when handling structure components.

Except where assembly is made impractical by existing lines in the construction area or where such assembly may affect the scheduled completion of the work, structures shall be completely assembled prior to setting.

The structure manufacturer may furnish shims or provide oversized attachment holes to aid in aligning the structure arms. The shims shall be inserted, if required, or otherwise the arms shall be straightened during assembly to properly align the structure arms. After assembly, the horizontal distance from the end of each arm center line to a vertical plane passing through the center line of the pole shall not exceed 2 inches.

Tubular shafts that are shipped in more than one piece using two jacks placed on opposite sides of the shaft shall be assembled. Pole shaft assembly shall be in accordance with the manufacturer's drawings and recommendations.

7.15.3. BOLTING

High strength bolts and their installation and bolting tools and equipment shall be in accordance with the structure manufacturer's recommendations and the "Specifications for Structural Joints Using ASTM A325 or A490 Bolts" including the commentary given therewith, as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation and endorsed by AISC, except as otherwise modified or supplemented herein. The Research Council Specification is dated August 14, 1980. All methods, tools, and equipment shall be subject to the acceptance of the Engineer. The work shall be done by competent and experienced bolting crews.

Galvanized high strength bolts shall be tightened using a calibrated torque wrench. Bolts to the torque values furnished by and in accordance with the recommendations of the structure manufacturer shall be tightened. A washer under the structure element to be turned in tightening shall be used.

Nuts and bolts shall be handled and installed in a manner that will not damage the structure's galvanized finish. Wrenches that deform the nut or bolt head or that mar the galvanized finish shall be repaired or replaced. Without cost to the Owner, all bolts and nuts damaged during installation shall be replaced with new, undamaged bolts and nuts of the same type, size, and quality as the originals.

Bolted connections shall be drifted to the proper position and the holes inspected to ensure that bolt threads will not be damaged by forcing the bolts in place. Connections shall be tightly drawn together using two bolts or 25 percent of the total number of bolts in the completed joint, whichever is greater. Bolts for initial tightening shall be distributed uniformly about the joint. Either fitting-up bolts or high strength bolts may be used for this purpose.

Connections shall be inspected to ensure that all bolts are tightened and that a locknut has been installed and tightened on each bolt where required.

Structure bolts that have been previously tightened to the specified torque shall not be loosened or retightened. Bolts that have been loosened after tightening shall be discarded. New bolts shall be used in their place. New bolts shall be furnished at no additional cost to the Owner.

7.15.4. TOUCHUP GALVANIZING

Damaged galvanized surfaces to white metal shall be cleaned. Grease, scale, and all foreign matter shall be removed from surface and surface shall be regalvanized with a zinc-rich coating such as "AMCO 322 Galvanizing Sticks" or "AMCO 321 Galvanizing Powder" as manufactured by Force Chemicals Division of American Solder & Flux Co., Inc. of Paoli, Pennsylvania, or an acceptable equal material. The touchup galvanizing material shall be applied in strict accordance with the manufacturer's application instructions to provide a uniformly coated surface. The zinc-rich coating shall deposit not less than 2 ounces of zinc per square foot. The touchup galvanizing material in the field shall be furnished and applied to any surface where the galvanizing coating is broken or removed. Where practical, the galvanizing repair shall be performed before the structures are set.

7.15.5. STRUCTURE SETTING

Structures shall not be set until the foundations are at least 7 days old and cylinder breaks are 3,000 psi. Two sets of nuts will be furnished by the pole manufacturer with the pole anchor bolts. One set shall be installed on the anchor bolts and they shall be level before the structures on the foundations are set.

7.16. INSULATORS AND SUPPORT HARDWARE

7.16.1. GENERAL

The following articles cover installation work for insulators and support hardware.

7.16.2. INSPECTION AND CLEANING

Each insulator unit shall be inspected and when installed shall be free of cracks, chips, bent pins, and other defects. Defective insulators shall be removed from the work site immediately.

All insulators installed shall have surfaces cleaned of all foreign material.

7.16.3. POLYMER INSULATOR ASSEMBLY AND ATTACHMENT

Where polymer insulator units are attached to the structure prior to erection, the insulator units shall be secured to the structure with rope slings in a manner acceptable to the Engineer. After erecting the structure, the insulators shall be lowered into position with rope slings.

Where polymer suspension insulator units must be attached to the structure after setting the poles, the insulator units shall be hoisted into position with nonmetallic slings in a manner acceptable to the Owner or Engineer.

Workmen shall not climb insulator units.

7.16.4. LINE POST INSULATOR ATTACHMENT

Line post insulators shall be securely mounted on each structure prior to setting the poles. The structures shall be supported off the ground before pole setting to maintain clean surfaces and to avoid damage to the insulators.

7.16.5. DEAD-END INSULATOR ASSEMBLY AND ATTACHMENT

Dead-end assemblies, when completely assembled, shall have cotter pins fully seated.

Dead-end insulator assemblies shall be attached to the structure after setting the structure. The insulator assembly shall be hoisted into position with slings or wires in a manner acceptable to the Owner. The number of slack units shall be kept to a minimum to avoid bending the pins.

7.17. INSTALLATION OF PHASE CONDUCTORS AND SHIELD WIRE

7.17.1. GENERAL

The installation of all phase conductors, shield wire, and optical ground wire shall be in accordance with the latest revision of IEEE Standard 524 – “IEEE Guide to the

Installation of Overhead Transmission Line Conductors". The following articles cover installation work for transmission phase conductors and shield wire. The installed wires shall be free from damage, including any deformity in, or foreign matter on, the wire which can be detected visually or by feel.

This section also includes general requirements for the installation of optical ground wire (OPGW).

7.17.2. STRINGING BLOCKS

Stringing blocks shall be securely fastened to the supporting structures. Stringing blocks may be attached to the insulators or may be supported by brackets or hangers which are attached to the structures. The stringing blocks shall support the wires at their permanent or "clipped in" elevations.

Stringing blocks shall have neoprene or urethane inserts covering all surfaces which may come in contact with the wire. Stringing blocks shall be designed and used such that the pulling line does not damage or deposit foreign matter in the sheave or insert in a manner which might cause damage to the wire. Sheaves shall operate freely. For 1590 kcmil Coreopsis conductor, sheave diameters and sheave grooves shall be selected in accordance with the following:

Minimum bottom of groove diameter	25"
Minimum bottom of groove diameter (if maximum sag section is limited to 10,000 feet)	21"
Minimum groove depth	1.82"
Minimum groove radius	0.80"
Maximum groove radius	1.10"

Sheave diameters and sheave grooves for all other conductor and wire types shall be selected in accordance with the latest revision of IEEE Standard 524 – "IEEE Guide to the Installation of Overhead Transmission Line Conductors".

7.17.3. CROSSING OVER UTILITIES, HIGHWAYS, AND RAILROADS

The Contractor shall furnish and install all guard structures required for all crossings over electric supply lines, communication lines, railroads, roads, highways, and other obstructions. The Owner will obtain the necessary permissions or permits for stringing wire over highways, railroads, and other obstructions. The Contractor shall obtain the necessary permission or permits for stringing wire over other utilities. The Contractor shall make adequate preparations to safely cross all facilities with a minimum of inconvenience and delay to the public.

The Contractor shall notify the Owner or Engineer at least 15 days in advance of the intended date of wire pulling across any transmission or distribution line, any highway, stream, or environmentally sensitive area, such as wetlands. If it is a requirement of any permit that specific public authorities be notified prior to pulling wire, then it shall become the responsibility of the Contractor to notify the Owner through the Engineer.

Guard structures shall be single poles, or two or more poles joined by timbers. Each guard structure shall be complete with all necessary guys, anchors, and braces, and shall have adequate provisions to prevent damage to wires. Stringing blocks shall be included as part of any guard structure which will continuously support the wire during installation. Guard structures with stringing blocks shall be equipped with provisions for supporting the wire if the block attachment assembly fails.

Upon completion of a section of line, all guard structures in that section, including the full length of all guard structure poles, shall be removed by the Contractor. All pole holes shall be backfilled, tamped, and seeded by the Contractor.

7.17.4. CONDUCTOR AND WIRE STRINGING

The lead lines for pulling in the conductor, shield wire, and OPGW shall be flown in with a helicopter in accordance with the latest revision of IEEE Standard 524 – "IEEE Guide to the Installation of Overhead Transmission Line Conductors". All wires and conductors shall be strung from reels firmly mounted on stands secured against displacement. Reel equipment shall include adjustable braking devices that shall be used to prevent wire or conductor overrun between the reel and the tensioning equipment. All reel equipment shall be continuously attended during conductor and wire pulling to assure proper operation. Each conductor and reel shall be carefully inspected and any protruding fasteners or other objects that might damage the cable shall be removed. A thorough visual inspection for flaws, breaks, or abrasions shall be made as the conductor and wire leaves the reel. Damaged portions of the conductor or wire shall be cut out and the conductor or wire spliced as specified hereinafter. Splices shall not be pulled through stringing blocks. Conductor or wire end stringing equipment shall meet or exceed OSHA, MOSHA, and SMECO safety and grounding requirements. The operator of the equipment shall work from a location safe from the reaction of broken wires.

All wire and conductors shall be strung using double bull wheel continuously controlled tensioning equipment located in line with each pull and anchored. Tensioning bull wheels shall be provided with multiple conductor grooves and shall have a diameter sized for the outside diameter of the conductor or wire being pulled. The wire and conductor grooves shall be lined with neoprene or other acceptable resilient material to provide cushioning in the grooves and protect wires and conductors smaller than the groove diameter from being flattened or otherwise damaged. Tensioning brakes and brake controls shall automatically maintain running tension after the set tension is obtained and shall be supplemented by a fail-safe type brake, which automatically engages upon loss of the running tension brakes.

Wire and conductor reels shall be located behind the tensioner with a maximum recommended angle of 2 degrees for entry of conductor or wire into the bull wheel. A constant back tension of approximately 1,000 pounds shall be maintained on the conductor or wire to minimize bird caging in the tensioner and conductor or wire over-running. The tensioner and puller shall be located so that the average slope of the top conductor or wire is 1/4 or less. If the sagging temperature is 60°F or higher, the Engineer may allow a slope as high as 1/3.

Conductor and grips shall be of a type, which will not damage the conductor or wire and shall be acceptable to the Owner.

Conductor and wire shall be pulled away from each tensioner by double bull wheel or drum type pulling equipment located in line with each pull and anchored. The conductor and wire pulling equipment shall provide a continuous, smooth, and steady pull; an uneven or jerky pull will not be acceptable.

Stringing blocks (stringing sheaves or travelers) shall be of such a design as to minimize conductor and wire deformation during pulling and to enhance good sagging practice through low friction. Blocks shall be equipped with ball or roller bearings and shall be maintained in accordance with the manufacturer's recommendations. It is recommended that block grooves be elastomer lined. Unlined smooth polished grooves may be used for conductor and wire stringing if the block material is aluminum or magnesium alloy. However, in no case shall unlined grooves be used if steel pulling line is used.

The tension on any conductor or wire during stringing shall not exceed 50 percent of the tension required by the stringing sag charts at the temperature existing at the time of stringing, or 3,600 pounds, whichever is less.

Wooden planks or other nonmetallic lagging acceptable to the Engineer shall be used to protect conductors and wire from direct contact with the ground during splicing and dead-ending operations. During pulling operations, the conductor and wire shall be kept clear of the ground and all other objects that might cause abrasion, kinks, loosening of strands, or other damage.

When, during the stringing operation, a conductor or wire contacts another conductor or wire, the ground, or some other object which might cause damage, the conductor or wire shall be lowered, wiped clean, and closely inspected by the Engineer to determine the extent of damage. Depending on the severity of damage and the length of the damaged section, repairs shall be made by smoothing of the conductor or wire with fine sandpaper or by cutting out the damaged section and splicing.

If at any time during the stringing and sagging operation it becomes necessary to leave the conductor or wire in the stringing blocks for an extended period of time due to equipment failures, inclement weather, or other delay, the conductor or wire sag shall be adjusted to twice normal sag or greater consistent with the maintenance of standard clearance at all crossings of utilities, roads, and railroad tracks. This shall be a temporary measure only until such time that the Contractor can complete the sagging and clipping procedures.

Conductors or wire shall not be left in stringing blocks for more than 24 hours before pulling to initial sags specified by the Engineer. If so directed by the Engineer, sag tables corrected for creep time shall be used. After being sagged, the conductor and wire shall remain in the stringing blocks for 12 hours prior to being clipped in. However, the total time in stringing blocks shall not exceed 96 hours prior to clipping in.

The Engineer may require the conductor or wire to be lowered after periods of stringing inactivity or exceedingly high wind to inspect the damage. The lowering of the conductor or wire and the repair or replacement found necessary shall not be cause for extra compensation.

7.17.5. SPLICING AND DEAD ENDING

Full tension conductor and wire splices and dead ends shall be installed in accordance with the manufacturer's recommendations. There shall be no splices in spans adjacent to or crossing creeks, county roads, railroads, major overhead utility lines, state or federal highways, or within 50 feet of suspension points or within 75 feet of dead-end fittings. All splices must be straight after completion. Only one splice will be allowed in any conductor or wire in a span. However, all phase conductors or wires may be spliced within a given span.

Splices shall not be pulled through stringing blocks. Reel-to-reel splices shall be made temporarily with Kellem grips and swivels until the final conductor or wire position is reached. Permanent splices shall be made after sections of conductor or wire damaged by the grips are removed.

Particular attention must be given to oxide inhibitor types of joint compound and the proper method of application and joint cleaning. Excess inhibitor shall be cleaned from all joints. "Flash" created by joint compression shall be removed and the outside of the sleeve shall be smoothed to touch by using emery cloth.

All compression fittings shall be filled with filler compound as recommended by the fitting manufacturer before compressing. Joint compound shall be applied to all flat-to-flat surface connections on dead-end bodies, jumper terminals, and splices. The joint compound shall be applied immediately following wire brush cleaning of contact surfaces.

The Contractor shall use a 60-ton press when making compression dead ends or splices on 556 kcmil or smaller conductor. The Contractor shall follow the manufacturer's recommendations for all other conductor and wire types.

The aluminum joint sleeves of each completed splice shall be centered longitudinally over the conductor or wire joint or steel joint sleeve.

After compressing, all burrs and sharp edges shall be removed from the joint surfaces. Any excess filler compound, which has been forced out of the connection during compression shall be cleaned from the conductor.

Minor straightening of sleeves shall be by cold forging using a wooden mallet and wood anvil.

Jumper loops installed between dead-end fitting terminals shall be formed into a regular shape to present a neat appearance. Where jumper loops are attached to vertical suspension insulators, the jumper loops shall allow the suspension insulators to remain plumb during cold weather.

The Contractor shall make all splices, taps, and dead ends in the conductors and wires as required to provide complete electrical circuits. All splice, dead-end, and jumper installations shall be performed in the presence of, and subject to, the inspection and acceptance of the Owner or the Engineer.

7.17.6. SAGGING

All conductors and overhead shield wires shall be sagged within 24 hours after stringing in accordance with stringing sag charts furnished by the Engineer. No conductor shall be stressed above the stress required by the stringing sag for the temperature existing at the time of sagging. The conductor temperature shall be determined at the time of sagging by means of a conductor thermometer acceptable to the Owner and Engineer. The sag thermometer shall be as manufactured by Sagline Incorporated, P.O. Box 351, Millwood, New York, NY 10546. The thermometer shall be suspended at least 10 feet above the ground and the temperature so determined shall be used as the sagging temperature.

Conductor sag shall be measured by the transit method. Transits shall be mounted on transmission line structures. Where the sagging pull includes more than six spans, the sag shall be verified on at least two spans. One sag check span will be at the ruling span length +10%. The other sag check span will be the longest span in that pull. For pulls longer than twelve spans, three spans will be checked.

Dynamometers on tensioning equipment may be used to ensure that conductors are not over stressed but shall not be used as substitutes for sag measurements.

Sags shall be held to the values indicated on the sag charts with a minus tolerance of zero to a plus tolerance of 3 inches (-0, +3 inches). The Contractor's superintendent shall keep an accurate sagging log listing the date, time, temperature, spans where sags are checked, computed sag, measured sag, and any other pertinent data or remarks. This log shall always be available to the Engineer for review and shall be given to the Engineer and Owner as a permanent record when the sagging operation is completed on the line. It is the Contractor's responsibility to obtain the clearance of the Owner's Construction Coordinator or Engineer on the completed sagging operation before proceeding to the next section of line. The Contractor shall provide such assistance as may be required by the Owner's Construction Coordinator or Engineer in checking the sags. Any changes in this procedure shall be acceptable to the Owner or Engineer.

Temporary guys, anchors, and reinforcements as required shall be provided during stringing and sagging operation to maintain all structures in alignment. This temporary material shall be included as part of the conductor assembly price.

Sagging shall not be done during periods of high or gusty winds, which in the judgment of the Owner or Engineer, might prevent accurate sag measurements.

7.17.7. SUSPENSION ATTACHMENT

Within 48 hours after all conductors or wires in a line section have been sagged in with the acceptance of the Engineer, stringing blocks shall be removed and all conductors or wires shall be permanently attached to suspension hardware using ties, armor rods, or Armor Grip Suspension Units as required for the particular conductor installation. Suspension units shall be installed in accordance with the manufacturer's recommendations.

Each insulator after clip-in shall not be more than 2 inches from the vertical plane through the structure centerline and the insulator support points on the structure. Where the distance exceeds 2 inches, offset clipping shall be used. Offset clip-in of conductors shall start at the lowest in the series of structures and work upward to the highest structure. The point of clip-in shall be as calculated and furnished by the Owner and Engineer.

Conductor attachment shall not be done during periods of gusty or high winds nor when the temperature is higher than 90°F or lower than 30°F except with the specific acceptance of the Owner or Engineer.

7.17.8. POLE AND CIRCUIT NUMBERS

Aerial pole and circuit numbers for poles shall be located near the top of the pole. Refer to the drawings and plan and profile sheets to determine which poles are to receive aerial numbers.

Circuit numbers, as indicated on the drawings, are to be attached to each structure.

Pole numbers as indicated on the drawings are to be affixed to every pole except guy stubs.

7.18. BOLTED ELECTRICAL CONNECTIONS

7.18.1. GENERAL

Where bolted connections are made to aluminum, the aluminum surface shall be thoroughly cleaned with a wire brush, then coated with joint compound and thoroughly brushed again through the compound. Additional compound shall then be added and the joint bolted together. Joint compound shall be Alcoa No. 2.

Where bolted connections are made between copper or brass surfaces, the metal surfaces shall be thoroughly cleaned and coated with Penetrox A as manufactured by Burndy Corp. Norwalk, Connecticut or No-Ox-Id A compound as manufactured by Sanchem Inc., Chicago, Illinois.

The tightness of each bolt in each factory made bolted electrical connection shall be checked during erection and connection of the equipment.

It shall be the Contractor's responsibility to certify that the tightness of each bolt in all bolted electrical connections, factory or field, is in accordance with the manufacturer's recommendations.

Bolted electrical connections shall be tightened with manual torque wrenches. Torque wrenches shall be so constructed that they will visually or audibly indicate when the proper torque is reached. The accuracy of each torque wrench shall be checked by a testing laboratory acceptable to the Engineer immediately prior to its use on equipment erected under these specifications.

7.18.2. TORQUE VALUES

If the equipment manufacturer's erection instructions do not include recommended torque values for bolt tightening or specify an alternate method for tightening bolted electrical connections, torque values shall be in accordance with those listed in the table which follows:

TORQUE VALUES FOR DRY, UNPLATED, NONLUBRICATED BOLTS

Bolt Size	18-8 Stain-less Steel	Brass	Silicon Bronze	Aluminum 24ST-4	316 Stain-less Steel
in.-lb.	in.-lb.	in.-lb.	in.-lb.	in.-lb.	

1/4"-20	75.2	61.5	68.8	45.6	78.8
1/4"-28	94.0	77.0	87.0	57.0	99.0
5/16'-18	132	107	123	80	138
5.16"-24	142	116	131	86	147
3/8"-16	236	192	219	143	247
3/8"-24	259	212	240	157	271
7/16"-14	376	317	349	228	393
7/16"-20	400	327	371	242	418
1.2"-13	517	422	480	300	542
1/2"-20	541	443	502	300	565
9/16"-12	682	558	632	413	713
9/16"-18	752	615	697	456	787
5/8"-11	1110	907	1030	715	1160
5/8"-18	1244	1016	1154	798	1301
3/4"-10	1530	1249	1416	980	1582
3/4"-16	1490	1220	1382	958	1558
7/8"-9	2328	1905	2140	1495	2430
7/8"-14	2318	1895	2130	1490	2420
1"-8	3440	2815	3185	2205	3595
1"-14	3110	2545	2885	1995	3250

7.18.3. CONNECTION BOLT TIGHTNESS CHECK

The tightened bolts in electrical connections shall be checked at random as selected by and in the presence of the Owner. The Contractor shall provide calibrated hand torque wrenches and the necessary platforms, equipment, and personnel for the random check.

The number of bolts checked shall be acceptable to the Engineer, based upon his observance of the equality and completeness of the tightening operations. A minimum of 10 percent of the bolts in each connection, but not less than two bolts in each connection, shall be checked.

The Contractor shall be responsible for coordinating the checking of bolt tightness so that minimum interference with equipment erection and connection will be experienced.

Removal of covers and similar dismantling of equipment to permit the Engineer to witness the testing of bolt tightness of enclosed connections shall be part of the work included under these specifications.

Checking of tightness of electrical connections in the presence of the Engineer is intended to assist the Contractor in avoiding the expense of repairing costly connection failures. This check shall not relieve the Contractor of complete responsibility for the integrity of the electrical connections.

7.19. GROUNDING

7.19.1. GENERAL

This section covers the installation of the Owner-furnished grounding materials described in Section 4.10 and the furnishing and installation of the grounding materials specified in this section of these specifications. All grounding materials not specifically stated as being Owner-furnished but which are required for a complete installation as indicated on the drawings and in these specifications shall be furnished and installed as indicated on the drawings and in accordance with this section of these specifications.

7.19.2. INSTALLATION

Grounding system materials shall be installed as indicated on the drawings and in accordance with the requirements which follow.

Except as otherwise indicated on the drawings, all buried ground conductors and ground rods shall be installed with no less than 18 inches of earth cover.

7.19.2.1. GROUND RODS

All ground rods shall be located as indicated on the drawings and installed to the depth indicated. The Contractor shall install ground rods at each structure as required to achieve 18 ohms or less ground resistance. The Construction Coordinator or Engineer shall be present when the ground rods are meggered.

The Contractor shall measure the ground resistance of each ground rod after each section has been driven into the ground. The resistances measured shall be recorded on the Structure Grounding Report specified hereinafter.

Where rock is located at a depth less than the required ground rod depth below the ground surface, the Contractor shall contact the Owner or the Engineer, who will advise the Contractor as to how he shall proceed.

7.19.2.2. POLE GROUNDING WIRE

Exposed grounding wire shall be installed inconspicuously on supporting structures. The grounding wire shall run parallel to or normal to dominant surfaces.

Damaged grounding wire shall be repaired or replaced by the Contractor as directed by the Owner or the Engineer.

7.19.2.3. CONNECTIONS

All bolted and screwed connections shall be securely tightened.

7.19.2.4. STRUCTURE GROUND RESISTANCE

After ground rods have been installed and interconnected as indicated on the drawings, but prior to connection to the pole, shield wire or system neutral, the Contractor shall measure the ground resistance at each structure and shall record the measured resistance on the Structure Grounding Report.

7.19.3. GROUND RESISTANCE MEASUREMENTS

All ground resistance measurements shall be made with a three terminal "megger" type ground tester which applies alternating current to the electrodes, and which gives a reading in direct current ohms. Two reference ground probes shall be used, and all tests shall be made in accordance with the instrument manufacturer's instructions for ground resistance testing. Some of the acceptable instruments are as follows:

Meg and megger ground testers, James G. Biddle and Co.

Vibroground, Associated Research, Inc.

Ground-Ohmer, Herman H. Sticht Co., Inc.

The Owner's representative shall be present for all ground resistance measurements.

7.19.4. STRUCTURE GROUNDING REPORTS

The Contractor shall maintain a record of the condition of the grounding facilities at each structure throughout the construction period. A standard form entitled Structure Grounding Report shall be prepared by the Contractor. The form shall provide space to report dimensions, depths, resistance measurements and the date each measurement was taken, revisions to the structure grounding arrangement indicated on the drawings, and other pertinent information.

7.19.5. FENCE GROUNDS

Fence grounds shall be furnished and installed as shown on the drawings and in accordance with the following requirements:

Fence grounds shall be installed at all fence crossings and at intervals not to exceed 400 feet along parallel fences that are within the transmission right-of-way. Where possible, fence grounds shall be attached to ground rod driven for nearest structure. When the nearest structure is more than 10 feet from the fence, a separate ground rod for the fence shall be driven.

7.20. TRANSMISSION LINE EXCAVATION AND BACKFILL

7.20.1. GENERAL

This section covers general earthwork including the preparation of construction areas; removal and disposal of debris; excavation as required; handling, storage, transportation, and disposal of excavated material; sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent construction; backfilling; finish grading; and other appurtenant work.

7.20.2. SURVEYING

Prior to commencing earthwork, a registered professional surveyor shall stake the transmission line center line, including points of intersection (PIs) and line of site points, and new structure pole and anchor locations. Excavation work shall not proceed until Owner approves staked structure locations.

7.20.3. SHEETING AND SORTING

The Contractor shall do all bracing, sheeting, and shoring necessary to perform and protect all excavations as required for safety and to conform to laws and regulations of all governmental bodies having jurisdiction. When sheeting is used, it shall be removed during or upon completion of backfilling.

The stability of previously constructed structures and facilities shall not be impaired or endangered by new excavation work. Previously constructed structures and facilities include those existing when this construction begins and those provided under these Specifications.

Adequate sheeting and shoring shall be provided as required to protect and maintain the stability of previously constructed structures and facilities and the sides of excavations until they are backfilled. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure. Sheeting and shoring shall maintain the shape of the excavation under all circumstances.

7.20.4. REMOVAL OF WATER

Adequate dewatering equipment shall be provided and maintained to remove and dispose of all surface and groundwater entering excavations and other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until construction to be provided therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result. Disposal of water shall be in accordance with federal, state, and local regulations.

7.20.5. CLASSIFICATION OF EXCAVATION AND EARTH MATERIALS

All excavation will be classified as "common excavation." All excavation, including soft shale, gravel or other material, which can be moved by hand or machine, is defined as common excavation. Owner shall be notified if excavated material is significantly different from that indicated in the soil borings. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.

7.20.6. PROTECTION OF UNDERGROUND CONSTRUCTION

All existing underground pipes, conduits, drains, and other underground facilities uncovered or otherwise affected by the excavation work shall be located, protected, shored, braced, supported, and maintained.

7.20.7. STABILIZATION

Subgrades for structures shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.

Structures that are otherwise solid but become mucky on top due to construction operations shall be reinforced with one or more layers of crushed rock or gravel subgrades.

The finished elevation of stabilized structure subgrades shall not be above the subgrade elevations indicated on the drawings.

7.20.8. STRUCTURE EXCAVATION

Excavation for structures shall be performed according to lines and elevations indicated on the drawings and to the limits required to perform the line construction work. Machine excavation shall be controlled to prevent undercutting the proper subgrade elevations. Machine excavation shall not be used within 5 feet of existing permanent structures and facilities. Only hand tools shall be used for excavation around existing permanent structures and facilities.

Work shall be performed so that construction areas will be as free as possible from obstructions and from interference with the transportation, storage, or handling of materials. Excavated materials free of trash, rocks, roots, and other foreign materials, and that meet the specified requirements, may be used as required for backfills constructed under these Specifications.

7.20.8.1. POLE EXCAVATIONS

The diameter of each pole hole shall be as required for compaction of backfill around the pole but shall not be less than the pole diameter at the butt plus 12 inches.

Pole hole excavation shall include removal of stumps, roots, and other obstructions necessary to provide a clean vertical hole to the depth specified on the drawings. Excavation shall be performed with a power-driven auger. As soon as the auger is withdrawn, the pole shall be set to the depth specified on the drawings and in accordance with these specifications.

Excavated pole holes shall be covered and protected when the associated poles will not be set during the same working day.

Pole holes may be excavated by the drilling and mud slurry technique. Prior to start of line construction, Owner's approval shall be submitted for a drilling mud procedure for wet hole excavation when sufficient side wall pressure cannot be obtained by use of water void of additives. Drilling mud shall be Super Mud manufactured by Polymer Drilling Systems or acceptable equal. Drilling mud shall be mixed in accordance with manufacturer's recommendations and to the proper consistency for maintaining the sides of the hole. With the Owner's approval, attapulgite clay type drilling mud may be substituted for Super Mud on holes where Super Mud will not provide sufficient side wall pressure to maintain the sides of the hole excavation.

Under no circumstances can bentonitic or kaolinitic clay products be used.

7.20.8.2. TEMPORARY CASING

Temporary casing will be required at all excavations where workmen are required to do hand excavation or remove obstructions in the lower portions of the caissons or to re-clean the bottoms of caissons prior to the placement of concrete. Temporary casings will also be required at locations where the soil will not stand without support or where, because of ground water or soil conditions, sloughing of the sides of caissons may seriously delay or endanger the satisfactory completion of excavation and placement of concrete. The Contractor shall have immediately available for use on the job an ample supply of casing for each size that will be required for use in the caissons and shall provide additional amounts, if required, to ensure orderly progress of the job. Such casing may be in short pieces but with jointing pieces of sufficient strength that assembled sections of casing may be pulled complete as concrete is placed or immediately thereafter. The casing shall also be of such strength and rigidity as to maintain the required excavation lines against the pressure of sloughing material from the sides of the caissons. All temporary casing shall be removed from caissons as concrete is placed or immediately thereafter, and in such a manner as to prevent sloughing material from dropping to the bottoms of caissons, falling on top of freshly placed concrete or intruding into the concrete mass.

Permanent casing will not be permitted except by special permission of the Owner or as shown on the drawings.

7.20.8.3. PERMANENT CASING

Corrugated metal pipe casing shall be installed as indicated on the drawings or as permitted by special permission of the Owner.

The casing shall not extend more than 6 inches below the top of the hole. Any part of the casing extending above this elevation shall be cut off. Casings shall be installed as drilling proceeds or immediately after the auger is withdrawn as required to prevent sloughing or caving of the excavation walls.

7.20.8.4. ROCK EXCAVATION

When solid rock, boulders, or detached stones are encountered and cannot be removed by normal power-driven drills or augers, the Owner shall be notified. Rock excavation techniques shall be used to achieve the desired excavated dimensions. Rock excavation shall consist of igneous, metamorphic, and sedimentary stones, each having a volume of 1/2 cubic yard or more, as determined by physical or visual measurements and approved by Owner.

An accurate record shall be kept of the dates and amounts of rock excavation at each location. The Owner will authorize payment for rock excavation at each location by signing the Contractor's record. Payment will be on a cubic yard basis as measured in place in the hole requiring rock excavation.

7.20.8.5. BLASTING

Blasting or other use of explosives will not be permitted without Owner's approval.

7.20.8.6. EXCAVATION MAINTENANCE

Excavations shall be maintained in a safe, clean, and sound condition up to the time of placement of concrete. All excavations shall be suitably protected when not attended. Whenever necessary, the Contractor shall re-excavate materials which have accumulated in previously prepared excavations. Any muck or other unsatisfactory bearing material resulting from frost, action or entrance of water into excavations previously prepared to the required bearing shall be removed and replaced with well-compacted stone or gravel, backfill or concrete at the Contractor's expense.

7.20.9. EARTH BACKFILL

Backfill around the foundation shall be carefully placed using the better materials or excavation near the foundations. All backfill around the foundation shall be compacted in 6-inch layers by means of mechanical tampers. When excavated material becomes so wet that, in the opinion of the Owner or Engineer, it is not suitable for backfill, the Contractor shall at his expense spread and aerate the material until the proper moisture content is attained, at which time the material shall be used as backfill around the foundation. The degree of compaction to be attained for all backfill shall be the equivalent density of adjacent undisturbed earth. Large stones, muck, frozen material, roots, or other undesirable material shall not be permitted or used in backfill. Selected earth borrow shall be used as backfill material when the excavated material has been deemed unsuitable by the Owner or Engineer. This material, furnished by the Contractor, shall be generally locally available earth which, when placed and compacted in 6-inch layers, will bind and compact around the foundation. Sources of this material shall be approved by the Owner or Engineer.

7.20.10. CONCRETE BACKFILL

For structures designated on the drawings to receive concrete backfill, concrete backfill shall be provided in accordance with Section 4P, Transmission Line Cast-In-Place Concrete.

Holes shall be filled with concrete to 12 inches below grade. The top 12 inches of backfill shall be well tamped, clean native topsoil.

Concrete backfill shall be placed after the pole is set in the hole. It shall be ensured that essentially void-free concrete encompasses the pole for the entire setting depth indicated on the drawings.

7.21. DRILLED CAISSON FOUNDATIONS

7.21.1. GENERAL

Drilled caissons shall be drilled to the diameters and to the depths shown on the drawings. Holes shall be drilled with such types of drilling equipment that will produce the excavation shown on the drawings. Drill rigs, which do not run true, will not be acceptable.

7.21.2. CAISSON EXCAVATION

Caisson excavation shall be according to Section 4M, Transmission Line Excavation and Backfill.

7.21.3. DEPTH REQUIRED

The depth noted on drawings is to be considered minimum. If unsuitable materials affecting required bearing value are encountered, the excavation shall be continued to whatever depth is necessary to obtain suitable material. When depth required by the Owner is greater than depth shown on the drawings, the neat line excavation and volume of reinforced concrete to fill it will be paid for by the Owner.

7.21.4. PROTECTION

The excavation shall be protected to prevent the collars to the caisson from caving until the concrete has been placed. All caissons shall be kept covered with strong covers until reinforcement and concrete have been placed.

7.21.5. TEMPORARY CASINGS

Temporary casings shall be as specified in Section 4M Transmission Line Excavation and Backfill.

7.21.6. DIMENSIONAL TOLERANCES

The location and dimensions of the drilled caisson shall be as exact as possible to the locations shown on the drawings and staked in the field. The maximum allowable tolerance will be as follows.

Top of the drilled caisson shall be set to the elevation shown on drawings, except where otherwise directed by the Owner or Engineer.

The variation in elevation of the bottom of the drilled caisson from the specified depth shall be from 0 to +6 inches, except where required to be deeper due to soil conditions.

Maximum deviation of the axis of the hole from the vertical shall be no more than 1 inch in 8 feet.

The diameter of any drilled caisson shall not be less than specified or more than 4 inches greater than specified.

7.21.7. PIER INSTALLATION RECORD

Accurate pier installation records shall be maintained and shall contain the following information for each pier:

- Contractor's name.
- Drill rig operator's name.
- Location.
- Shaft diameter.
- Elevation of shaft above grade.
- Depth of rock.
- Depth of shaft.
- Depth of ground water.
- Caving or sloughing of excavation.
- Drilling difficulties.
- Casing insertion, size and length, and whether or not removed.
- Date and time of start and finish excavation.
- Length and diameter of reinforcing bar cage.
- Date and time concrete placed.
- Calculated volume of excavation based on diameter of shaft.
- Total quantity of concrete placed.

7.22. TRANSMISSION LINE CAST- IN- PLACE CONCRETE

7.22.1. GENERAL

This section specifies the minimum materials, workmanship, and performance standards for transmission line cast-in-place concrete including reinforcing steel, forms, finishing, curing, and other associated work.

Transmission line cast-in-place concrete shall be in accordance with the latest applicable requirements of the ACI, ASTM, and CRSI, except as modified by these Specifications.

The Owner shall be informed at least 24 hours in advance of the times and places at which concrete will be placed.

7.22.2. MATERIALS

Materials shall be in accordance with the following requirements:

Cement	ASTM C150, Type (1), Portland cement.

