
Draft Dated May 20, 2011

*NOTE: Insert definition listing of acronyms in the beginning?

Introduction
This document outlines the Design Best Practices and Performance Criteria (DBP&PC) to be used by the Transmission Owner (TO) when developing Study Estimates for the SPP footprint projects rated at voltages of 100 kV and greater. To establish Design Best Practices and Performance Criteria (DBP&PC) to be used by the SPP’s Transmission Owners (TOs) in developing Study Estimates for SPP footprint projects rated at voltages at 100 kV and greater. These DBP&PC are intended to ensure consistency in TO Study Stage estimates.

The SPP Project Cost Working Group (PCWG) will use the DBP&PC in evaluating those projects (as outlined in the PCWG Charter) and to formulate its recommendation regarding a project to the SPP Board of Directors.

Recognizing the importance of well defined scopes when developing cost estimates, these scoping guidelines are provided for the Conceptual and Study estimate phases. These will ensure mutual understanding of the project definition between SPP and the TOs as the project is developed and estimates are prepared for the applicable phase of the potential project.

Design Best Practices
Design Best Practices represent high-level, foundational principles on which sound designs are based. These facilitate the design of transmission facilities in a manner that is compliant with NERC, SPP, and TO requirements; is consistent with Good Utility Practice as defined in the SPP Open Access Transmission Tariff (SPP Tariff); is consistent with industry standards such as NESC, IEEE, ASCE, CIGRE, and ANSI; and is cost-effective. Although not addressed here,

1 The SPP Tariff defines Good Utility Practice as follows: “Good Utility Practice: Any of the practices, methods and acts engaged in or approved by a significant portion of the electric utility industry during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the region, including those practices required by Federal Power Act section 215(a)(4).”
construction and maintenance best practices must be considered during the design phase to optimize these costs and efficiencies.

**Performance Criteria**
Performance Criteria will further define the engineering and design requirements needed to ensure a more uniform cost and reliability structure of the transmission facilities and to ensure that the TOs are constructing the project as requested by SPP. Flexibility is given such that the TO’s historical performance criteria, business processes, and operation and maintenance practices are considered.

**Scope Management**
A well developed and rigorously managed scoping document promotes consistent estimates and helps control costs. It also ensures that the SPP and TO have a clear understanding of the project being reviewed.

**Applicability**
The Design Best Practices, Performance Criteria, and Scoping Requirements shall apply to all SPP transmission facilities rated at voltages of 100 kV and greater.
Design Best Practices

Transmission Lines

General
Any criteria established for the design of transmission lines must consider safety, reliability, operability, maintainability, and, economic impacts. The NESC contains the basic provisions considered necessary for the safety of utility personnel, utility contractors, and the public. However, the NESC is not intended to be used as a design manual, so Good Utility Practice must also be considered, as well as RUS guidelines where applicable...

Siting and Routing
The impact of the transmission facility to the surrounding environment should be considered when developing the study estimate. Sensitivity to wetlands, cultural and historical resources, endangered species, archeological sites, existing neighborhoods, and federal lands, among others, are examples that should be considered when siting transmission facilities. The TO must comply with the requirements of all appropriate regulatory agencies during the siting process, and all applicable environmental and regulatory permits must be obtained for the transmission facilities. The TO should describe any known environmental issues and associated estimated costs in its Study Estimate, as well as any estimated regulatory siting and permitting costs. Initial study estimates will use a default assumption for line mileage that is based upon right angle design absent better assumptions from the TO as detailed in the Standardized Cost Estimate Reporting Template (SCERT) that is in development by the PCWG. *Note: Address multiple TO projects.

Electrical Clearances
The clearances of the NESC shall be adhered to in the design of transmission lines. Conductor-to-ground and conductor-to-conductor clearances should include an adequate margin during design to account for tolerances in surveying and construction. Sufficient climbing and working space for NESC and OSHA working clearances should be considered when establishing the geometrical relationships between structure and conductors. Where applicable, dynamic effects (e.g. galloping conductors, ice-drop, etc.) shall be considered.

