

Project 2006-02: Assess
Transmission Future Needs -
System Planning Performance
Requirements: TPL-001-1

Latest Developments from the ATFNSDT
January 14, 2010



Agenda

- Overview of Proposed TPL-001-1
 - Project Scope
 - Project Overview
 - Project Status
- Detailed Review
- Q&A and Discussion



Drafting Team Roster

- **John Odom, FRCC (Chair)**
 - Bob Millard, RFC
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 - Bill Harm, PJM
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 - Ron Mazur, Manitoba Hydro
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 - Bernie Pasternack, AEP
 - Bob Pierce, Duke
 - Chifong Thomas, PG&E
 - Jim Useldinger, KCPL
 - Dana Walters, National Grid
 - **Active observers**
 - NERC Staff Coordinator – Ed Dobrowolski
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Project Scope

- Standards Involved

- TPL-001-0.1 (NERC A, No Contingency)
- TPL-002-0a (NERC B, Single Contingency)
- TPL-003-0 (NERC C, Multiple Contingency)
- TPL-004-0 (NERC D, Extreme Contingency)
- TPL-005-0 (RRO Regional and Interregional Studies)
- TPL-006-0.1 (RRO Data, Reports, as requested by NERC)

- Applicable Entities Involved

- Planning Authority (Planning Coordinator)
- Transmission Planner
- Regional Reliability Organization

[NERC Website Project 2006-02](http://www.nerc.com/filez/standards/Assess-Transmission-Future-Needs.html)

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Project Scope

Create a new standard that:

1. Has clear, enforceable requirements
2. Is not a Least Common Denominator standard
3. Addresses the issues raised in the SAR and issues raised by FERC and others



FERC Order 693 Highlights

- Consider consolidating into a single standard
- Consider differences in regional and RTO planning
- Consider a full range of variables to identify critical system conditions
- Ensure simulations replicate real-time expectations
- Should not allow for firm load shedding or curtailment of firm transfers in response to single contingencies.



FERC Order 693 Highlights

- Clarify what is permitted for system adjustments
- Use of Special Protection Schemes
- Generator voltage ride through capability
- Spare equipment strategy
- Dynamic behavior of loads.
- Stability of on-peak load models.



TPL-001-1 Overview

- R1: System Models
- R2: Assessments
 - Near-term Steady-State
 - Long-term Steady-State
 - Short Circuit
 - Near-term Stability
 - Long-term Stability
 - Qualified Past Studies
 - Corrective Action Plans
 - Corrective Action Plans - Short Circuit
- R3: Steady-State Studies
- R4: Stability Studies
- R5: Voltage Criteria
- R6: Cascade Criteria
- R7: PC/TP Responsibilities
- R8: PC/TP Peer Reviews

Table 1 – Performance Requirements

Planning Events

- P0: Normal System
- P1: Single Contingency
- P2: Single Contingency [*higher impact*]
- P3: Generator + 1
- P4: Stuck Breaker
- P5: Protection System Failure
- P6: Overlapping contingencies [*Non-gens, Two P1 Events*]
- P7: Common Structure [2 circuits]

- *Simulate the removal of all elements that Protection Systems and other controls are expected to automatically disconnect for each event.*
- *Require Corrective Action Plans for inability to meet performance requirements*

Table 1 – Performance Requirements

Planning Events, Table Components (Columns)

- Category (P0, P1, ... P7)
- Initial system condition
- Event
- Fault Type (3-phase or Single Line to Ground)
- BES Level (EHV or HV)
- Interruption of Firm Transmission Service Allowed
- Non-Consequential Load Loss Allowed

Consequential Load Loss: *All Load that is no longer served by the Transmission System as a result of Transmission Facilities being removed from service by a Protection System operation designed to isolate the fault.*