Types of Cement and Water-Cementitious Materials Ratio Required for Concrete Exposed to Sulfate Attack				
Sulfate Exposure	**Water-Soluble Sulfate (SO_4) in Soil, percent by mass**	**Sulfates (SO_4) in Water, ppm (mg/L)**	**Cement Type**	**Water-Cementitious Materials Ratio and Strength**
Negligible	0.00-0.10	0-150 (0-150)	I or II	0.45 4,000 psi
Moderate*	0.10-0.20	150-1,500 (150-1,500)	II	0.42 4,500 psi
Severe	0.20-2.00	1,500-10,000 (1,500-10,000)	V	0.40 5,000 psi
Very Severe	Over 2.00	Over 10,000 (Over 10,000)	V plus Class F Fly Ash	0.38 5,000 psi
*Seawater. Source: ACI 318-02, Table 4.3.1, and ACI 350-01, Table 4.3.1.				

Supplemental Cement Materials	
Fly Ash	ASTM C618, Type F shall not exceed 15 percent by weight of total cementitious materials.
Fine Aggregate	Clean natural sand, ASTM C33. Manufactured sand will not be accepted.
Coarse Aggregate	Crushed stone, washed gravel, or other acceptable inert granular material in accordance with ASTM C33. Clay and shale particles shall not exceed 1 percent.
Water	Potable, clean and free from mud, oil, organic matter, or other deleterious substances. Iron shall not exceed 0.25 ppm.
Admixtures	All admixtures shall be manufactured by Master Builders, WR Grace & Co., or Sika Chemical. All admixtures shall be supplied by one manufacturer.
Water reducing (plasticizer)	ASTM C494, Type A.
Water reducing and retarding	ASTM C494, Type D.
High range water reducer	ASTM C494, Type F.
High range water reducer and retarder	ASTM C494, Type G.
Air-entraining agent	ASTM C260.
Reinforcing Steel	
Bars not otherwise noted	ASTM A615, Grade 60.
Welded wire fabric	ASTM A185 or A497.
Bar supports	CRSI Class 1, plastic protected; or Class 2, stainless steel protected.
Mechanical Splice	Classified Type 2 in accordance with ACI 318-02 or in accordance with UBC-97. Dayton/Richmond "Dowel Bar Splicer" or "Coupler Splice" system, Bar-Lock "Coupler Systems" or Barsplice Products.

Forms	
Plywood	Product Standard PS1, waterproof, resin-bonded, exterior type Douglas fir; face adjacent to concrete Grade B plywood or better.
Metal	Of sufficient gauge to resist deformation.
Fiberboard	Fed Spec LLL-B-810, Type II; tempered, waterproof, screenback.
Lumber	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
Chamfer strips	Clear pine, surface against concrete shall be planed.
Form coating	Nonstaining and nontoxic after 30 days, VOC compliant; Burke "Form Release (WB)," L&M Chemical "E Z Strip," Nox-Crete "Form Coating," or Symons "Thrift Kote E."
Polyethylene film	Fed Spec L-P-378D, Type I; 6 mil.
Finishes	
Epoxy bonding compound	Sika Chemical "Sikadur Hi-Mod"; Five Star Products, Inc. "Five Star Epoxy"; or acceptable equal.
Membrane curing compound	ASTM C1315, Type I, Class A, maximum VOC 5.8 lb./gal (700 g/L), minimum 25 percent solids, acrylic, nonyellowing, unit moisture loss 0.40 kb/m^2 maximum in 72 hours; L&M Chemical "Dress & Seal 30," Sonneborn "Kure-N-Seal 30," or Symons "Cure & Seal 30%."

7.22.3. PRELIMINARY REVIEW

7.22.3.1. REPORTS

Three copies of the concrete design mix reports shall be submitted to Owner prior to placing concrete. The report should include the source and quality of concrete materials and the concrete proportions proposed for the work. Complete certified reports covering the materials and proportions proposed and tested in accordance with ACI 318 shall be submitted to the Owner. Report shall be prepared by an independent testing laboratory. Owner review of these reports will be for general acceptability only; continued compliance with all contract provisions will be required.

Reports on cement shall include the type, brand, manufacturer, composition, and method of handling (sack or bulk).

Reports on admixtures shall include the ASTM 260 or ASTM C494 classification, brand, manufacturer, and active chemical ingredients. All admixtures shall be the products of one manufacturer.

Reports on aggregates shall include the source, type, gradation, deleterious substances, soundness, potential for harmful materials, and potential for alkali reactivity. The results of all tests and field service records to verify potential reactivity are required to verify compliance with ASTM C33, including Appendix XI.

Reports on coarse aggregates shall include the source, type, gradation, deleterious substances, soundness, abrasion loss, and the results of all tests required to verify compliance with ASTM C33.

7.22.3.2. PROPORTIONS

A tentative concrete mix shall be designed and tested for each size and gradation of aggregates and for each mix class specified. Design quantities and test results of each mix shall be submitted to Owner for review. With Owner's approval, acceptable mixes may be field adjusted as necessary to meet the requirements of these Specifications.

The report for each tentative concrete mix submitted shall contain the following information:

- Design Slump.
- Total gallons of water per cubic yard.
- Cement content.
- Ratio of fine to total aggregates.
- Weight (surface dry) of each aggregate per cubic yard.

- Quantity of each admixture.
- Air content.
- Compressive strength based on 7 day and 28 day compression test.
- Times of initial set.

7.22.3.3. TESTING

Initial set tests shall be made at ambient temperatures of 70º F and 90º F to determine compliance with the initial set time specified hereinafter. The test at 70º F shall be made using concrete containing the specified plasticizing and air-entraining admixtures. The test at 90º F shall be made using concrete containing the specified plasticizing retarder and air-entraining admixtures. The initial set shall be determined in accordance with ASTM C403.

7.22.4. CONCRETE CLASSES

Each concrete mix class shall be designed and controlled within the limits specified in the following table:

Mix Class Table Coarse					
Usage	**28 Day Strength (psi)**	**Aggregate Size No. 4 Sieve to**	**Slump ± 1"**	**Min Cement (lb./cu yd)**	**Max Water/ Cement Ratio**
General Usage	4,000	1"	4"	555	0.45
Drilled Piers	4,000	3/4"	6"	620	0.45
Underwater	4,000	3/4"	8"	658	0.41
Note: A plasticizer or plasticizing retarder shall be included in all general usage and drilled piers concrete mixes. High range water reducer (Type F or G) shall be included in all underwater mixes.					

7.22.5. MIX REQUIREMENTS

The acceptability of concrete will be judged on compliance with the specified requirements listed in the Mix Class Table and not on the basis of strength alone.

Coarse aggregate sizes listed hereinafter are the nominal sizes given in Table 2 of ASTM C33. To qualify as a certain aggregate size, the gradation of the aggregate must be within the tabulated limits.

Quantity of Cement (lb./cu yd)			
Concrete Slump	**Coarse Aggregate Size from No. 4 Sieve to**		
	1/2"	3/4"	1"
4 inches	611	583	555
6 inches	649	620	592
8 inches	687	658	630

7.22.5.1. TOTAL WATER CONTENT

Total water content of concrete shall not exceed the amount calculated using the maximum water to cement ratio indicated in the Mix Class Table.

7.22.5.2. SLUMP

Unless otherwise authorized by the Owner, slump shall not be greater than indicated in the Mix Class Table for each mix class. For drilled pier and underwater concrete construction, a large slump is desirable to provide a self-compacting and self-leveling mix.

7.22.5.3. RATIO OF FINE TO TOTAL AGGREGATES

The ratio of fine to total aggregates based on solid volumes (not weights) shall be as follows:

Coarse Aggregate Size from No. 4 Sieve to	Minimum Ratio	Maximum Ratio
1/2 inch	0.40	0.55
3/4 inch	0.35	0.50
1 inch	0.30	0.46

7.22.5.4. INITIAL SET

The initial set as determined by ASTM C403 shall not be attained until at least 2.5 hours after the water and cement are added to the aggregates. The quantity of retarding admixture shall be adjusted as necessary to compensate for variations in temperature and job conditions.

7.22.5.5. TOTAL AIR CONTENT

The total volumetric air content of concrete after placement shall be 5 percent plus or minus 1 percent.

7.22.5.6. ADMIXTURES

The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer's recommendations for compliance with these Specifications.

A plasticizing or plasticizing retarder admixture shall be included in all concrete, unless otherwise accepted by the Owner.

Plasticizing retarder admixture shall be adjusted as specified under the initial set.

7.22.5.7. STRENGTH

The minimum 28-day acceptable compressive strength for each mix class as determined by ASTM C39 shall not be less than that indicated in the Mix Class Table.

All concrete shall exceed the specified minimum compressive strengths. Each test cylinder will be evaluated separately, and the Owner will be the sole judge of the validity and representative qualities of the tests.

In cases where the strength of the test cylinders for any portion of the work falls below the requirements specified herein, the Owner or Engineer may require the Contractor to secure test specimens of the hardened concrete represented by these cylinders. Specimens shall be secured and tested in accordance with ASTM C-42 and shall have a minimum diameter of 3 inches.

Dependent upon the location of the concrete section in question, the Owner or Engineer may approve low frequency ultrasonic testing or other nondestructive techniques as an alternate to cone drilling and testing.

If the additional investigation verifies the existence of defective concrete, one of the following remedial actions shall be implemented as determined by the Owner:

- Assume the costs to remove and replace all defective concrete.
- Assume the cost of design and construction changes necessary to incorporate the inferior concrete.

- Provide satisfactory reimbursement or allowance to the Owner for the acceptance of the lower quality concrete.

7.22.6. STORAGE OF MATERIALS

Cement shall be stored in suitable moisture proof enclosures. Reclaimed cement or cement that has become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles that have been in contact with the ground shall not be used.

Reinforcing steel and embedments shall be carefully handled and stored on supports that will keep the steel from contact with the ground.

7.22.7. BATCHING AND MIXING

Batching and mixing may be performed at the jobsite with suitable equipment, or by an acceptable ready-mix concrete supplier. Personnel performing the batching and mixing shall be qualified and experienced. Mixing and transporting concrete shall be in accordance with ASTM C94 unless otherwise indicated herein.

7.22.7.1. BATCHING

Aggregates and cement shall be measured by weight. Aggregate weights shall be adjusted for moisture content.

Each admixture shall be dispensed by a mechanical device that will ensure accurate and automatic measurement.

The minimum amount of water required to produce the desired slump shall be batched automatically. Any additional water required to produce and maintain a uniform slump shall be added manually by the mixer operator. Slump shall be kept uniform. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated.

7.22.7.2. MIXING

Concrete shall be mixed in a rotating drum as specified in ASTM C94 until all ingredients are uniformly distributed throughout the batch. Mixers shall not be loaded in excess of their rated capacities. Each batch shall be completely discharged before the mixer is recharged.

7.22.7.3. READY-MIXED CONCRETE

Ready-mixed concrete shall conform to ASTM C94, except as otherwise specified herein.

Truck mixers shall be revolving drum type and shall be equipped with a mixing water tank. Only the prescribed amount of mixing water shall be placed in the tank for any one batch, unless the tank is equipped with a device by which the amount of water added to each batch can be readily verified by the Owner.

A delivery ticket shall be prepared for each load of ready-mixed concrete delivered. The truck operator shall hand a copy of each ticket to the Owner at the time of delivery. Tickets shall indicate the mix identification, the number of yards delivered, the quantities of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the jobsite and completely discharged within 45 minutes, or before the drum has revolved 150 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates, unless a retarding agent is used, in which case the time may be doubled. Longer time periods must be approved by the Owner. In hot weather, or under conditions contributing to quick stiffening of the concrete, a time less than the specified 45 minutes or
1-1/2 hours may be required by the Owner. When a truck mixer is used for the complete mixing of the concrete, the mixing operation shall begin within 30 minutes after the cement has been mixed with the aggregates.

7.22.8. FIELD CONTROL TESTING

Field control testing operations consisting of aggregate gradation tests, slump tests, air content tests, and the securing of compression test cylinders shall be made by qualified employees of the Contractor in the presence of the Owner. All equipment, supplies, and qualified employees required for field control testing operations shall be provided.

All tests required for preliminary review shall be made and all compression test cylinders for the entire project shall be tested by an acceptable independent testing laboratory at the Contractor's expense.

The frequency hereinafter specified for each field control test is a minimum. If directed to do so by the Owner, any additional field control tests required shall be made.

7.22.8.1. AGGREGATE GRADATION

For initial acceptance, aggregates shall be sampled and tested in accordance with applicable state DOT standards and ASTM C33. Aggregate soundness may be determined by either the sodium sulfate or magnesium sulfate test. The bulk specific gravity of each aggregate shall be determined in accordance with ASTM C127 and ASTM C128.

It is not anticipated that aggregate gradation tests will be required after the tests made for the initial acceptance of the materials. However, if directed to do so by the Owner, the fine and coarse aggregate shall be sampled, and field tested in accordance with ASTM D75 and C136.

7.22.8.2. SLUMP

A slump shall be performed on each of the first three batches mixed each day. An additional slump test shall be performed for each additional 50 cubic yards of concrete placed in any 1 day. Slump shall be determined in accordance with ASTM C143.

7.22.8.3. AIR CONTENT

An air content test shall be performed on one of the first three batches mixed each day and on each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with ASTM C231.

7.22.8.4. COMPRESSION TEST

At each foundation location, the Contractor shall be required to make a set of compressive test specimens, each set consisting of three compressive test cylinders made in accordance with standard sampling procedures. One of the cylinders shall be taken from the concrete used in the top 5 feet of each pole foundation. Such cylinders shall be individually identified by pole number and tested prior to pole erection. Testing of the cylinders shall be handled by the Contractor through a qualified testing laboratory approved by the Owner and Engineer. The cost of testing shall be borne by the Contractor. The Contractor shall require the laboratory to send three sets of compressive test reports to the Owner, in addition to those copies furnished to the Contractor.

Concrete test cylinders shall be prepared, cured, stored, and delivered to the laboratory in accordance with ASTM C31 to be tested in accordance with ASTM C39.

Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump.

7.22.8.5. TEST REPORT

Certified reports of all tests made by the testing laboratory shall be promptly furnished to the Owner, and all other persons designated by the Owner.

7.22.9. REINFORCEMENT

Reinforcements shall be accurately formed. Unless otherwise indicated on the drawings or specified herein, the details of fabrication shall conform to ACI 318.

7.22.9.1. ACCESSORIES

All bar supports, ties, spacers, bolsters, inserts, screeds, and other concrete accessories required shall be provided to maintain reinforcing in its proper position and permit proper placement of concrete.

Responsibility for the design of all bar support systems shall be assumed by the contractor.

7.22.9.2. CERTIFICATION

A certification that the reinforcing steel furnished complies with the requirements specified in the Article titled “Materials” in this section shall be furnished to the Owner. The certification shall be signed by the Contractor and the reinforcing steel fabricator.

7.22.9.3. TENSILE TESTS

Tensile tests on reinforcing steel shall be performed in accordance with ASTM A615.

7.22.9.4. WELDING

Except where indicated on the drawings, welding of reinforcement for any purpose, and tack welding in particular, is expressly prohibited. Reinforcements upon which unauthorized welding has been performed will be presumed to be damaged and such reinforcing shall be removed and replaced at Contractor's expense. Replacement materials shall conform to all applicable requirements of these specifications.

Welded chairs and supports may be used provided they are clamped or wired to the reinforcement.

7.22.9.5. SHOP DRAWING AND BAR LISTS

Bar lists and drawings for the fabrication and placement of reinforcements shall be prepared, checked, and submitted for approval. Each bar list and placement drawing shall have noted thereon "ASTM A615 Grade 60 only" or a similar statement which identifies the grade of proposed reinforcing.

7.22.9.6. CONCRETE COVER

Except as otherwise indicated on the drawings, metal reinforcement for concrete shall have the concrete protective cover specified in Chapter 7 of ACI 318.

7.22.9.7. PLACEMENT

Steel reinforcing bars shall be placed in the concrete wherever shown on the drawings. Unless otherwise shown on the drawings or directed, measurements made in placing the bars shall be to the center lines of the bars. Before the reinforcing bars are placed, the surfaces of the bars and the surfaces of any metal bar supports shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease, or other foreign substances. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete. Main reinforcement shall have a minimum clear protective cover to the surface of the concrete as shown on the drawings. Reinforcing bars shall be accurately placed and secured in position so that they will not be displaced during the placing of the concrete, and special care shall be exercised to prevent any disturbance of the reinforcing bars in concrete that already has been place. Rustproof metal chairs, metal hangers, metal spacers, or other satisfactory metal supports may be used for supporting reinforcing bars. Precast concrete blocks may be used for supporting reinforcing bars.

With the exception of lapped portions of spliced bars that are wired or clamped together, the clear distance between parallel bars shall be not less than 1.5 times the maximum size of coarse aggregate in the concrete, or less than 2 inches.

7.22.9.8. UNDERWATER CONCRETE PLACEMENT

If approved by the Owner, underwater concrete shall be placed through tremies. The tremies shall be equipped with a tremie seal at the lower end and a hopper at the upper end. The tremie shall be watertight and large enough to allow a free flow of concrete. After the flow of concrete is started, the lower end of the tremie shall be kept below the surface of the deposited concrete. Agitation of the deposited concrete shall be avoided. When necessary to move laterally, the tremie shall be lifted free of the concrete and shall be lowered vertically at the new location. The entire mass of concrete shall be placed as quickly as possible so that it will flow into place without the necessity of horizontal shifting below water. The water shall be quiescent when concrete is deposited therein. After placing, the groundwater level shall be kept in the area adjacent to the pier static until the concrete has taken its initial set.

7.22.9.9. SPLICES

If approved by the Owner, underwater concrete shall be placed through tremies. The tremies shall be equipped with a tremie seal at the lower end and a hopper at the upper end. The tremie shall be watertight and large enough to allow a free flow of concrete.

After the flow of concrete is started, the lower end of the tremie shall be kept below the surface of the deposited concrete. Agitation of the deposited concrete shall be avoided. When necessary to move laterally, the tremie shall be lifted free of the concrete and shall be lowered vertically at the new location. The entire mass of concrete shall be placed as quickly as possible so that it will flow into place without the necessity of horizontal shifting below water. The water shall be quiescent when concrete is deposited therein. After placing, the groundwater level shall be kept in the area adjacent to the pier static until the concrete has taken its initial set.

7.22.10. FORMS

Forms shall be designed and constructed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings. Design and construction tolerances shall be in accordance with ACI 117. Forms shall be designed and constructed in proper position and accurate alignment. Formed surfaces exposed to view shall have a Class C finish, and concealed surfaces may have a Class D finish as defined by ACI 117.

Concrete shall be placed against job-built plywood forms or forms that are lined with plywood or fiberboard, except as otherwise specified. At Owner's discretion, prefabricated forms or metal frames with plywood inserts may be permitted only for surfaces that are not normally exposed to view when construction has been completed. Plywood and fiberboard shall be new when brought to the construction site and shall be properly coated, protected, and maintained throughout its use. All plywood and fiberboard materials that are damaged, cracked, weathered, or otherwise unsuitable, in the Owner's opinion, for producing smooth, uniformly textured formed surfaces will be rejected as form material.

Vertical surfaces of footings extended above grade shall be formed.

7.22.10.1. DESIGN

Forms shall be substantial and sufficiently tight to prevent leakage of concrete mortar. Forms shall be properly braced or tied so they will maintain the desired position, shape, and alignment during and after placing concrete therein. Whalers, studs, internal ties, and other form supports shall be of sufficient size and number and located and spaced so that allowable stresses therein are not exceeded.

The top edges of forms shall be finished to a specified elevation, slope, or contour. They shall be brought to a true line and grade so that the top concrete surface can be finished with a screed or template resting on the top edges of the forms.

7.22.10.2. FORM TIES

Form ties shall be of the removable end, permanently embedded body type, and shall have sufficient strength, stiffness, and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Outer ends of the permanently embedded portions of form ties shall be at least 1 inch back from adjacent outer concrete faces. Permanently embedded portions of form ties that are not provided with threaded ends shall be constructed so that the removable ends can be broken off by twisting, without chipping or spalling the concrete surface. The type of form ties used shall be acceptable to the Owner.

Form ties shall be uniformly spaced in exposed surfaces and aligned in horizontal and vertical rows.

7.22.10.3. EDGES AND CORNERS

Chamfer strips shall be placed in forms to bevel all salient edges and corners except edges, which are to be buried and edges, which are indicated on the drawings as requiring special treatment. Foundations shall have formed beveled salient edges for all vertical and horizontal corners unless specifically indicated otherwise on the drawings. Bevel dimensions shall be 3/4 by 3/4 inch unless indicated otherwise on the drawings.

7.22.10.4. FORM REMOVAL

Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads to be imposed thereon. Surface gouging, corner or edge breakage, or other damage to the concrete shall be avoided during form removal.

7.22.11. ANCHOR BOLTS

Anchor bolts shall be accurately positioned and securely anchored. The center of each anchor bolt group or cluster shall be within 1/8 inch of the location indicated on the drawings. The center-to-center dimensions between the anchor bolts in a group or cluster shall be within 1/16 inch of the dimension indicated on the drawings.

Anchor bolts shall be provided with sufficient threads to permit a nut to be installed on each side of the template and structure baseplate. The nuts shall secure the bolt in its proper position.

Anchor bolts shall not be welded to reinforcement.

Anchor bolts shall be cleaned when they are installed. After concrete placement, exposed surfaces not in contact with concrete of all concrete spatter and other foreign substances shall be cleaned.

7.22.12. PLACEMENT

The handling, depositing, and compacting of concrete shall conform to these Specifications subject to adjustment by the Owner for weather or placement conditions.

Concrete shall not be pumped through aluminum pipe or aluminum alloy pipe.

Before concrete is placed, forms and anchor bolts shall be rigidly secured in their proper position; all dirt, mud, water, and debris removed from the space to be occupied by the concrete; and all surfaces cleaned that may have become encrusted with dried mortar or concrete from previous placement operations. The entire installation shall be acceptable to the Owner.

7.22.12.1. BONDING TO HARDENED CONCRETE

The surface of hardened concrete upon which fresh concrete is to be placed shall be rough and clean. An epoxy bonding compound shall be applied in accordance with the manufacturer's recommendation.

7.22.12.2. CONVEYANCE AND DISTRIBUTION

Concrete shall be brought to the point of final deposit by methods that prevent the separation or loss of the ingredients. Concrete shall be deposited in its final position without moving it laterally in the forms for a distance greater than 5 feet.

7.22.12.3. CONCRETE PLACEMENT DRY HOLE

Concrete shall be placed in the drilled caisson as soon after excavation as possible. Immediately prior to the placement of concrete, the caisson shall be cleaned of water, debris, or other materials harmful to concrete including ice, clods, and piles of loose earth. Surfaces against which concrete is being placed shall be free of frost, and in cold weather shall be enclosed or heated, if necessary, prior to placing concrete to ensure this requirement is met. Water in bottom of caissons must be removed or absorbed. Equipment shall include a pump and two vibrators in good working condition, hoppers and elephant trunks for directing the flow of concrete down the caissons, and an ample supply of sacked cement for use in drying the bottom of caissons. The Contractor shall not place any concrete until the excavation and embedded items are checked and approved by the Owner or Engineer. In a drilled caisson where the Contractor can free fall the concrete down the center of the caisson without having the concrete come in contact with the embedded items, which will cause segregation of the aggregate, the Contractor may place the concrete with the use of an elephant trunk or drop chutes and shall use vibrators. The maximum free fall distance shall be no more than 5 feet. If the Owner or Engineer sees the above method cannot be implemented, then the Contractor shall place the concrete for the first lift using hoppers and sections of elephant trunk or drop chutes. Normal procedure expected to be followed by the Contractor will be to place the concrete to an elevation approximately 5 feet above the bottom of the caissons and vibrate this deposit with one pass of the vibrator down to the bottom of the caisson and back to the top of concrete. Following this, the remainder of the concrete may be poured in two or more lifts of equal height with one pass of the vibrator down to the bottom of the lift and back up on each lift. In placing concrete, internally operated vibrators of a minimum diameter of 2-1/4 inches and having a speed of 5,000 rpm or more are to be used. On the upper lifts of the piles, elephant trunks will not be required, but the placing of the concrete shall be done in such a manner as to prevent segregation of the aggregates.

7.22.12.4. CONCRETE PLACEMENT WET HOLE

Where sufficient ground water is encountered in excavating caissons to cause standing water in the caissons, the Contractor shall provide pumps with sumps just large enough for pump sections or special pumps, which can extract water from the bottom of the caisson without the requirement of a sump. Immediately prior to the start of the concrete placement, water shall be pumped from the caisson to the elevation of the bottom of the caisson or, if a sump is used, leaving a depth of water not exceeding 4 inches in the sump. The use of dry cement to “dry up” the water left in the sump will then be permissible provided the rate of inflow is sufficiently slow to permit placement of concrete without increasing the water-cement ratio. To follow this procedure, the Contractor must have dry cement ready to place into the caisson immediately after pumping is terminated and also have adequate concrete at the site. If, in the opinion of the Owner or Engineer, the rate of inflow of ground water is too great to obtain concrete of acceptable quality, it will be necessary for the Contractor to place concrete using the tremie method.

7.22.12.5. PLACEMENT CONCRETE TREMIE METHOD

Where the inflow of water into a caisson is too rapid to permit placement of concrete in the dry, the Contractor shall place the concrete underwater by the tremie method. In such cases, a special mix of concrete will be required with coarse aggregate (gravel), ¾ inch maximum size, and a minimum of seven bags of cement per yard. A retarding agent, approved by the Owner and Engineer, may be used. The slump of the concrete when being placed shall be between 5 inches and 7-1/2 inches. Minimum mix strength of 4,000 psi shall be maintained. No vibration of the tremie concrete will be required or permitted, but it will be permissible to vibrate the tremie pipe under certain conditions when the flow of concrete becomes sluggish, and it will also be permissible to vibrate the casing, if used, when the caisson is filled with concrete at the time the casing pull is started. The tremie pipe shall have the minimum diameter of 8 inches and shall be equipped with a foot valve or gate at the bottom end, which is watertight and can be positively controlled from the ground surface. If joints are required in the tremic pipe, they shall be watertight. The entire assembly shall be watertight, and under no circumstances will concrete be permitted to flow through water in the tremie. In placing concrete, the lower end of the tremie shall be placed as close to the bottom as possible and no more than 6 inches to the bottom of the caisson and shall not be raised until a seal has been established between the tremie pipe and the concrete sufficient to prevent entry of water into the tremie. The discharge end of the tremie shall be kept submerged in the concrete a sufficient depth to maintain, at all times, an adequate seal during underwater placement. The placing of concrete by tremie in any caisson shall not be started until a sufficient supply of concrete is at the site to complete placing of concrete in the caisson up to the ground surface. Once started, the underwater placement shall proceed without interruption until the top of the concrete has been brought to the above-mentioned elevation. As soon as the level of concrete has reached the above-mentioned level over the tremie pipe, the Contractor shall remove the water being displaced by the concrete. Concrete may be placed by tremie only when authorized by the Owner or Engineer.

7.22.12.6. COMPACTION

During and immediately after depositing, concrete shall be compacted thoroughly and worked around reinforcements, embedment's, and into the corners of the forms.

Concrete shall be compacted by means of mechanical vibrating equipment supplemented by hand rodding, spading, and/or tamping. Unless otherwise accepted by the Owner, mechanical vibrators shall be spud type immersion vibrators which will maintain at least 9,000 cycles per minute when immersed in concrete. The number and type of vibrators shall be subject to the acceptance of the Owner.

The vibrator shall be constantly relocated and placed in each location only once for each lift. Lower lifts shall be vibrated with the one immediately above it.

7.22.12.7. PLACEMENT TEMPERATURE

The temperature of concrete, when being placed, shall be as follows.

- Not less than 40°F in moderate weather
- Not less than 50°F in weather during which the mean daily temperature drops below 40°F.
- Not greater than 90°F during hot weather

7.22.12.8. HOT WEATHER CONCRETING

Except as modified herein, hot weather concreting shall comply with ACI 305. A water-reducing retarder shall be added to the concrete mix when the placement temperature of the concrete exceeds 75° F.

At air temperatures of 90° F or above, special procedures shall be applied to keep the concrete as cool as possible during placement and curing. The temperature of the concrete during placement shall not exceed 90° F.

7.22.12.9. COLD WEATHER CONCRETING

Cold weather concreting shall comply with ACI 306.

7.22.12.10. PROTECTION

The Contractor shall protect all concrete against injury until final acceptance by Owner. The Contractor shall be prepared to protect all concrete in accordance with the requirements of this paragraph. Temperature shall be controlled by controlling the temperature of aggregate and mixing water. Mixing time shall be kept at a minimum and elapsed time between mixing and placing shall be minimized. The interior surfaces of forms and ground upon which concrete is to be placed shall be thoroughly wetted before concrete is poured. After the first frost and until the mean daily temperature in the vicinity of the work rises above 40°F for more than 1 day, the concrete shall be protected against freezing for not less than 48 hours after it is placed.

7.22.13. FINISHING FORMED SURFACES

All fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that will be in contact with earth backfill. In addition, surfaces shall be cleaned and rubbed that will be exposed above grade. Rubbing shall produce a smooth, uniform surface free of marks, voids, surface glaze, and discolorations.

Hand rubbing shall be performed with a carborundum stone using only the mortar produced by the rubbing action and the application of water.

Projecting ends of all form ties shall be removed. The resulting recesses shall be cleaned, wetted, and filled with patching mortar. For rubbed surfaces, patches shall match the texture of the adjacent concrete.

7.22.14. FINISHING UNFORMED SURFACES

No surface treatment will be required for buried or permanently submerged concrete not forming an integral part of a structure except that required to obtain the surface elevations or contours and surfaces free of laitance. The unformed surfaces of all other concrete shall be screeded and given an initial float finish, followed by additional floating and troweling where required.

Float finished surfaces shall be finished to provide a flat profile within 1/4-inch deviation as measured from a 10-foot straightedge. Trowel finished surfaces shall be finished to form a flat plane in which the profile shall not deviate more than 1/8 inch when measured from a 10-foot straightedge.

7.22.14.1. SCREEDING

Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in adjacent mortar. Surface irregularities in screeded surfaces shall be limited as required to produce finished surfaces within the tolerances specified. If no further finishing is required, surface irregularities shall not exceed 1/4 inch as measured from a 10-foot straightedge.

7.22.14.2. FLOATING

Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate that may be disturbed by the float or that causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface with the float.

The initial floating shall be followed with a second floating at the time of initial set. The second floating shall produce a smooth, uniform, and workmanlike float finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for all unformed surfaces shall be a float finish as produced by the second floating.

Floating shall be performed with hand floats or suitable mechanical compactor floats.

7.22.14.3. TROWELING

Any surfaces designated on the drawings to be troweled shall be steel trowel finished. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

7.22.14.4. AGGREGATE EXPOSURE

All surface mortar shall be removed from surfaces that are later to be covered with mortar, concrete, or grout. The coarse aggregate shall be exposed in all such surfaces to improve bonding. The method employed shall be effective and acceptable to the Owner.

7.22.14.5. EDGING

Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having a 1/4-inch corner radius.

7.22.15. CURING

Concrete shall be protected from loss of moisture for a minimum of 5 days after concrete is placed.

Curing of concrete shall be by methods which will keep the concrete surfaces adequately wet during the specified curing period.

Troweled surfaces shall be cured, except those which will receive a separate finish or coating, with the membrane curing compound specified in the article titled "Materials" in this section. Float finished surfaces shall be cured, except those which will receive a separate finish, with either the membrane curing compound specified or with water. Only water curing will be permitted on surfaces that will receive a separate finish or coating.

7.22.15.1. WATER CURING

Water saturation of concrete surfaces shall begin as quickly as possible, but no later than 12 hours in dry weather and 24 hours in damp weather after initial set of the concrete. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to formed surfaces may be interrupted for surface rubbing only over the areas being rubbed at the time. The concrete surface shall not be allowed to become dry during such interruption.

After rubbing has been completed, rubbed surfaces shall be covered with saturated burlap for the remainder of the curing period.

7.22.15.2. MEMBRANE CURING

Membrane curing compound shall be applied within 30 minutes after final finishing of the surface. Membrane curing compound shall be spray applied at a coverage of not more than 300 square feet per gallon. Membrane curing shall not be used on surfaces that will be covered at a later date with grout, mortar, concrete, or other coating.

7.22.16. REPAIRING DEFECTIVE CONCRETE

Defects in formed concrete surfaces shall be repaired to the satisfaction of the Owner within 24 hours, and defective concrete replaced within 48 hours after the adjacent forms have been removed. All concrete that is porous, honeycombed, or otherwise defective to a depth in excess of 1 inch shall be cut out and removed to sound concrete, with edges square cut to avoid feathering. Surfaces shall be coated with epoxy bonding compound before the repair concrete is placed.

Concrete repair work shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Mortar and concrete used in repair work shall be adequately cured and finished to match adjacent surfaces.

7.22.17. STRUCTURE BACKFILL

Concrete backfill shall be deposited around and outside direct embedded transmission line structure in accordance with Section 4M titled "Transmission Line Excavation and Backfill."

7.23. ACCESS ROAD CONSTRUCTION

7.23.1. GENERAL

- Contractor shall contact Calvert Soil Conservation District at 65 Duke Street, Kaine Building, Suite 106, Prince Frederick, MD 410-535-1521, extension 3 (or other appropriate District) to schedule a Pre-Construction meeting ten days prior to the beginning of construction.
- A copy of the approved erosion and sediment control plan must be available at the project site at all times.
- Maryland Department of the Environment NPDES and County Grading Permit Placards shall be posted at the entrance of each access road (To be provided by the OWNER).
- All vegetative and structural practices shown on this plan will be installed according to the provisions, standards, and specification found in the Draft 2010 MD Standards and Specifications for Soil Erosion and Sediment Control (Manual) as well as the site specific "Erosion and Sediment Control Plan" prepared for approval by the Calvert Soil Conservation District, dated August 2011.
- Following initial soil disturbance or re-disturbance, permanent or temporary stabilization shall be completed within three (3) calendar days as to the surface of all perimeter controls, dikes, swales, ditches, perimeter slopes, and all slopes greater than 3 horizontal to 1 vertical (3:1) and seven (7) calendar days for all other disturbed or graded areas on the project site not under active grading.
- Maintenance of erosion and sediment control practices and devices shall be performed as necessary to ensure that the disturbed areas continuously meet the appropriate requirements of the E&S Manual, and that runoff from these areas does not adversely impact downstream properties.
- If conditions warrant, and with the ENGINEER'S approval, additional measures may be employed as construction proceeds, to ensure effective erosion and sediment control on site.
- The Contractor is responsible for the acquisition of all required easements and/or rights-of-way pursuant to the discharge from the sediment and erosion control practices, stormwater management practices, and the discharge of stormwater onto

or across adjacent or downstream properties affected by this plan (also for grading or other work).

- The CONTRACTOR is required to protect all points of construction ingress and egress to prevent the deposition of materials onto public roads. All materials deposited onto public roads shall be removed immediately.
- The CONTRACTOR will inspect all erosion and sediment control practices and devices after each storm event and maintain them in an effective operating condition until such time as they are removed as part of the normal sequence of construction, and after permission from the inspecting agency representative.

7.23.2. MATERIALS

7.23.2.1. CLEARING AND GRUBBING

Clearing and Grubbing. Clearing for site access shall be contained to the existing SMECO right of way (ROW) and areas outside of the ROW indicated on the drawings. Clearing will be considered tree and brush cutting and mowing so that the installation of perimeter erosion and sediment controls, stockpiles, and use of existing access roads can be completed per the drawings.

Materials removed in the clearing and grubbing operations shall be either disposed of onsite or removed from the SITE by the CONTRACTOR.

Only trees and shrubs marked by flagging shall be removed, and the color and method of marking established in the pre-construction meeting. The CONTRACTOR shall have verified the removal of trees, shrubs, and other general plantings for areas of access outside of the ROW as well as within the ROW for property owners specifically identified by SMECO. Trees and shrubs removed in error shall be replaced in kind at the expense of the CONTRACTOR. ‘

7.23.2.2. TOPSOIL

- Topsoil shall consist of the uppermost 12 inches of soil material remaining after the clearing and grubbing operations. It may contain organic matter, but not rubbish or frozen materials. Topsoil shall be identified by the onsite ENGINEER and stockpiled separately from excavated site Subsoils. Topsoil shall not be utilized as fill material for temporary roadways.
- The areas stripped shall be graded to avoid standing water. Areas stripped that are not completed and will remain inactive for more than 7 days, shall be temporarily seeded. Temporary upland seeding shall be performed as specified in Section 6.23.2.46.
- The temporary stockpiles shall be located as shown on the drawings or as

directed by the OWNER or ENGINEER. E&S control measures shall be installed prior to placement of material.