Structure Design Loads
Structures will be designed, at a minimum, to the NESC and in accordance to the TO’s past practices, as appropriate.

Structure and Foundation Selection and Design
Structure types may be either latticed steel towers, steel or concrete tubular poles or wood for facilities at the TO’s discretion. The choice should be based on consideration of structural loading, phase configuration, total estimated installed cost and other economic factors, aesthetic requirements, siting restrictions, and right-of-way requirements.
Structure design can be based on the following as they apply:

- *ASCE Standard No. 10, Design of Latticed Steel Transmission Structures*
- *ASCE Standard No. 48, Design of Steel Transmission Pole Structures*
- *ASCE Publication Guide for the Design and Use of Concrete Poles*
- *ANSI 05-1, Specifications and Dimensions for Wood Poles*

*IEEE Std. 751, Trial-Use Design Guide for Wood Transmission Structures* Structures may be supported on concrete piers, grillages, or piles, or they may be directly embedded. The method selected shall be based on known geotechnical conditions, and structure loading.

**Insulation Coordination, Shielding, Grounding**

Metallic transmission line structures shall be grounded. Overhead static wires (shield wires) should also be grounded, or a low impulse flashover path to ground should be provided by a spark gap. Individual structure grounds should be coordinated with the structure insulation level and static wire shielding angles (with reference to the phase conductors) to limit momentary operations of the supported circuit(s) to the targeted rate. The coordination of grounding, shielding and insulation should be established considering the effects of span lengths, conductor-to-ground clearances, lightning strike levels, and structure heights.

**Rating of Phase Conductors**

The maximum operating temperature of phase conductors should be based on metallurgical capacity (i.e., the maximum temperature the conductor can withstand without incurring damage due to heat) and assuming a reasonable loss of strength.

The conversion to ampacity shall be based on the *IEEE Publication No. 738 Standard for Calculating the Current-Temperature of Bare Overhead Conductors*. The TO should select environmental parameters based on its experience and historical line rating and operating procedures. *Note: AI (SPP) to find out the SPP criteria for conductor rating and selection.*

**Selection of Phase Conductors**

Phase conductors should be selected to meet Performance Criteria requested by SPP and based on the anticipated power flow of the circuit, metallurgical and mechanical properties and proper consideration for the effects of the high electric fields.

**Optical Ground Wire**

Optical Ground Wire (OPGW) is preferred for all overhead shield wires to provide a communication path for the transmission system. Where there are multiple static wires only one should be OPGW. Where there is an underground fiber communication path OPGW is not preferred. The size shall be determined based on the anticipated fault currents generating from the terminal substations.
Transmission Substations

General

Any criteria established for the design of transmission substations must consider safety, reliability, operability, maintainability, and, economic impacts. The NESC contains the basic provisions considered necessary for the safety of utility personnel, utility contractors, and the public. However, the NESC is not intended to be used as a design manual, so Good Utility Practice must also be considered, as well as RUS guidelines where applicable...

Substation Site Selection and Preparation

When selecting the substation site, careful consideration must be given to factors such as line access and right-of-way, vehicular access, topography, geology, grading and drainage, environmental impact, and plans for future growth. Each of these factors can affect not only the initial cost of the facility, but its on-going operation and maintenance costs. Storm water management plans and structures must comply with all federal, state, and local regulations.

Grounding

The substation ground grid should be designed in accordance with the latest version of *IEEE Std. 80, Guide for Safety in AC Substation Grounding*. The grid should be designed using the maximum fault current expected for the life of the facility.

Substation Shielding

All bus and equipment should be protected from direct lightning strikes using an acceptable analysis method such as the *Rolling Sphere Method*. *IEEE Std. 998, Guide for Direct Lightning Stroke Shielding of Substations*, may be consulted for additional information.

Bus Selection and Design

Bus selection and design must take into consideration the electrical load (ampacity) requirements to which the bus will be subjected, in addition to structural loads such as gravity, ice, wind, short circuit forces, and thermal loads. Bus conductor and hardware selection are also critical to acceptable corona performance and the reduction of electromagnetic interference. Allowable span lengths for rigid-bus shall be based on both material strength requirements of the conductor and insulators, as well as acceptable bus deflection limits. Guidelines and recommendations for bus design can be found in *IEEE Std. 605, Guide for the Design of Substation Rigid-Bus Structures*.

