Manual 14B Updates for TPL-001-5.1 Summary of Changes

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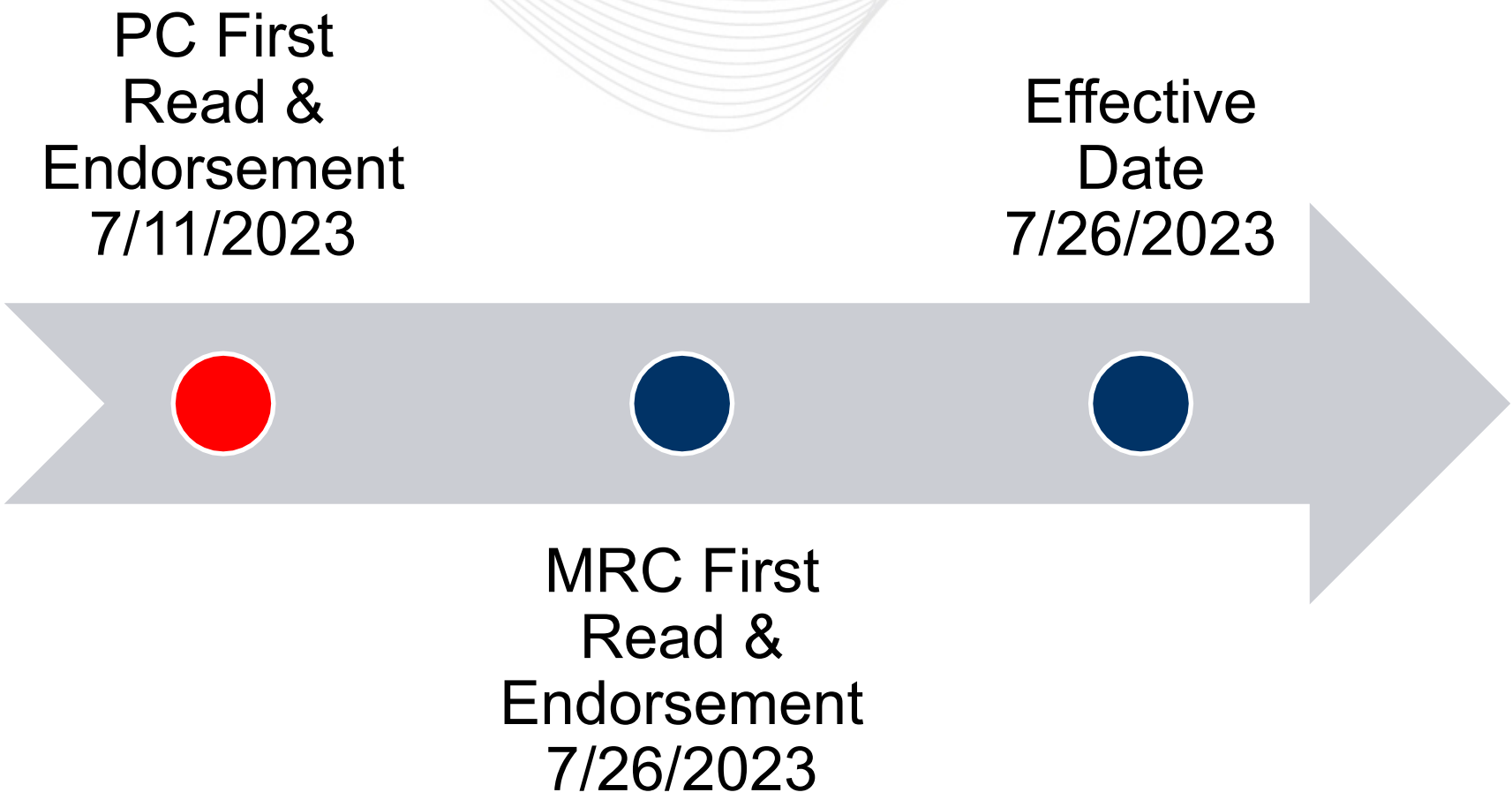
Issue Charge / Problem Statement