- The surface of the temporary stockpiles shall be graded to provide positive drainage at all times. Upon completion, the temporary stockpiles shall be vegetated with the temporary upland seed mixture, as specified in Section 6.23.2.46.

7.23.2.3. SUBSOIL

Subsoil shall consist of excavated soil and rock below the topsoil.

7.23.2.4. UNSUITABLE MATERIAL

Unsuitable material for topsoil or subsoil shall be defined as ice, frozen material, organic matter, rubbish, debris, or any other material determined by the OWNER to be unsuitable for fill or subbase material. The unsuitable material, except rubbish, shall be stored in the permanent spoil area or in an offsite location. Rubbish, if encountered, shall be disposed of per ENGINEER, and at the cost of the CONTRACTOR.

7.23.2.5. SUITABLE MATERIAL

- Fill material shall contain no rock fragments larger than 6 inches, roots larger than ½-inch in diameter, organic matter, or frozen soil. Where compaction is accomplished by means of hand-directed equipment, the maximum allowable rock fragment size shall be 3 inches.
- The contractor shall construct fills using material acquired from within the right-of-way where such material meets the requirements of these notes and the drawings. Fill material in excess of that available from within the right-of-way shall be obtained from sites with an active MDE NPDES permit. Excavated material not used for fill shall be placed in an on-site stockpile or disposal area, as indicated on the drawings, or as indicated in the typical pole installation or removal details.
- Fill material utilized for the backfill of the underground conduit trench shall adhere to those thermal fill requirements provided with the specific detail.
- For fill placed on slopes 3:1 (Vertical:Horizontall) or steeper, the existing grade shall be cleared, grubbed, and scarified. The contractor shall place fill in horizontal uniform lifts no greater than 9 inches in thickness (loose) and compacted. The contractor shall compact all fills within four feet of existing structures (including poles and foundations) with hand equipment.
- If wetness is encountered on the constructed crane pad or access road, the area is to be stripped of soil to three inches below the oversaturated region. This material is to be stockpiled onsite. The road or crane pad shall then be restored to the desired height utilizing additional on-site suitable material.

7.23.2.6. STONE CHECK DAM

Stone Check Dams shall be installed in the locations indicated on the drawings, and per the detail provided on Sheet 61 of the drawings. Stone Check Dams shall be constructed of 4" to 7" stone. The upstream side of the stone check dam shall be lined with approximately 1 foot thick of ¾ inch to 1 ½ inch aggregate.

7.23.2.7. TEMPORARY SWALE

Temporary Swale shall be installed in the locations indicated on the drawings Temporary swales shall be lined with temporary channel lining, as indicated in section 6.23.2.17.

7.23.2.8. FILTER BAG

Filter Bags shall be installed in the locations indicated on the drawings, and per the detail provided on Sheet 59 of the drawings. Filter bag shall consist of a Nonwoven geotextile with a minimum surface area of 225 square feet per side and with double stitched seams using high strength thread. The bag shall be sleeved to accommodate a maximum 4-inch diameter pump discharge hose. The bag must be manufactures from a nonwoven geotextile that meets or exceeds minimum average roll value for the following:

Grab Tensile	250 LB	ASTM D-4632
Puncture	150 LB	ASTM D-4833
Flow Rate	70 GAL/MIN/FT^2	ASTM D-4491
Permittivity	1.2 (SEC^{-1})	ASTM D-4491
UV Resistance	70% Strength @500 Hours	ASTM D-4355
Apparent Opening Size	0.15-0.18 MM	ASTM D-4751
Seam Strength	90%	ASTM D-4632

7.23.2.9. SILT FENCE

Silt Fence shall be installed in the locations indicated on the drawings

7.23.2.10. GEOTEXTILE FABRIC

The geotextile fabric shall consist of woven monofilament fiber and shall conform to the Manual, as provided in Table H.1: Geotextile Fabrics, and per the manufacturer's recommendations. Silt Fence shall be placed as indicated on the drawings.

Table H.1: Geotextile Fabrics

		WOVEN MONOFILAMENT GEOTEXTILE		NONWOVEN GEOTEXTILE	
		MINIMUM AVERAGE ROLL VALUE[1]			
PROPERTY	TEST METHOD	MD	CD	MD	CD
Grab Tensile Strength	ASTM D-4632	370 lb	250 lb	205 lb	205 lb
Grab Tensile Elongation	ASTM D-4632	15%	15%	50%	50%
Trapezoidal Tear Strength	ASTM D-4533	100 lb	60 lb	80 lb	80 lb
Puncture or CBR Puncture[2]	ASTM D-4833 ASTM D-6241	950 lb 120 lb		500 lb 110 lb	
Apparent Opening Size[3]	ASTM D-4751	U.S. Sieve 70 (0.212 mm)		U.S. Sieve 80 (0.18 mm)	
Percent Open Area	CWO[5]-02215	4-6%		N/A	
Permittivity	ASTM D-4491	0.28 sec^{-1}		1.1 sec^{-1}	
Water Flow Rate	ASTM D-4491	18 $gal/min/ft^2$		90 $gal/min/ft^2$	
Ultraviolet Resistance at 500 hours	ASTM D-4355	90%		70% strength retained	

7.23.2.11. FENCE POSTS

Fence posts shall be wood and minimum 2x2 inch square cut, or minimum 1¾ inch diameter round, of sound quality hardwood. Posts shall be a minimum of 36 inches in length. As an alternative to wooden post use standard “T” or “U” section steel posts weighing not less than 1 pound per linear foot.

7.23.2.12. STRAW BALES

Straw Bales shall be installed as reinforcement to Silt Fencing, Section 6.23.2.9, in the locations indicated on the drawings. Straw Bale shall also be utilized for the perimeter of a Concrete Washout Area, per Section 6.23.2.41. Straw bales shall never be utilized in lieu of silt fence. Straw bales size shall have the approximate dimensions (L x W x H): 35-40” x 14” x 18”, and weigh approximately 50 lbs.

7.23.2.13. EROSION CONTROL MATTING

Erosion Control Matting shall be installed in the locations indicated on the drawings. In instances where the Manufacturer’s instructions conflict with the drawings, the CONTRACTOR must notify the OWNER for clarification prior to installation of the matting.

7.23.2.14. TEMPORARY EROSION CONTROL MATTING

Matting shall consist of Curlex I CL, manufactured by American Excelsior Company, 850 Avenue H East, Arlington, Texas, (817-385-3500), or equal as approved by the ENGINEER.

7.23.2.15. PERMANENT EROSION CONTROL MATTING

Matting shall consist of Curlex I CL for all slopes 3:1 (H:V) or greater, and Curlex II CL for all slopes steeper, or equal as approved by the ENGINEER.

7.23.2.16. STAKING

Secure matting using steel or wood stakes. Staples must be "U" or "T" shaped steel wire having a minimum gauge of no. 11 and no. 8 respectively. "U" shaped staples must average 1 to 1 1/2 inches wide and be a minimum of 6 inches long. "T" shaped staples must have a minimum 8 inch main leg, a minimum 1 inch secondary leg, and a minimum 4 inch head. Wood stakes must be rough-sawn hardwood, 12 to 24 inches in length, 1x3 inch in cross section, and wedge shaped at the bottom.

7.23.2.17. CHANNEL LINING

Channel Lining shall be installed in the locations indicated on the drawings and all locations where disturbed slopes are 3:1 (Horizontal: Vertical) or steeper. Matting shall be installed and per the detail provided on Sheet 57 of the drawings, and per Manufacturer's instructions. In instances where the Manufacturer's instructions conflict with the drawings, the CONTRACTOR must notify the OWNER for clarification prior to installation of the matting.

7.23.2.18. TEMPORARY CHANNEL LINING

Lining shall consist of DS75 Erosion Control Blanket or SC250 Turf Reinforcement Mat, manufactured by North American Green, 14649 Highway 41 North, Evansville, Indiana 47725 (1-800-772-2040), or equal as approved by the ENGINEER.

7.23.2.19. PERMANENT CHANNEL LINING

Lining shall consist of DS75 Erosion Control Blanket or SC250 Turf Reinforcement Mat, manufactured by North American Green, or equal as approved by the ENGINEER.

7.23.2.20. TIMBER

Timber mats shall be a hardwood timber mat, laminated mat, or an accepted equal. Timber Mats shall be installed in the locations indicated on the drawings.

Hardwood mats shall consist of:
1. Full length timbers with recessed one and one quarter inch tie belts on four-foot centers.
2. Minimum dimensions of four feet wide, 12 inches thick for Primary Access Roads, 6-inches thick for Secondary Access Roads, and lengths of 12feet.
3. Notched lifting eyes for installation.

Corrugated mats shall consist of:
1. Three layers of two foot by eight-foot hardwood timbers and marked on both sides.
2. Minimum dimensions of eight feet wide, six inches thick, and lengths of 16 feet.

Approved equal shall be submitted to the ENGINEER for approval prior to construction, with sufficient time for the ENGINEER to review and comment.

7.23.2.21. TIE BARS

Tie bars shall consist of 1 ¼" minimum steel rods for lifting purposes. All other interior rods shall consist of 1" steel. Placement of tie bars shall be per manufacturer's specifications.

7.23.2.22. GEOTEXTILE

Woven geotextile matting shall be utilized in areas where matting is susceptible to punching through topsoil and wetlands. Geotextile matting shall conform to the specifications in Section 6.23.2.10.

7.23.2.23. TEMPORARY ACCESS BRIDGES

Temporary Access Bridges shall be installed in the locations indicated on the drawings. Temporary Bridges shall consist of a prefabricated structure, or on-site fabricated structure, that can withstand the structural loads exhibited by the equipment to be utilized by the CONTRACTOR. The Temporary Bridge shall, at minimum, span the stream from the top of the stream banks. Temporary Bridges shall be supported at the stream banks so that the banks remain stable. The ENGINEER and OWNER shall approve of temporary bridge type, size, and placement prior to use by the CONTRACTOR.

7.23.2.24. FILTER LOG

Filter Logs shall be installed in the locations indicated on the drawings. Filter media shall, as shown below in table H.4: Compost, or other biodegradable material as approved by the ENGINEER.

Table H.4: Compost

Parameters[1]	Acceptable Range
pH	5.0 - 8.5
Moisture content	30% - 60%, wet weight basis
Organic matter content	25% - 65%, dry weight basis
Particle size	% passing a selected mesh size, dry weight basis 3 in (75 mm), 100% passing 1 in (25 mm), 90 – 100% passing 0.75 in (19 mm), 70 – 100% passing 0.25 in (6.4 mm), 30 – 60% passing 0.04 in (1 mm), 30% min. passing
Physical contaminants (manmade inerts)	<1% dry weight basis

Adapted from AASHTO Standards Specs for Compost Filter Socks and EPA Example Compost Filter Parameters.

[1] Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMEC , The U.S Composting Council).

7.23.2.25. MOUNTABLE BERMS

Mountable berms shall be installed in the locations indicated on the drawings.

7.23.2.26. COMPACTED FILL

Compacted Fill shall consist of suitable material, as indicated in Section 6.20.9.

7.23.2.27. STONE

Stone size shall conform to the Manual, as indicated in Section 6.23.2.5. All mountable berms shall utilize Number 1 Stone and be placed as indicated on the drawings.

7.23.2.28. GEOTEXTILE

The geotextile fabric shall be nonwoven and shall conform to the Manual, as indicated in Section 6.23.2.10.

7.23.2.29. EARTH DIKES

Earth dikes shall be installed in the locations indicated on the drawings. Compacted Fill shall consist of suitable material, as indicated in Section 6.20.9. Erosion Control Matting shall conform to the requirement of Temporary Matting, as provided in Section 6.23.2.10. or equal as approved by the ENGINEER.

7.23.2.30. CULVERTS

Culverts shall be composed of HDPE material, Type S, with corrugated exterior and smooth interior. Culvert shall be installed at the locations indicated on the drawings.

7.23.2.31. STONE OUTLET STRUCTURES

Stone Outlet Structures shall be installed in the locations indicated on the drawings.

7.23.2.32. BAFFLE BOARD

Baffle board shall be composed of 2 inch by 10 inch by 12 feet standard cut lumber with 3 rows of 1 inch diameter holes, spaced at 6 inches on center. Baffle board shall be embedded 4 inches into the ground. Baffle board shall be supported with 2 inch by 2 inch posts on the downslope side of the baffle board, driven 6 inches deep, and extend above the baffle board.

7.23.2.33. STONE AND ROCK

Stone size shall conform to the Manual, as indicated in Section 6.23.2.6. All stabilized construction entrances shall utilize crushed aggregate, or equivalent recycled concrete (without rebar), 2 to 3 inches in size, and be placed as indicated on the drawings.

1. All stone shall not be acid-forming or toxic-forming and shall be free of clay, iron, shale or other deleterious material.
2. Rock and stone shall be of a quality that will withstand the action of water, frost, and other weathering. Rounded rocks or boulders shall not be used.

7.23.2.34. PIPE

The corrugated high-density polyethylene (HDPE) or Polyvinyl Chloride (PVC) pipe for the temporary crossings of roadside drainage be undamaged sections of sufficient strength required to support the equipment utilized by the CONTRACTOR. At a minimum, each run of pipe shall be 36 feet long and be able to convey the 2-year storm event. Minimum interior pipe diameter shall be 6 inches.

7.23.2.35. ORANGE CONSTRUCTION SAFETY FENCING

Orange Construction Safety Fencing shall be installed in the locations indicated on the drawings, and per the detail provided on the drawings.

7.23.2.36. FENCING

Fencing shall comprise of orange high density polyethylene safety fence, a minimum of 48 inches in height. Fencing shall be secured to posts at the top, middle and bottom of each stake with wire or zip ties.

7.23.2.37. FENCE POSTS

Fence posts shall use standard “T” section steel posts weighing not less than 1 pound per linear foot, and a minimum of 66 inches in height.

7.23.2.38. ROCK OUTLET PROTECTION

Rock Outlet Protection shall be installed in the locations indicated on the drawings, and per the detail provided on the drawings.

7.23.2.39. STONE

Stone size shall conform to the Manual, as provided in Table H.2: Stone Size. All rock outlet protection shall utilize class 1 riprap and be placed as indicated on the drawings.

Table H.2: Stone Size

TYPE	SIZE RANGE	d_{50}	d_{100}	AASHTO	MIDSIZE WEIGHT[3]
NUMBER 57[1]	3/8 to 1 ½ inch	½ in	1 ½ in	M-43	N/A
NUMBER 1	2 to 3 inch	2 ½ in	3 in	M-43	N/A
RIPRAP[2] (CLASS 0)	4 to 7 inch	5 ½ in	7 in	N/A	N/A
CLASS I	N/A	9 ½ in	15 in	N/A	40 lb
CLASS II	N/A	16 in	24 in	N/A	200 lb
CLASS III	N/A	23 in	34 in	N/A	600 lb

[1] This classification is to be used on the upstream face of stone outlets and check dams.

[2] This classification is to be used for gabions.

[3] Optimum gradation is 50 percent of the stone being above and 50 percent below the midsize.

Stone must be composed of a well graded mixture of stone sized so that fifty (50) percent of the pieces, by weight, are larger than the size determined by using the charts. A well graded mixture, as used herein, is defined as a mixture composed primarily of larger stone sizes but with a sufficient mixture of other sizes to fill the smaller voids between the stones. The diameter of the largest stone in such a mixture must not exceed the respective d_{100} selected from Table H.2. The d_{50} refers to the median diameter of the stone. This is the size for which 50 percent, by weight, will be smaller and 50 percent will be larger.

7.23.2.40. CONCRETE WASHOUT AREA

Concrete Washout Areas shall be installed in the locations indicated on the drawings.

7.23.2.41. STRAW BALES

Straw Bales shall be in accordance with Section 6.23.2.12.

7.23.2.42. PLASTIC LINING

Plastic Lining shall consist of polyethylene plastic of a minimum of 10 mil thickness. Material shall be free of holes, tears or other defects that would compromise the impermeability of the material. Soil base beneath the liner shall be prepared free of rocks or other debris that would cause tears or holes in the liner.

7.23.2.43. SIGNAGE

Signage shall be provided by the CONTRACTOR to indicate travel to and the actual location of the washout facility.

7.23.2.44. WOOD PLANKS

Wood planks can be utilized, in lieu of straw bales, as a containment wall. Walls shall consist of three high stacked 2 inch x 12 inch rough wood planks so that a total height of 3 feet is obtained. Planks shall be securely fastened around entire perimeter with two stakes. Staking shall be driven to a depth necessary to support the planks and extend to the top of the plank wall.

7.23.2.45. TEMPORARY SEEDING

. Temporary seeding shall conform to the species and application rates as shown below:

Hardiness Zone (from Figure B.3): 7a					**Fertilizer Rate (10-10-10)**	**Lime Rate**
Season	**Species**	**Application Rate (lb./ac)**	**Seeding Dates**	**Seeding Depths (inches)**		
Cool (select 1)	Annual Ryegrass (Lolium Perenee ssp. Multiflourum)	40	Feb 15 to Apr 30; Aug 15 to Nov 30	0.5	600 pounds/acre (14 lb./1000 sf)	2 tons/acre (100 lb./1000 sf)
	Barley (Hordeum Vulgare)	96	Feb 15 to Apr 30; Aug15 to Nov 30	1.0		
Warm (select 1)	Foxtail Millet (Setaria Italica)	30	May 1 to Aug 14	0.5		
	Pearl Millet (Pennisetum Glaucum)	20	May 1 to Aug 14	0.5		

- Seeding rates for the warm-season grasses are in pounds of Pure Live Seed (PLS). Actual planting rates shall be adjusted to reflect percent seed germination and purity, as tested. Adjustments are usually not needed for the cool-season grasses.

- Seeding rates listed above are for temporary seedings, when planted alone. When planted as a nurse crop with permanent seed mixes, use 1/3 of the seeding rate listed above for barley, oats, and wheat. For smaller-seeded grasses (annual ryegrass, pearl millet, foxtail millet), do not exceed more than 5% (by weight) of the overall permanent seeding mix. Cereal rye generally should not be used as a nurse crop, unless planting will occur in very late fall beyond the seeding dates for other temporary seedings. Cereal rye has allelopathic properties that inhibit the germination and growth of other plants. If it must be used as a nurse crop, seed at 1/3 of the rate listed above.

- Oats are the recommended nurse crop for warm-season grasses.

7.23.2.46. PERMANENT SEEDING

Hardiness Zone: 7a Season: Warm-Season/Cool-Season Grasses					Fertilizer Rate (10-10-20)			Lime Rate
#	Species	Application Rate (lb./ac)	Seeding Dates	Seeding Depths (inches)	N	P_2O_5	K_2O	
3	Deertongue (Dichanthelium Clandestinum)	20	Feb 15 to Apr 30; May 1 to May 31	¼ - ½	90 pounds/acre (2.0 lb./1000 sf)	175 pounds/acre (4 lb./1000 sf)	175 pounds/acre (4 lb./1000 sf)	2 tons/acre (92 lb./ 1000 sf)
	Canadian Wild Rye (Elymus Canadensi)	3						
	Redtop (Agrostis Gigantean)	1						
	Common Lespedeza (Lespedeza Stipulacea)	10						

Hardiness Zone: 7a Season: Cool-Season Grasses					Fertilizer Rate (10-10-20)			
#	Species	Application Rate (lb./ac)	Seeding Dates	Seeding Depths (inches)	N	P_2O_5	K_2O	Lime Rate
12	Hard Fescue (Fesctuca Trachphylla)	25	Feb 15 to Apr 30; Aug 15 to Oct 31; Nov 1 to Nov 30	¼ - ½	90 pounds/acre (2.0 lb./1000 sf)	175 pounds/acre (4 lb./1000 sf)	175 pounds/acre (4 lb./1000 sf)	2 tons/acre (92 lb./ 1000 sf)
	White Clover (Trifolium Repens)	3						
	Red Clover (Trifolium Pretense)	3						

- Seeding Rates: Seeding rates for the warm-season grasses are in pounds of Pure Live Seed (PLS). Actual planting rates must be adjusted to reflect percent seed germination and purity, as tested. Adjustments are usually not needed for the cool-season grasses, legumes, or wildflowers. All legume seeds must be inoculated before planting with the appropriate Rhizobium bacteria. When feasible, hard-seeded legumes should be scarified to improve germination.

- Turf-type cultivars of tall fescue and Kentucky bluegrass must be selected based on recommendations of the University of Maryland Cooperative Extension Service, Agronomy Mimeo 77 (APRIL 2000).

7.23.2.47. WETLAND AND CRITICAL AREA BUFFER SEEDING

Mix	Recommended Cultivar	Seeding Rate[2] lbs./ac.	Seeding Rate[2] lbs./ 1,000 sq. feet	Soil Drainage Class[3]	Maximum Height (feet)	Maintenance Level[4]
Big Broomsedge bluestem *Andropogon geradii*	Common	15	0.34	E-MW	2 to 6	C-D
Little Broomsedge bluestem *Schizachgrium scoparius*	Common	15	0.34	E-MW	1 to 2	C-D
Switch Grass *Panicum virgatum*	Common	15	0.34	E-MW	3 to 7	C-D
Indian Grass *Sorghastrom nutrans*	Common	15	0.34	E-MW	4 to 6	C-D
Eastern Gamma Grass *Tripsacum dactyloides*	Common	15	0.34	E-MW	4 to 6	C-D
Black-eyed Susan *Rudbeckia hirta*	Common	1	0.025	E-MW	2 to 3	C-D
Lance-leaved Coreopsis *Coreopsis lanceolata*	Common	1	0.025	E-MW	2 to 3	C-D
Purple Coneflower *Echinacea purpurea*	Common	1	0.025	E-MW	2 to 3	C-D
Partridge Pea *Chamaecrista fasciculata*	Common	1	0.025	E-MW	2 to 3	C-D
Butterfly Milkweed	Common	1	0.025	MW-SP	1 to 3	C-D

Asclepias tuberose						
Pale Coneflower *Echinacea pallida*	Common	1	0.025	MW-SP	2 to 5	C-D
Common Sneezeweed *Helenium autumnale*	Common	1	0.025	MW-SP	2 to 6	C-D
Great Blue Lobelia *Lobelia siphilitica*	Common	1	0.025	MW-SP	1 to 3	C-D
Grass Leaved Goldenrod *Euthamia gramanifolia*	Common	1	0.025	E-MW	2 to 4	C-D
Cardinae Flower *Lobelia cardinalis*	Common	1	0.025	MW-SP	2 to 5	C-D
New York Fern *Vernonia noveboracensis*	Common	1	0.025	MW-SP	3 to 10	C-D
Cinnamon Fern *Osmunda cinnamomea*	Common	1	0.025	MW-SP	2 to 6	C-D

- Taken from USDA Natural Resources Conservation Services, Maryland Conservation Practice Standard, Critical Area Planting Code 342, September 2002.
- Seeding Rates: Seeding rates for the warm-season grasses are in pounds of Pure Live Seed (PLS). Actual planting rates shall be adjusted to reflect percent seed germination and purity, as tested. Adjustments are usually not needed for the cool-season grasses, legumes, or wildflowers. All legume seeds shall be inoculated before planting with the appropriate *Rhizobium* bacteria. When feasible, hard-seeded legumes should be scarified to improve germination.
- Soil Drainage Class: E - Excessively Drained; W - Well Drained; MW - Moderately Well Drained; SP - Somewhat Poorly Drained; P - Poorly Drained.
  - Intensive mowing (every 2 to 4 days), fertilization, lime, insect and weed control, and watering (examples: high maintenance lawns and athletic fields).
  - Frequent mowing (every 4 to 7 days), occasional fertilization, lime, pest control, and watering (examples: residential, school, and commercial lawns).

- Periodic mowing (every 7 to 14 days), occasional fertilization and lime (examples: residential lawns, parks).
- Infrequent or no mowing, fertilization, or lime after the first year of establishment (examples: wildlife areas, roadsides, steep banks).

7.23.2.48. TRENCH PLUG

Trench Plugs shall be installed incidentally throughout the project to repair locations where excavation for the establishment of access roads or pole foundations damaged by the CONTRACTOR during construction. Trench plugs shall be replaced in-kind, but usually consist of earth filled or concrete sacks. Suitable, rock free, material shall be used for the trench plugs. Trench plugs shall be installed per the drawings.

7.23.2.49. SLOPE BREAKERS

Slope Breakers shall be installed incidentally throughout the project to repair locations where excavation for the establishment of access roads or pole foundations damaged by the CONTRACTOR during construction. Slope Breakers shall be replaced in-kind, and consist of compacted soil, and permanently revegetated per Section 6.23.2.47. Slope Breakers shall be installed per the drawings.

7.23.2.50. DOMESTIC UTILITY CROSSINGS

Domestic Utility Crossings. Domestic Utility Crossings shall be installed in the locations indicated on the drawings. Crossing shall be constructed of Standard Timbermat, per Section 6.23.3.10. Crossing may also be constructed of 2-foot minimum thickness compacted suitable back fill, per Section 6.20.9, and 4 to 6-inch-thick AASHTO No. 2 stone, separated with separator geotextile, per Section.6.22.2.

7.23.2.51. TEMPORARY ACCESS PIPELINE CROSSING

Temporary Access Pipeline Crossing shall be installed in the locations indicated on the drawings, and per the detail provided on the drawings. Crossing shall be constructed of Standard Timbermat, per Section 6.23.3.12, for primary and secondary crossings. Primary Crossing may also be constructed of 2-foot minimum thickness compacted suitable back fill, per Section.6.20.9, and 6-inch minimum thick AASHTO No. 2 stone, separated with separator geotextile, per Section.6.23.2.10. Secondary Crossing may also be constructed of 1-foot minimum thickness compacted suitable back fill, per Section 6.20.9, and 4 to 6-inch-thick AASHTO No. 2 stone, separated with separator geotextile, per Section 6.22.2.

7.23.2.52. MAINTENANCE OF TRAFFIC

All signage, barriers, flagging and barricades necessary for the maintenance of traffic shall be in accordance with Maryland State Highway Administration specifications, and the details and specifications provided.

7.23.3. CONSTRUCTION

All access road construction and sediment controls shall be completed and installed in the location and grades indicated on the drawings.

7.23.3.1. CLEARING AND GRUBBING

Clearing and grubbing shall be performed to the extent indicated on the drawings.

7.23.3.2. EXCAVATION

- Excavation shall conform to the lines and grades shown on the drawings. Any deviation shall require prior approval of the OWNER. Excavated areas shall be shaped and fine graded to provide a uniform surface free from windrows, bumps, and hollows.
- Excavation operations shall be conducted so that material outside the excavation limits is not disturbed or loosened. Material disturbed or loosened shall be restored to at least its original condition. All excavation operations shall be conducted in accordance with OSHA Subpart P and all equipment shall be equipped with backup alarms and safety equipment in accordance with OSHA regulations.
- The condition and grading of excavated surfaces shall be subject to approval by the OWNER prior to placement of subbase, structures, or topsoil.
- The CONTRACTOR shall grade cut areas to provide positive drainage. If positive drainage cannot be attained due to the surrounding topography, dewatering measures shall be used to limit the amount of saturated soils in the excavation areas. Any material which in the opinion of the OWNER is rendered unsuitable due to the failure of the CONTRACTOR to maintain proper drainage shall be removed and disposed of as unsuitable material and replaced all at the CONTRACTOR's expense.
- Any over excavation beyond the lines and grades shown on the drawings that was not directed by the OWNER shall be brought back to the designated grade(s) with approved material and compacted at CONTRACTOR's expense.
- The CONTRACTOR shall maintain all CONTRACTOR used access roads which shall include the application of any dust suppressants to minimize fugitive dust. All dust control and access road maintenance required due to the CONTRACTOR's operation shall be at CONTRACTOR's expense.
- Mass rock excavation (as defined above) is not anticipated.
- Excavation for the establishment of permanent and temporary diversion channels shall be completed as outlined in Section 4.8.

7.23.3.3. FILL PLACEMENT

- No fill shall be placed while rain is falling unless approved by the ENGINEER. Prior to resuming fill operations after rain, all muddy material shall be graded off the surface to a depth necessary to expose firm compacted material.
- At the end of the day's operation and when rain is threatening, the fill shall be sloped to provide positive drainage for E&S control measures.
- Fill layer shall be placed to within plus or minus 0.5 foot of the grades shown on the drawings. Any deviation in line and level from that shown on the drawings shall require prior approval of the OWNER and the ENGINEER.

7.23.3.4. ROAD GEOMETRY

Roadways shall be constructed to the horizontal and vertical geometries indicated on the drawings. Where field modifications are deemed necessary by the CONTRACTOR, prior approval by the OWNER and ENGINEER is required. Roadway geometry shall conform to the following criteria, unless otherwise directed by the ENGINEER or indicated on the drawings.

- Road Width: 18 foot primary; 15 foot secondary.
- Typical Cross Sections: Refer to the drawings.
- Minimum horizontal radius: 60 feet
- Maximum Grade Along Direction of Travel: 18 percent
- Maximum Grade at Minimum Turning Radius: 7 percent
- Maximum Cross Gradient: 2 percent
- Minimum Vertical Clearance: 18 feet
- Minimum Crest/Dip: 1 ft over 50 feet
- Bearing Capacity: 0.5 tons/ft^2 (clay, sandy clay, silty clay and clayey silt) to 0.75 tons/ft^2 (sand, silty sand, clayey sand, silty gravel and clayey gravel).
- Section Thickness: 8 inches of suitable onsite material or AASHTO No. 2 stone.

7.23.3.5. STONE CHECK DAM

- Swales where stone check dams shall be utilized shall be prepared in accordance with Section 4.8.
- The stone for the check dam shall be placed so that it completely covers the width of the channel and is keyed into the channel banks.
- The top of the check dam shall be constructed so the center is approximately 6 inches lower than the outer edges, forming a weir that water can flow across.
- The maximum height of the check dam at the center shall not exceed 2 feet.
- The upstream side of the check dam shall be lined with approximately 1 foot of ¾ inch to 1 ½ inch aggregate.
- Accumulated sediment shall be removed when it has built up to ½ of the original height of the weir crest.

7.23.3.6. TEMPORARY SWALE

- Construct flow channel on an uninterrupted, continuous grade, adjusting the location due to field conditions as necessary to maintain positive drainage.
- Provide outlet protection as required on the drawings.
- Remove and dispose of all trees, brush, stumps, obstructions, and other objectionable material so as not to interfere with proper function of temporary swale. Excavate or shape temporary swale to line, grade, and cross section as specified on the drawings. Bank projections or other irregularities that impede flow are not allowed.
- Stabilize temporary swale within three days of installation. Stabilize swales used for clear water within 24 hours of installation.
- Inspect and provide necessary maintenance periodically and after each ran event.
- Upon removal of temporary swale, grade area flush with existing ground. Within 24 hours of removal, stabilize disturbed area with topsoil, seed and mulch, or as specified on the drawings.

7.23.3.7. FILTER BAG

- Tightly seal sleeve around the pump discharge hose with a strap or similar device.
- Place filter bag on a suitable base (e.g., mulch, leaf/wood compost, woodchips, stone, or straw bales) located on a level or 5% maximum sloping surface. Discharge to a stabilized area.
- Control pumping rate to prevent excessive pressure within the filter bag. As the bag fills with sediment, reduce pumping rate.
- Remove and properly dispose of filter bag upon completion of pumping operations or after bag has reached capacity, whichever occurs first. Spread the dewatered sediment from the bag in an approved upland area and stabilize by the end of the work day. Restore the surface area beneath the bag to original condition upon removal of the device.

7.23.3.8. SILT FENCE

- Drive the wooden 16 inch minimum into ground no more than 10 feet apart.
- Fasten geotextile securely to each fence post with wire ties or staples at top and mid-section.
- Where two sections of geotextile adjoin; overlap, twist, and staple in accordance the detail provided in the drawings and the Manual.
- Provide manufacturer certification to the authorized representative of the inspection/enforcement authority showing that the geotextile used meets the requirements set forth in this specification.
- Extend both ends of the silt fence a minimum of five feet upslope at 45 degrees to the main fence alignment to prevent runoff from going around the ends of the silt fence.

- Remove accumulated sediment when "bulges" develop in the silt fence or when sediment reaches 25% of the fence height.
- Inspect and provide necessary maintenance periodically and after each rain event.

7.23.3.9. STRAW BALES

- Straw bales are only to be utilized as reinforcement to silt fencing. Straw bales shall be placed as indicated on the drawings, and as warranted as an additional erosion and sediment control.
- Straw bales shall be staked twice, evenly along the bale, with minimum 36-inch posts. Posts shall be driven 16 inches minimum into the ground.
- Remove accumulated sediment when sediment reaches 25% of the height of the silt fencing being supported.

7.23.3.10. EROSION CONTROL MATTING

- Perform final grading, topsoil application, seedbed preparation, and permanent seeding in accordance with specifications. Place matting within 48 hours of completing seeding operations unless end of workday stabilization is specified on the approved erosion & sediment control plans.
- Unroll matting downslope. Lay mat smoothly and firmly upon the seeded surface. Avoid stretching the matting.
- Overlap or abut roll edges per manufacturer recommendations. Overlap roll ends by 6 inches (minimum), with the upslope mat overlapping on top of the downslope mat.
- Key in the upslope end of mat 6 inches (minimum) by digging a trench, placing the matting roll end in the trench, stapling the mat in place, replacing the excavated material, and tamping to secure the mat end in the key.
- Staple/stake mat in a staggered pattern on 4-foot (maximum) centers throughout and 2-foot (maximum) centers along seams, joints, and roll ends.
- Inspect and provide necessary maintenance periodically and after each rain event.

7.23.3.11. CHANNEL LINING

- Perform final grading, topsoil application, seedbed preparation, and permanent seeding in accordance with specifications. Place matting within 48 hours of completing seeding operations, unless end of workday stabilization is specified on the approved erosion and sediment control plans.
- Unroll matting down slope. Lay matting smoothly and firmly upon the seeded surface. Avoid stretching the matting.
- Overlap or abut edges of matting rolls per manufacturer recommendations. Overlap roll ends by 6 inches (minimum), with the upstream mat overlapping on top of the downslope mat.
- Key in the top of slope end of mat 6 inches (minimum) by digging a trench, placing the matting roll end in the trench, stapling the mat in place, replacing the excavated material, and tamping to secure the mat end in the key.

- Staple/stake mat in a staggered pattern on 4-foot (maximum) centers throughout and 2-foot (maximum) centers along seams, joints, and roll ends.
- If specified by the designer or manufacturer and depending on the type of mat being installed, once the matting is keyed and stapled in place, fill the mat voids with top soil or granular material and lightly compact or roll to maximize soil/mat contact without crushing mat.
- Inspect and provide necessary maintenance periodically and after each rain event.

7.23.3.12. TIMBER MATS

- Timber Mats shall be utilized for the crossing of wetland and streams where indicated on the drawings, as well as where deemed necessary by the CONTRACTOR or OWNER due to construction conditions.
- Woven geotextile matting shall be placed beneath the timber matting, as necessary. In areas of wetland crossing, woven geotextile must be used beneath the matting.
- Crushed rock, or approved equal, shall be placed at the ends of timber mats to produce an acceptable ramp to the mat by construction equipment. Rock shall be replaced, as necessary, to maintain the crossing throughout the use of the matting.