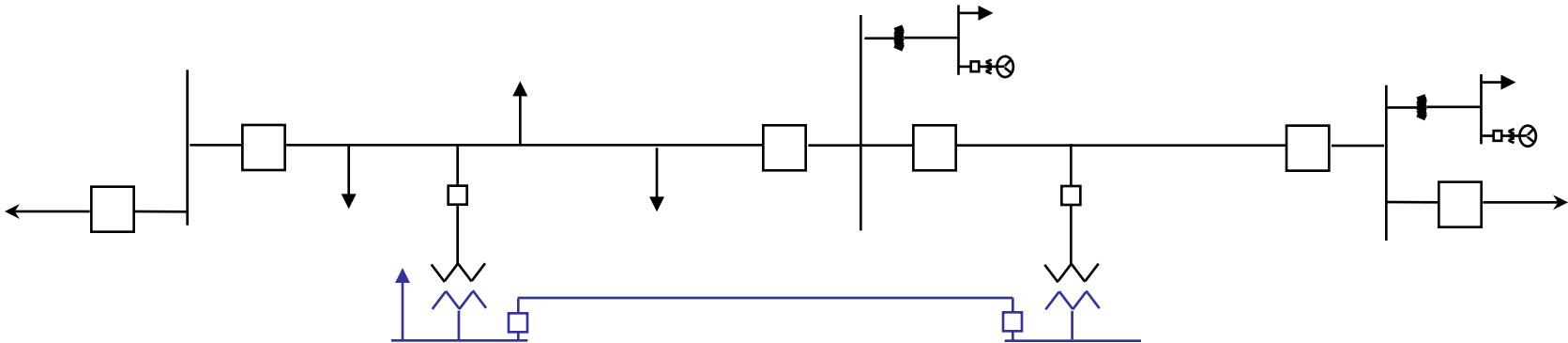
Non-Consequential Load Loss: *Non-Interruptible Load loss that does not include: (1) Consequential Load Loss, (2) the response of voltage sensitive Load, or (3) Load that is disconnected from the System by end-user equipment.*

Table 1 – Performance Requirements

Planning Events, Example

If the event analyzed involves BES elements at multiple System voltage levels, the lowest System voltage level for stated performance criteria applies regarding allowances for interruptions of Firm Transmission Service and loss of Non-Consequential Load

Category	Initial System Condition	Event ¹	Fault Type ²	BES Level ³	Interruption of Firm Transmission Service Allowed ⁴	Non-Consequential Load Loss Allowed
P0 No Contingency	Normal System	None	N/A	EHV, HV	No	No
P1 Single Contingency	Normal System	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer ⁵ 4. Shunt Device ⁶	3Ø	EHV, HV	No	No
		5. Single Pole of a DC line	SLG			
P2 Single Contingency	Normal System	1. Opening of Breaker(s) w/o fault ⁷	N/A	EHV, HV	No	No
		2. Bus Section Fault	SLG	EHV HV	No Yes	No Yes
		3. Internal Breaker Fault ⁸ (Non Bus-tie)	SLG	EHV HV	No Yes	No Yes
		4. Internal Breaker Fault (Bus-tie) ⁸	SLG	EHV, HV	Yes	Yes



Planning Horizons & Year One

- Year One

- *The first year that a Planning Coordinator or a Transmission Planner is responsible for assessing. This is further defined as the planning window that begins 12-18 months from the end of the current calendar year.*

Current Year (2009)												2010												2011																				
Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4											
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D									
Blue			Orange			Red			Orange			Blue			Blue			Orange			Red			Orange			Blue			Blue			Orange			Red			Orange			Blue		



During the calendar year 2009, Year One for a winter peaking system would be winter 2010/2011 and for a summer peaking system summer 2011.

- Near-Term Horizon (Year 1-5)
- Long-term Horizon (Year 6-10) or beyond for long lead-time projects



TPL-001-1 Overview

- Implementation Plan
 - Staggered Implementation Plan (12mo, 24mo, 60mo)
- Areas where “bar was raised” for EHV
 - Single contingency (P1-2 & 1-3, and P2-1, and P2-2 & P2-3 above 300 kV)
 - Generator + 1 (P3)
 - Stuck Breaker (P4 above 300 kV)
 - Protection System Failure (P5 above 300 kV)



Project Status

NERC Website Project 2006-02

- Draft 5, 30 day pre-ballot pool period
 - January 20, 2010 through February 19, 2010
- Plan to ballot in early Q1 2010
 - 10 day ballot period
 - Need to achieve quorum (75% of Registered Ballot Body)
 - Approval requires 2/3 approval from ballot body

<http://www.nerc.com/filez/standards/Assess-Transmission-Future-Needs.html>



TPL-001-1 *Detailed Review*

- R1: System Models
- R2: Assessments
 - Near-term Steady-State
 - Long-term Steady-State
 - Short Circuit
 - Near-term Stability
 - Long-term Stability
 - Qualified Past Studies
 - Corrective Action Plans
 - Corrective Action Plans – Short Circuit
- R3: Steady-State Studies
- R4: Stability Studies
- R5: Voltage Criteria
- R6: Cascade Criteria
- R7: PC/TP Responsibilities
- R8: PC/TP Peer Reviews



R1 System Models

Each Transmission Planner and Planning Coordinator shall maintain System models within its respective area for performing the studies needed to complete its Planning Assessment. The models shall use the latest data consistent with that provided in accordance with the MOD-010 and MOD-012 standards, supplemented by other sources as needed, including items represented in the Corrective Action Plan, and shall represent projected System conditions.