Bus conductors should be sized for the maximum anticipated load (current) calculated under various planning conditions and contingencies. To prevent the ampacity rating of substation bus from limiting system capacity, bus ratings should allow full capacity of the line ratings and provide for the overload capacity of the transformer.
Rating of Bus Conductors
The maximum operating temperature of bus conductors should be based on metallurgical capacity (i.e., the maximum temperature the conductor can withstand without incurring damage due to heat) and assuming a reasonable loss of strength.

The conversion to ampacity shall be based on the IEEE Std. 738, Standard for Calculating the Current-Temperature of Bare Overhead Conductors, and IEEE Std. 605, Guide for the Design of Substation Rigid-Bus Structures. The TO should select environmental parameters based on its experience and historical line rating and operating procedures.

Substation Equipment
Future improvements should be considered when sizing equipment.

Surge protection should be applied, where appropriate, on all line terminals with circuit breakers and considered on all oil-filled electrical equipment in the substation such as transformers, instrument transformers and power PTs.

All substation equipment should be specified such that audible sound levels at the edge of the substation property are appropriate to the facility’s location.

Substation Service
There should be two sources of AC substation service for preferred and back-up feeds. Some acceptable substation service alternatives would be to feed the substation service transformers via the tertiary winding of an autotransformer or connect power PTs to the bus. Distribution lines should not be used as the primary AC source because of reliability concerns, but can be used as a back-up source when other sources are unavailable. If there are no good alternatives for a back-up substation service, installation of a generator could be considered.

Structure and Foundation Selection and Design
Structures and foundations should be designed for all loads acting on the structure and supported bus or equipment, including forces due to gravity, ice, wind, line tension, fault currents and thermal loads.

Structures may be designed and fabricated from tapered tubular steel members, hollow structural steel shapes, and standard structural steel shapes. The selection of structure type (e.g., latticed, tubular, etc.) should be based on consideration of structural loading, equipment mounting requirements, total estimated installed cost and other economic factors, and aesthetic requirements.

Structure design should be based on the following, as appropriate:

- ASCE Standard No. 10, Design of Latticed Steel Transmission Structures
- ASCE Standard No. 48, Design of Steel Transmission Pole Structures
Structures may be supported on concrete piers, spread footings, slabs on grade, piles, or they may be directly embedded. The method selected shall be based on geotechnical conditions, structure loading, and obstructions (either overhead or below grade).

Control Buildings
Control buildings may be designed to be erected on site, or they may be of the modular, prefabricated type. Buildings may be constructed of: steel, block, or other alternative materials, and should be designed and detailed in accordance with the applicable sections of the latest edition of *NOTE find design standards for buildings made of materials other than steel. the AISC Specification for Structural Steel Buildings. Light gauge structural steel members may be designed and detailed in accordance with the latest edition of the AISI Specification for the Design of Cold-Formed Steel Structural Members.

Design loads and load combinations should be based on the requirements of the International Building Code or as directed by the jurisdiction having authority. Building components shall also be capable of supporting all cable trays and attached equipment such as battery chargers and heat pumps.

Wall and roof insulation should be supplied in accordance with the latest edition of the International Energy Conservation Code for the applicable Climate Zone.

Oil Containment
Secondary oil containment shall be provided around oil-filled electrical equipment and storage tanks in accordance with the requirements of the United States EPA. More stringent provisions may be adopted to further minimize the collateral damage from violent failures and minimize clean-up costs.2

Phase Measurement Units (PMUs)
PMUs or Intelligent Electronic Devices (IEDs) should be installed in all new 230 kV and above substations. *NOTE: AI (SPP) will research what we have now.