7.23.3.13. TEMPORARY ACCESS BRIDGE

- Construct temporary access bridge structure at or above the bank elevation to prevent impacts from floating materials and debris.
- Place abutments parallel to, and on, stable banks.
- Construct bridge to span entire channel.
- Use stringers consisting of logs, sawn timber, prestressed concrete beams, metal beams, or other approved materials.
- Select decking materials to provide sufficient strength to support the anticipated load. Place all decking members perpendicular to the stringers, butted tightly, and securely fasten to the stringers. Decking materials must be butted tightly to prevent any soil material tracked onto the bridge from falling into the waterway below.
- Securely fasten optional run planking for the length of the span. Provide a run plank for each track of the equipment wheels. Although run planks are optional, they may be necessary to properly distribute loads.
- Install curbs the entire length of the outer sides of the deck to prevent sediment from entering the stream channel.
- Anchor bridge securely at only one end using steel cable or chain. Anchoring at only one end will prevent channel obstruction in the event that floodwaters float the bridge. Acceptable anchors are large trees, large boulders, or driven steel posts. Anchor must be sufficient to prevent the bridge from floating downstream.
- Areas disturbed during bridge installation and/or removal must not be left unstabilized overnight unless the runoff is directed to an approved sediment control device.
- Clean sediment from bridge daily and dispose of properly. Remove any debris trapped by bridge. Ensure that decking and curbs remain securely butted without gaps.
- Inspect and provide necessary maintenance periodically and after each rain event.

- After the temporary crossing is no longer needed, remove it within 14 calendar days unless subject to the use designation closure period. Protect stream banks during bridge removal and stabilize all disturbed areas with erosion control matting. Accomplish removal of the bridge and cleanup of the area without construction equipment working in the waterway channel. Store all removed materials in an approved staging area.

7.23.3.14. FILTER LOG

- Prior to installation, clear bedding area of obstructions including rocks, clods, and debris greater than one inch.
- Fill log netting uniformly with compost (in accordance with section h-1 materials), or other approved biodegradable material to desired length such that logs do not deform.
- Install filter logs perpendicular to the flow direction and parallel to the slope with the beginning and end of the installation pointing slightly up the slope creating a "j" shape at each end to prevent bypass.
- For untrenched installation blow or hand place mulch or compost on uphill side of the slope along log.
- Stake filter log every 4 feet or closer along entire length of log or trench log into ground a minimum of 4 inches and stake log every 8 feet of closer.
- When more than one log is needed, overlap ends 12 inches minimum and stake.
- Remove sediment when it has accumulated to a depth of the exposed height of log.
- Inspect and provide necessary maintenance periodically and after each rain event.

7.23.3.15. MOUNTABLE BERMS

- Use minimum length of 10 feet to allow for vehicular passage.
- Place nonwoven geotextile over the earth mound prior to placing stone.
- Place stone at least 6 inches deep over the length and width of the mountable berm.

7.23.3.16. EARTH DIKES

- Construct flow channel on an uninterrupted, continuous grade, adjusting the location due to field conditions as necessary to maintain positive drainage.
- Provide outlet protection as indicated on the drawings.
- Remove and dispose of all trees, brush, stumps, obstructions, and other objectionable material so as not to interfere with proper function of earth dike.
- Excavate or shape earth dike to line, grade, and cross section as specified. Bank projections or other irregularities that impede flow are not allowed.
- Compact fill.
- Stabilize earth dike within three days of installation. Stabilize flow channel for clear water dike within 24 hours of installation.
- Inspect and provide necessary maintenance periodically and after each rain event.
- Upon removal of earth dike, grade area flush with existing ground. Within 24 hours of removal stabilize disturbed area with topsoil, seed, and mulch, or as specified on approved plan.

7.23.3.17. CULVERTS

- Excavate the trench for installation of the temporary culvert. Excavated trench shall allow for pipe outer diameter with an additional foot of clearance either side of the pipe.
- Compacted fill shall be placed up to ½ the diameter of the culvert.
- Remaining backfill over the pipe shall be hand tamped. Backfill shall be a minimum of 12 inches over top the crown of the culvert.
- Appropriate rock outlet protection shall be installed with the installation of the culvert, as provided in Section 4.9.

7.23.3.18. STONE OUTLET STRUCTURES

- Embed the perforated baffle board 4 inches (minimum) into the ground.
- Place woven monofilament geotextile on upstream face and cover with a minimum of 6 inches of additional stone. Use nonwoven and woven monofilament geotextiles.
- Place the stone on nonwoven geotextile.
- Set weir crest of stone 6 inches lower than the top of earth dike. Use minimum length of 6 feet for weir crest.
- Inspect and provide necessary maintenance periodically and after each rain event. Remove sediment when it has accumulated to within 6 inches of the weir crest. Replace stone when structure ceases to function and ponding results.
- Upon removal of stone outlet structure, grade area flush with existing ground. Within 24 hours stabilize disturbed area with topsoil, seed, and mulch, or as specified on approved plan.

7.23.3.19. STABILIZED CONSTRUCTION ENTRANCES

- Locate SCE at every point where construction traffic enters or leaves construction site. Vehicles must travel over the entire length of the SCE. The orientation of the SCE may vary from a straight line and be curved or "T" -shaped depending on the topography and right of way. Avoid locating entrances along the low point of work area where possible.
- Minimum length of 50 feet.
- Minimum width of 10 feet. Flare SCE 10 feet minimum at the existing road to provide a turning radius.
- Place nonwoven geotextile over the existing ground prior to placing stone.
- Place crushed aggregate at least 6 inches deep over the length and width of the SCE.
- Pipe all surface water flowing to or diverted toward the SCE under the entrance, maintaining positive drainage. Protect pipe installed through the SCE with a mountable berm with 5:1 slope and a minimum of 12 inches of stone over the pipe. When the SCE is located at a high spot and has no drainage to convey, a pipe is not necessary. A mountable berm is required when SCE is not located at a high spot.
- Inspect and provide necessary maintenance periodically and after each rain event. Periodic top dressing of stone may be necessary.

7.23.3.20. ORANGE CONSTRUCTION SAFETY FENCING

- Safety fencing shall be installed a minimum of 7 feet offset of the natural gas transmission pipeline nearest to construction disturbance, unless otherwise indicated on the drawings.
- Fence staking shall be at 12 feet on center. Fencing shall be secured, at minimum, three times to the posts at the top, middle, and bottom of each stake.

7.23.3.21. ROCK OUTLET PROTECTION

- Prepare the subgrade for geotextile or stone filter and riprap to the required lines and grades. Compact any fill required in the subgrade to a density of approximately that of the surrounding undisturbed material.
- Where no end wall is used, construct the upstream end of the apron so that the width is two times the diameter of the outlet pipe, and extend the stone under the outlet by a minimum of 18 inches.
- Riprap and stone must conform to the specified grading limits.
- Use nonwoven geotextile, and protect from puncturing, cutting, or tearing. Repair any damage other than an occasional small hole by placing another piece of geotextile over the damaged part or by completely replacing the geotextile. Provide a minimum of one-foot overlap for all repairs and for joining two pieces of geotextile together.
- Geotextile must extend at least 6 inches in from edge of riprap and be embedded at least 4 inches at sides of the riprap.
- Construct riprap outlet to full course thickness in one operation and in such a manner as to avoid displacement of underlying materials. Place stone for riprap outlet in a manner that will ensure that it is reasonably homogenous with the smaller stones and spalls filling the voids between the larger stones. Place riprap in a manner to prevent damage to the stone filter blanket or geotextile. Hand place to the extent necessary.
- Construct apron with 0% slope along its length and without obstructions. Place stone so that it blends in with existing ground.

7.23.3.22. CONCRETE WASHOUT AREA

- Locate washout area a minimum of 50 feet away from open channels, storm drain inlets, sensitive areas, wetlands, buffers or water courses and away from construction traffic.
- Size washout area for required computed volume considering wash water, solids and rainfall. Minimum dimensions are 10 feet x 10 feet x 3 feet deep.
- Place signage in a highly visible location along the construction accesses to indicate location of washout areas.

7.23.3.23. SEEDING AND MULCHING

- Seeding and mulching shall be completed at the rates described in Section 6.23.2.46 for all areas disturbed by construction activities. Lime and fertilizer shall be applied at the rates indicated for temporary or permanent seeding.
- Weed free mulch, consisting of hay or straw, shall be applied at a rate of 3 tons per acre. In areas of steep slopes (3:1 or steeper), erosion control matting shall be installed in lieu of mulch.
- In wetland areas, only annual ryegrass and mulch shall be applied, no fertilizer or lime.

7.23.3.24. TRENCH PLUGS

Trench Plugs shall be installed where existing trench plugs are incidentally damaged by roadway grading or construction of pole foundations. Trench plugs shall be repaired per the drawings.

7.23.3.25. SLOPE BREAKERS

Slope Breakers shall be installed where existing slope breakers are incidentally removed by roadway grading or construction of pole foundations. Prior to construction of the construction access roadway, the location of existing Slope Breakers is to be staked in the field along the edge of the ROW, and the location recorded by the OWNER. Slope Breakers shall be repaired per the drawings.

7.23.3.26. DOMESTIC UTILITY CROSSING

- Prior to the installation of the Domestic Utility line crossing, the area must be cleared of all vegetation, debris, rubble, and obstructions.
- Where the CONTRACTOR or OWNER prefers a timber mat crossing, crossing shall be completed per Section 6.23.3.12. Matting shall be a minimum length of 16 feet at the crossings.
- Where Soil Fill crossing is preferred, contractor shall place compacted fill to a minimum depth of two feet.
- Place separator geotextile to the extents of the compacted fill.
- Place AASHTO #2 stone to a thickness 4-6 inches over the compacted suitable fill. The ends of the driving lane shall be sloped such that an 8:1 (horizontal: vertical) slope is created to allow for construction traffic.
- Crossing shall be maintained throughout construction. In areas where compaction, rutting, or displacement occurs, additional AASHTO #2 shall be placed to original crossing height. A supply of additional stone shall be kept in the vicinity of the crossing so that repairs can be immediately made.

7.23.3.27. TEMPORARY ACCESS PIPELINE CROSSING

- Prior to the installation of the crossing, the area must be cleared of all vegetation, debris, rubble, and obstructions.

- Where the CONTRACTOR or OWNER prefers a timber mat crossing, crossing shall be completed per Section 6.23.3.12. Matting shall be a minimum length of 7 feet beyond any pipeline.
- Where Soil Fill crossing is preferred, contractor shall place compacted fill to a minimum depth of two feet for primary accesses and one foot for secondary accesses.
- Place separator geotextile to the extents of the compacted fill.
- Place AASHTO #2 stone to a thickness 4-6 inches over the compacted suitable fill. The ends of the driving lane shall be sloped such that an 8:1 (horizontal:vertical) slope is created to allow for construction traffic.
- Crossing shall be maintained throughout construction. In areas where compaction, rutting, or displacement occurs, additional AASHTO #2 shall be placed to original crossing height. A supply of additional stone shall be kept in the vicinity of the crossing so that repairs can be immediately made.

7.23.3.28. MAINTENANCE OF TRAFFIC

Contractor shall provide for any and all maintenance of traffic necessary for the completion of the project. All signage, flagging and methods shall be in accordance to Maryland State Highway Administration standards. CONTRACTOR shall install devices of the type and locations indicated on the drawings.

8. SITE GRADING CRITERIA

8.1. GENERAL

This section specifies the general technical requirements applicable to the technical specifications' sections, including furnishing and installing materials for and documenting the construction of overhead electric transmission lines.

The requirements of this section are intended as an addition to and not to conflict with any specific requirements included in any other section of the technical specifications.

8.1.1. CODES AND STANDARDS

The Contractor shall construct the work specified in accordance with applicable requirements of the latest versions of the codes and standards referenced in this section. Codes and standards applying to a specific portion of the work will be referenced in the technical section applicable to that portion of the work.

8.1.1.1. STANDARD VERSION

All references to codes and standards shall be the current version of the code or standard in effect (including all amendments) unless otherwise stated.

8.1.1.2. CONFLICTS

The Contractor shall comply with the requirements of the referenced federal, state and local code or standards as well as standards specified by association, or trade. Where codes and standards are in conflict with each other, the most stringent requirements apply. If specified reference codes and standards conflict with technical specification sections, the Contractor shall request clarification from the Owner before proceeding.

8.1.1.3. CODES

The work shall comply with relevant portions of the following codes:

National Electrical Safety Code (ANSI C2).

Federal and State Occupational Safety and Health Act (OSHA).

8.1.1.4. STANDARDS

The work shall comply with relevant portions of the industry accepted standards published by the following institutes, associations, and societies:

American Concrete Institute.

American Institute of Steel Construction.

American Iron and Steel Institute.

American Institute of Timber Construction.

American National Standard Institute.

American Society of Civil Engineers.

American Society of Mechanical Engineers.

American Society for Testing and Materials.

American Welding Society.

Concrete Reinforcing Steel Institute.

Institute of Electrical and Electronics Engineers, Inc.

National Electrical Manufacturer's Association.

Underwriters' Laboratories, Inc.

8.1.2. EXISTING UNDERGROUND INSTALLATIONS

The Contractor shall be solely responsible for locating all existing underground installations in advance of any required excavations. The Contractor shall use his own information and shall not rely upon any information indicated on the drawings concerning existing underground installations.

The Contractor will be held responsible for any interruption in the service of underground facilities resulting from his operations, unless the facilities owner has given specific approval for the interruption in each case.

Except where the damaged parties desire to conduct their own repair and restoration work, the Contractor shall repair and fully restore any underground facility damaged during the construction period to a condition equal to or better than that which existed at the time of damage. All repair and restoration work shall be done to the complete satisfaction of the damaged parties and the Owner and Engineer.

The Contractor shall make his own arrangements with any jurisdictional authority requiring inspection of repaired or reconditioned utility facilities. The Contractor shall pay all applicable inspection fees.

Where the damaged parties desire to conduct their own repair and restoration work, the Contractor shall render all assistance to facilitate this corrective work. The Contractor shall assume all just and reasonable expenses thus incurred by the damaged parties.

The Contractor shall call Miss Utility (1-800-257-7777) at least 48 hours in advance of drilling to have the appropriate underground utilities located.

Each underground facility encountered shall be accurately located on the drawings, indicating the original location and relocation, if any. When all work is completed, the marked copy of the drawings shall be submitted to the Owner and Engineer as part of the field records.

8.2. SITE CONDITION

Contractor acknowledges that he has satisfied himself as to the nature and location of the work, the general and local conditions. The Contractor is aware of the bearing on the project of the following: availability of transportation; disposal, handling and storage of materials; availability of labor, water, and roads; the uncertainties of weather, water levels, or similar physical conditions at the project site; the conformation and condition of the ground; the character of equipment and facilities needed during the execution of the work; and all other matters that can in any way affect the scope of work or the Contract Price.

Contractor further acknowledges that he has satisfied himself as to the character, quality, and quantity of surface and subsurface materials to be encountered from his inspection of the project site and from reviewing any available records of exploratory work furnished by the Owner or included with these Documents. Failure by the Contractor to acquaint himself with the physical conditions of the project site and all available information will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the work.

Contractor warrants that, as a result of his examination and investigation of all the aforesaid data, he can perform the work to the satisfaction of the Owner. Owner assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this Contract, unless (1) such representations are expressly stated in the Contract and (2) the Contract expressly provides that the responsibility thereof is assumed by the Owner.

8.3. MODIFICATION AND REMOVAL OF EXISTING FACILITIES

During construction, existing facilities may require modification or removal in order to properly execute project construction. The Contractor shall make such modifications and removals as indicated on the drawings and as required by these Specifications.

The Contractor will coordinate all work regarding modifications and removal of existing facilities with the Owner to minimize interruptions on the Owner's system. Prior to starting the modification and/or removal work, the Contractor will prepare and submit to the Owner a proposed detailed schedule for such work. The Contractor shall not proceed with the modification and/or removal work until the schedule has been approved by the Owner.

The Contractor shall protect from damage all existing structures and materials that are to remain in place. Existing facilities that are damaged during modification work shall be restored to their original condition to the Owner's satisfaction. The Contractor shall pay all costs in connection with repairing damages to existing facilities resulting from this work.

8.4. EASEMENTS AND PERMITS

Where portions of the work will be located on public or private property, easements and/or permits will be obtained by the Owner as described in Section 3A. Copies of the easements and permits are available from the Owner for review.

It is anticipated that all required easements and permits will be obtained by the Owner before the start of construction. However, should the procurement of any easement or permit be delayed, the Contractor will schedule the work in such a way that construction can continue confined to areas where easements or permits have been obtained or are not required, until the delayed easement or permit is secured.

The Contactor shall comply with restrictions on limitations listed in the easement or permit documents.

8.5. EQUIVALENT MATERIAL AND EQUIPMENT

Approval of equivalent material and equipment shall be as specified in the Special Conditions.

Where one or more manufacturers are listed in the Contract Documents for a material item, without the words "or equal," the Contractor shall provide the product of one of the manufacturers listed. Where one or more manufacturers are listed followed by the words "or equal," "or approved equal," "or equivalent," and "or acceptable equal," the Contractor shall provide the product of one of the manufacturers listed, or an equivalent material item may be proposed as a substitute for the one specified. The proposed substitution must be a product of equal quality; must meet or exceed the attributes, performance, or other standards of the specified product; and must be approved by the Owner.

When an equivalent material or equipment item is approved by the Owner, all costs associated with changes required to incorporate the equivalent item into the work shall be borne by the Contractor without increase in the Contract Price.

8.5.1. SALVAGED MATERIALS

Contractor shall deliver all salvaged poles, structures, equipment, conductors, and materials to the Owner's storage area and unload as directed by the Owner. Dispose of all materials not being salvaged.

Contractor shall obtain a signed voucher from the Owner's storekeeper for all returned material.

The Contactor shall disassemble, sort, and store all structures and materials. Wood and concrete poles removed shall be freed of dirt and other debris and inspected for damage. The Contractor shall Identify and inform Owner of any wood poles that may need treatment to prevent further deterioration and notify Owner of any damage needing repair.

Contractor shall spool and tag all conductors, shield wires, fiber optic cables, and guy wires with information concerning the type and approximate length of conductor or wire in feet contained in each spool. The Contractor shall remove all splices and connectors and identify and inform Owner of any damaged sections of wire.

The Contractor shall provide all reels, shoring, and crating required for the storage of salvaged structures, equipment, and materials.

8.5.2. DISPOSAL OF RAZED ITEMS

All electrical equipment, materials, wire, conduit and miscellaneous items removed shall be disposed of by the Contractor unless otherwise indicated on the drawings or specified herein. Conduit and wire, which have been removed from the existing installation, shall not be reinstalled at other locations as part of the work under these specifications.

8.6. PROTECTION OF THE ENVIRONMENT

The Contractor shall observe the rules and regulations of the Owner and the state, local, and federal agencies having jurisdiction over the protection of the environment.

8.7. CONTRACTOR FURNISHED MATERIAL

The materials included in this section shall be furnished and installed by the Contractor under these specifications. Other miscellaneous materials shall be furnished and installed by the Contractor as indicated on the drawings.

This section covering Contractor-furnished materials describes the type, functions, and general arrangements desired. The content of these specifications does not necessarily cover all design details and features. The Owner reserves the right to require modifications of construction details or operational features that may not have been discussed in these specifications and which, in the estimation of the Owner or Engineer, are substandard or undesirable.

The Contractor shall furnish all the material required for a complete project as shown on the drawings. Following is a list of the major material and should not be considered a complete and final list:

Stone and Gravel
Filter Cloth
Drain Pipe
Select Fill
Stabilized Matting
Seed and Straw
Silt fence
Stabilized Construction Entrance

Specifications for this material can be found on the drawings.

8.8. SITE WORK SPECIFICATIONS

The site work shall be constructed as shown on the drawings and in accordance with the specifications provided on the Cover page. The following specifications are intended to supplement the Site Work Specifications on the drawings and not supersede them.

This section covers general earthwork and shall include the necessary clearing and grubbing of the construction areas; removal and disposal of all debris; pumping and dewatering as necessary; protection of adjacent construction; preparation of sub grades, construction of fills and embankments; excavation, trenching, and backfilling; access drives; disposal of excavated materials, final grading and other appurtenant work, all in accordance with applicable federal, state and local laws, ordinances, permits and codes.

The contractor shall maintain dust control measures during construction and limit the impact of dust on the neighboring houses. Contractor shall be prepared to use water to limit air born dust.

Ground surfaces within the construction areas shall be cleared of all trees, brush, debris, and surface vegetation. Stumps and roots larger than 2 inches in diameter shall be completely grubbed and removed. Matted roots shall be removed regardless of size. Surface vegetation shall be removed complete with roots to a depth of not less than 6 inches below the ground surface.

Organic topsoil which is free of trash, vegetation, rocks, and roots shall be stockpiled for later use under these specifications.

8.8.1. SEDIMENT AND EROSION CONTROL

Concurrent with the substation site work, soil erosion and sediment control devices shall be constructed to prevent sediment and soil erosion at those areas not protected by either existing vegetation or natural barriers.

Sediment and erosion control plan as presented and approved by Maryland Department of the Environment (MDE), Maryland Department of Natural Resources, County Dept. of Public Works and/or Land Use and County Conservation Service are hereby made a part of this contract.

All sediment and erosion control shall be subject to inspection by the Natural Resources, Conservation Service and MDE as to compliance with appropriate rules, ordinances and regulations. Contractor shall be responsible for maintaining the Sediment and Erosion Control plan throughout the duration of the project.

Topsoil, soil containing roots, rootmat or other coarse material, shall not be used as base material in constructing berms, stormwater retention ponds or other sediment and erosion control devices.

8.8.2. SEEDING

Seed bed preparation and seeding as per specification of sediment and erosion control plan shown on the accompanying drawings as approved by Natural Resources Conservation Service and MDE.

Contractor shall obtain testing of the topsoil to determine the soil PH and verify the best seed mix needed for the given soil conditions

8.8.3. EXCAVATION, TRENCHING AND BACKFILLING

The excavations shall conform to the dimensions and elevations indicated on the drawings, except as specified below. Where unsuitable bearing is encountered at the elevations indicated on the drawings, the Engineer may direct, in writing, that the excavation be carried to elevations below those shown on the drawings. Unless so directed by the Engineer, excavation shall not be carried below the elevations indicated on the drawings. Where the excavation is made below the elevations indicated, the excavations, if under slabs, shall be restored to the proper elevation in accordance with the procedure specified for backfill, or if under footings, the heights of the walls or footings shall be increased, as may be directed by the Engineer. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, and for inspection, except where the concrete for footings is authorized to be deposited directly against excavated surfaces. Undercutting will not be permitted.

8.8.3.1. DRAINAGE IN VICINTIY OF BUILDINGS AND OTHER STRUCTURES

The Contractor shall control the grading in the vicinity of buildings and other structures so that the surface of the ground will be properly sloped to prevent water from running into the excavated areas. Any water that accumulates in the excavation shall be promptly removed.

8.8.3.2. EXCESS MATERIAL

Excess material from excavation, not required for fill or backfill, shall be removed from the site to a suitable landfill area.

8.8.3.3. BACKFILLING

Where backfill is required, such backfill shall consist of broken stone, sand, gravel, or other material approved by the Owner. Where broken stone, sand or gravel is used for backfilling, it shall be placed in layers not exceeding twelve (12) inches in thickness and thoroughly compacted. When earth is used for fill, it shall be placed in layers not exceeding eight (8) inches in thickness. Each layer shall be moistened during compaction to a moisture content such that the required degree of compaction as specified in section 4.8 may be obtained. (Where there is a conflict MDE, Natural Resources Conservation Service or County Regulations shall be used.)

After completion of foundations, footings, walls and slabs, and prior to backfilling, all forms shall be removed, and the excavation shall be cleaned of all trash and debris. Material for backfilling around said foundations, etc., shall consist of the excavated material and shall be free of trash, lumber, or other debris. Backfill shall be placed in horizontal layers not in excess of 12 inches in thickness and shall have moisture content such that the required degree of compaction, as specified, may be obtained. Unless otherwise stated, this compaction shall be at least 95 percent modified AASHTO density.

8.8.4. DRAINAGE PIPING

This section covers materials, manufacture, and installation for underground drainage piping and appurtenances, as shown on the drawings.

Trenching, embedment, backfill, and other related earthwork shall be in accordance with the requirements of the Section titled EARTHWORK, except that pipe culvert bedding and fill material shall meet the additional requirements of specification ID S-AGG ~ CULV-01.00 and French drain materials shall meet the additional requirements of specification ID-S-AGG ~ FRDRN-01.00, at the end of Section 2A.

8.8.4.1. LAWS AND REGULATIONS

Drainage piping work shall be performed in accordance with all applicable governmental codes and ordinances and laws and regulations of the city and state which pertain to such work. In case of conflict between these specifications and any law or ordinance, the latter shall govern.

8.8.4.2. HANDLING

Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in loading, unloading, reloading, and hauling pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in the ends of pipe shall have broad, well-padded contact surfaces. Damaged pipe shall be removed from the site.

Clay pipe and fittings shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint surfaces.

Pipe coating which has been damaged shall be repaired by the Subcontractor before installing the pipe.

Plastic pipe shall be shaded as required to prevent curvature due to thermal expansion.

8.8.4.3. GENERAL INSTALLATION REQUIREMENTS

Drainage piping shall be accurately installed in accordance with lines and grades indicated on the drawings or as required by connections to other piping. Pipe grades between designated invert elevations shall be uniform to ensure unrestricted flow and eliminate low spots or traps that would retain water. Pipe shall be laid in a manner to provide uniform support throughout its length.

Pipelines intended to be straight shall be laid straight.

8.8.4.4. CUTTING

Cutting shall be done in a neat manner, without damage to the pipe. Cuts shall be smooth, straight, and at right angles to the pipe axis. Pipe shall be cut with Mechanical pipe cutters. Where the use of mechanical cutters would be difficult or impracticable, the proposed method of pipe cutting shall be acceptable to the Project Field Manager.

8.8.5. CLEANING

Foreign matter shall be thoroughly cleaned from the interior of all pipe and fittings before installing. Pipe shall be kept clean until the work has been accepted. Surfaces shall be wire brushed, if necessary, and wiped clean, dry, and free from oil and grease before the joints are assembled. Joint contact surfaces shall be kept clean until the jointing is completed.

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe.

8.8.6. INSPECTION

Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. Defective pipe and fittings shall be removed from the site of the work.

8.8.7. ALIGNMENT

Piping shall be laid to the lines and grades indicated on the drawings. Batter boards, laser beam equipment, or surveying instruments shall be used to maintain alignment and grade.

Batter boards, if used, shall be erected at intervals of not more than 25 feet. Batter boards shall be used to determine and check pipe subgrades. Not less than three batter boards shall always be maintained in proper position when trench grading is in progress.

If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

8.8.8. LAYING PIPE

Lateral displacement of the pipe shall be prevented during embedment operations. Pipe shall not be laid in water, nor under unsuitable weather or trench conditions.

Pipe laying shall begin at the lowest elevation with bell ends facing the direction of laying except when reverse laying is permitted by the Project Field Manager.

Whenever pipe laying is stopped, the open end of the pipe shall be closed with an end board closely fitting the end of the pipe to keep sand and earth out of the pipe. The end board shall have several small holes near the center to permit water to enter the pipe and prevent flotation in the event of flooding of the trench.

When jointed in the trench, the pipe shall form a true and smooth line. Pipe shall not be trimmed except for closures. Pipe not making a good fit shall be removed. Permissible defects shall be placed in the top of the line.

Culvert trenches shall be graded to the required slopes. Trenches shall be shaped and tamped to receive and fit the lower part of the pipe. If rock is encountered in the excavation, it shall be removed and replaced with suitable earth or granular fill material to a minimum depth of 6 inches below the bottom of the pipe. Pipe shall be laid on the pre-pared bed starting at the outlet end with sections firmly joined. Outside laps of circumferential joints shall point upstream. Longitudinal seams of corrugated metal culverts shall be placed at the side of the trench.

8.8.9. JOINTING

Joint preparation and jointing operations shall comply with the written instructions and recommendations of the pipe manufacturer.

8.8.9.1. VITRIFIED CLAY PIPE JOINT

Plastic joints for vitrified clay pipe shall be installed in accordance with the instructions and recommendations of the joint manufacturer. Immediately before joints are pushed together, joint surfaces shall be lubricated with the lubricant furnished by the joint manufacturer.

8.8.9.2. PVC GASKET PIPE JOINTS

Elastomeric gasket joints shall be in-stalled in accordance with the instructions and recommendations of the joint manufacturer. Immediately before joints are pushed together, joint surfaces shall be lubricated with lubricant furnished by the joint manufacturer.

8.8.9.3. PVC PIPE WELDED JOINTS

Solvent welded joints shall be made in accordance with the recommendations of the pipe manufacturer. Prior to joining, the ends of the pipe shall be cut square and smooth and wiped clean. Solvent cement shall be applied to the outside of the pipe and inside of the fitting socket with a small paint brush. The coated surfaces shall be immediately pushed snugly together, and the pipe rotated approximately one-half turn to ensure uniform distribution of the cement. Excess cement shall be removed by wiping.

8.8.9.4. CORRUGATED METAL PIPE JOINTS

Joints in corrugated metal pipe shall be made with galvanized corrugated bands and galvanized bolts.

8.8.9.5. REINFORCED CONCRETE PIPE JOINTS

Concrete pipe shall have tongue and groove type joints. All joints shall be provided with flat gaskets. Gaskets shall conform to ASTM C443. Polymer shall be neoprene or other synthetic rubber. Natural rubber will not be acceptable.

8.8.10. AGGREGATOR SURFACING

This section covers the materials and construction for substation aggregate surfacing.

All aggregate surfaced areas constructed under these specifications shall be maintained by the Contractor until final acceptance of the work by the Project Construction Supervisor.

8.8.10.1. PROTECTION OF SUBGRADE

Ditches and drains along the subgrade shall be maintained to provide effective drainage. Whenever ruts are formed, the subgrade shall be brought to grade, reshaped, and recompacted. In no case shall aggregate surfacing be placed on a muddy subgrade. Storage or stockpiling of materials on the subgrade will not be permitted.

8.8.10.2. SUBGRADE PREPARATION

Immediately prior to surfacing, the subgrade shall be shaped to the grade and cross section indicated on the drawings and compacted. This operation shall include any scarifying, reshaping, and wetting required to obtain a firm, dense surface. Soft, organic, and otherwise unacceptable material shall be removed from the subgrade and replaced with acceptable material.

Any deviation of the subgrade surface in excess of 1 inch as indicated by a 16-foot straightedge, or template cut to typical section, shall be corrected by loosening, adding or removing material, reshaping, and recompacting.

8.8.10.3. MATERIALS

Materials for the aggregate surfacing shall be as stated on the drawings and comply with all applicable sections of the State Highway Administration Standard specification.

A job mix formula shall be established by the Subcontractor and shall be acceptable to the Project Construction Supervisor prior to the start of work. This mix shall not be changed without prior authorization from the Project Construction Supervisor.

8.8.10.4. APPLICATION

Aggregates shall be handled and spread in a manner that will prevent segregation of sizes. The surfacing shall be uniformly spread and compacted with vibratory rollers or tampers. Care shall be taken to prevent damage to any structures with the rolling or tamping equipment.

Surface of the completed aggregate layer shall not deviate more than 1/2 inch when tested with a 10-foot straightedge. The completed compacted thickness of any course shall be within plus 3/4 inch and minus 1/2 inch of indicated thickness, and the average thickness shall not be less than the design thickness indicated.

8.8.10.5. MAINTENANCE

Maintenance of aggregate surfacing shall consist of periodic maintenance operations by the Contractor throughout the period utilized to complete the work under these specifications. Maintenance operations shall include loosening, adding, and removing material, grading, reshaping, and recompacting as required to keep the surfaced areas in first-class condition.

8.8.11. TESTING

All field and laboratory testing required to determine compliance with the requirements of this section shall be provided by the Contractor. All laboratory testing shall be done by an independent testing laboratory acceptable to the Project Construction Supervisor and retained and paid by the Contractor. Field sampling shall be done by the testing laboratory.

The following tests will be required:

- One gradation test for each type of granular embedment or fill material.
- One laboratory density test (ASTM D698 or ASTM D4253 and D4254) for each type of fill, embankment or backfill material proposed.
- In-place field density tests for each 500 cubic yards of compacted material, a minimum of two tests shall be performed at each site.
- For trenching work: In-place field density tests at average intervals of one test per 200 feet of trench.

Field samples shall be taken at locations selected by the Project Construction Supervisor. If additional field control tests are necessary, in the opinion of the Project Construction Supervisor, such tests shall be made.

Maximum density for cohesive compacted materials shall be determined in accordance with ASTM D698. The terms “maximum dry density” (MDD) and “optimum moisture content” (OMC) shall be as defined in ASTM D698.

Relative density for noncohesive compacted materials shall be determined in accordance with ASTM D4253 and D4254. The term “relative density” shall be as defined in ASTM D4254.

Copies of each test result shall be promptly furnished to the Project Construction Supervisor

8.8.12. SURVEYING AND STAKING

Unless noted otherwise, prior to commencing earthwork the Subcontractor shall engage the services of a registered professional surveyor to stake all property lines, grading limits, and vertical and horizontal control points. Contractor shall be responsible for maintaining the surveying and staking throughout the project duration. The owner will provide the limits of disturbance and the substation fence corner locations. There are benchmarks already established on the site.

8.9. CONCRETE FOR SITE WORK

8.9.1. GENERAL

The work under this item shall include all labor, materials, tools, equipment, and services for performing of all work necessary to complete the following concrete items but not limited to curbs, curb & gutter, sidewalks, footings, and walls as indicated on the Site Grading Contract drawings.

Where referred to in these Specifications, Standard Specifications shall mean the Maryland State Highway Administration (MSHA) Standard Specifications for Construction and Materials dated January 2008, amended to date.

7.9.1.1 QUALITY ASSURANCE

Deliver, store, and handle materials in accordance with manufacturer's instructions. Materials are to be stored in areas that will not impede construction progress.

The contractor will provide monitoring and testing by a Registered Professional Geotechnical Engineer, at the contractor's expense, to ensure proper construction in accordance with Specifications. Footing excavations are to be inspected and tested by the geotechnical engineer and confirmation of suitable sub-foundation soils (exhibit minimum 2,000 PSF bearing capacity) shall be provided prior to concrete placement. On-site concrete pours are to be tested in accordance with the ASTM Standards C-94/ C94M 04 for each concrete batch. Any areas not constructed in accordance with specifications will be removed and replaced by Contractor at no expense to the Owner. Testing rates are to be determined by the Registered Professional Geotechnical Engineer to ensure certification of construction for acceptance by the owner and/or governing agency. Two copies of testing reports are to be provided to the owner.

8.9.2. SUBMITTALS

The contractor is to provide the Owner with two (2) submittals for all materials covered under this section, and material certificates. Certificates are to be signed by Material Producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

8.9.3. MATERIALS

- Portland cement concrete and related products are to be in accordance with the drawings. Mix designs as follow or as stated on contract drawings:

    A. Curb and Gutter – Mix No. 2 (3,000 psi)
    B. Sidewalks – Mix No. 2 (3,000 psi)
    C. Retaining Wall and Footings – Mix No. 3 (3,500 psi)

- Reinforcement steel and welded wire fabric is to be in accordance with Standard Specification - Section 908.

- Joint sealer is to be in accordance with Standard Specification – Section 911.

- Preformed joint filler is to be in accordance with Standard Specification - Section 911.

- Porous Backfill is to be clean washed gravel or crushed stone, free of clay, vegetative matter, loam or deleterious matter graded to meet AASHTO M-43, No. 57.

8.9.4. CONSTRUCTION METHODS

Curb, and combination curb and gutter forming, depressions, openings, finishing, and joints, shall be as shown on the drawings.

Storm drain structures are to be constructed in accordance with the drawings. Consistency will be determined in the field by the slump test, in accordance with ASTM Specification C143. Slump for concrete shall be 2 to 3 inches for footing construction and 2 to 4 inches for other construction. Air content shall be four to six percent by on-site testing using the pressure method in accordance with ASTM C231.

8.9.5. TESTING

The Contractor shall provide equipment and labor to make slump and air entrainment tests. All slump tests shall be made at the time of the pour and as directed by the Owner. Test cylinders shall be poured, and strength tested by the Contractor as directed by the Owner for each shipment of concrete. Test results shall be sent to the Owner. All costs for tests shall be the Contractor's responsibility.

The Contractor shall take three (3) test cylinders for breakage testing. The first shall be broken after seven (7) days, the second after twenty-eight (28) days, and the third kept as a spare.

- Job-Mixed Concrete - Concrete mixed at the job site shall be mixed in a batch mixer and in a manner subject to the approval of the Owner.