- Six Subparts
- What's New?
 - New Requirement for TPL
 - Equivalent does not exist in current TPL standards
 - Team felt it was important to define ownership of the models/data



R1 System Models

■ Six Subparts

- Existing Facilities
- Known outage(s) of generation or Trans. Facility(ies)
> 6 months
- New planned Facilities and changes to existing Facilities
- Real and reactive Load forecasts
- Known commitments for Firm Transmission Service and Interchange
- Resources (supply or demand side) required for Load



R2 Planning Assessments

Each TP and PC shall prepare an annual Planning Assessment of its portion of the BES. This Planning Assessment shall use current or past studies, document assumptions, summarize documented results, and cover steady state analyses, short circuit analyses, and Stability analyses.

- Eight parts

- What's new
 - Clearer description of documentation
 - Explicit description of analyses



2.1 Near-term Steady-State

The Near-Term Transmission Planning Horizon portion of the steady state analysis shall be assessed annually and be supported by the following annual current studies, supplemented with qualified past studies

What's new

- More specificity on study years
- Off-peak study specifically required
- Sensitivity analysis required
- Specific consideration of spare equipment strategy



2.2 Long-term Steady-State

The Long-Term Transmission Planning Horizon portion of the steady state analysis shall be assessed annually and be supported by the following annual current study, supplemented with qualified past studies

What's new

- No significant change



2.3 Short Circuit Analysis

The short circuit analysis portion of the Planning Assessment shall be conducted annually addressing the Near-Term Transmission Planning Horizon and can be supported by current or qualified past studies. The analysis shall be used to determine whether circuit breakers have interrupting capability for Faults that they will be expected to interrupt using the System short circuit model with any planned generation and Transmission Facilities in service which could impact the study area.

What's new

- Explicit analysis requirement



2.4 Near-term Stability

The Near-Term Transmission Planning Horizon portion of the Stability analysis shall be assessed annually and be supported by qualified current or qualified past studies

What's new

- Load models must represent dynamic behavior; e.g. behavior of induction motors
- Off-peak study specifically required
- Sensitivity analysis required



Load Modeling

- System peak Load studies shall include a Load model which represents the dynamic behavior of Loads that could impact the study area, considering the behavior of induction motor Loads.
- Commenters:
 - Don't know how to do this
 - Don't know specifics of loads at each bus
- An aggregate System Load model which represents the overall dynamic behavior of the Load is acceptable
 - WECC – Model Verification Working Group (MVWG) is developing dynamic load models (Note should be specific to your region)



2.5 Long-term Stability

The Long-Term Transmission Planning Horizon portion of the Stability analysis shall be assessed to address the impact of proposed generation additions or changes in that timeframe and be supported by current or qualified past studies.

What's new

- Specific requirement to assess proposed generation in long term horizon



2.6 Qualified Past Studies

Past studies may be used if:

- The study is five calendar years old or less, unless a technical rationale can be provided to demonstrate that the results of an older study are still valid.
- The study does not include any material changes unless a technical rationale can be provided to demonstrate that System changes do not impact the performance results in the study area.

What's new

- Specific qualifications for continued validity of past studies



2.7 Corrective Action Plan

For planning events - When the analysis indicates an inability of the System to meet the performance requirements in Table 1, the Planning Assessment shall include Corrective Action Plan(s). Revisions to the Corrective Action Plan(s) are allowed in subsequent Planning Assessments but the planned System shall continue to meet the performance requirements in Table 1. Corrective Action Plan(s) include:

- List of System deficiencies and actions needed to achieve required performance
- Actions to resolve performance deficiencies in multiple sensitivity studies or rationale why actions are not needed -- New
- Document situations beyond the control of the TP or PC and actions being taken to resolve situation -- New
- Annual review of implementation status



2.8 Corrective Action Plan for Short Circuit Duty

For short circuit analysis, if the short circuit current interrupting duty on circuit breakers exceeds their Equipment Rating, the Planning Assessment shall include a Corrective Action Plan to address the Equipment Rating violations.