Single Pole Switching / Breakers / Controls

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2 Additional design information can be found in IEEE Std. 980, Guide for Containment and Control of Oil Spills in Substations.
All 500kV and above facilities in SPP should consider single pole switching. The application of single pole switching to UHV facilities should facilitate maintenance, improve grid stability and performance, and potentially accommodate future changes to existing reliability metrics and standards that could provide tremendous benefit to SPP customers without sacrificing system reliability. Consideration of single pole switching for select 345 kV facilities is encouraged to the extent it’s warranted.
Transmission Protection and Control Design

General
Best practices for employing protection and control principles in the design and construction of new substations must adhere to NERC Reliability Standards, SPP Criteria, as well as individual TO standards.

These guiding principles and best practices center on the following criteria:

- Communication Systems
- Voltage and Current Sensing Devices
- DC Systems
- Primary and Backup Protection Schemes

Communication Systems
Power Line Carrier (PLC) equipment or fiber as the communication medium in these pilot protection schemes is recommended to meet the high-speed communication required. PLC equipment is typically used on existing transmission lines greater than five miles in length. Fiber protection schemes should be considered on all new transmission lines being constructed using OPGW. Relays manufactured from the same vendor must be installed at both ends of the line when fiber protection is being considered. The same relay vendor shall be used if required by the type of relay scheme chosen for PLC (e.g., directional comparison blocking). *NOTE: Add in other forms or Comm; microwave, tone.

Voltage and Current Sensing Devices
Independent current transformers (CTs) are recommended for primary and backup protection schemes in addition to independent secondary windings of the same voltage source (i.e., CCVTs).

DC Systems
DC systems should be designed in accordance with NERC standards, SPP criteria, and TO practices.

Primary and Backup Protection Schemes
Primary and backup protection schemes shall be required for all lines and must be capable of detecting all types of faults on the line. The primary scheme must provide high-speed, simultaneous tripping of all line terminals at speeds that will provide fault clearing times for system stability as defined in NERC Transmission Planning and Reliability Standards TPL-001 through TPL-004.
Performance Criteria

Transmission Lines

Electrical Clearances
The clearances of the NESC shall be adhered to as a minimum in the design of transmission lines. Conductor-to-ground clearances should include a two-foot minimum margin during design to account for tolerances in surveying and construction. Appropriate clearances should be maintained considering NESC requirements, maximum operating temperature, and extreme ice loading. Conductor-to-conductor clearances should also include extra clearance to account for sag and tension, wire movement variances, and minimum approach distances.

Design Load Application
Structures and foundations should be designed to withstand a combination of gravity, wind, ice, conductor tension, construction, and maintenance loads. The following base loadings recommended by ASCE Manual Of Practice (MOP) 74 should be considered to help ensure structural integrity under most probable loading combinations. Dynamic loading (e.g. galloping, ice-drop, etc.) of conductors should also be considered.

Loads with All Wires Intact
- NESC requirements
- Extreme wind applied at 90° to the conductor and structure
- Extreme wind applied at 45° to the conductor and structure
- Combined wind and ice loadings
- Extreme ice loading

Unbalanced Loads
- Longitudinal loads due to unbalanced ice conditions (ice in one span, ice fallen off of adjacent span) with all wires intact
- Longitudinal loads due to a broken ground wire or one phase position (the phase may consist of multiple sub-conductors)
- Unbalanced loads should be considered to prevent cascading failure with spacing predicated on T. O. practices

Construction and Maintenance Loads
- Construction and maintenance loads shall be applied based on the recommendations of ASCE MOP 74
• These loads may be modified based on local TO construction, maintenance, and safety practices

Rating of Phase Conductors
The maximum operating temperature of phase conductors shall be based on metallurgical capacity (i.e., the maximum temperature the conductor can withstand without incurring damage due to heat) and assuming a reasonable loss of strength.

• The conversion to ampacity shall be based on IEEE Publication No. 738 Standard for Calculating the Current-Temperature of Bare Overhead Conductors, and SPP criteria 12, including: Winter Ambient Temperature:
• Summer Ambient Temperature:
• Wind Velocity:
• Wind Direction:
• Emissivity Factor:
• Solar Absorption Factor:
• Angle of Sun’s Rays:
• Elevation:

Minimum Conductor Sizing
The conductor size shall be selected by the TO based on metallurgical (losses, impedance), mechanical, and corona performance criteria to meet SPP’s designated needs. The TO should also consider electrical system stability (voltage and stability), ampacity, and efficiency effects when selecting conductor size.