- Ready-Mixed Concrete - Concrete mixed off-site and transported to the job site shall be used in lieu of job-mixed concrete, provided it meets previous specifications for strength and slump at the time of delivery. All ready-mixed concrete shall be in compliance with ASTM C94-86a, "Standard Specification for Ready-Mixed Concrete."

8.9.6. PREPARATION FOR PLACING

Water shall be removed from excavations before concrete is deposited. Hardened concrete, debris, and other foreign materials shall be removed from the interior of forms and from the inside of mixing and conveying equipment; reinforcement secured in position will be subject to inspection and approval by the Owner. Runways for buggies or wheelbarrows shall not be supported on reinforcement.

- Conveying - Concrete shall be conveyed from mixer to forms as rapidly as practicable without segregation or loss of ingredients.

- Placing Concrete - Concrete having attained its initial set or having contained its water content for more than 1-1/2 hours shall not be used in the work. Concrete shall not be dropped freely more than 5 feet in unexposed work and not more than 3 feet in exposed work. Unless approved by the Owner, concrete shall be mixed and placed only when the temperature is at least 40° F; concrete footings shall be placed upon surface free from frost, ice, mud, lose or unsound rock and other detrimental substances.

- Vibrating - All concrete shall be vibrated thoroughly with mechanical devices designed for the purpose while pouring into forms. Stirring or settling with shovels only will not be accepted. The vibrator is to be inserted only straight down into the concrete. The vibrator is not to be used to move the concrete after it is dumped into the form.

- Slabs on Grade - The subgrade shall be brought to an even plane and compacted solid. Concrete shall be deposited to the required thickness and finished monolithically to a smooth, level surface by floating and troweling.

- Finishes of Concrete Other Than Floors and Slabs - Slight honeycomb and minor defects shall be patched with cement mortar made with non-shrinking grout. Exposed surfaces shall be given a rubbed finish. Fins and other projections shall be carefully removed, offsets leveled, and surface damage repaired. The surfaces then shall be rubbed with cement or Carborundum bricks and water, leaving the surface uniformly smooth and clean and concrete sealer applied.

8.9.7. PROTECTION AND CURING

- Protection Against Moisture Loss - Immediately after placing or finishing, concrete surfaces not covered by forms shall be protected against moisture loss for not less than 7 days by covering with Kraft paper, mats, or burlap, lapped 4 inches at edges and ends. Burlap may be used only for unexposed concrete surfaces and shall be in at least 2 layers. Surfaces from which forms are removed before the curing period has elapsed shall be protected as specified for surfaces not covered by forms. All materials used for prevention of moisture loss shall be in accordance with ASTM C-171-69.

- Curing - Curing shall be done by keeping the forms and other protective material thoroughly wet.

- Clean-Up - All forms shall be completely removed. All materials and equipment and rubbish shall be removed, and the premises left in a neat condition.

8.10. STORM DRAINAGE AND APPURTENANCES

8.10.1. GENERAL

The Contractor shall furnish all labor, material and equipment to extend and appurtenances as shown on the Contract drawings and as specified. The work shall include, but not be limited to, excavation, dewatering, backfilling, concrete, masonry work, placement of all pipe, and all incidental items to complete the work as shown on the Contract drawings and as specified.

- The Contractor shall perform all excavations of whatever material encountered to the dimensions necessary for the installation of pipe and the construction of the trenches as shown on the Contract drawings and backfill same.

- Where referred to in these Specifications, Standard Specifications shall mean the Maryland State Highway Administration (MSHA) Standard Specifications for Construction and Materials dated January 2008, amended to date.

8.10.2. QUALITY ASSURANCE

- Any areas not constructed in accordance with specifications will be removed and replaced by Contractor at no expense to the Owner.

- Upon completion of work for this section the Contractor will provide as-built surveys performed by a Licensed Land Surveyor or Engineer, the as built is to ensure certification of construction for acceptance by the governing agency. Five copies of the as-builts are to be provided to the owner. If any construction is not in compliance with the design requirements the contractor will provide compliance at no additional cost to the Owner.

- Construction within MSHA Right of Way is to be in accordance with the MSHA Engineering Access Permit and subject to review and approval of MSHA inspector.

8.10.3. SUBMITTALS

The contractor is to provide the Owner with two (2) submittals for all materials covered under this section, and material certificates. Certificates are to be signed by Material Producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

8.10.4. PRODUCTS

- Pipe – Storm drain pipe shall be as noted on the approved plans.
  A. HDPE shall be ADS N-12 with soil tight joint in accordance with AASHTO M294 Type S
  B. PVC shall be Schedule 40 PVC in accordance with AASHTO M278.
  C. CMP shall be 14 gauge aluminized corrugated steel pipe arch per AASHTO M36.

- Manholes, inlets, shall be as stated on plans.

- Riprap for ditches shall be of the sizes or class shown on the Contract drawings and shall conform to the requirements of Standard Specifications – Section 901: Class I (unless stated otherwise on Contract drawings). Stone shall be quarry stone from a state and county approved source.

- Filter cloth/geo-textiles shown or called out on the Contract Drawings shall conform to the requirements of the drawings.
- Soil Stabilized Matting shall conform to Standard Specifications – Section 709 Type A or Type B as noted on the Contract drawings. Staples shall conform to the drawings.
- 2Select Backfill shall conform to Standard Specifications – Section 302: Selected Backfill and shall meet requirements of No. 57 aggregate.

8.10.5. EXECUTION

- Pipe shall be carefully handled and lowered into the trench. In laying pipe, special care shall be taken to ensure that each length shall abut against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the bottom half of the pipe trench.
- Before joints are made, each pipe shall be well bedded on a solid foundation until the preceding length has been thoroughly embedded and secured in place. The Contractor at his own expense shall correct any defects caused by settlement. Where concrete pipe is required bell holes shall be dug sufficiently large to insure the making of proper joints.
- Proper and suitable tools and appliances for the safe and convenient handling and placement of pipes shall be used.
- The pipe shall be thoroughly cleaned before they are placed and shall be kept clean until the acceptance of the completed work. The open ends of all pipelines shall be provided with a stopper carefully fitted, so as to keep dirt and other substances from entering. This stopper shall be kept in the end of the pipeline at all times when placement of the pipe is not in actual progress.
- Whenever a pipe requires cutting, to fit into the line or to bring it to the required location, the work shall be done in a satisfactory manner so as to leave a smooth end. Cost of cutting pipe shall be included in the price for the pipe.
- The excavation in which pipe is being laid shall be kept free of water and no joint shall be made under water. Water shall not be allowed to rise in the excavation. Care shall be used to secure water-tightness and to prevent damage to, or disturbing of, the joints during the backfilling process, or at any other time.
- No pipe shall be laid upon a foundation into which frost has penetrated, or at any time when there is danger of the formation of ice or the penetration of frost at the bottom of the excavation.

- Excavation shall conform to Section 301 of the Standard Specifications and backfill shall conform to the requirements of Section 302 of the Standard Specifications and as shown on the details included on the Site Grading Contract drawings.

- Pipe construction shall be as recommend by the manufacturer.

- Manholes and inlets, construction shall be in accordance with the drawings.

- Riprap placement for ditches shall be in accordance with the Section 311 of the Standard Specifications.

- Filter cloth/geo-textiles placement shall be in accordance with the drawings.
- Inlet grates and tops, and Manhole covers when on a sloped grade are to be placed to match the sloped grade in the surrounding area in all directions, if the structure grates, tops, or rims do not match the surrounding slopes the contractor will reset the structure surface feature as part of the contract at no cost to the owner.

- Inlets that are shown in sump locations are to be the low point in the structure drainage area.

- Soil stabilized matting shall be placed and secured in accordance with the drawings.
- Prior to acceptance of the storm drain system all forms, trash, debris, and sediments, are to be removed from the storm drainage structures and piping.

8.11. PAVEMENT

8.11.1. GENERAL

Perform all work necessary and required for the construction of the project as indicated. Such work includes but is not limited to the following:

- MSHA Pavement
- Pavement Removal
- Driveway Pavement

Where referred to in these Specifications, Standard Specifications shall mean the Maryland State Highway Administration (MSHA) Standard Specifications for Construction and Materials dated January 2008, amended to date.

8.11.2. QUALITY ASSURANCE

The contractor will retain testing and monitoring services of a Registered Professional Geotechnical Engineer, to perform field and laboratory testing during sub grade and paving operations and to provide quality assurance of compliance with the drawings and Specifications. Testing rates are to be determined by the Registered Professional Geotechnical Engineer in accordance with the stated specification to ensure certification of construction for acceptance by the owner or governing agency.

- Pavement Subgrade testing will be required as stated in geotechnical report with subgrade soils having a minimum California Bearing Ratio (CBR) value of 7.
- Graded Aggregate Base Course testing required will be in accordance with Standard Specification Section 501, compaction is to be 97%. Bank Run Gravel base and existing subbase shall be compacted to 95% of maximum dry density as determined by AASHTO T-180.
- HMA Testing required will be compaction testing and Core Method Testing in accordance with the drawings, with the exception of the number of tests (location and number of the tests will be determined by MSHA). The tests are to yield no less than the tolerances stated within this specification.
- The contractor is to provide two copies of reports for all testing to the Owner

8.11.3. SUBMITTALS

The contractor is to provide the Owner with two (2) submittals for all materials covered under this section, and material certificates. Certificates are to be signed by Material Producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

8.11.4. JOB CONDITIONS

Establish and maintain required lines and elevations, no puddles are to occur once final hot mix asphalt, or CR-6 surface is provided.

8.11.5. PRODUCTS

8.11.5.1. PAVEMENT SUBGRADE

- All pavement sub grade shall be in accordance with this specification, MSHA permit requirements, the geotechnical report, and as stated on plans.

8.11.5.2. BASE COURSE

- Graded Aggregate Base Course and Bank Run Gravel Base Course material as indicated on drawings is to be in accordance with and as stated on plans.

8.11.5.3. HOT MIX ASPHALT PAVEMENTS

- Surface course materials are to be in accordance with and as stated on plans.
- Base course materials are to be in accordance with and as stated on plans.

Tack coat material is to be in accordance with the drawings.

8.11.5.4. FABRIC

- Geotextile reinforcing fabric is to be Marifi 500x. (If required)

8.11.6. EXECUTION

8.11.6.1. PAVEMENT SUBGRADE

- The pavement sub grade preparation shall be in accordance with the Earthwork Specifications stated on the plans in addition to requirements of this section.
- The pavement sub grade preparation shall be conducted in the presence of the geotechnical engineer. The completed work shall be tested and approved by the geotechnical engineer prior to construction of the succeeding work. Finished sub-grade shall be true to required lines and Sections for paving and shall be hard, uniform and smooth.
- Pavement sub grade shall be proof rolled using a loaded tandem dump truck with an axle weight of at least 10 tons. Soft, loose or wet conditions identified during the proof roll are to be corrected in accordance with the following procedures:

A. Unsuitable materials shall be removed and replaced with suitable fill materials compacted to the required density.
B. The contractor shall be diligent in identifying unsuitable materials.
C. High plasticity (CH) soils shall be identified by conducting Atterberg Limits testing.
D. Any soft or unsuitable materials encountered during the proof rolling shall be removed and replaced with an approved backfill compacted to the criteria stated on the plans.

- The Contractor shall proceed with the placement of the graded aggregate base course within twenty-four (24) hours after sub grade approval. If precipitation occurs during this operation, an evaluation by the Geotechnical Engineer shall be made before proceeding.
- Longitudinal under drains shall be installed in poorly drained areas as directed by the Geotechnical Engineer or his representative.

- Any and all additional work associated with pavement sub grade preparation shall be documented by the Geotechnical Engineer or his representative and approved by the Owner before implementation.

- A supplemental CBR testing program is to be conducted on the pavement sub grade soils, after mass grading and utility installation and backfill, and just prior to pavement construction. The design of the pavement section may require modification based on the results of the supplemental CBR testing.

8.11.6.2. GRADED AGGREGATE BASE COURSE/ BANK RUN GRAVEL BASE

- Sufficient Graded Aggregate Base Course shall be uniformly spread to give the required thickness when compacted.

- Aggregate Base Course Construction shall be in accordance with the drawings.

- Aggregate base course shall be maintained in its finished condition until the hot mix asphalt pavement is placed.

- The contractor is to proceed with the binder course within (24) hours of the satisfactory placement of the graded aggregate base. If precipitation occurs during this operation, an evaluation by the Geotechnical Engineer shall be made before proceeding.

8.11.6.3. HOT MIX ASPHALT PAVEMENT

- Hot mix asphalt pavements are to be constructed in accordance with the drawings.

- The hot mix asphalt pavements shall be delivered to the job site and applied to the prepared surfaces with approved trucks, spreaders and finishing machines in such manner as to produce the required thickness pavement courses.

- The Contractor shall proceed with the construction of the binder course within twenty-four (24) hours of the completion of the base course. If precipitation occurs during this operation, an evaluation by the Geotechnical Engineer shall be made before proceeding.

- Traveled binder course shall be cleaned before application of the surface course.

- Areas to receive hot mix asphalt pavement or rigid structures that abut hot mix asphalt pavement are to be tack coated prior to placement of pavement. This includes binder course and surface course. Tack coats are to be applied in accordance with the drawings.

8.11.6.4. HOT MIX ASPHALT PAVING AND AGGREGATE BASE TOLERANCES

Following are maximum permissible deviations from specified hot mix asphalt pavement and aggregate base thickness:

- Thickness of HMA surface and HMA binder course (plus 1/4 inch no minus) as indicated on Contract drawings.

- Thickness of aggregate base course (plus 1/2 inch no minus) from grades determined from Contract drawings.

  Following are maximum permissible surface smoothness. Compact each course to produce a surface smoothness within the following tolerances as determined by using a ten-foot (10’) long straight edge applied transversely or longitudinally to pavement areas:

- Base Pavement: 1/4 inch

- Surface Pavement: 1/8 inch

8.11.6.5. CLEAN UP

After paving work is complete, remove excess stone, gravel, millings, and hot mix asphalt pavements, rubbish, etc., from site.

8.11.6.6. CORRECTION OF DEFECTIVE WORK

Settlement, low spots, raveling out of surface or edges and any other defects in workmanship or materials which appear within one (1) year of substantial completion of project as a whole shall be repaired by the Contractor to original design criteria specified at no additional cost to the OWNER.

8.12. FENCES AND GATES

8.12.1 GENERAL

Provide materials, equipment and manpower to construct a chain link fence with chain link swing gates and ornamental sliding gates as described on the drawings. All materials shall conform to this specification and any accompanying drawing(s).

8.12.1.1 STANDARDS

Applicable ASTM Standards, latest revisions, as published by the American Society for Testing Materials and indicated hereinafter. The following subcontractor(s) are pre-approved by SMECO for supply of material and installation of the perimeter fence. Utilization of any other supplier and/or subcontractor shall be approved by SMECO prior to award of this contract.

1. Long Fence
   8545 Edgeworth Drive

   Capitol Heights, MD 20743

   Contact: Ronnie Bennet

   Phone: 301-350-2400

8.12.2. PRODUCTS

8.12.2.2.1 GENERAL

8.12.2.1.1 DIMENSIONS

To extend eleven (11) feet above grade including 12 inch, 3-strand barbed wire overhang. The total length of fence and gate requirements and details is shown on the drawings. The chain link vehicle gates shall be twenty (20) feet wide and consist of two (2) ten-foot gates with three (3) hinge points each and thirty (30) feet wide and consist of two (2) fifteen-foot gates with three (3) hinge points each. The personnel gate shall be 3 feet wide (If required). The ornamental slide gate shall be (30) feet wide and consist of one (1) ten-foot cantilevered gate and one (1) twenty-foot cantilevered gate.

8.12.2.1.2 SCOPE

Fence fabric, line posts, gate and corner posts, footings, barbed wire extension arms, three lines of barbed wire, top rails, gates and associated hardware, such as fittings, latches, etc., all as specified hereinafter.

8.12.2.1.3 FENCE FRAMING MATERIALS

8.12.2.1.3.1 BASE METAL

Base metal shall be steel of such quality that the fabricated product will meet the performance criteria set forth in this standard. The steel strip used in the manufacture of the pipe shall conform to ASTM A-569.

8.12.2.1.3.2 ZINC COATING

The zinc used in the manufacture of the pipe shall conform with ASTM B-6 High Grade and Special High-Grade Zinc. The weight of zinc coatings shall be determined by the method contained in ASTM A-90.

8.12.2.1.3.3 CLEAR COATING

The clear coating shall be manufactured from high-grade raw materials, which produce a crosslinked acrylic polyurethane coating.

8.12.2.1.3.4 INTERNAL COATING

The internal zinc rich based coating shall have minimum zinc powder loading of 87% by weight and be capable of providing galvanic protection.

8.12.2.1.3.5 CHROMATE

A chromate conversion coating shall be deposited on the surface of the zinc to improve the corrosion resistance.

8.12.2.1.3.6

All fence posts and frame pipes are to be Allied Tube & Conduit Corporation Type SS-40 or Wheatland Type WT-40, unless specified otherwise.

8.12.2.1.4 FENCE FRAME

Strength. Pipe products manufactured in accordance with this specification shall have minimum yield strength of 50,000 pounds demonstrated by measurement of the tensile yield strength of a randomly selected piece from each lot, and calculation of the section modulus according to the established formula for this purpose. The tensile yield strength shall be determined according to the methods outlined in ASTM E-8. For materials manufactured under this specification the 0.2 offset methods shall be used to determine the yield strength.

8.12.2.1.5 CORROSION PERFORMANCE OF THE COATED SURFACE

8.12.2.1.5.1 SALT SPRAY RESISTANCE

The exterior and interior surfaces of the pipe shall have a demonstrated ability to resist exposure to salt fog when conducted in accordance with ASTM B-117.

8.12.2.1.5.2 HUMIDITY RESISTANCE

The clear-coated exterior surface of the pipe shall have a demonstrated ability to resist exposure to 100% relative humidity without blistering and peeling when conducted in accordance with ASTM D-2247.

8.12.2.2 FABRIC FOR FENCE AND GATES

The fence fabric shall be a minimum of 10 feet high. It shall consist of a minimum No. 9 USWG aluminum coated steel wire woven into a 2-inch square mesh. The minimum breaking strength of the wire shall be 1200 pounds. The sides of the mesh pattern shall be approximately 45 degrees to a vertical line.

8.12.2.3 LINE POSTS

8.12.2.3.1 MATERIALS

2 1/2” O. D. standard weight steel pipe, 3.12 lb./ft, SS-40 or WT-40, hot-dipped galvanized, per ASTM A-90.

8.12.2.3.2 HEIGHT

Shall be of sufficient height to:

(a) Accommodate a 10-foot fabric.

(b) Accommodate an extension arm.

(c) Be imbedded three (3) feet into a concrete footing.

8.12.2.4 CORNER POSTS

8.12.2.4.1 MATERIAL

3.0" O.D. x 4.64 lb./ft. standard weight steel pipe, SS-40 or WT-40, hot-dipped galvanized per ASTM A-90.

8.12.2.4.2 HEIGHT

Shall be of sufficient height to:

(a) Accommodate a 10-foot fabric.

(b) Accommodate an extension arm.

(c) Be imbedded three (3) feet into a concrete footing.

8.12.2.5 SWING GATE POSTS

8.12.2.5.1 MATERIAL

Vehicle gateposts shall be 6.0" I.D. x 18.97 lb./ft standard weight steel pipe, Sch. 40 hot dipped galvanized, per ASTM A-120. **Vehicle gates shall have three (3) hinges per gate leaf.** Personnel gateposts shall be of the same material as corner posts above.

8.12.2.5.2 HEIGHT

Shall be of sufficient height to:

(a) Accommodate a l0 ft. fabric.

(b) Accommodate an extension arm.

(c) Be imbedded four (4) feet into a concrete footing.

8.12.2.6 GATES

8.12.2.6.1 Double gate frames shall be 2" O.D. x 2.28-lb/ft. standard weight steel pipe, SS-40 or WT-40, hot dipped galvanized per ASTM A-90. Each double gate frame shall be secured to a vehicle gatepost with **three (3) hinges**. Height shall be same as fence fabric with three (3) strands vertical and six (6) strands of horizontal barbed wire. Vehicle gates shall include a stop latch in the open position. See Fence Drawing for details.

8.12.2.6.2 Personnel Gate frame shall be 2" O.D. x 2.28 lb./ft standard weight steel pipe, SS 40, hot dipped galvanized per ASTM A-90. Height shall be same as fence fabric. See Fence Drawing for details.

8.12.2.6.3 Gate latches shall be lockable, heavy duty, double latching type, hot-dipped galvanized per ASTM A-90. **The location for the padlock shall be centered below the latch and be accessible from both sides of the gate. (International Security Products, Inc., PL152 Models or approved equals.)**

8.12.2.6.4 Sliding Gate (30' opening) shall be Privacy Panel Single Track Slide Gate as manufactured by Iron World or approved equal. Materials shall be hat dipped galvanized per ASTM A-90 and polyester resin powder-coated finished (color to be determined by owner).

8.12.2.7 EXTENSION ARMS

8.12.2.7.1 MATERIAL

The extension arms shall extend upward and outward from the fence at an angle of 45 degrees. There shall be provisions for three equally spaced strands of barbed wire on the extended arms. The upper most wire shall be approximately 1 foot vertically above the fabric.

The extension arm shall be made of pressed steel or malleable iron and should be capable of supporting a downward force of 300 lbs.

The extension arm shall be galvanized in accordance with ASTM A-153, Class B1.

8.12.2.7.2 FASTENING OF BARBED WIRE

Slots secured by heavy wire pins.

8.12.2.8 TOP RAIL

8.12.2.8.1 MATERIAL

1 5/8" O.D. x 1.84 lb./ft. standard weight steel pipe, SS-40 or WT-40, hot-dipped galvanized per ASTM A-90.

8.12.2.8.2 COUPLINGS

Outside sleeve type, spaced about 20 feet apart, at least 5 1/2 inches long, with provisions for expansion and contraction, hot-dipped galvanized per ASTM A-123.

8.12.2.8.3 FASTENINGS

Top rail is to pass through base of extension arm to be securely fastened to end, gate and pull posts.

8.12.2.9 STRETCHER BARS

Stretcher bars shall be galvanized steel bars not less than 1/4 in. x 3/4 in. They shall be approximately 1" less than the fabric height.

The stretcher bar shall be used for securing the fabric to all corner posts. One bar is required for each gate and end posts and **two required for each corner and pull post**.

8.12.2.10 BARBED WIRE

8.12.2.10.1 MATERIAL

Two strands of No. 12 1/2 USWG 4 half-round barbs, max. 5-inch spacing, aluminum coated barbed wire, per ASTM A-121 Class 3.

8.12.2.10.2 NUMBER OF LINES

Three.

8.12.2.11 BRACES

8.12.2.11.1 LOCATION.

At gate and terminal posts only, extending to first line post, midway between top rail and ground.

8.12.2.11.2 MATERIAL

Same as top rail.

8.12.2.11.3 CONNECTIONS AND FITTINGS

Malleable iron, per ASTM A-47 or pressed steel, SAE-1025, fittings, hot-dipped galvanized, per ASTM A-123.

8.12.2.11.4 DIAGONAL BRACE ROD

3/8" diameter rod with turnbuckle, hot dipped galvanized per ASTM A-90.

8.12.2.12 FABRIC TIES AND BANDS

8.12.2.12.1 MATERIAL

Aluminum wire per ASTM "Tentative Specifications for Aluminum and Aluminum-Alloy Bars, Rods and Wire." B-211, Alloy 990A or aluminum strip per ASTM "Tentative Specifications for Aluminum and Aluminum-Alloy Sheet and Plate, "B-209, Alloy 990A. Bands and/or clamps shall be beveled and non-climbing.

8.12.2.12.2 SPACING

Ties - every 24 inches to top rail.

Bands - every 24 inches to posts.

8.12.2.13 TENSION WIRE

8.12.2.13.1 MATERIAL

7-gauge high carbon steel coil spring tension wire.

8.12.2.13.2 LOCATION

Installed 4 inches above grade around perimeter of fence, except on gates.

8.12.2.14 MISCELLANEOUS HARDWARE

Material: ("Castings" per ASTM "Standard Specification.")

(1) Industrial drop rod minimum diameter of ½". Rod with two guides.

(2) Center stop for vehicle gate to be mushroom type, set in concrete.

(3) For "Gray Iron Castings" A-48.

(4) For "Malleable Iron Castings" A-47.

(5) For "Steel Castings" A-27.

(6) Beveled non-climbing type clamps, bands.

Rolled, pressed and forged steel: SAE 1025.

8.12.3. INSTALLATION

8.12.3.1 SPACING OF POSTS

Not more than 10 feet center to center. Post locations shall be coordinated on site with ground stinger installed by others.

8.12.3.2 CONCRETE FOOTINGS

8.12.3.2.1 CONCRETE

Maximum compressive strength of 2500 psi at 28 days with a maximum size aggregate of 1".

8.12.3.2.2 DIAMETER

18 inches for center stop, 12 inches for line posts, 18 inches for corner posts and gate posts; **all with crowned tops**. **The crowned tops shall extend 3-inches above the sub grade using sonar tube forms. The sonar tube shall be removed from all piers prior to fabric installation. The mushroom center stop shall be above the stone.**

8.12.3.2.3 DEPTH

All posts to extend into footings, three (3) feet for corner posts and line posts, and four (4) feet for gate posts. Bottom of post to be three (3) inches above bottom of pier. Center stop pier to be two and one-half (2.5) feet deep.

8.12.3.3 FABRIC

The fabric shall be secured to the fence posts at the top of the crowned post piers and shall extend up to the top of the posts and top rail. See Fence drawing for details.

8.12.3.4 SLIDING GATE

The sliding gate shall be installed in accordance with manufactures specifications and to satisfy manufacturer warranty requirements.

Exhibit C:

Interconnection Requirements

Revision Date: February 28, 2019

Version No: 1.0

Approved By: Chip Kingsley

Technical Review: Dave Appleby

TABLE OF CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is interconnected to the Potomac Electric Power Company (PEPCO) transmission system and serves as a Local Control Center (LCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." tariff, the "Interconnection and Mutual Operating Agreement" between Potomac Electric Power Company (PEPCO) and SMECO, and the PJM Manual 14 series documents.

1.2. DISCLAIMER

This document and all the material contained herein are developed for guidance purposes only. It is produced as an informational and illustrational aid for customers operating generation equipment that is interconnecting with the SMECO electric system. The information herein is intended to be of a general and typical nature and does not pertain to a specific facility or site. Furthermore, the requirements and practices described herein are subject to change based upon several factors, such as changing regulations. Accordingly, SMECO makes no warranty of any nature whatsoever concerning the information contained in this document.

1.3 PURPOSE

This document is developed to provide guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

2. CUSTOMER GENERATION INTERCONNECTION REQUIREMENTS

2.1. 600V INTERCONNECTION

The 600V interconnection configuration requires a visible load break disconnect on the customer side of the Point of Interconnect (POI). The Customer 600V interconnection requirements are shown on the attached Drawing:

- A-4560 - Typical Interconnection 600V Simplified One Line (2MW or Less)

2.2. 15KV INTERCONNECTION

The 15kv interconnection configuration requires a 600A, 2 way, padmount switch. The Customer 15kV interconnection requirements are shown on the attached Drawing:

- A-4561 - Typical Interconnection 15kV Simplified One Line (10MW or Less)

2.3. 69KV OR 230KV INTERCONNECTION – GENERATOR REQUIREMENTS

The 69kV or 230kV interconnection configuration is described in more detail below in this document. The Customer 69kV or 230kV interconnection requirements are shown on the attached Drawing:

- A-4562 - Typical Interconnection 69kV or 230kV Simplified One Line (Generator Requirements)

2.4 69KV INTERCONNECTION

The 69kV Interconnection Station configuration is a 4 breaker Ring with up to 3 SMECO line positions and 1 interconnection circuit positions. See attached Drawings:

- D-3611 - Typical Interconnection 69kV Functional One Line - Four Breaker Ring
- D-3612 - Typical Interconnection 69kV Site Plan

2.5 230KV INTERCONNECTION

The 230kV Interconnection Station configuration is a 6 breaker Ring with 4 SMECO line positions and 2 interconnection circuit positions. See attached Drawings:

- D-3613 - Typical Interconnection 230kV Functional One Line Six Breaker Ring - Sheet 1 and 2

- D-3614 - Typical Interconnection 230kV Site Plan

2.6 INTERCONNECTION COMMUNICATIONS BLOCK DIAGRAM

The 69kV or 230kV transmission line relaying requires dual independent communications to the remote substations. See attached Drawing:

- D-3610 - Typical Interconnection Communication Block Diagram - Four Breaker Ring

3. TRANSMISSION LINE RELAYING PHILOSOPHY

To meet the overall design philosophy, SMECO's high level philosophy for 230kV & 69kV transmission line relaying is dual, fully redundant, fully independent line relay schemes, including dual independent communications to remote substations and independent DC control circuits with dual station batteries. All of SMECO's 230kV & 69kV breakers are also equipped with dual, fully redundant breaker failure schemes. One-line relay scheme is designated as Line Relays #1 and the other is designated as Line Relays #2. The zone of protection, selectivity and operating speed are essentially the same for both schemes. For any in zone line fault, it is expected that both schemes will operate to initiate the clearing of the fault. With this approach, one set of relays can be taken out of service for testing/maintenance without any degradation in line protection. Line relay scheme and manufacturer diversity is also achieved by deploying line relays with different operating characteristics (i.e., current differential & impedance) and different manufacturers for Line Relays #1 and Line Relays #2. Most SMECO 230kV & 69kV transmission lines are terminated with a dedicated breaker, or with a breaker and a half substation configuration. Where appropriate, separate breaker currents, instead of summed currents are being connected to the line relay current inputs.

Presently, Line Relays #1 applications are being deployed with GE's UR-L90 microprocessor relays, either in a direct under-reaching and permissive over-reaching impedance scheme; or in a line current differential scheme, with over-reaching impedance back up if communications with the remote relay(s) is lost.

Presently, Line Relays #2 applications are being deployed with SEL's 411L microprocessor relays, either in a direct under-reaching and permissive over-reaching impedance scheme; or in a line current differential scheme, with over-reaching impedance back up if communications with the remote relay(s) is lost.

Line side VTs are connected to both sets of line relays. VTs with dual secondary windings are considered independent voltage circuits and meet industry standards. Leveraging the capability of the 411L relay to accommodate and utilize two independent 3-phase sets of voltage inputs, the 411L relay will be connected to both line side and bus VTs where applicable.

This high level of line relay scheme redundancy and independence meets or exceeds all industry accepted best practices and the applicable line relay requirements specified in the following documents. (or superseded by PJM & IEEE)

- PJM Manual 07, Effective Date: 11/16/2011
- Protective Relaying Philosophy and Design Guide – PJM Relay Subcommittee, August 15, 2013
- IEEE Transmission Line Relay Guide C37.113 Draft #8

4. TRANSMISSION BREAKER FAILURE AND AUTO RECLOSING PHILOSOPHY

To meet the overall design philosophy, SMECO's high level philosophy for 230kV & 69kV transmission station relaying is dual, fully redundant, fully independent breaker failure relay schemes, including dual independent DC control circuits with dual station batteries. One of the breaker failure relay schemes is designated as Breaker Failure #1, and the other is designated as Breaker Failure #2. Breaker Failure # 1 is initiated by Line Relays #1, and Breaker Failure # 2 is initiated by Line Relays #2.

Presently, Breaker Failure #1 applications are being deployed with GE's UR-C60 microprocessor relays, and Breaker Failure #2 applications are being deployed with Basler BE1-11 microprocessor relays.

Breaker Failure #1 also provides automatic reclosing when applicable. Line Relays #1 and #2 initiate auto reclosing. Typically, one of the two associated breakers for a line will be designated as the lead breaker, and the other will be designated as the follower breaker for auto reclosing purposes.

Breaker Failure #1 also provides full SCADA capability for all applicable devices.

5. INTERCONNECTION DRAWING LIST

A-4560 - Typical Interconnection 600V Simplified One Line (2MW or Less)

A-4561 - Typical Interconnection 15kV Simplified One Line (10MW or Less)

A-4562 - Typical Interconnection 69kV or 230kV Simplified One Line (Generator Requirements)

D-3611 - Typical Interconnection 69kV Functional One Line - Four Breaker Ring

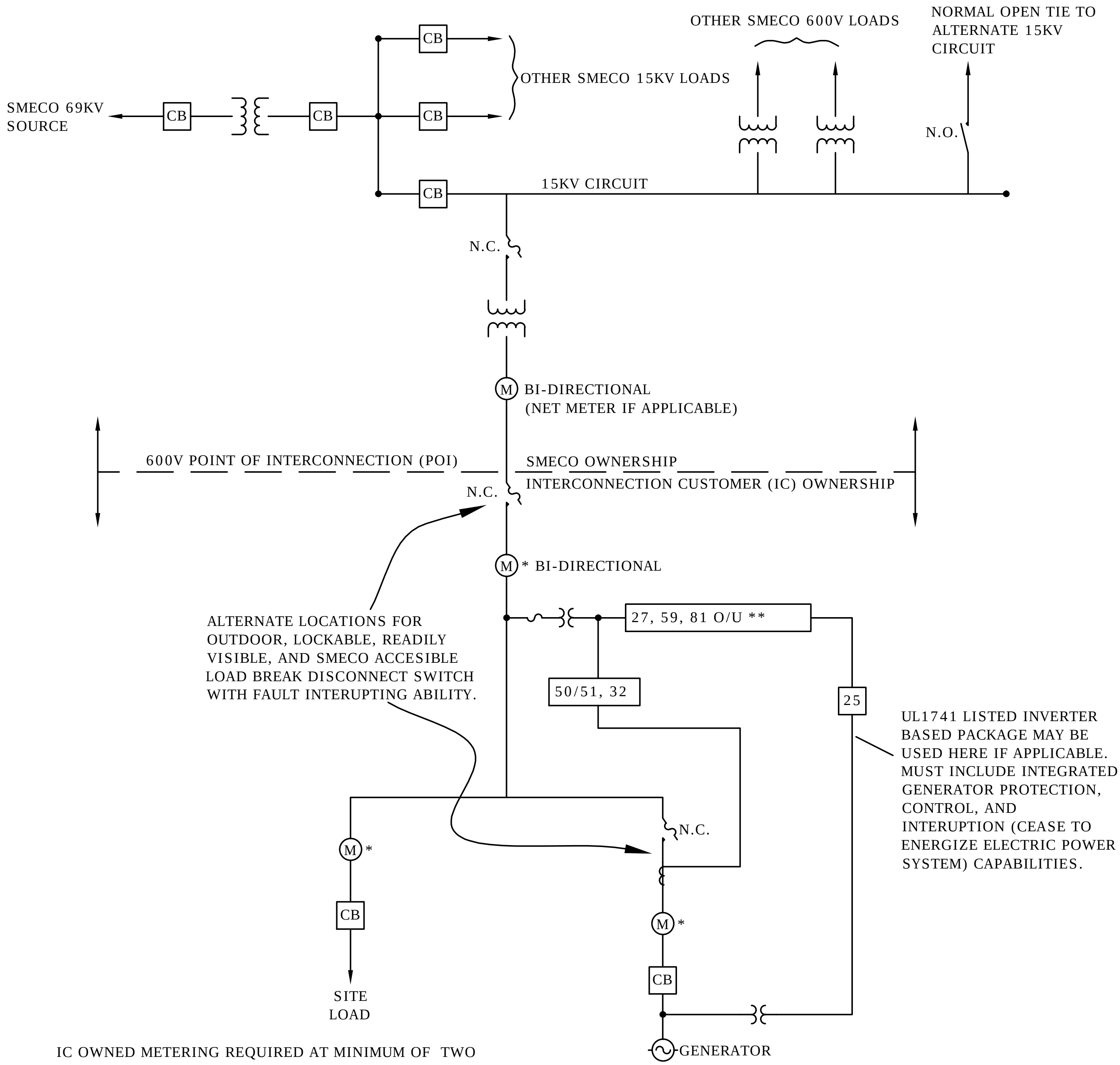
Exhibit C			
Interconnection Requirements			
Distribution: Public		Procedure No: 3010 Exhibit C	
Version No: 1.0	Revision Date: February 28, 2019	Review Cycle: 5 Years	Effective Date: February 28, 2019

D-3612 - Typical Interconnection 69kV Site Plan

D-3613 - Typical Interconnection 230kV Functional One Line Six Breaker Ring - Sheet 1 and 2

D-3614 - Typical Interconnection 230kV Site Plan

D-3610 - Typical Interconnection Communication Block Diagram - Four Breaker Ring



* IC OWNED METERING REQUIRED AT MINIMUM OF TWO IDENTIFIED LOCATIONS (EXCEPT IF NET METER). IC MAY BE REQUIRED TO PROVIDE REAL TIME TELEMETRY TO SMECO AT THESE LOCATIONS.