What's new

- Specific performance requirement for short circuit analysis
- Corrective action plan for short circuit performance deficiencies



R3 Steady state studies

For the steady state portion of the Planning Assessment, each Transmission Planner and Planning Coordinator shall perform studies for the Near-Term and Long-Term Transmission Planning Horizons in Requirement R2, parts 2.1, and 2.2. The studies shall be based on computer simulation models using data provided in Requirement R1.

- Five Parts
- What's New?
 - More explicit requirements
 - Simulate anticipated Protection System performance
 - Need to simulate automatic controls
 - Generator voltage ride through limitations



Differences from Existing Standard

- Planning Events look a lot like contingencies in existing standard
 - P0 applicable to steady state only
- One difference in Planning Events
 - Existing: fault with stuck breaker OR protection system failure
 - New: fault with stuck breaker AND fault with failure of protection system
- Made clear that a three-phase fault could be used to demonstrate a SLG fault requirement



Differences from Existing Standard

- Extreme Events have a lot of differences
- Major change from the existing standard is that those events which did not apply to stability were only included in the steady state section of extreme events



R3 Steady state studies

- Part 3.1: study Table 1 planning events per Part 3.4
- Part 3.2: study Table 1 extreme events per Part 3.5
- Part 3.3: contingency analysis specifications
 - Simulate removal of elements from Protection System and automatic control actions
 - Generator low voltage ride through
 - Trip unit in simulation if voltage are less than ride through voltage limitations
 - Ride-through can be known or assumed
 - Trip Transmission elements when relay loadability limits are exceeded.
 - Simulate automatic operation of LTCs, Phase-shift TRs, ...



R3 Steady state studies

■ Contingency Lists

- Flexibility for engineering judgment.
 - *" Those [planning or extreme] events in Table 1, that are expected to produce more severe System impacts on its portion of the BES"*
- Similar to existing TPL contingencies
- Part 3.4: planning event contingency list ... *P1 through P7*
 - Coordinate with neighboring TPs/PCs for contingencies that may impact your system
- Part 3.5: extreme event contingency list



R4 - Stability

- Existing standards are not very clear on what's steady state and what's stability
 - Some contingencies don't seem to be appropriate for stability
- New standard is very clear on stability
 - Separate standard for stability? No.
 - Separate table of contingencies for stability? No.
 - Consistent with steady state requirements? Yes, where possible.

4.1 Requirements for stable system



- Existing standard simply says system must be stable but doesn't define "stable"
- TPL-001-1 gives performance requirements for system response to be called stable
 - P1 events (single contingency, normal clearing): No unit shall pull out of synchronism
 - P2-P7 events: Units can pull out of synchronism
 - Resulting impedance swings not result in tripping lines other than the generator and the associated gen-tie Facilities
 - Show that generation loss does not cause problem
 - P1-P7: Power oscillations shall exhibit acceptable damping

4.1/4.4 Planning Event Contingencies



- Part 4.1: Run the list of contingencies per Part 4.4
- Part 4.4: Make a list of contingency events which produce more severe results
 - Use your judgment
 - Provide rationale for contingencies selected
 - 4.4.1: Coordinate with adjacent PCs and TPs
 - Provide contingencies on your system that impact them
 - Receive contingencies on their system which impact you



4.2/4.5 Extreme Events

- Part 4.2: Run the list of contingencies developed per Part 4.5
- Part 4.5: List of contingencies which produce more severe system impacts
 - Provide rationale for contingencies selected
 - If cascading results, evaluate actions to reduce likelihood or make consequences better

4.3 Contingency Analysis

Shall:

- Simulate removal of all elements that Protection and other automatic controls are expected to disconnect
- Consider impact of successful or unsuccessful high speed reclosing
 - High speed reclosing is closing within one second
- Generator low voltage ride through
 - Trip unit in simulation if voltage are less than ride through voltage limitations

4.3.3 Impact of Swings on Protection

- Simulate the impact of transient swings on Protection System operation for Transmission lines and transformers.
- Commenters: Do we have to model all zone 3 relays in the whole system???
- Can use generic impedance relay on all branches as a screen
 - Generic relay defines protection zones based on branch impedance
 - Two widely used dynamic simulation programs have this capability
 - If swings get into generic relays, make decision based on that result or model specific relay characteristics