The following minimum amperage settings should be considered: met: (other voltages? 115kV, 138kV, 161kV) be met: *NOTE: Revisit this table

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>230</td>
<td>2,000</td>
</tr>
<tr>
<td>345</td>
<td>3,000</td>
</tr>
<tr>
<td>500</td>
<td>3,000</td>
</tr>
<tr>
<td>765</td>
<td>4,000</td>
</tr>
</tbody>
</table>
Could the 230 be changed to 1500 amps?

Reconductoring

TOs will consider the application of advanced conductors for reconductoring projects if existing structures are adequate and have sufficient life expectancy to preclude tear down and rebuilds.
Transmission Substations

Electrical Clearances
The clearances for substation design shall be in accordance with all applicable standards and codes. Vertical clearances to ground shall meet or exceed the NESC requirements. When the exposed conductors are in areas where foot traffic may be present, a two-foot margin shall be added to the NESC clearance. Substation phase spacing shall meet IEEE C37.32 and NESC requirements. Sufficient space for OSHA working clearances should be provided when establishing the geometrical relationships between structure and conductors.

Design Load Application
Structures and foundations should be designed for all loads acting on the structure and supported bus or equipment, including forces due to gravity, ice, wind, line tension, fault currents and thermal loads.

Line Structures and Shield Wire Poles
- NESC requirements
- Extreme wind applied at 90 degrees to the conductor and structure
- Combined wind and ice loadings
- Extreme ice loading

Equipment Structures and Shield Poles without Shield Wires
- Wind, no ice
- Combined wind and ice loadings
- In the above loading cases, wind loads shall be applied separately in three directions (two orthogonal directions and at 45 degrees)
- When applicable, forces due to gravity, line tension, fault currents and thermal loads shall also be considered
- Deflection of structures should be limited such that equipment function or operation is not impaired

Rating of Phase Conductors
The maximum operating temperature of phase conductors shall be based on metallurgical capacity (i.e., the maximum temperature the conductor can withstand without incurring damage due to heat) and assuming a reasonable loss of strength.
The conversion to ampacity shall be based on *IEEE Publication No. 738, Standard for Calculating the Current-Temperature of Bare Overhead Conductors*. Modify like the data in the transmission section above

- Winter Ambient Temperature: 68º F (20º C)
- Summer Ambient Temperature: 104º F (40º C)
- Wind Velocity: two feet/second
- Wind Direction: 60º to all line conductors
- Emissivity Factor: 0.8 for copper; 0.5 for aluminum
- Solar Absorption Factor: 0.8 for copper; 0.5 for aluminum
- Angle of Sun’s Rays: 90º to all line conductors
- Elevation: 1,000 feet above sea level

**Bus and Equipment Insulation Levels**

BIL ratings for substation insulators, power transformer bushings, potential transformer bushings, and current transformer bushings can be found in the tables below. When placed in areas of heavy contamination (coastal, agricultural, industrial), insulator contamination can be mitigated by using extra-creep insulators, applying special coatings to extra-creep porcelain insulators, and using polymer insulators.

**Substation Insulators Add line for 115 kV**

<table>
<thead>
<tr>
<th>Nominal System L-L Voltage (kV)</th>
<th>BIL (kV Crest)</th>
<th>BIL (kV Crest) Heavy Contaminated Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>138</td>
<td>550</td>
<td>650 (Extra Creep)</td>
</tr>
<tr>
<td>161</td>
<td>750</td>
<td>750 (Extra Creep)</td>
</tr>
<tr>
<td>230</td>
<td>900</td>
<td>900 (Extra Creep)</td>
</tr>
<tr>
<td>345</td>
<td>1050</td>
<td>1300 (Extra Creep)</td>
</tr>
<tr>
<td>500</td>
<td>1550</td>
<td>1800 (Standard Creep)</td>
</tr>
<tr>
<td>765</td>
<td>2050</td>
<td>2050 (Standard Creep)</td>
</tr>
</tbody>
</table>
Power Transformers, Potential Transformers and Current Transformers