** WYE GND / WYE GND VT CONNECTION. ONE SINGLE PHASE 81 O/U REQUIRED. THREE PHASE 27 AND 59 REQUIRED UNLESS 59G IS USED WITH SEPERATE WYE GND / OPEN CORNER DELTA VT SOURCE.

NOTE: SEE ALSO PJM MANUAL 14G ATTACHMENT C "SMALL GENERATOR (10MW OR LESS)TECHNICAL REQUIREMENTS AND STANDARDS".

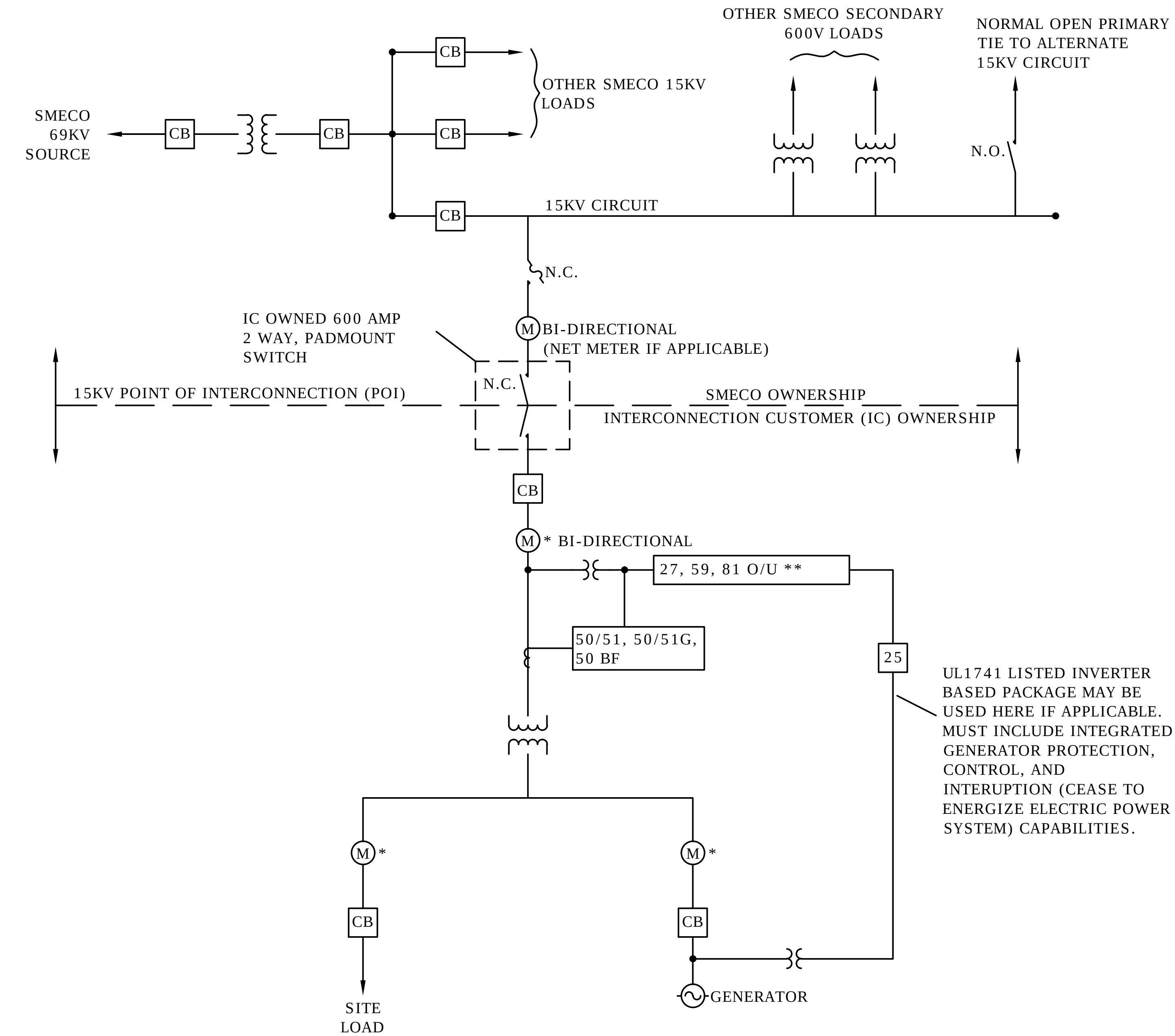
NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
0	02/28/2019	ISSUED AS PJM INTERCONNECTION STANDARDS		HS	AD		JTB

SOUTHERN MARYLAND ELECTRIC COOPERATIVE, INC.
HUGHESVILLE, MARYLAND 20637

TYPICAL INTERCONNECTION
600V SIMPLIFIED ONE LINE
(2MW OR LESS)

DRAWN	JML	DATE	02/28/19
CHECKED	HDR	REV.	0
APPROVED	JTB	DWG. NO.	A-4560
SCALE	NONE	SHT. NO.	1 OF 1

FILE_LOCATION



* IC OWNED METERING REQUIRED AT MINIMUM OF TWO IDENTIFIED LOCATIONS (EXCEPT IF NET METER). IC MAY BE REQUIRED TO PROVIDE REAL TIME TELEMETRY TO SMECO AT THESE LOCATIONS.

** WYE GND / WYE GND VT CONNECTION. ONE SINGLE PHASE 81 O/U REQUIRED. THREE PHASE 27 AND 59 REQUIRED UNLESS 59G IS USED WITH SEPERATE WYE GND / OPEN CORNER DELTA VT SOURCE.

NOTE: SEE ALSO PJM MANUAL 14G ATTACHMENT C "SMALL GENERATOR (10MW OR LESS) TECHNICAL REQUIREMENTS AND STANDARDS".

FILE_LOCATION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
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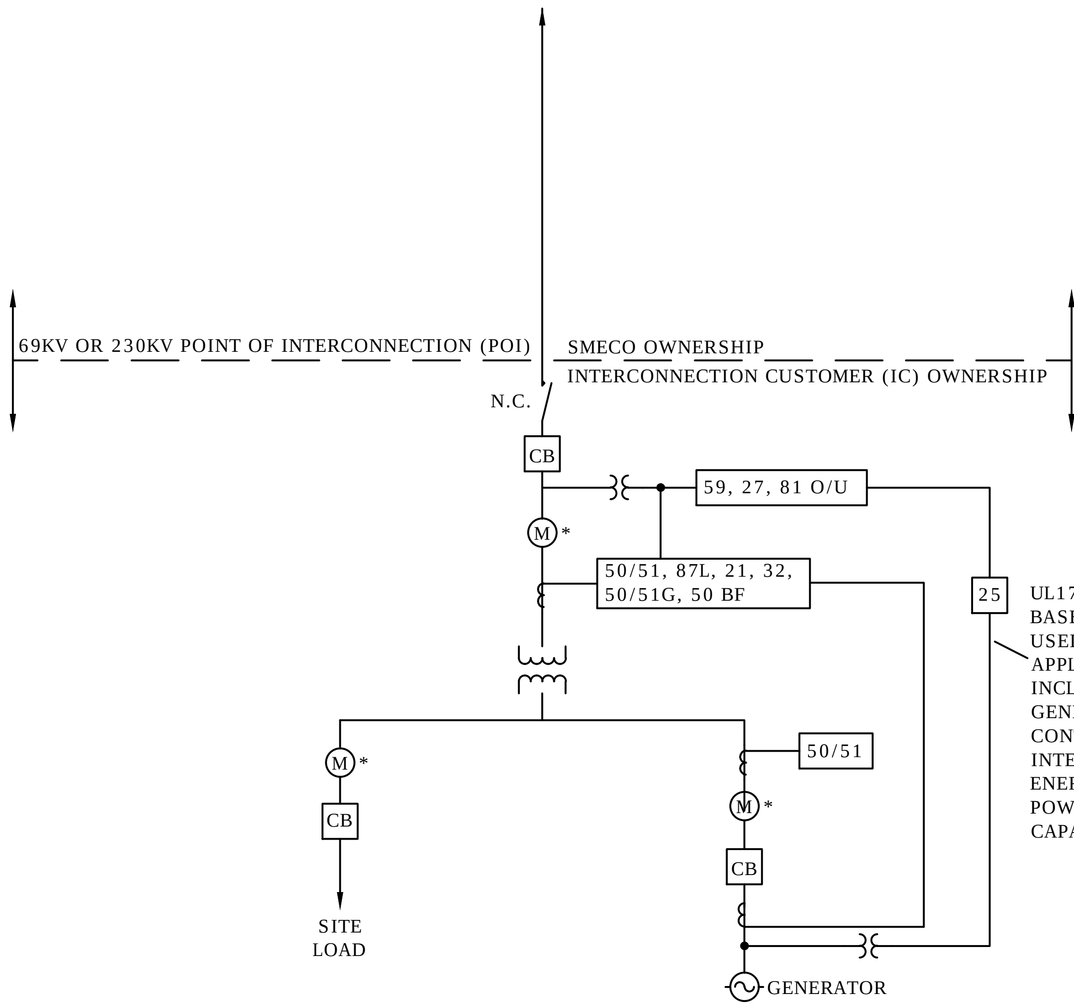
SOUTHERN MARYLAND ELECTRIC COOPERATIVE, INC.
HUGHESVILLE, MARYLAND 20637

TYPICAL INTERCONNECTION
15KV SIMPLIFIED ONE LINE
(10 MW OR LESS)

DRAWN	JML	DATE	02/28/19
CHECKED	HDR	REV.	0
APPROVED	JTB	DWG. NO.	A-4561
SCALE	NONE	SHT. NO.	1 OF 1

SEE EXHIBIT C - INTERCONNECTION
REQUIREMENTS FOR SMECO
ARRANGEMENT AND FUNCTIONAL ONE-LINE
DIAGRAM.



UL1741 LISTED INVERTER BASED PACKAGE MAY BE USED HERE IF APPLICABLE. MUST INCLUDE INTEGRATED GENERATOR PROTECTION, CONTROL, AND INTERUPTION (CEASE TO ENERGIZE ELECTRIC POWER SYSTEM) CAPABILITIES.

IC MAY BE REQUIRED TO PROVIDE REAL TIME TELEMETRY
TO SMECO AT THESE LOCATIONS.

*
NOTE: SEE ALSO PJM MANUAL 14G ATTACHMENT C
"SMALL GENERATOR (10MW OR LESS) TECHNICAL
REQUIREMENTS AND STANDARDS".

FILE_LOCATION

0	02/28/2019	ISSUED AS PJM INTERCONNECTION STANDARDS		HS	AD		JTB
NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP

SOUTHERN MARYLAND ELECTRIC COOPERATIVE, INC.
HUGHESVILLE, MARYLAND 20637

TYPICAL INTERCONNECTION
69KV OR 230KV SIMPLIFIED
ONE LINE (GENERATOR
REQUIREMENTS)

DRAWN	JML	DATE	02/28/19
CHECKED	HDR	REV.	0
APPROVED	JTB	DWG. NO.	A-4562
SCALE	NONE	SHT. NO.	1 OF 1

SOUTHERN MARYLAND ELECTRIC COOPERATIVE, INC.
HUGHESVILLE, MARYLAND 20637

TYPICAL INTERCONNECTION 69KV FUNCTIONAL ONE LINE FOUR BREAKER RING

0	02/28/2019	ISSUED AS PJM INTERCONNECTION STANDARDS	HS	AD		JTB		
NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP	

DRAWN	TIER_1	DATE	02/28/19
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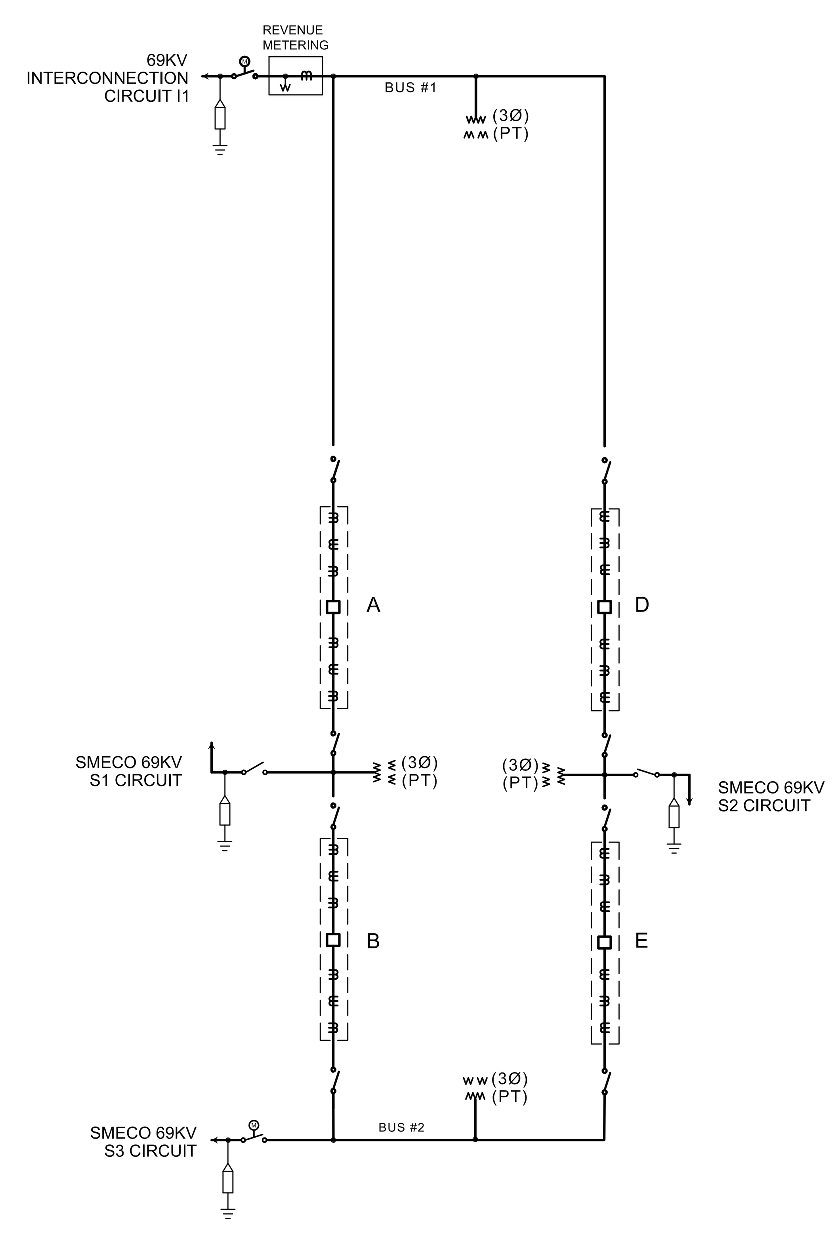
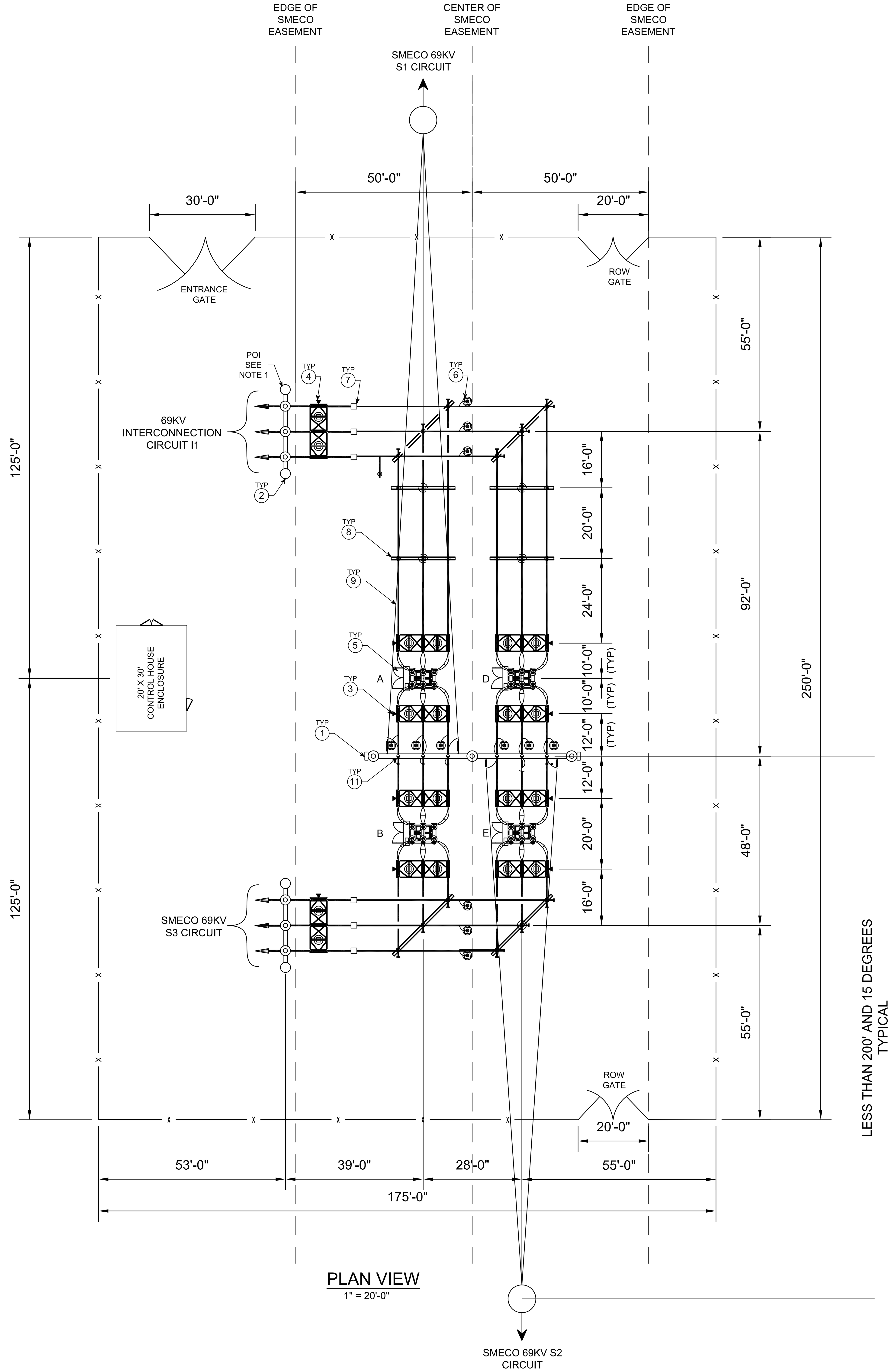


SIMPLIFIED ONE LINE



PLAN VIEW
1" = 20'-0"

Legend		
Item #	Quantity	Description
1	1	69kV double bay termination structure.
2	2	69kV single bay termination structure.
3	8	69kV, 2000A, USCO center break, horizontal upright mounted, group manually operated with Aux switch
4	2	69kV, 2000A, USCO vertical break, horizontal upright mounted, group motor operated with Aux switch
5	4	69kV, 2000A, Meppi SF6 circuit breaker, 350kV BIL, 40KA, 48VDC
6	12	69kV Relaying PT, 350kV BIL
7	6	69kV Metering CT/PT Combo, 350kV BIL
8	8	69kV three phase bus support.
9	Lot	4" EHIPS AL 6063-T6 seamless schedule 80 bus
10	Lot	Dual 1590 kcmil AAC "Coreopsis" conductor
11	12	57kV MCOV station class surge arrester

Notes

1. The Point of Interconnection (POI) will be the jumper connection to the deadend insulator on the 69kV single bay termination structure.
2. The 69kV revenue metering units will be a PT/CT combo with metering accuracy.
3. SMECO will allow use of the existing transmission easement for the switching station but the IC is responsible for acquiring and conveying the necessary land to SMECO prior to any site work.
4. The existing SMECO 69kV lines, if possible, shall be aligned with the double bay termination structures. New transmission dead-end poles shall be located within 200 feet of the termination structure with a 15 degree or less take off.
5. If the new interconnection facility must be located away from the existing transmission easement, additional transmission structures will be required.
6. The Interconnecting Customer (IC) is responsible for all aspects of the new 69kV interconnecting lines and any collector substation facilities subject to SMECO review and approval.
7. The existing 69kV transmissions lines shall remain in service during construction which may require a temporary bypass line.
8. The interconnection switching station shown is a typical plan that may need to be modified based on the actual proposed site.

PLAN VIEW SCALE

20' 10' 0 20' 40'

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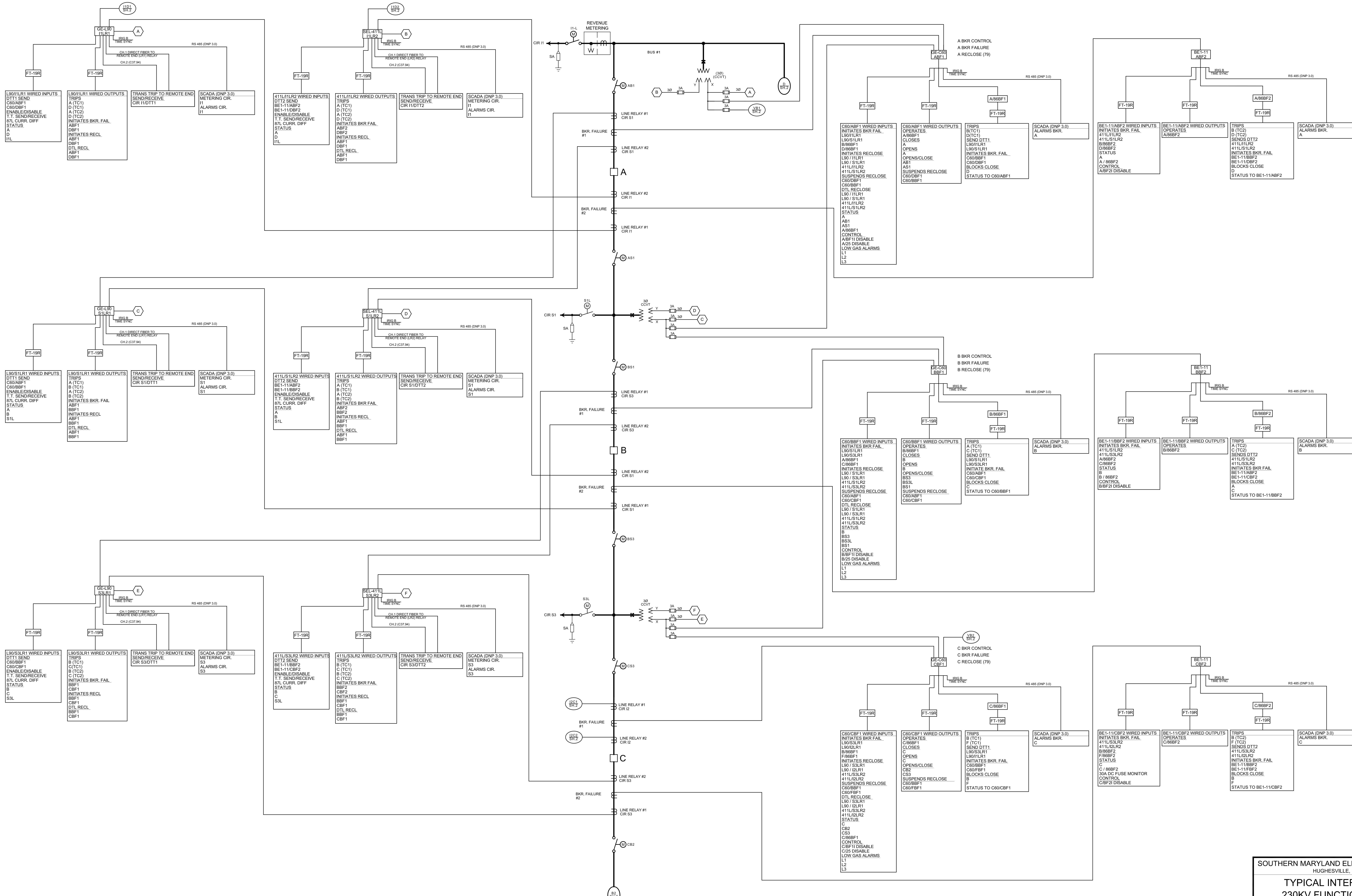
SOUTHERN MARYLAND ELECTRIC COOPERATIVE, INC.
HUGHESVILLE, MARYLAND 20637

TYPICAL
INTERCONNECTION
69KV SITE PLAN

DRAWN	TIER_1	DATE	02/28/19
CHECKED	H.SUMMERS/A.DEPEW	REV.	0
APPROVED	JTB	DWG. NO.	D-3612
SCALE	1"=20'	SHT. NO.	1 OF 1

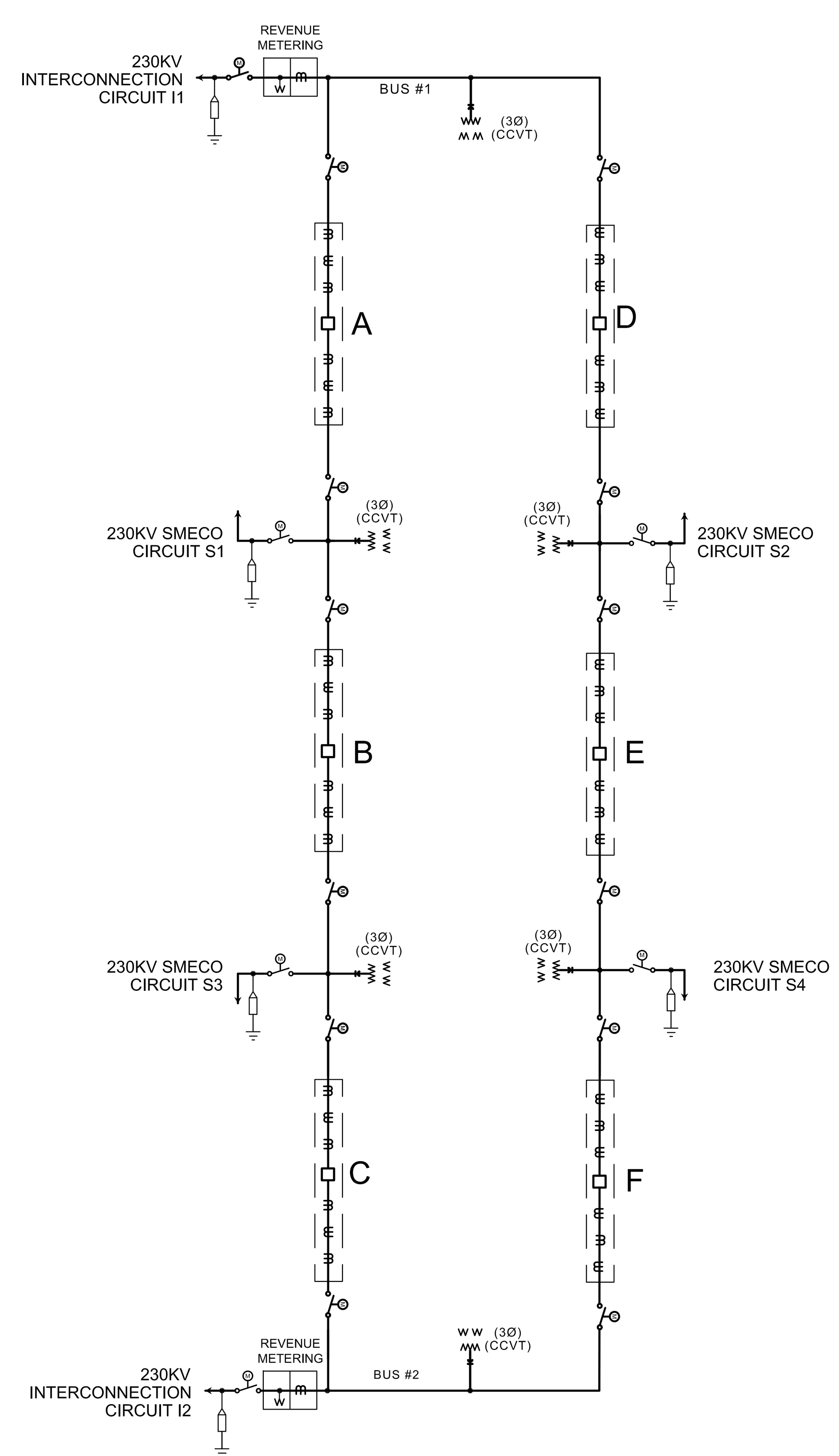


NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
0	02/28/2019	ISSUED AS PJM INTERCONNECTION STANDARDS		HS	AD		JTB

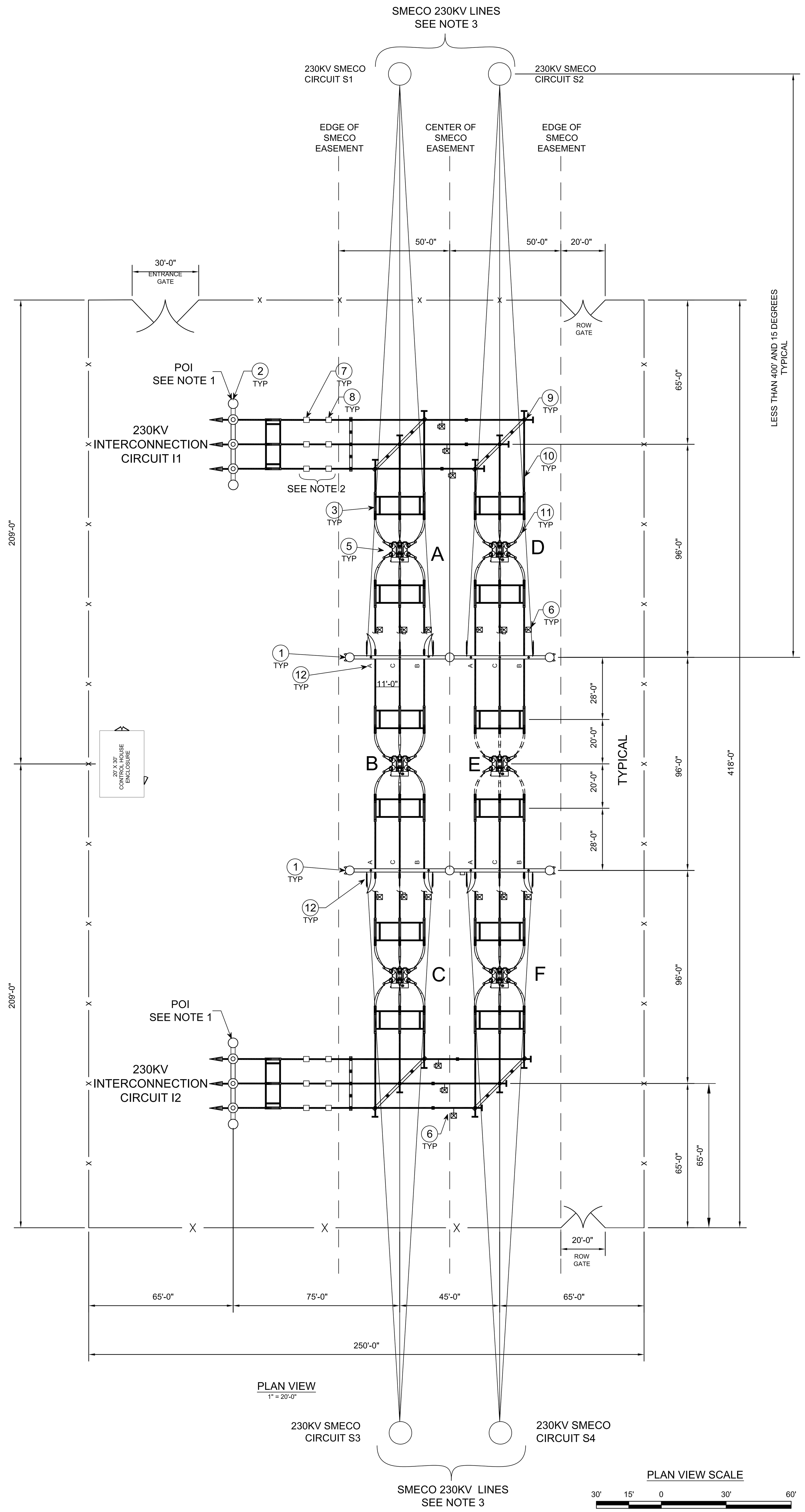
SOUTHERN MARYLAND ELECTRIC COOPERATIVE, INC.
HUGHESVILLE, MARYLAND 20637

TYPICAL INTERCONNECTION
230KV FUNCTIONAL ONE LINE
SIX BREAKER RING
SHEET 1

DRAWN	TIER_1	DATE	02/28/19
CHECKED	H.SUMMERS/A.DEPEW	REV.	0
APPROVED	JTB	DWG. NO.	D-3613
SCALE	N.T.S.	SHT. NO.	1 OF 2



SIMPLIFIED ONE LINE



PLAN VIEW
1" = 20'-0"

PLAN VIEW SCALE
30' 15' 0 30' 60'

Item #	Quantity	Description
1	2	230kV double bay termination structure.
2	2	230kV single bay termination structure.
3	14	230kV, 3000A, USCO vertical break, horizontal upright mounted, group motor operated with Aux switch
4	4	230kV, 3000A, southern states double end break, vertical mounted, group motor operated with Aux switch
5	6	230kV, 3000A, Meppi SF6 circuit breaker, 900kV BIL, 63KA, 125VDC
6	18	230kV Relaying CCVT, 900kV BIL
7	6	230kV Metering PT, 900kV BIL
8	6	230kV Metering CT, 900kV BIL
9	10	230kV three phase bus support.
10	Lot	4" EHIPS AL 6063-T6 seamless schedule 80 bus
11	Lot	Dual 1590 kcmil AAC "Coreopsis" conductor
12	18	144kV MCOV station class surge arrester

Legend

Notes

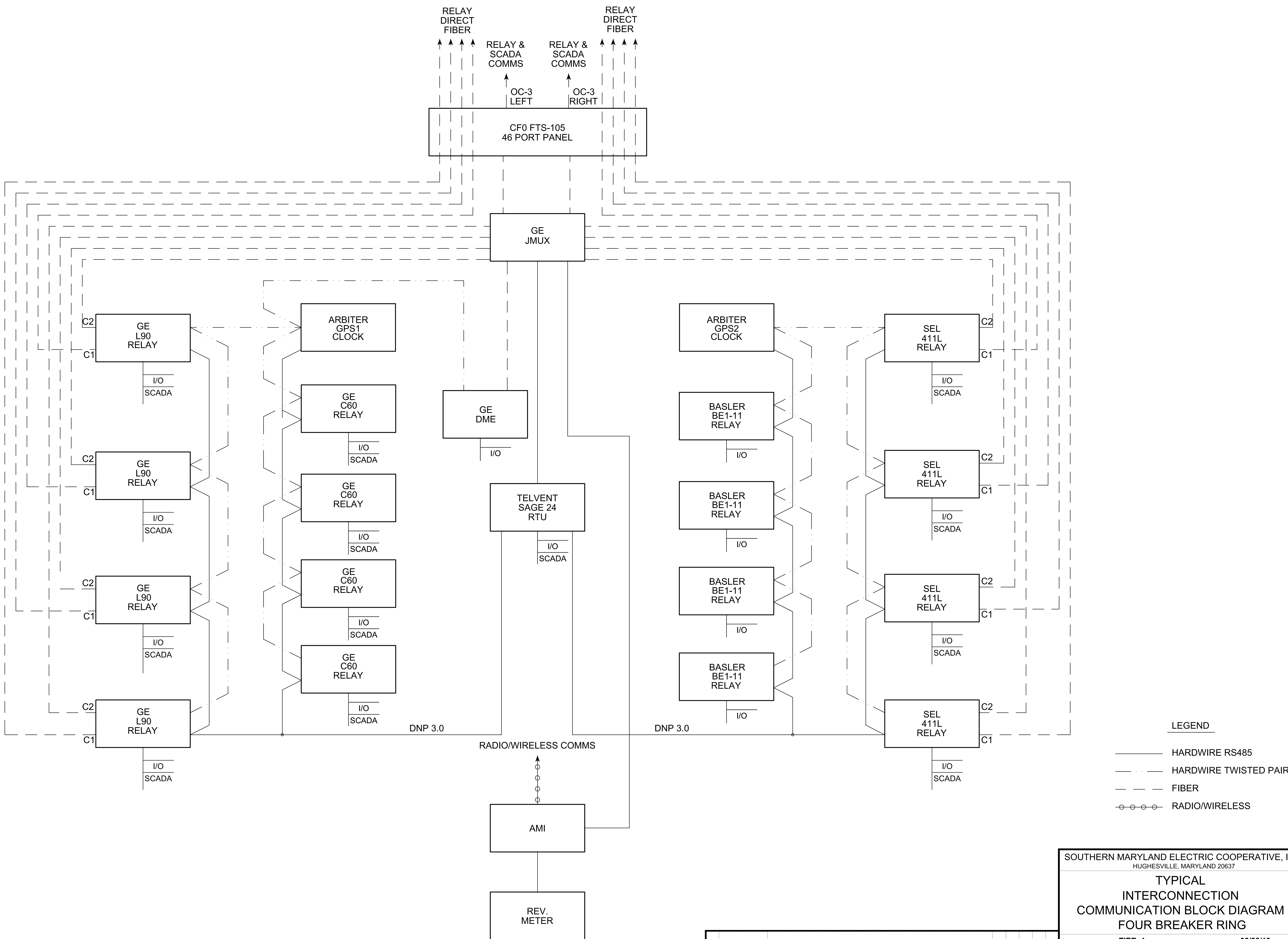
1. The Point of Interconnection (POI) will be the jumper connection to the deadend insulator on the 230kV single bay termination structure.
2. The 230kV revenue metering PT's and CT's shall be separate units and shall be metering accuracy.
3. SMECO will allow use of the existing transmission easement for the switching station but the IC is responsible for acquiring and conveying the necessary land to SMECO prior to any site work.
4. The existing SMECO 230kV lines, if possible, shall be aligned with the double bay termination structures. New transmission dead-end poles shall be located within 400 feet of the termination structure with a 15 degree or less take off.
5. If the new interconnection facility must be located away from the existing transmission easement, additional transmission structures will be required.
6. The Interconnecting Customer (IC) is responsible for all aspects of the new 230kV interconnecting lines and any collector substation facilities subject to SMECO review and approval.
7. The existing 230kV transmissions lines shall remain in service during construction which may require a temporary bypass line.
8. The interconnection switching station shown is a typical plan that may need to be modified based on the actual proposed site.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
0	02/28/2019	ISSUED AS PJM INTERCONNECTION STANDARDS		HS	AD		JTB

SOUTHERN MARYLAND ELECTRIC COOPERATIVE, INC.
HUGHESVILLE, MARYLAND 20637

TYPICAL INTERCONNECTION 230KV SITE PLAN

DRAWN	TIER_1	DATE	02/28/19
CHECKED	H.SUMMERS/A.DEPEW	REV.	0
APPROVED	JTB	DWG. NO.	D-3614
SCALE	1"=30'	SHT. NO.	1 OF 1



NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
0	02/28/2019	ISSUED AS PJM INTERCONNECTION STANDARDS	HS	AD			JTB

SOUTHERN MARYLAND ELECTRIC COOPERATIVE, INC.
HUGHESVILLE, MARYLAND 20637

TYPICAL INTERCONNECTION COMMUNICATION BLOCK DIAGRAM FOUR BREAKER RING

DRAWN	TIER_1	DATE	02/28/19
CHECKED	H.SUMMERS/A.DEPEW	REV.	0
APPROVED	_	DWG. NO.	D-3610
SCALE	N.T.S.	SHT. NO.	1 OF 1

Exhibit D:

Customer Generation Protective Relaying Requirements

Revision Date: February 28, 2019

Version No: 1.0

Approved By: Chip Kingsley

Technical Review: Dave Appleby

Exhibit D Customer Generation Protective Relaying Requirements			
Distribution: Public		Procedure No: 3010 Exhibit D	
Version No: 1.0	Revision Date: February 28, 2019	Review Cycle: 5 Years	Effective Date: February 28, 2019

TABLE OF CONTENTS

Exhibit D	
Customer Generation Protective Relaying Requirements	
Distribution: Public	Procedure No: 3010 Exhibit D

Version No: 1.0	Revision Date: February 28, 2019	Review Cycle: 5 Years	Effective Date: February 28, 2019

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is interconnected to the Potomac Electric Power Company (PEPCO) transmission system and serves as a Local Control Center (LCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." tariff, the "Interconnection and Mutual Operating Agreement" between Potomac Electric Power Company (PEPCO) and SMECO, and the PJM Manual 14 series documents.