R5 Steady state studies

- Each Transmission Planner and Planning Coordinator shall have criteria for acceptable **System steady state voltage limits, post-Contingency voltage deviations,** and the transient voltage response for its System. For transient voltage response, the criteria shall at a minimum, specify a voltage level and a maximum length of time that transient voltages may remain outside that level.
 - Single point reference



R5 Transient Voltage Criteria

- Each TP/PC shall have criteria for acceptable transient voltage response for its System.
- Minimum expectation: voltage level with time allowed to remain below that level
- Can be more detailed if desired



R6 Criteria or Methodology to Identify System Instability

- Each TP/PC shall define and document any criteria or methodology used in the analysis to identify System instability for conditions such as Cascading, voltage instability, or uncontrolled islanding.
- How can you meet this requirement?
 - Cascading example: trip line if loading exceeds 125%, drop load if voltage below .8 pu
 - Uncontrolled islanding example: impedance swings get into line relay protection zones



R7 Responsibility for Studies

Each PC, in conjunction with each of its TPs, shall determine and identify each entity's individual and joint responsibilities for performing the required studies for the Planning Assessment.

- New requirement; statement of best practice
- Ensures completeness

R8 Distribution of Assessment Results



Each PC and TP shall distribute its Planning Assessment results to adjacent PCs, adjacent TPs, and to any functional entity that has a reliability related need and submits a written request for the Planning Assessment results.

- New requirement
- Recipients of the Planning Assessment can provide written comments; the TP or PC must respond within 90 days
- Ensures consideration of outages and performance deficiencies on neighbors' systems

Implementation Plan - Schedule



- R1 (Modeling) and R7(Responsibilities) are effective 12 months after regulatory approval
- All other requirements (R2 – R6 and R8) become effective 24 months after regulatory approval except for more stringent performance requirements
- 60 months before “raising the bar” performance becomes effective

Implementation Plan - Schedule



- Allow entities to develop, perform and/or validate new and/or modified studies, methodologies, assessments, procedures, etc. necessary to implement and meet the TPL-001-1 requirements.
- Specified effective dates expected to allow sufficient time to assess available options to create a viable Corrective Action Plan that is compliant with the new Standard.



Implementation Plan – Raising the Bar

- TPL-001-1 'raises the bar' in several areas where performance requirements have been changed versus those in the existing TPL Standards because loss of Non-Consequential Load or interruption of firm transfers is no longer allowed for certain events, whereas the existing Standards were interpreted by many to allow such actions.



Implementation Plan – Raising the Bar

- Performance requirements associated with the following events represent “raising the bar”:
 - P1-2 (N-1: controlled interruption of local network customers)
 - P1-3 (T-1: controlled interruption of local network customers)
 - P2-1 (Open line w/o fault)
 - P2-2, above 300 kV (Bus section fault)
 - P2-3, above 300 kV (Internal breaker fault)
 - P3-1 through P3-5 (G-1, system adjust, N-1)
 - P4-1 through P4-5, above 300 kV (SLG, delay clearing due to stuck breaker)
 - P5, above 300 kV (SLG, delay clearing due to protection system failure)



Implementation Plan – Raising the Bar

- “Raising the bar” is beyond the control of the TP and PC and may have significant impacts on many Transmission Owners.
- The SDT reviewed industry inputs and determined that a timeframe coincident with the end of the Near-Term Transmission Planning Horizon would be appropriate to implement the changes.

Implementation Plan – Raising the Bar

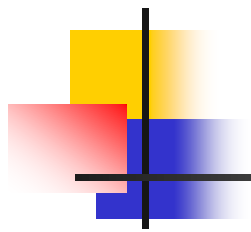


- Corrective Action Plans applying to performance for selected events are allowed to include tripping of Non-Consequential Load or curtailment of Firm Transmission Service during the 60 month transition that would not otherwise be permitted by the requirements of TPL-001-1.

Implementation Plan – Raising the Bar



- Any entity which cannot eliminate the need to trip Non-Consequential Load or curtail Firm Transmission Service for these performance elements by that date shall submit a mitigation plan to their Regional Entity outlining the steps they will take to correct the problem. If the entities follow the established ERO procedure for mitigation, it is the intent of the SDT that no penalties will be assessed.



Questions ?