<table>
<thead>
<tr>
<th>Nominal System L-L Voltage (kV)</th>
<th>Power Transformer Winding BIL (kV Crest)</th>
<th>PT and CT BIL (kV Crest)</th>
<th>Circuit Breaker BIL (kV Crest)</th>
</tr>
</thead>
<tbody>
<tr>
<td>138</td>
<td>650</td>
<td>650</td>
<td>650</td>
</tr>
<tr>
<td>161</td>
<td>750</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>230</td>
<td>825</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>345</td>
<td>1050</td>
<td>1300</td>
<td>1300</td>
</tr>
<tr>
<td>500</td>
<td>1550</td>
<td>1550/1800</td>
<td>1800</td>
</tr>
<tr>
<td>765</td>
<td>2050</td>
<td>2050</td>
<td>2050</td>
</tr>
</tbody>
</table>

Rating Margins for Substation Equipment
Substation equipment shall be rated to carry the anticipated worst-case loading over a 20-year period. If actual loading forecasts are not available, then a 50% load growth may be assumed over the 20-year period, based on an annual load growth rate of 2%. Substation equipment shall also be rated for maximum short-circuit levels over the same 20-year period. If the maximum short-circuit level forecast is unknown, then a 22% increase may be assumed over the 20-year period, based on an annual growth rate of 1%.

Maximum Interrupting Fault Current Levels
The common levels of substation design symmetrical fault current ratings can be found in the following table.

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Interrupting Current Symmetrical (kA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>138</td>
<td>40 or 63</td>
</tr>
<tr>
<td>161</td>
<td>40 or 63</td>
</tr>
<tr>
<td>230</td>
<td>40 or 50 ??</td>
</tr>
<tr>
<td>345</td>
<td>40 or 50</td>
</tr>
<tr>
<td>765</td>
<td>50</td>
</tr>
</tbody>
</table>
Bus Configuration
Each new substation should have an initial one-line of the substation and ultimate one-line of the substation prepared. The ultimate one-line will be subjected to continuous revisions to accommodate future improvements. TOs will retain responsibility to ensure new substations are designed to accommodate future expansion of the transmission system, if SPP or the TO has identified that as an area of potential growth. The following table provides suggested bus configurations. Substations should be designed to accommodate the ultimate substation arrangement, including the purchase of land to accommodate the ultimate substation if SPP cost recovery is provided for that additional purchase.

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Number of Terminals</th>
<th>Substation Arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>230/345</td>
<td>One or Two</td>
<td>Single Bus</td>
</tr>
<tr>
<td></td>
<td>Three to Four</td>
<td>Ring Bus</td>
</tr>
<tr>
<td></td>
<td>More than Four</td>
<td>Breaker-and-a-half</td>
</tr>
<tr>
<td>765</td>
<td>One or Two</td>
<td>Single Bus</td>
</tr>
<tr>
<td></td>
<td>Three to Four</td>
<td>Ring Bus</td>
</tr>
<tr>
<td></td>
<td>More than Four</td>
<td>Breaker-and-a-half</td>
</tr>
</tbody>
</table>

The following sketches show substation arrangements for breaker-and-a-half and ring bus schemes. System requirements, however, may require alternative layouts.

Depending on TO practices, a line switch may or may not be required in 345 kV breaker-and-a-half schemes or 345 kV ring bus schemes.

**Breaker-and-a-Half**

![Typical One-Line Diagram](image)
Minimum Rating of Terminal Equipment
Minimum terminal ratings of substation equipment should be as follows:

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>138 &amp; 230</td>
<td>2,000</td>
</tr>
<tr>
<td>345</td>
<td>3,000</td>
</tr>
<tr>
<td>500</td>
<td>3,000</td>
</tr>
<tr>
<td>765</td>
<td>4,000</td>
</tr>
</tbody>
</table>

Transmission Protection and Control Design

Primary and Backup Protection Schemes

The following criteria shall be used to determine if one or two high speed protection systems are needed on a line. While it is possible that the minimum protective relay system and redundancy requirements outlined below could change as NERC Planning and Reliability Standards evolve, it will be the responsibility, of each individual TO, to assess the protection systems and make any modifications that they deem necessary for transmission construction on its system.