1.2. DISCLAIMER

This document and all the material contained herein are developed for guidance purposes only. It is produced as an informational and illustrational aid for customers operating generation equipment that is interconnecting with the SMECO electric system. The information herein is intended to be of a general and typical nature and does not pertain to a specific facility or site. Furthermore, the requirements and practices described herein are subject to change based upon several factors, such as changing regulations. Accordingly, SMECO makes no warranty of any nature whatsoever concerning the information contained in this document.

1.3 PURPOSE

This document is developed to provide guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

2. TECHNICAL INTRODUCTION

2.1. PARALLEL OPERATION OF CUSTOMER GENERATION

Parallel operation of customer generation equipment on the Southern Maryland Electric Cooperative (SMECO) system requires that SMECO and the customer meet certain minimum requirements for operation and safety. This document attempts to describe the general interconnection requirements and includes several illustrative installations. SMECO and the customer's registered Professional Engineer (PE) will be guided by this document when planning such an installation. The equipment and protection listed in the attached diagrams represent specific examples from which a final customer installation can be developed and approved. It is stressed that all interconnections between customer-owned generation and the SMECO system should be reviewed by SMECO early in the design stage. SMECO personnel will work closely with the customer, from an early stage of the project, to ensure that the intent of these guidelines are met.

Customers considering parallel operation facilities should contact SMECO as early in the project as possible for additional information.

For planning and estimating purposes, these examples include equipment normally included by the customers for the protection of their facilities. While not intended to be specific requirements by SMECO, these facilities are identified on the diagrams and will be reviewed during the SMECO-customer, site-specific planning process for overall system integrity.

2.2. GUIDELINES AND PERFORMANCE STANDARDS

These GUIDELINES AND PERFORMANCE STANDARDS are based on current electrical engineering practice and normal equipment design. Consistent with SMECO's desire to support and encourage customer-owned generation and small power production, SMECO will entertain any alternative equipment proposal and evaluate any that appears upon preliminary review with the customer's engineer to be feasible for the particular site and/or type of generation contemplated.

All customer installations must adhere to all applicable national and local codes, standards, rules and regulations.

Metering requirements are detailed in Exhibit F, and meter equipment locations are detailed in Typical Interconnection drawings contained in Exhibit C – Interconnection Requirements.

3. SYSTEM CLASSIFICATIONS

3.1. TYPE OF POWER FLOW

In planning paralleled operation of customer generation equipment, proposed facilities can be categorized into one of two major groups: One-Way Power Flow or Two-Way Power Flow.

3.1.1. ONE-WAY POWER FLOW

Customers whose load is always greater than their generating capacity, or who do not desire to sell their excess power are defined as one-way power installations. This type of installation will receive power from SMECO but will never sell power back to SMECO.

3.1.2. TWO-WAY POWER FLOW

Customers whose load is sufficiently variable or smaller than their generating capacity and who wish to sell their excess power to SMECO are defined as two-way power flow installations. This type of installation provides for normal power flow in either direction, with SMECO selling power to the customer or customer selling power to SMECO.

Note: This category also covers installations whose normal power flow is only to SMECO, with no power sold by SMECO to the customer.

3.2. TYPE OF GENERATION EQUIPMENT

The type of generation equipment used by the customer, along with the power flow requirements, determines what type of protective equipment is needed. The customer may use either Synchronous Generators or Signal Dependent Generators, which may include DC-AC inverters, both photovoltaic and wind.

3.2.1. SYNCHRONOUS GENERATORS

This type of generation equipment is capable of operation independent of any signal from SMECO and can supply power to the customer’s load when the SMECO supply is unavailable. Special protection and/or communications schemes must be installed to ensure that synchronous generators do not supply power back to an isolated part of the SMECO system when the supply feeder's circuit breaker is open at the SMECO source station. This condition is called "islanding" and is not permitted under any conditions in order to insure public safety and to prevent possible damage to other customers' equipment. Two-Way Power Flow installations may frequently use synchronous generators.

3.2.2. SIGNAL DEPENDENT GENERATORS

This type of generation equipment requires a signal from the SMECO system to operate. It is not generally capable of supplying backup power to the customer's load upon loss of the SMECO supply. The protection of this type of equipment is less complex than that required for synchronous generators. Induction generators and inverters usually fall into this category. All signal dependent generator installations must meet the anti-islanding criteria as specified in the latest revision of IEEE Standard 1547, specifically.

4. GENERAL REQUIREMENTS – SYSTEM PROTECTION

4.1. CRITICAL CONCERNS

In the course of reviewing a proposed customer owned generation installation, two critical concerns must be addressed. These issues can affect the viability of a proposed interconnection and should therefore be reviewed in the early planning stages of the project.

Fault Duty - The effect of fault contributions from the customer owned generator on the interrupting and momentary ratings of the SMECO supply busses' and other customers' equipment must be determined and considered. Customer owned generator fault current flows cannot be allowed to over-duty existing SMECO or other customers' equipment. Fault duty mitigation methods and/or equipment replacement may be needed to prevent any over-duty issues on existing SMECO or other customers' equipment.

Load Flow - In the case of two-way power flow installations, the proposed power sold to SMECO must be able to be absorbed into the SMECO system at the interconnection point. The effect of power flow from customer owned generator installations on SMECO's load flows must be studied, and affect the design of the interconnection station, including interconnection location and voltage, as well as the customer's generation system.

4.2. PROTECTIVE DEVICES

Certain protective devices, including an interrupting device and protective relays, will be required and must be approved by SMECO and must be installed at any location where a customer desires to operate generation equipment in parallel with the SMECO system. The protection of the customer's system beyond the Point of Interconnection (POI) is the sole responsibility of the customer. See Section 8 for additional details.

4.3. SYSTEM SEPARATION

The protection applied at the intertie point will be designed to separate the customer's system from the SMECO system for the following conditions.

- For faults or other intolerable conditions on the SMECO system within the zone of protection encompassing the intertie point which produce in-feed from the customer's generation equipment into the SMECO fault.
- For faults or other intolerable conditions on the customer's system.
- Whenever the SMECO feeder is deenergized, either by the opening of its circuit breaker(s) at the SMECO source station(s) or by any other means.

4.4. SINGLE CONTINGENCY.

The design and application of the required protective relaying is based on a "Single Contingency" philosophy. This means that sufficient relaying redundancy must be included so that the failure of any single component in the proposed protective relaying system, including any one protective relay, communication channel, trip coil, or DC supply system, will not prevent proper operation of the protective relaying system, and associated interrupting devices.

4.5. CUSTOMER RESPONSIBILITY.

Protection - The customer is fully responsible for protecting their equipment in such a manner that automatic or manual circuit reclosing, faults, or any other disturbances or operations on the SMECO system or the customer's system does not cause damage to their equipment. The customer's generator controls must include automatic voltage regulation equipment that is inherently self-protecting in both lead and lag conditions.

Separation - The customer's generation may not maintain supply to a SMECO circuit following the opening (de-energizing) of the SMECO circuit. Whenever the SMECO supply circuit breaker opens or the supply feeder is otherwise de-energized, the intertie breaker must also open through some definite means.

Relay Settings - All relay setting calculations and coordination at the POI will be prepared by the customer's PE and reviewed and approved by SMECO. The customer must supply SMECO with all pertinent calculations to allow review of the intertie relay settings. For coordination purposes, SMECO will provide applicable up stream protective device settings as necessary.

Testing and Commissioning - The initial setting and commissioning of the protective devices at the intertie point will be done by a recognized testing agency. Functional test and setting results must be furnished to SMECO for review. Depending on the specific installation, SMECO may require witnessing of the testing and commissioning. See also Section 6 of this document for routine testing requirements.

Inspection - SMECO reserves the right to inspect, with adequate notice, all protective equipment including relays, circuit breakers, etc., at the intertie station. Inspection may include the tripping of the intertie breaker by the protective relays, which would be coordinated between SMECO and the customer.

Communications - Installations connected to the SMECO system will require protection schemes consistent with the local system configuration and existing relaying schemes. In order to satisfy protective relaying requirements stated in this document, communication channels may be required for transfer trip. These communication channels, depending on site location, may be fiber optic or other approved reliable means.

Connection - SMECO's 4-wire 15 kV system is designed to allow switching of customers from one feeder to another and from one substation to another, in order to permit reliable operation of the system. Since this switching philosophy precludes use of transfer trip, only Signal Dependent Generators or one-way power flow installations can be connected to SMECO's 15 kV System.

5. GENERAL REQUIREMENTS – SWITCHING

5.1. OPERATIONAL CONTROL – WITHOUT NOTICE

Switching of the intertie breaker, or other disconnect device (if applicable), must be under the operating control of SMECO. SMECO reserves the right to operate the intertie breaker without prior notice in any of the following circumstances:

- Emergency Conditions (Local, System Wide or Regional).
- Inspection of intertie station reveals an unsafe condition.
- The customer's generation interferes with other customers' systems, or with the operation of the SMECO system.

5.2. OPERATIONAL CONTROL – WITH NOTICE

SMECO reserves the right to open the intertie device with twenty-four hour notice if:

- Inspection of intertie station and protective equipment reveals a lack of maintenance, records of maintenance or any other conditions not meeting these guidelines.
- An outage is scheduled on the SMECO supply feeder.

5.3. BREAKER CONTROL

The intertie device will be allowed to close only if the customer side of the intertie breaker is deenergized.

5.4. SYNCHRONIZING

The customer shall be solely responsible for properly synchronizing his generation equipment with SMECO's system.

5.5. ISLAND OPERATION

The customer's generation equipment shall not be permitted to energize or maintain supply to a deenergized SMECO circuit.

5.6. SCADA.

SMECO's requirements for supervisory control and data acquisition equipment as well as the associated metering equipment will be specified on an individual basis.

6. SYSTEM PROTECTION - SHORT DURATION CLOSED TRANSITION SWITCHING

6.1. MAKE - BEFORE – BREAK

A short duration closed transition (make-before-break) switching application involves switching the generation facility's load from the SMECO supply to the generation supply and vice versa such that the two supplies are paralleled for a time spanning no greater than 5 minutes (ref. IEEE 1547).

6.2. AUTOMATIC TRANSFER SWITCH

Generation facilities may propose to use an Automatic Transfer Switch (ATS) to implement short duration closed transition switching. SMECO will consider the application of such a switch on a case by case basis, considering:

- The impact that the operation of an ATS would have on personnel safety and other customers on the SMECO system.
- The possibility that a failed automatic transfer switch could result in continuous paralleling of both supplies, simultaneous loss of both supplies, and simultaneous tripping of both supplies.
- All applicable safety and industry standards.
- The ATS manufacturer's current and voltage ratings.

For those generation facilities whose only interest is to implement closed transition switching via an ATS, additional relaying may not be required if the proposed ATS is capable of switching the supplies in less than 100 milliseconds, and has a retrip feature that will automatically trip the necessary breakers to prevent continuous paralleling if the ATS malfunctioned in any manner, and if the generation facility's protection system is adequately designed for a one way power flow installation.

7. GENERAL REQUIREMENTS – OTHER

7.1. ROUTINE MAINTENANCE

The customer has full responsibility for the routine maintenance of his generation and protective equipment. Intertie protective relays must be tested on a four-year basis by a certified agency. Testing records must be maintained by the customer and available for SMECO review upon twenty-four hours' notice. If the customer fails to provide proper testing documentation, they must cease parallel operation until such maintenance is performed.

7.2. SYSTEM ISOLATION

The configuration of SMECO's electric system is such that customer generation equipment often must be isolated from the SMECO system by a dedicated power transformer. Isolation is required at most locations to achieve the following:

- Decrease voltage variations experienced by other customers.
- Attenuate harmonics, particularly on those installations using inverters.
- Reduce the effects of fault currents on both the customer owned generator and other customers on SMECO system.
- Decrease the likelihood of self-excitation where an induction generator is used.
- Isolate the zero sequence circuit of the customer's generation system from the zero sequence circuit of SMECO.

7.3. ISOLATING TRANSFORMER

SMECO will evaluate customer proposals for achieving the foregoing performance criteria without use of an isolating transformer with specific reference to the customer's proposed generation equipment and location on the SMECO system. If an isolating transformer is necessary, SMECO will determine whether this transformer shall be delta-connected, wye-connected solidly grounded, grounded through an impedance or ungrounded at the interconnection line voltage.

8. CLASSIFICATION OF CUSTOMER GENERATION INSTALLATION

Customers with generation equipment connected to SMECO's system are divided into four groups: One-Way or Two-Way Power Flow, with Synchronous or Signal Dependent generation. These categories were discussed in Sections 2.0.

Three diagrams are included in Exhibit C – Interconnection Requirements to show examples of customer owned generation intertie stations:

- A-4560: Typical Interconnection 600V Simplified One Line (2MW or Less)
- A-4561: Typical Interconnection 15kv Simplified One Line (10MW or Less)
- A-4562: Typical Interconnection 69kv or 230kv Simplified One Line (Generator Requirements)

Note that the diagrams are illustrative and do not cover all acceptable operating arrangements, including transformer connections. Specific requirements must be determined for each installation.

9. DESCRIPTION OF PROTECTION AND RELAY SETTING GUIDELINES

The following protective devices may be applicable to a customer owned generation site. Discussions between SMECO and the customer are necessary to determine which relays are required for each specific application.

- **Phase Distance and Timer (21/62)** – Detects faults on SMECO system by measuring voltage and current flow out of the customer facility, operating instantaneously for near faults and after a time delay for remote faults. System configurations and fault levels determine applicable relay settings.

- **Line Current Differential (87L)** – Detects faults on the interconnecting line by monitoring current at both ends of the line, operating instantaneously for all fault on the line. System configurations and fault levels determine applicable relay settings

- **Transformer Primary Phase and Ground Overcurrent (51/51G)** – Provides time delayed backup protection for faults on the SMECO system and on the customer primary or transformer by operating on current flow which is above normal.

  Phase overcurrent relays are set for approximately 200% of transformer rated current. Ground overcurrent relays are set for approximately 100% of transformer rated current. Time delays are coordinated with other system relays and are affected by fault current magnitudes.

- **Over/Under Voltage (59/27)** - Detects SMECO supply feeder faults or de-energization and ferro-resonance conditions.

  Overvoltage relay is generally set at 110% of nominal. Undervoltage is generally set at 80% of nominal. Time delay is usually 5 to 10 seconds.

- **Transformer Differential (87)** - Detects high current faults on transformer bushings or inside transformer by comparing input and output currents.

  Set to trip for a differential current of 10-30% between input and output current flows (adjusted for voltage level).

- **Sudden Pressure** – Detects high or low level transformer internal faults by operating on rapid increase of pressure inside a transformer tank.

  Often specified with transformer, installed & set by manufacturer.

- **Transformer Secondary Phase and Ground Overcurrent (51/51G)** – Provides time delayed backup protection for faults on the customer's system by operating on current flow above normal.

  Settings are similar to those of the Transformer Primary Phase and Ground Overcurrent Relays.

- **Breaker Failure and Timer (50BF/62)** – Detects failure of intertie circuit breaker to open following operation of any other protective relay. Set trip at <75% of minimum fault current, with approximately 250 milli-second delay.

- **Over/Under Frequency (81)** – Monitors the customer system frequency and operates whenever the frequency goes above or below nominal. Protects against Ferro resonance and other system disturbances. The primary function of the frequency relays is to assure the safety of personnel and operating equipment.

Due to size, location and generation scheduling, some customer owned generation installations may be included in SMECO's capacity planning. Underfrequency protection for these installations will be coordinated with SMECO's Load Shedding Program.

For all other customer owned generation installations, frequency relays should be set to trip whenever the system frequency deviates by more than 1Hz. The time delay for operation must be 5 seconds or less. Actual settings will depend on type of relays and equipment used. Note that relays with inverse time characteristics, as well as those with definite time characteristics, are generally acceptable, but are site specific.

- **Power Directional and Phase Directional Relays (32/67)** – Prevent fault current or excessive power flow into the SMECO system. In one-way flow installations, set to trip the intertie breaker when any power flows into the SMECO system. For two-way power flow installations, set above the anticipated current to be sold to SMECO, to operate for faults on the SMECO supply feeder.

Small generating plants will have to take into consideration in their protective schemes that fuses, sectionalizers, or automatic reclosers may be in the line between the substation and the intertie station.

Signal Dependent customer owned generators do not generally have the capability to run without the utility supply (Self-excitation). However, if industry experience or special tests of the particular customer owned generation facility indicate that it can, under any circumstances, continue to generate power after the removal of utility supply, protective measures similar to those required for synchronous generators must be installed.

Exhibit E:

SCADA and Communications Requirements

Revision Date: February 28, 2019

Version No: 1.0

Approved By: Chip Kingsley

Technical Review: Dave Appleby

TABLE OF CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is interconnected to the Potomac Electric Power Company (PEPCO) transmission system and serves as a Local Control Center (LCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." tariff, the "Interconnection and Mutual Operating Agreement" between Potomac Electric Power Company (PEPCO) and SMECO, and the PJM Manual 14 series documents.

1.2. DISCLAIMER

This document and all the material contained herein are developed for guidance purposes only. It is produced as an informational and illustrational aid for customers operating generation equipment that is interconnecting with the SMECO electric system. The information herein is intended to be of a general and typical nature and does not pertain to a specific facility or site. Furthermore, the requirements and practices described herein are subject to change based upon several factors, such as changing regulations. Accordingly, SMECO makes no warranty of any nature whatsoever concerning the information contained in this document.

1.3 PURPOSE

This document is developed to provide guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

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2. SCADA REQUIREMENTS (TRANSMISSION, GENERATION, AND END-USER) TRANSMISSION INTERCONNECTION SUBSTATIONS

2.1 LOOP AND NETWORK CONNECTED FACILITIES

Loop and network connected facilities shall be equipped with a SCADA Remote Terminal Unit (RTU) and shall be connected via an appropriate, Connecting Party supplied, dedicated digital communications channel to the respective SMECO Transmission System Control Center. The RTU shall be a SAGE 2400 RTU (or an equivalent device specifically approved by SMECO),and will provide SMECO with at a minimum the information and control capabilities listed below and must communicate via DNP 3.0 protocol. Facilities with non-conforming load characteristics may be required to provide additional information and control capabilities beyond those listed.

2.1.1 CONTROL

The RTU shall provide SMECO with control of all circuit interrupting devices that are directly in the SMECO transmission path or connected to the transmission path.

2.1.2 POSITION INDICATION

The RTU shall provide SMECO position indication of all transmission voltage circuit interrupting devices and disconnect devices.

2.1.3 ALARMS

The RTU shall provide SMECO equipment alarm information for each circuit interrupting device and associated protective relaying in or connected to the transmission path. Indication of protective relay operation alarms for relaying other than the transmission line relaying that operates a circuit interrupting device in or connected to the transmission path will also be provided. (These might include breaker failure relaying, bus differential relaying, transformer differential relaying, etc.).

2.1.4 OPERATIONAL METERING

The RTU shall provide SMECO instantaneous bi-directional real and reactive power metering (MW and MVAR) and voltage for all SMECO transmission lines connected to the facility, as well as ampere metering of each circuit breaker in or connected to the transmission path. Current transformers (CTs) having a minimum metering accuracy class of 0.3% (as defined in IEEE C57.13) at a minimum burden designation of B-1.8, voltage transformers having a minimum accuracy rating of 0.3%, and meters/transducers having a minimum accuracy rating 0.25% must be used where these quantities are required to meet the accuracy requirements of PJM Manual 01 –Control Center and Data Exchange Requirements. The operational metering equipment shall be provided, installed, and maintained by the Connecting Party. The Connecting Party shall install and maintain metering equipment and data acquisition system (“DAS”) equipment at each Interconnection Point for measuring electric energy for the purposes of determining load, effecting settlements, and monitoring and telemetering power flows under this Agreement. All connecting Parties are responsible for providing all SCADA data, as required by their Regional Transmission Organization, via their respective ICCP data links. The Parties may receive operational data regarding the interconnection between the Parties via the ICCP data links to their Regional Transmission Organization.

3.0 SCADA (OPERATIONAL METERING) REQUIREMENTS FOR GENERATION FACILITIES (GENERATION AND END-USER)

For Generation facilities with a direct electrical connection to a SMECO substation, the generator owner is responsible for providing all SCADA data as required by the PJM Tariff via their respective ICCP data links to PJM.SMECO will receive operational data regarding the generator inte5rconnection via its ICCP data link to PJM.

For a tapped line generation facility, the generator shall be equipped with a SCADA RTU and shall be connected via an appropriate Connecting Party supplied, dedicated digital communications channel to the respective SMECO Control Center (SCC) . The RTU shall provide SMECO with at least the information and control capabilities listed below and must communicate via DNP 3.0 protocol. Facilities with unusual or non-conforming load characteristics may be required to provide additional information and control capabilities beyond those listed.

3.1 TAPPED LINE GENERATION CONNECTED TO THE TRANSMISSION SYSTEM

3.1.1 CONTROL

There is no requirement for SMECO SCADA control of breakers contained within the Connecting Party's generation facility beyond the interconnection breaker.

3.1.2 POSITION INDICATION

The Connecting Party's RTU shall provide SMECO position indication of all transmission circuit interrupting devices and motor operated disconnect devices, and if this position indication is not available, position indication will be provided for low side circuit interrupting devices or generator output breakers.

3.1.3 ALARMS

The RTU shall provide SMECO indication of protective relay operation alarms for relaying that impacts the associated SMECO transmission substation. These might include breaker failure relaying, bus differential relaying, transformer differential relaying, etc.

3.1.4 OPERATIONAL METERING

The RTU shall provide SMECO instantaneous bi-directional real and reactive power metering (MW and MVAR) and voltage for all Connecting Party facility interconnection points to SMECO transmission lines. This metering may be on the generator transformer, or circuit breakers owned by the Connecting Party at transmission voltages. Ampere metering of each circuit breaker in the transmission path shall also be provided. If there is additional metering available on an individual generator basis, this information (instantaneous megawatts, instantaneous megavars, and b phase amps) shall be provided to the SMECO Control Center (SCC). Current transformers (CTs) having a minimum metering accuracy class of 0.3% (as defined in IEEE C57.13) at a minimum burden designation of B-1.8, voltage transformers having a minimum accuracy rating of 0.3%, and meters/transducers having a minimum accuracy rating 0.25% must be used where these quantities are required to meet the accuracy requirements of PJM Manual 01 –Control Center and Data Exchange Requirements. The operational metering equipment shall be provided, installed, and maintained by the Connecting Party.

4.0 COMMUNICATIONS (TRANSMISSION, GENERATION, AND END-USER) NORMAL VOICE COMMUNICATIONS

When required by SMECO, the Connecting Party shall provide a dedicated voice communication circuit to the SMECO Control Center (SCC). Such a dedicated voice communication circuit would originate from the Connecting Party's 24 hour manned operations office and would be typically required for:

Generation Facilities –Synchronization and operation of significant capacity within SMECO's Control Area. Transmission Substations –Connected transmission facilities that significantly affect the SMECO's transmission network capacity and operations.

All other normal voice communication concerning facility operations shall be conducted through the public telephone network to the SCC phone number(s) issued by SMECO.

5.0 EMERGENCY VOICE COMMUNICATIONS

Voice communications in the event of a transmission facility emergency shall use the dedicated voice circuits, if available, or public telephone network and phone number(s) designated for emergency use.

It is the Connecting Party's responsibility to take prudent steps when an area or system wide capacity emergency is declared. Load reductions shall be implemented by reducing non-essential loads. This type of reduction is usually conveyed through the local media. Contractual load reductions should already be in effect.

The Connecting Party is responsible for providing the assigned SCC a "Connecting Party Contact List" containing the names of two or more representatives of the Connecting Party, their titles and business, cell and home phone numbers. Any special information such as police and fire department phone numbers as well as substation phone numbers should be included in the list. Connecting Parties will be provided an unlisted SMECO phone number to be used for emergency or routine operations. Operational emergencies (equipment) warrant a direct call either way. The SCC dispatcher will advise the designated SMECO representative of problems that need to be handled directly with the Connecting Party.

System capacity emergencies are communicated through the local media except for Connecting Parties with special agreements. These parties are notified electronically in the event of an emergency interruption.

6.0 INTERCONNECTION STATION COMMUNICATIONS BLOCK DIAGRAM

See Drawing No. D-3610 Typical Interconnection Station Communication Block Diagram – Four Breaker Ring in Exhibit C for details.

SMECO

People. Power. Progress.

Exhibit F:

Revenue Metering Requirements

Revision Date: February 28, 2019

Version No: 1.0

Approved By: Chip Kingsley

Technical Review: David Johnson

Exhibit F Revenue Metering Requirements			
Distribution: Public		Procedure No: 3010 Exhibit F	
Version No: 1.0	Revision Date: February 28, 2019	Review Cycle: 5 Years	Effective Date: February 28, 2019

TABLE OF CONTENTS

Exhibit F	
Revenue Metering Requirements	SMECO People. Power. Progress.

Distribution: Public		Procedure No: 3010 Exhibit F	
Version No: 1.0	Revision Date: February 28, 2019	Review Cycle: 5 Years	Effective Date: February 28, 2019

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

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1.3 PURPOSE

This document is developed to provide guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

2. REVENUE METERING REQUIREMENTS (TRANSMISSION, GENERATION, AND END-USER)

SMECO approved revenue metering shall be installed for energy accounting and billing purposes. The revenue metering shall be located at the Connecting Party's facility interconnection point to SMECO unless otherwise agreed to by SMECO, PJM, and the Connecting Party.

2.1 EQUIPMENT

Revenue metering equipment includes but is not limited to current transformers, voltage transformers, mounting structures, wiring, primary and back-up revenue meters, meter sockets, test switches, communication circuits, and associated devices.

2.1.1 GENERAL REQUIREMENTS

The revenue metering equipment shall meet or exceed all applicable industry standards (e.g., ANSI, IEEE, and NEMA). SMECO shall generally provide, own, operate, test, and maintain the revenue metering equipment at the Connecting Party's expense.

At least (N-1) metering elements shall be used for revenue metering, where N is the number of wires in the electrical system associated with the revenue metering. Three metering elements shall be the standard for revenue metering connecting to SMECO system voltages 69 kV and higher unless otherwise agreed to by SMECO, PJM, and the Connecting Party.

The revenue metering installation shall meet all applicable industry standards for phase-to-phase and phase-to-ground electrical clearances. Connections to primary terminals on current and voltage transformers shall be designed so the associated mechanical stresses do not exceed manufacturer specified limits SMECO will provide the Connecting Party with current and voltage transformer manufacturer's information when such devices are furnished by SMECO and installed by the Connecting Party.

The revenue meters shall be capable of recording, storing, and transmitting 4-Quadrant MWh and MVARh data (or kWh and kVARh data). The revenue meters shall record this data in fifteen-minute intervals.

2.1.2 CURRENT TRANSFORMERS

The revenue meters shall be connected to current transformers (CTs) having a minimum 0.3% metering accuracy class (as defined in IEEE C57.13) at a minimum burden designation of B-1.8. CTs with lower burden designations may be allowed by SMECO in special cases, but the secondary burden on the CTs must not exceed the nameplate burden rating.

The continuous current on the CTs shall not exceed the primary nameplate rating with the thermal current rating factor (RF) applied. The available fault current must not exceed the withstand ratings of the CTs.

The revenue meters shall generally be connected to dedicated metering CT secondary circuits and should not share the same circuits with relays or other devices. SMECO may consider using CT/VT combo units depending on the type of Connecting Party facility or the supply voltage.

2.1.3 VOLTAGE TRANSFORMERS

The revenue meters shall be connected to voltage transformers (VTs) or coupling capacitor voltage transformers (CCVTs) having a minimum 0.3% metering accuracy class (as defined in IEEE C57.13) at a minimum burden designation of Y. The secondary burden on the VTs or CCVTs must not exceed the nameplate burden rating.

The revenue meters shall generally be connected to dedicated metering VT or CCVT secondary circuits and should not share the same circuits with relays or other devices. The revenue meters may be connected to dedicated secondary windings on VTs or CCVTs that have separate secondary windings used for relays or other devices.

VTs are preferred for revenue metering. The use of CCVTs for revenue metering shall generally be limited to facilities connecting to SMECO system voltages 230 kV and higher or where it is impractical to use VTs for technical reasons. A Connecting Party responsible for any CCVTs used for revenue metering may be required to utilize a VT against which the CCVTs can be periodically tested and calibrated. SMECO may consider using CT/VT combo units depending on the type of Connecting Party facility or the supply voltage.

2.1.4 DATA COMMUNICATIONS

The Connecting Party shall, at its own expense, install, operate, test, and maintain any communications equipment required to transmit data from the revenue metering located at the Connecting Party's facility.

Upon request and at the Connecting Party's expense, SMECO may provide the Connecting Party access to bi-directional kWh and kVARh interval data or pulses from a SMECO revenue or backup meter installed at a Connecting Party facility.

2.1.5 OPERATIONAL METERING DATA

Operational metering data (e.g., real-time MW and MVAR) are generally not available from revenue meters that are provided by SMECO at Connecting Party facilities. The Connecting Party shall, at its own expense, install, operate, test, and maintain any metering and communications equipment necessary to provide operational metering data that may be required by PJM and/or SMECO.

3.0 ACCESS, SECURITY, AND TESTING

At Connecting Party facilities where SMECO provides revenue metering equipment, the Connecting Party shall grant SMECO employees and authorized agents access to the equipment at all reasonable hours and for any reasonable purpose.

The Connecting Party shall not permit unauthorized persons to have access to the revenue metering equipment.

The meters, test switches and any other secondary devices that could have an impact on the performance of the revenue metering shall be sealed at all times and the seals shall be broken by the party responsible for the equipment only when tests, adjustments, and/or repairs are required and after the other party has been informed.

The revenue metering shall be tested for accuracy as specified by the applicable tariffs, Interconnection Agreement, PJM requirements, or state commission regulations.

4.0 FACILITY-SPECIFIC REVENUE METERING REQUIREMENTS

4.1 ADJACENT TRANSMISSION OWNER FACILITIES

The Connecting Party is permitted to install, own, operate, test, and maintain redundant revenue metering equipment at the Connecting Party's facility unless otherwise agreed to by SMECO and the Connecting Party.

SMECO owned revenue metering equipment shall be installed at the Point of Interconnection (POI) between the Connecting Party's facility and the SMECO Transmission System unless otherwise agreed to by SMECO and the Connecting Party.

The revenue metering shall be compensated for losses to the POI if the metering equipment is not located at the POI.

4.2 WHOLESALE GENERATION FACILITIES

Revenue metering is required at all generating facilities within the SMECO footprint. The revenue metering equipment shall be located at the POI unless otherwise agreed to by SMECO, PJM, and the Connecting Party. The revenue metering shall be compensated for losses to the POI if the metering equipment is not located at the POI.

The revenue metering CTs and VTs shall be installed on the high-side of the Connecting Party's step-up transformer, on the generation side of the fault-interrupting device, and within the local zone of fault protection for the facility.

The specific revenue metering requirements for wholesale generation facilities will fall under one of the following categories:

<u>New Generation Facilities Connected to SMECO's 69 kV or 230 kV system</u> – SMECO shall generally provide, own, operate, test, and maintain the revenue metering at the Connecting Party's expense.

The revenue metering equipment includes, but is not limited to, current transformers, voltage transformers, secondary wires, meter socket, bidirectional revenue meter, and associated devices.

