Electric System Planning Criteria

Southern Maryland Electric Cooperative, Inc.
Hughesville, Maryland

SMECO[SM]
People. Power. Progress.

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Preface

Southern Maryland Electric Cooperative, Inc. (SMECO) is a non-profit electric utility owned by the customer-members it serves. SMECO was founded in 1937 and is a progressive forward-thinking organization who puts its employees and customer-members first. SMECO is one of the local region's largest employers with over 500 full and part-time employees. Many of the non-management SMECO employees are also members of the International Brotherhood of Electrical Workers (IBEW) Union Local 1718.

SMECO is centrally located between Charles, Prince Georges, Calvert, and Saint Mary's Counties in Maryland's Southern peninsula ~25 miles southeast of Washington, D.C. This central location is positioned between the Potomac and Patuxent Rivers and the Chesapeake Bay and provides a beautiful rural setting to live and work. SMECO's main Headquarters and Engineering and Operations Center are located in Hughesville Maryland with a Regional Office and Back-Up Control Center located in Leonardtown Maryland. The aging Leonardtown complex is being replaced with a new facility at the same Leonardtown location and is expected to be put in-service by late 2020.

SMECO is one of the ten largest electric utility cooperatives in the United States serving more than 160,000 customer-members with over 13,000 miles of transmission and distribution lines. SMECO covers a 1,150 square mile service area and is only a short drive to downtown Washington DC, Annapolis and Baltimore Maryland's Inner Harbor, or Arlington, Fairfax, and Alexandria Virginia. SMECO's service area offers a moderate climate with four distinct seasons, ranges from remote rural areas to a vibrant urban center, and has a wide variety of local area amenities.

SMECO is committed to the surrounding local community and actively promotes both personal employee and corporate community involvement. SMECO partners with the local school systems, two colleges, Patuxent River Naval Air Station, and numerous commercial businesses and believes in giving back both time and resources to the community it serves.

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I. Introduction

Southern Maryland Electric Cooperative's (SMECO) *Electric System Planning Criteria* document provides the reliability planning philosophy by which SMECO reviews its electric transmission and distribution system. The Planning Criteria document addresses voltage profile, thermal loading, short-circuit and ground fault interrupting duty, and transient stability requirements.

The planning criteria described herein helps ensure the SMECO electric system is planned, constructed, and operated to deliver power from a generation source, through the transmission and distribution system, to an end-use customer in a reliable and economical fashion. To do so means maintaining continuity of service within an acceptable voltage profile and within facility thermal limits under a wide range of defined operating conditions. The criteria outlined within this document will help determine where and when reinforcements to SMECO's electric system are needed to maintain stated continuity of service.

SMECO's electric system is interconnected to the Potomac Electric Power Company (Pepco) electric system at three 230 kV locations and four 69 kV locations. The SMECO 230 kV system is governed by the North American Electric Reliability Corporation (NERC), ReliabilityFirst (RF), and PJM Interconnection, LLC (PJM) organizations. These governing organizations have their own established planning criteria and philosophy documentation that supersedes the SMECO 230 kV system related criteria in case of any conflicts.

SMECO is a Transmission Owner (TO) with an executed PJM Consolidated Transmission Owners Agreement (CTOA). This Agreement places SMECO's 230 kV facilities under PJM's operational control. PJM is the Transmission Operator (TOP), Balancing Authority (BA), Planning Authority (PA), Planning Coordinator (PC), Reliability Coordinator (RC), Transmission Planner (TP), and Resource Planner (RP) for SMECO 230 kV facilities.

SMECO maintains a Local Control Center (LCC) for PJM and also complies with the "Amended and Restated Operating Agreement of PJM Interconnection, L.L.C." (PJM Operating Agreement), the PJM Open Access Transmission Tariff (Tariff), and the PJM Manual 14 series documents. The PJM Manual 14 series documents contain information specific to the generation and transmission line interconnection process, planning studies, and facility connection requirements specific to the PJM system.

II. 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. 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.

III. 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.

IV. Study Criteria

IV.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%

IV.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.

IV.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

IV.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.

IV.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 summer peak load scenarios to determine critical system conditions.

SMECO does not own any area generation and does 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.

V. 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 leading 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).

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