500 / 765 kV Line Applications
At least two high speed pilot schemes and dual direct transfer trip (DTT) using PLC and/or fiber are required. Fiber shall be used on all new transmission lines using OPGW and PLC equipment for existing lines (Mode 1 coupling to all three phases). PLC-based protection schemes using directional comparison blocking (DCB) require automatic checkback features to be installed to ensure the communication channel is working properly at all substations.
345 kV Line Applications (SPS suggests this be for 300 kV and above. This is not what we would do on our 230 kV lines)

Dual high speed pilot schemes and one direct transfer trip (DTT) using PLC and/or fiber are required. Dual DTT is required if remote breaker failure protection cannot be provided with relay settings. Fiber shall be used on all new transmission lines using OPGW and PLC equipment for existing lines. The meaning of this statement is not completely clear, but I would use the word should rather than shall) Independent PLC communication paths may be required for proper protective relay coordination. PLC-based protection schemes using directional comparison blocking (DCB) require automatic checkback features to be installed to ensure the communication channel is working properly at all substations.

Below 300 kV Line Applications

A minimum of one high speed pilot scheme using PLC and/or fiber is required. Fiber shall be used on all new transmission lines using OPGW and PLC equipment for existing lines. Dual pilot schemes may be required for proper relay coordination. If dual high speed systems are needed, independent communication channels will be used. PLC-based protection schemes using directional comparison blocking (DCB) require automatic checkback features to be installed to ensure the communication channel is working properly at all substations.
Scoping Requirements

This section describes the Scoping Requirements to be used by the SPP when developing Conceptual cost estimates and the TOs when developing Study cost estimates for transmission facilities for the SPP footprint.

Conceptual Scope Requirements

Transmission Line Projects

- Description of project
- Termination points of each transmission line (Point A to Point B)
- Voltage
- Estimated Line length
- Expected Performance Criteria
- Need Date

Substation Projects

- Each substation involved in the project, including the required configuration and improvements at the remote end substations
- Continuous ratings and interrupting ratings

Study Scope Requirements

The Study Scope document should include the Conceptual Scope requirements in addition to the information listed below.

Transmission Line Projects

- Structure type—lattice structures, poles (wood, steel, concrete, etc.)
- Number of circuits
- Conductor size, type and number/phase
- Type of terrain
- Foundation information
- Switch requirements
- Labor force - company crews or contract crews
- Legal requirements
- Environmental study requirements
Transmission Line Projects (cont’d)

- Geotechnical requirements
- Survey requirements - ground and LiDAR
- Special material requirements
- Preliminary line route (rough location when practical)
- Preliminary design
  - Number of structures
  - Structure types—dead ends, running corners, tangents
- Access road requirements
- Design criteria
- Distribution/Joint Use requirements
- Right-of-Way requirements
- Right-of-Way clearing requirements Traffic control requirements
- FAA Requirements
- Wetland Requirements/Mitigation
- Threatened and Endangered Species Mitigation
- Cultural/Historical Resource Requirements

Transmission Substation Projects

- Preliminary dispatch/switching one-line diagram
- All major equipment, including rehab of existing equipment to meet the SPP project scope
- BIL and wind ratings
- Contamination requirements
- Mobile substation requirements
- Required substation property/fence expansions (indicating anticipated arrangement of proposed facilities and any resulting expansion needed)
- Control house expansions (indicating anticipated panel layout and any resulting expansion needed)
- Identification of parent level Design Module standards needed on the project
- Preliminary one-line diagram
- Fiber optic requirements
- Remote end requirements
- Any single item that would impact the cost of the associated component by > 5%
- Metering requirements
- Third Party requirements
- Reactive Compensation requirements
- Wetland/T&E/Community Approval/Unusual site prep requirements.