The revenue metering equipment shall be located at the Point of Interconnection (POI) unless otherwise agreed to by PJM, SMECO, and the Connecting Party. The revenue metering will be compensated for electrical energy losses if it is not located at or near the POI.

The Connecting Party must provide SMECO with a facility one line, the estimated bidirectional power flow at the revenue metering point, and any loss compensation data.

The Connecting Party shall provide and install the mounting structures (or enclosures) and conduits necessary for the SMECO metering installation unless otherwise agreed to by SMECO. SMECO will install the wiring in the conduit between the instrument transformers and the meter socket.

The instrument transformers and meter socket shall be installed in a location that is readily accessible to authorized SMECO representatives. The meter socket shall be installed generally within 50 feet of the instrument transformers unless an alternate design has been approved by SMECO. The meter sockets shall be mounted such that the centerline of the meter is approximately five feet above final grade.

Behind-The-Meter Generation Facilities Participating in the PJM Energy or Capacity Market –The revenue metering requirements will be reviewed by SMECO on a case-by-case basis for retail or wholesale load facilities with behind-the-meter generation participating in the PJM energy or capacity markets. In general, SMECO shall continue to own, operate, test, and maintain the revenue metering equipment at the retail or wholesale load facility's POI to SMECO per the applicable retail tariff or wholesale load Interconnection Agreement. Any additional revenue metering equipment or metering data that PJM or SMECO may require for the behind-the-meter generation shall be the responsibility of the Connecting Party.

The Connecting Party must provide SMECO with a facility one line and the estimated bidirectional power flow at the existing SMECO metering point.

The existing SMECO revenue meter at the POI will be replaced with a bidirectional revenue meter if the existing meter is not capable of bidirectional operation. The SMECO metering current transformers will be replaced with higher capacity units if required. This work will generally be completed at the Connecting Party's expense.

The Connecting Party shall, at its expense, install, own, operate, test, and maintain any additional metering and telemetry equipment at the facility that may be required by PJM or SMECO.

Upon request and at the Connecting Party's expense, SMECO may provide the Connecting Party with access to bidirectional kWh and kVARh interval data or pulses from the SMECO revenue meter or backup meter.

4.3 End-User Facilities

Energy Storage Facilities Connected at Any Voltage (Direct Connections to SMECO Facilities or Connections Behind-the-Meter) –The Connecting Party of Energy Storage Facilities used in PJM's frequency regulation market and settled via PJM's ancillary market shall provide, own, operate, test, and maintain the revenue metering at the Connecting Party's expense. The Connecting Party shall provide the revenue metering data to PJM and SMECO unless otherwise agreed to by SMECO and the Connecting Party.

Existing Non-Utility Generator Facilities That Are Ending Power Purchase Agreements with SMECO–The revenue metering requirements will be reviewed on a case-by-case basis for existing non-utility generator (NUG) facilities that are ending power purchase agreements with SMECO and will sell their power in the PJM energy market.

SMECO will generally continue to own, operate, test, and maintain the existing SMECO revenue metering equipment at the Connecting Party's expense if the metering is located at or adjacent to the existing NUG facility. In this case the SMECO revenue meter's real-time kWh and kVARh data will be made available to the Connecting Party for submittal to PJM.

If the existing SMECO revenue metering equipment is located in a remote SMECO facility rather than at or adjacent to the NUG facility the Connecting Party will generally be required to provide, own, operate, test, and maintain a new revenue metering point at the Connecting Party's facility. Any of the special communications equipment required for the Connecting Party to obtain real-time kWh and kVARh data from the SMECO revenue meter over the significant distance between the facilities will not be provided or supported by SMECO.

Any real-time metering and SCADA communications equipment provided, installed, and maintained by SMECO at the NUG facility under a previous agreement will in general no longer be maintained or supported by SMECO. This equipment may be retired in place or removed if necessary.

Revenue metering is required at delivery points for wholesale electric customers (i. e. municipals, RECs) and Operating Companies' end-use customers.

The revenue metering equipment for End-User Facilities shall generally be provided by SMECO and located at the Connecting Party's facility as specified in the applicable tariffs or the Interconnection Agreement.

The revenue metering shall generally be installed on the primary side of the Connecting Party's step-down transformer, on the load side of the fault-interrupting device, and within the local zone of fault protection for the facility. The Connecting Party's proposed metering installation design must be reviewed and accepted by SMECO.

The revenue metering may require compensation for losses if it is not located at or near the POI.

End-User Facilities with behind-the-meter wholesale generation shall follow the revenue metering requirements specified in Section 1.3.2 – Wholesale Generator Facility. The revenue metering requirements for End-User Facilities with behind-the-meter generation used strictly for load shaving purposes will be reviewed by SMECO on a case-by-case basis.

Any End-User Facilities with behind-the-meter generation may be required to provide additional revenue metering at the output of the generation equipment. The Connecting Party shall install, own, operate, test, and maintain this equipment as specified in the applicable tariffs or Interconnection Agreement. The Connecting Party is also responsible for providing SMECO with the generation revenue metering data if required.

Exhibit G:

Engineering and Construction Deliverables

Revision Date: February 28, 2019

Version No: 1.0

Approved By: John Bredenkamp

Technical Review: Hugh Voehl

TABLE OF CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is interconnected to the Potomac Electric Power Company (PEPCO) transmission system and serves as a Local Control Center (LCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." tariff, the "Interconnection and Mutual Operating Agreement" between Potomac Electric Power Company (PEPCO) and SMECO, and the PJM Manual 14 series documents.

1.2. DISCLAIMER

This document and all the material contained herein are developed for guidance purposes only. It is produced as an informational and illustrational aid for customers operating generation equipment that is interconnecting with the SMECO electric system. The information herein is intended to be of a general and typical nature, and does not pertain to a specific facility or site. Furthermore, the requirements and practices described herein are subject to change based upon several factors, such as changing regulations. Accordingly, SMECO makes no warranty of any nature whatsoever concerning the information contained in this document.

1.3 PURPOSE

This document is developed to provided guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

2. ENGINEERING DELIVERABLES

2.1. SWITCHING STATIONS AND SUBSTATIONS

2.1.1. Physical drawings shall be submitted for SMECO review.

- Simplified One Line Drawn Physically
- Simplified Site Plan including overall Plan
- Site Grading Drawings including S&EC, SWM, FCP, Grading, and Landscaping
- Fence Plan and Details
- Electrical Layout drawings including plans, sections and BOM
- Steel Structure Loading drawings or Detail Structure Drawings
- Foundation Plan and Details including BOM
- Grounding Plan and Details including BOM
- Raceway Plan and Details including BOM
- Control Building Plan and Details including BOM
- Permitting Requirements

2.1.2. Electrical drawings shall be submitted for SMECO review.

- Relaying and Metering One-line Diagram
- Functional One Line Diagram.
- AC and DC Panel Diagrams including AC source and DC Batteries.
- Cable Schedules including conductor type and length
- Relaying and Metering Three Lines including Current and Potential Elementary
- Breaker DC Relaying Schematic and Wiring Diagrams including Line Relaying, Breaker Control, and Bus Relaying.
- Power Transformer DC Relaying Schematic and Wiring Diagrams.
- Disconnect Switch Motor Operator DC Relaying Schematic and Wiring Diagrams
- Relay Rack Layout and Wiring Diagrams including Relay Model Numbers
- Communications and Scada Drawings

2.1.3. Manufacturer drawings and data of all equipment supplied shall be submitted for SMECO review.

- Physical Plans & Sections with Material Identification and Steel Detail Drawings
- Equipment drawings including outlines, schematics, wiring diagrams, and instruction books for Breakers, Transformers, CCVT, PT's, Switches, MOD's, Bus, Hardware, Insulators, and control building

2.1.4. Design calculations shall be submitted for SMECO review

- Grounding and Lightning Shielding Protection

- AC/DC Station Service including Battery Calculations
- Rigid Bus Design
- Branch Circuit Sizing
- Structure Loading and Manufacturer Steel Detail Design
- Foundations and Soil Borings
- Storm water and Grading
- Relay setting and setting philosophy documentation
- Relay setting calculations shall be included, along with Relay Coordination Study for all interconnection devices.

2.2. OVERHEAD TRANSMISSION LINES

2.2.1. Design drawings shall be submitted for SMECO review

- Plan and Profile
- Road Grading and Details
- Tension or Sagging Charts
- OPGW Layout and Splicing
- Foundation Details and Schedules including Soil Borings
- Phasing
- Pole Top drawings including layout and material
- Tubular Steel Loading Drawings per Structure Type
- ROW Clearing and Cutting
- Permitting Requirements

2.2.2. Manufacturer drawings and data of all material supplied shall be submitted for SMECO review.

- Steel Structure Details
- Insulators and Hardware
- Conductor and OPGW

2.2.3. Design calculations shall be submitted for SMECO review

- Foundations including Soil Borings
- Structure Loading and Manufacturer Steel Detail Design

2.3. FINAL CONFORMED TO CONSTRUCTION RECORD DRAWINGS SHALL BE SUBMITTED FOR SMECO RECORDS.

A final issue of approved as-built documents shall be submitted for record purposes along with all manufacture drawings and instruction books. All drawings shall be submitted electronically in the latest SMECO CAD standards in use.

3. CONSTRUCTION DELIVERABLES

3.1. CONSTRUCTION SCHEDULE

An overall Construction Schedule is required for SMECO's review prior to the start of construction. SMECO may require specific schedules for design, procurement, and construction, including outages and testing/commissioning.

3.2. CONSTRUCTION SCHEDULE UPDATES

Periodic schedule updates are required, monthly if not more frequently to reflect project status. The DCM will review new schedules with the SCM, identifying the changes, progress and problems with key dates.

3.3. CONSTRUCTION PROJECT PROGRESS MEETING MINUTES

Through the duration of the construction process, project progress discussions are required no less than monthly; copies of Meeting Minutes will be issued and SMECO provided a copy.

3.4. SCHEDULE FOR OUTAGE ACTIVITIES

SMECO and PJM shall be notified regarding the outage requirements. Outage schedule and cutover sequencing drawings shall identify the outage activities, sequence and duration.

3.5. CUTOVER SEQUENCE

SMECO shall be notified on the energization and cutover sequence for new equipment. The sequence will be documented, and a specific schedule developed for this part of the project.

4. QUALITY ASSURANCE/QUALITY CONTROL

4.1. QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM

The quality Assurance and quality control program shall be provided to assure that the highest quality is specified and obtained in the engineering, procured material and equipment and is constructed to meet or exceed the technical requirements of the project.

4.2. DEFINITIONS

Work Product- The results of engineering, design, drafting and construction performed by a Provider/Supplier and delivered to meet the expectations of SMECO.

Quality Assurance - A process that ensures the Work Product provided to SMECO meets the specifications and expectation.

Quality Control - A set of measures and procedures to ensure the quality of the Work Product is maintained, and errors are eliminated.

4.3. QUALITY PROGRAM

4.3.1 SMECO shall be provided the Quality Program for review. The program is used to examine the Work Product to assure the Work Products are of the highest quality. The program shall include:

- Requirements for Inspector's reports, including timely inspections and prompt problem resolution to avoid schedule delays.
- The DCM will discuss significant issues with the SCM and any schedule impact.
- Quality Control checklist for receipt of major equipment.
- Quality Control Checklists for checkout of major pieces of equipment including but not limited to foundations, structures, transformers, breakers and switches.
- A process for tracking non-conformances and ensuring items are corrected and re-inspected.

4.3.2 Inspection checklists

SMECO reserves the right to modify and or require additional inspection checklists.

4.3.3 Third party testing

All third-party testing shall be approved by SMECO, including the documentation of the testing details and their associated results.

5. SAFETY

5.1. SAFETY MANUAL SUBMITTAL

The developer and contractors' safety manuals shall be submitted for SMECO's review.

5.2. SMECO SAFETY REQUIREMENTS

SMECO may have specific additional safety requirements as equipment becomes energized/operational.

5.3. PROJECT SITE SPECIFIC SAFETY PLANS

Project site specific safety plans may also be required as deemed necessary by SMECO.

SMECO
People. Power. Progress.

Exhibit H:

Construction Management Requirements for Interconnection Customers

Revision Date: February 28, 2019

Version No: 1.0

Approved By: John Bredenkamp

Technical Review: Hugh Voehl

TABLE OF CONTENTS

Exhibit H	
Construction Management Requirements for Interconnection Customers	SMECO People. Power. Progress.
Distribution: Public	Procedure No: 3010 Exhibit H

Version No: 1.0	Revision Date: February 28, 2019	Review Cycle: 5 Years	Effective Date: February 28, 2019

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is interconnected to the Potomac Electric Power Company (PEPCO) transmission system and serves as a Local Control Center (LCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." tariff, the "Interconnection and Mutual Operating Agreement" between Potomac Electric Power Company (PEPCO) and SMECO, and the PJM Manual 14 series documents.

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1.3 PURPOSE

This document is developed to provide guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

2. ORGANIZATION

2.1. The Developer's Construction Manager (DCM) is part of a Project Management Team which manages the Engineering, Construction, Schedule, Cost Control, Environmental Management and provides the structure for all aspects of project management.
2.2. The Developer's CM will be knowledgeable of the Scope of Work, the bidding and contracting strategy, schedule and materials for the project.
2.3. SMECO's Construction Manager (SCM) will require on site access.
2.4. SMECO's CM will interact with the Developer's CM but will not direct the Developer's contractors.
2.5. SMECO's presence on-site does not transfer responsibility for the project nor should the Developer infer from SMECO's presence the acceptance of work, progress or practices on site.
2.6. SMECO's CM (or designee) is the SMECO point of contact for the Developer's CM.

3. COMMUNCIATION

3.1. The SMECO Project Manager, may authorize the SMECO Construction Manager to participate in technical discussions with the Developer. All communication between these representatives must be documented and the documentation forwarded to the SMECO Project Manager.
3.2. Project correspondence pertaining to changes in the technical scope, schedule, budget, or contract will be sent to the SMECO Project Manager in writing (email shall suffice) for approval.
3.3 All oral conversations of Project importance shall be documented by memorandum (or telephone memorandum), or email, sent to the SMECO PM.

4. DEVELOPER'S CONSTRUCTION MANAGER

4.1. The Developer's Construction Manager (DCM) is responsible for the overall completion of the project on time and ensuring the construction conforms to drawings and specifications.
4.2. The DCM will be knowledgeable of generally accepted construction practices, standards and codes and ensure construction activities are performed accordingly.
4.3. When specific Quality Control requirements are outlined by SMECO, the DCM is responsible for ensuring the fulfillment of those specifics.
4.4. The DCM will ensure compliance with requirements for all Permits (Building, Environment, Noise, etc.) and coordinate agency inspections.
4.5. The DCM will be responsible for site order, safety, security for workers and the public, emergency response, public relations and labor relations.

4.6. The DCM will record site contractors and visitors on site, activities and weather conditions daily.

4.7. The DCM will ensure materials delivered to the site are properly recorded, handled and stored prior to installation.

4.8. The DCM will ensure document control measures are in place to ensure work is proceeding to the latest drawing/document revisions.

4.9. The DCM will monitor activity to ensure that work performed within the Scope of Work is completed.

4.10. The DCM will monitor work to ensure Schedule compliance and report issues and concerns to the SCM.

4.11. When a project requires compliance with NERC standards; the DCM will ensure cooperation of contractors working with SMECO personnel to ensure all elements of the standards are met including all applicable documentation and escorting as necessary.

4.12. The DCM will report project status to the SCM and ensure SMECO is included in meetings and conference calls.

4.13. The DCM will be familiar with the Quality Control program (as reviewed and approved by SMECO) is being adhered to.

4.14. The DCM will ensure the SCM is provided copies of inspection checklists for in-progress or completed work upon request.

Exhibit I:

Operational and Tagging Requirements

Revision Date: February 28, 2019

Version No: 1.0

Approved By: Chip Kingsley

Technical Review: Andre Francis

TABLE OF CONTENTS:

1. INTRODUCTION

1.1. BACKGROUND

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1.3 PURPOSE

This document is developed to provide guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

2. OPERATIONAL REQUIREMENTS

2.1. OPERATIONS CENTER

Interconnecting customers are required to maintain a 24-hour, 7 day per week operations center staffed by individuals trained for their position pursuant to Good Utility Practice. Customers will be also expected to provide SMECO with a list of the appropriate contacts that include both email addresses and telephone numbers for the respective operations centers.

2.2. DISPATCH SCHEDULE

Interconnection Customers shall keep the SMECO's Transmission Control Center informed of the Facility's dispatch schedule on a daily basis. Interconnecting Customers, using reasonable efforts, shall directly inform and coordinate with SMECOs' Transmission Control Center before making any sudden significant changes in the Facility Output.

2.3. GENERATOR NOTIFICATION OF SYNCHRONIZATION & DISCONNECTION

Interconnecting customers with facility generation equipment rated 10 MW or less will most likely not require approval for synchronization and disconnection from SMECO's Transmission Control Center. SMECO does reserves the right though to require certain customers of 10 MW or less to request approval for synchronization and disconnection. All interconnecting customers with facility generation equipment rated 10 MW or greater, will require approval of SMECO's Transmission Control Center prior to synchronization. Disconnection from the SMECO electrical system will also require prior notification to SMECO's Transmission Control Center, except the Facility Generation Equipment may be disconnected from the system without prior notice to SEMCO to prevent injury to personnel or damage to equipment. The notifications above are also required for any group of generators totaling 10 MW or more either synchronized or disconnected from the system within one hour. The approval shall not unreasonably be withheld. In the event of disconnection of the Facility Generation Equipment from the SMECO electrical System without prior notice to SMECO's Transmission Control Center, interconnecting customers shall immediately notify SMECO's Transmission Control Center of such disconnection.

2.4. EMERGENCY OPERATIONS

Interconnecting customers shall coordinate its operation with SMECO's Transmission Control Center during local emergency conditions so as to enable SMECO's Transmission Control Center to operate within applicable reliability principles and standards in accordance with all applicable PJM Manuals. When PJM initiates emergency procedures, interconnecting customers shall inform SMECO's Transmission Control Center of any condition which inhibits the Facility from operating in a reliable manner. Such conditions include but are not limited to the availability of fuel, and inability to operate due to labor, equipment, environmental, and weather-related problems.

2.5. OPERATION OF EQUIPMENT

Operation of any equipment directly connected to the SMECO electrical system shall not be undertaken without the direct involvement of, and coordination with, SMECO's Transmission Control Center

2.6. VOLTAGE REGULATION

Interconnecting customers shall install and have available automatic generator field excitation regulators and normally operate with such automatic voltage control equipment in service. Interconnecting customers shall regulate the reactive output of its generator(s)

2.7. NOTICE TO DE-RATE OR SHUTDOWN

Interconnecting customers shall make a reasonable effort to provide a minimum one (1) year notice to SMECO of its intent to de-rate the Facility by more than ten (10) percent or to remove, relocate or otherwise dispose of or retire the Facility.

3. SAFETY AND TAGGING REQUIREMENTS

3.1. COMMUNICATION

When Switching Orders, Clearances, and instructions are implemented by radio, it is essential that personnel identify themselves to each other by call sign when beginning any radio communication. Conversations between the interconnecting customers and SMECO system operator must be clear, concise, and conducted in a business-like manner. The interconnecting customers will be expected to exchange information using proper lines and equipment terminology so that SMECO and another unity company connected to the SMECO electrical system will have a clear understanding of the work to be performed. All switching orders are required to be performed on a recorded line. Switching orders are to be repeated back as follows:

- System Operator orders operation to be performed.
- Crew Leader repeats operation to be performed back to the System Operator.
- System Operator verifies repeat back was correct.
- Then and only then may the Crew Leader perform the operation.
- Crew Leader reports operation accomplished.
- System Operator repeats operation accomplished back to Crew Leader.
- Crew Leader verifies repeat back correct.

Anytime there is confusion or something is misstated; both the Crew Leader and the System Operator shall repeat the communication with the correct information. See figurer A, Script as a standardized script for switching communication.

3.2. CLEARANCES

3.2.1. CLEARANCES AND GENERAL SWITCHING

Clearances – are used to establish in a formal, coordinated, and safe manner, a de-energized area where work can be performed. A Clearance is for the protection of Personnel; equipment protection is incidental. A Clearance provides protection against accidental energization from known sources of energy. It does not provide protection against occurrences such as lightning strikes, induced electrical energy, or falling conductors from nearby circuits. Protection against such hazards is provided by proper personal grounding and is the responsibility of the crew leader.

General Switching – is performed for line sectionalizing or system rearrangement due to changes in system operating conditions.

3.2.2. GENERAL

All switching and tagging, and any work that may affect system integrity, shall be done with the knowledge of and under the direction of SMECO Operations. Switching devices shall be identified by Equipment Number. All lines and equipment shall be considered energized until appropriate testing and grounding prove it to be de-energized.

3.2.3. ISSUING A CLEARANCE

The interconnecting customer shall request a Clearance from SMECO Operations at least 48 hours in advance of the time required, except in emergencies, and shall give the required information and the perimeter needed for adequate protection/boundary. Please see figure F, for applicable timelines associated with Transmission Switching Requests. A SMECO Operator shall prepare a Switching Order that shows the sequence of the required switching operations. All Switching Orders shall be checked by second qualified person when possible. Every party involved in issuing and receiving a Clearance shall review the Switching Order whenever practical. If there are any questions as to its completeness or correctness, these questions shall be resolved before switching is started. If questions arise during the switching operation, they will be resolved before continuing with the Switching Order. After all the above requirements have been fulfilled; the SMECO shall issue the Clearance to the interconnecting customer including exactly what protection/boundary has been provided. SMECO shall then log the information in the Clearance log. The Clearance log information shall include the time the Clearance was issued, the Clearance Number, and to whom the Clearance was issued. Once the interconnecting customer has accepted the Clearance, it is their responsibility to ensure all personnel under their direction understand the Clearance limits and the personal protection/boundary provided by that Clearance. It is also the interconnecting customer to inform their crew of any energized lines or equipment in close proximity to the equipment under the Clearance.

3.3. EMERGENCY SWITCHING

In emergencies, qualified personnel may immediately de-energize circuits and perform such switching, in their opinion, is required. If done by qualified personnel, SMECO shall be notified of the switching performed. The circuits shall not be re-energized until information is received that the emergency is over and SMECO is notified.

3.4. CLEARANCE TAGS

Purpose - The Clearance Tag, colored white, is used to convey the signal word, "DANGER; DO NOT OPERATE; DO NOT REMOVE THIS TAG." The Clearance Tag on a switch or device shall convey to the observer that the switch or device so tagged is not to be operated; it is to be considered as inoperable as if it were mechanically locked. The Clearance Tag is shown in Figure D. If SMECO issues a Clearance they will inform the interconnecting customer with all the information required for the tag. A Clearance Tag shall be attached to the control device(s) of the switches/devices used to provide a visible opening for a section of line or piece of equipment. When the authorized employee holding a clearance releases a Clearance, the System Operator may begin procedures to remove the Clearance Tags. Clearance Tags are not to be removed until the associated Clearance is released. The Crew Leader will receive verification from the System Operator that the Clearance has been released. The Crew Leader may then be given the order to remove the Clearance Tag(s).Once all the Clearance Tag(s) on a device are removed, the switching/isolating device may be operated.

4.0 REFERENCES

FIGURE A

600 amp Overhead Switches (Closed)

Switching Procedure

- **Unit** – #________ standing by switch #_______________
  - **Operation** – 10-4 unit #_________ stand by.
  - **Operations** – At this time I what you to close switch #_________ energizing line/Feeder #_________________
- **Unit- #**_____________ At this time you want me to close switch #__________ energizing Line/Feeder #____________
  - **Operations-** 10-4 that is correct
- Unit-#_________ at this time I have closed Switch #____________ and all three blades are locked in.
  - **Operations-** at this time you have closed Switch #____________ and all three blades are locked in.
- **Unit- #**________ 10-4 that is correct

600 amp Overhead Switches (Opening Switch for Clearance)

Script

- **Unit** – #________ standing by switch #______________
    - **Operation** – 10-4 unit #_________ stand by.
    - **Operations** – At this time I what you to open switch #_________ and **Tag** under Clearance #_________ for Unit #_________
- **Unit** – At this time you want me to open switch #_________ and **Tag** under Clearance #_________ for Unit #_________
-
    - **Operations** – 10-4 that is correct
- **Unit #**________ 10-4 standby
- **Unit** – At this time I have open switch #_________ all three blades are in the clear and **Tag** under Clearance #_________ for Unit #_________
    - **Operations**– At this time you have open switch #_________ all three blades are in the clear and **Tag** under Clearance #_________ for Unit #_________ test, Tag and ground for yourself
- **Unit**- 10-4 that is correct
    - **Operation** – That completes the switching/ Move to switch #____________

FIGURE B

REQUEST FOR DISTRIBUTION SWITCHING

REQUEST:	CLEARANCE			R-T-W		
ISOLATE:	DAY:		DATE:		TIME:	
RESTORE:	DAY:		DATE:		TIME:	
TAG FOR:	UNIT:		CREW LEADER			

SUBSTATION:		FEEDER:	
SUBSTATION:		FEEDER:	

DESCRIPTION OF WORK:	

CLEARANCE BOUNDARIES:	

PHASING REQUIRED:	YES		NO	
1/0 SWITCHING REQUIRED:	YES		NO	
WORK REQUEST NUMBER:				

REQUESTED BY:		DATE:	

Exhibit I	
Operational and Tagging Requirements	
Distribution: Public	Procedure No: 3010 Exhibit I

Version No: 1.0	Revision Date: February 28, 2019	Review Cycle: 5 Years	Effective Date: February 28, 2019

FIGURE C

DISTRIBUTION SWITCHING ORDER

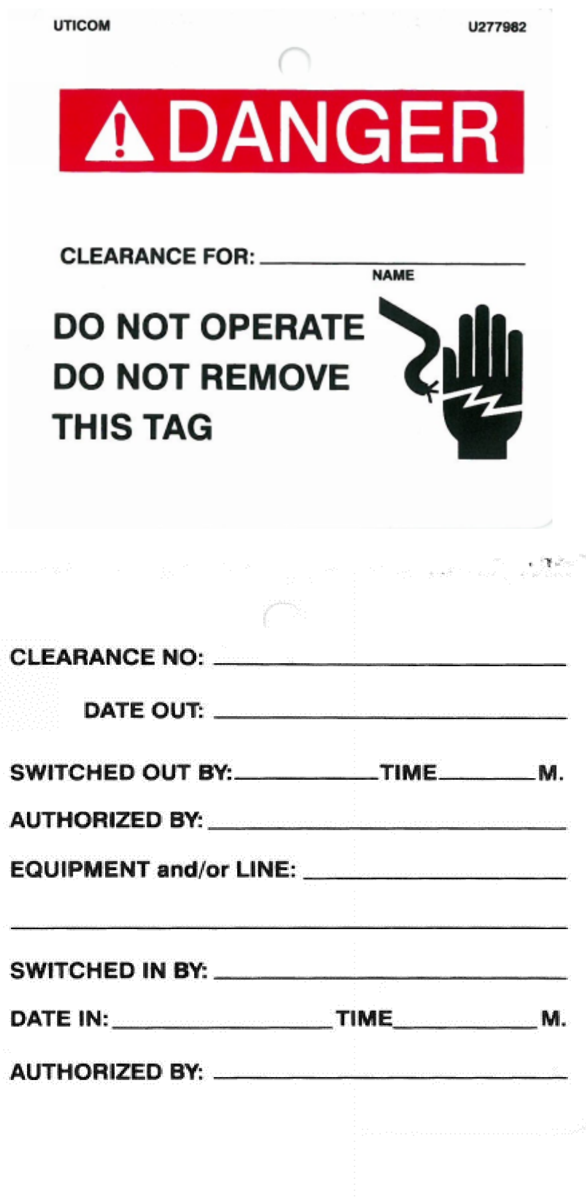
SWITCHING DATE: __________ **WIND:** ________ **TEMPD:** ______ **ORDER #**

REASON:

Prepared:______ **Prep Date:**________ **Checked:**_____ **Ops Appr:**______**Issued:**____ **Given Up:** ______

UNIT	TIME GIVEN	TIME COMP.	DESCRIPTION	LOCATION

FIGURE D


UTICOM U277982

DANGER

CLEARANCE FOR: ____________________
NAME

DO NOT OPERATE
DO NOT REMOVE
THIS TAG

CLEARANCE NO: ____________________

DATE OUT: ____________________

SWITCHED OUT BY: __________ TIME ________ M.

AUTHORIZED BY: ____________________

EQUIPMENT and/or LINE: ____________________

____

SWITCHED IN BY: ____________________

DATE IN: ______________ TIME __________ M.

AUTHORIZED BY: ____________________

FIGURE E

the TO shall use reasonable efforts to submit the planned outage schedule via eDART one year in advance but no later than 0000 hours on the first of the month six months in advance of the requested start date along with a minimum of monthly updates.

PJM maintains a planned transmission outage schedule for a period of at least the next 13 months. The planned transmission outage schedule is posted, subject to change, on the PJM Open Access Same-time Information System (OASIS). Planned transmission outages are given priority based on the date of submission. All planned transmission outages will be posted on OASIS within 20 minutes of Transmission Owner submittal of the outage through the PJM eDart system, with further updates as new information is provided in eDart. PJM periodically reviews all submissions of planned transmission outages and considers the effect of proposed transmission outages upon the integrated operation of the transmission system using established operating reliability criteria, as described within Sections 2 and 3 of this manual. Advance notification assures that the outage is reflected in both the ATC analysis and the FTR Auction.

Outages scheduled for the following Planning year (i.e. June 1 – May 31) exceeding 30 days in duration are to be submitted via eDART before February 1 for use in the annual FTR auction.

For example, outages scheduled to begin between June 1, 2009 and May 31, 2010 are to be submitted before February 1, 2009. Estimated start and stop dates are acceptable.

4.2.1 Requirements

The TO is required to submit all outage requests in excess of 5 calendar days in duration before the 1st of the month six months in advance of the start of the outage. Outages exceeding 30 calendar days in duration for the following planning cycle (June 1 – May 31) must be submitted before February 1. The most restrictive deadline will be enforced. In other words, an outage exceeding 30 days in duration starting in June would have to be submitted no later than November 30th at 2359 hours to be considered on-time. The TO is required to submit all other outage requests before the 1st of the month prior to the month of the requested start date of the outage. Recognizing that this may not always be possible, the following table illustrates the different time frames in which an Outage Request can be submitted and the different Actions PJM can take. The "PJM Actions" are defined in more detail in the Section: "*Processing Transmission Outage Requests, PJM Actions*".

Request Submitted	Ticket Received Status	PJM Actions
Outage > 30 Calendar Days		
Before February 1 (for the following planning cycle June 1 – May 31)OR by the 1st of the month six months prior to the starting month of the outage (whichever is more	"On Time"	The outage will be approved, provided it does not jeopardize system reliability.

Request Submitted	Ticket Received Status	PJM Actions
restricted)		
On or after February 1 (for the following planning cycle June 1 – May 31) OR on or after the 1st of the month six months prior to the starting month of the outage (whichever is more restrictive)	"Late"	The outage may be cancelled if it causes congestion requiring off-cost operations.
5 Calendar days < Outage <= 30 Calendar Days		
Before the 1st of the month six months prior to the starting month of the outage	"On Time"	The outage will be approved, provided it does not jeopardize system reliability.
On or after the 1st of the month six months prior to the starting month of the outage	"Late"	The outage may be cancelled if it causes congestion requiring off-cost operations.
Outage <= 5 Calendar Days		
Before the 1st of the month prior to the starting month of the outage	"On Time"	The outage will be approved, provided it does not jeopardize system reliability.
On or after the 1st of the month prior to the starting month of the outage, and before 0800 three days before the start of the outage	"Late"	The outage may be cancelled if it causes congestion requiring off-cost operations.
After 0800 three days before the start of the outage	"Past Deadline"	Only Emergency or Exception requests (i.e., a generator tripped and the TO is taking advantage of the situation) will be considered.

When the Transmission Owners notify PJM using eDART of an Outage Request, the notification includes the following information:

- Date
- Facility and associated elements
- All line and transformers that will be outaged or open ended as a result of the scheduled maintenance must be included in the outage request. For example, an outage request for CB work that open ends a line must include the line as being

Exhibit J:

Approved Engineers, Contractors and Equipment Manufacturers

Revision Date: February 28, 2019

Version No: 1.0

Approved By: John Bredenkamp

Technical Review: Hugh Voehl

TABLE OF CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

SMECO is a customer-owned electric cooperative providing electricity to over 165,000 customers in southern Prince George's County, Charles County, Saint Mary's County, and all but the northeast portion of Calvert County.

SMECO is interconnected to the Potomac Electric Power Company (Pepco) transmission system and serves as a Local Control Center (LCC) in PJM. SMECO complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." tariff, the "Interconnection and Mutual Operating Agreement" between Potomac Electric Power Company (PEPCO) and SMECO, and the PJM Manual 14 series documents.

1.2. DISCLAIMER

This document and all the material contained herein are developed for guidance purposes only. It is produced as an informational and illustrational aid for customers operating generation equipment that is interconnecting with the SMECO electric system. The information herein is intended to be of a general and typical nature and does not pertain to a specific facility or site. Furthermore, the requirements and practices described herein are subject to change based upon several factors, such as changing regulations. Accordingly, SMECO makes no warranty of any nature whatsoever concerning the information contained in this document.

1.3 PURPOSE

This document is developed to provided guidelines for interconnection requirements for construction projects being proposed and/or approved for connection to the SMECO electrical system.

The approved contractor list may be modified in the future. Other companies may be included to bid on substation and transmission work. They will go through the SMECO formal vetting process to perform this work at SMECO. SMECO may entertain proposals from other Contractors but no award will be made until the vetting process is complete. SMECO will be providing qualified oversight for all contractors working within system on our substation and transmission facilities.

2. APPROVED CONTRACTORS-SUBSTATION ENGINEERING DESIGN:

- Black and Veatch
- Sebesta/ NV5
- SECO

3. APPROVED CONTRACTORS-SUBSTATION CONSTRUCTION:

- New River
- Utility Line Construction
- CW Wright

4. APPROVED CONTRACTORS-TRANSMISSION ENGINEERING DESIGN:

- Black and Veatch
- Booth and Associates

5. APPROVED CONTRACTORS-TRANSMISSION CONSTRUCTION:

- Utility Line Construction
- CW Wright
- AUI, Inc.

6. APPROVED MANUFACTURERS/VENDORS

Transformers:

- DeltaStar
- ABB
- Virginia Transformer
- PTTI
- Howard
- SPX
- Fortune

Cap Bank:

- ABB
- GE

Circuit Breakers 230kV:

- MEPPI

Circuit Breakers 69kV

- MEPPI

Circuit Breakers 15kV:

- MEPPI

Disconnect Switches:

- Cleaveland/Price
- Southern States
- Pascor
- USCO

Relay Panels:

- Keystone
- Power Electronics
- ICSE

RTU:

- Televent

Protective Relays:

- GE (B90, L90, F35, F60, T60, C60, C70 & B30) or SMECO approved equivalents
- SEL (487E, 411L, 487V, 387L, 351S) or SMECO approved equivalents
- Basler (BE1-11) or SMECO approved equivalents

VTs & CCVTs:

- GE
- Trench
- ABB

Surge Arrestors:

- GE
- Ohio Brass

JMUX:

- GE

GPS Clock:

- Arbiter

Substation Steel Structures:

- Valmont
- Distran
- MD Henry

Steel Poles:

- Valmont Industries, Inc.
- MD Henry
- Trinity Meyer
- TransAmerican Power Products, Inc
- Sabre Tubular Structures
- Thomas & Betts Corporation

AAC CONDUCTOR:

- Southwire
- Midal Cable
- Alcan
- General Cable
- CME

SHIELD WIRE:

- Alcoa
- General Cable

OPGW:

- Alcoa

Hardware Suppliers:

- HD Supply
- Wesco
- Graybar

Insulators-Polymer:

- Ohio Brass
- MPS
- Sediver

Insulators-Porcelain:

- Seves
- LAPP
- Newell

Revenue PT/CT Combos

- GE
- Ritz

Revenue PT/CT Individual Units

- GE
- ABB
- Trench
- Ritz
-

Revenue Meters

- Provided by SMECO