- PJM is updating its Regional Transmission Planning Manual, M14B to align with revisions to the NERC TPL-001-5.1 standard. The target effective date of the revised M14B Revision 54 is scheduled for July 26th 2023. PJM uses its planning requirements and guidelines as outlined in Manual 14B to support its compliance with NERC standards. These changes cover the following aspects of planning assessments as outlined in M14B;
  - Maintenance Outages in the Planning Horizon
  - Spare Equipment Strategy (Long Lead Time)
  - Single Points of Failure (SPF) – Planning & Extreme Events
  - M14B Administrative Updates for TPL-001-5.1 (References to TPL-001-5.1 replacing those initially referencing TPL-001-4)

- **TPL-001-5**
  - FERC Order issued approving TPL-001-5
  - Docket No. RM19-10-000
  - January 23, 2020
- **TPL-001-5.1**
  - FERC Order issued approving TPL-001-5.1
  - Docket No. RD20-8-000
  - June 10, 2020
    - Errata: Updates incorrect references made in Requirement R2 Part 2.7.
- Effective Date of Standard: 7/1/2023(1)
  - (1)Requirement R2 Part 2.7: 7/1/2025 – See Implementation Plan

Review and Approval Timeline



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M14B Updates for TPL-001-5.1

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Appendix

Maintenance Outages in the Planning Horizon

- **Revisions**
  - Known outage(s) shall be selected for assessment consistent with a documented outage coordination procedure or technical rationale by the Planning Coordinator or Transmission Planner
  - Six month outage duration removed
    - Known outage(s) shall not be excluded solely based upon outage duration.
  - Steady State analysis includes P0 (no contingency) & P1 (single contingency) planning event categories identified in Table 1 of standard
  - Stability analysis now required in Requirement R2 Part 2.4.4.
    - Includes P1 (single contingency) planning event category identified in Table 1 of standard

Spare Equipment Strategy (Long Lead Time)

- **Revisions**
  - Minor language updates to Requirement R2 Part 2.1.5

2.1.5. When an entity's spare equipment strategy could result in the unavailability of major Transmission equipment that has a lead time of one year or more (such as a transformer), the impact of this possible unavailability on System performance shall be ~~studied~~assessed. Based upon this assessment, an~~The~~ ~~studies~~ analysis shall be performed for the P0, P1, and P2 categories identified in Table 1 with the conditions that the System is expected to experience during the possible unavailability of the long lead time equipment.

  - Stability analysis now required in Requirement R2 Part 2.4.5.
    - *"An analysis shall be performed for the selected P1 and P2 category events identified in Table 1 for which the unavailability is expected to produce more severe System impacts on its portion of the BES."*

Single Points of Failure(SPF) – Planning Events

Category	Initial Condition	Event [1]	Fault Type [2]	BES Level [3]	Interruption of Firm Transmission Service Allowed [4]	Non-Consequential Load Loss Allowed
P5 Multiple Contingency *(Fault plus ~~relay~~non-redundant component of a Protection System failure to operate)*	Normal System	Delayed Fault Clearing due to the failure of a non-redundant ~~relay~~[12] component of a Protection System[13] protecting the Faulted element to operate as designed, for one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6] 5. Bus Section	SLG	EHV	No[9]	No
				HV	Yes	Yes

13. ~~Applies~~For purposes of this standard, non-redundant components of a Protection System to ~~the following~~consider are as follows:

a. A single protective relay which responds to electrical quantities, without an alternative (which may or may not respond to electrical quantities) that provides comparable Normal Clearing times;

b. A single communications system associated with protective functions ~~or types: pilot (#85), distance (#21), differential (#87), current (#50, 51,~~ necessary for correct operation of a communication-aided protection scheme required for Normal Clearing (an exception is a single communications system that is both monitored and ~~67),~~ reported at a Control Center);

c. A single station dc supply associated with protective functions required for Normal Clearing (an exception is a single station dc supply that is both monitored and reported at a Control Center for both low voltage ~~(#27 & 59), directional (#32, & 67), and tripping (#86, & 94),~~ and open circuit);

d. A single control circuitry (including auxiliary relays and lockout relays) associated with protective functions, from the dc supply through and including the trip coil(s) of the circuit breakers or other interrupting devices, required for Normal Clearing (the trip coil may be excluded if it is both monitored and reported at a Control Center).

Single Points of Failure(SPF) – Extreme Events

Table 1 – Steady State & Stability Performance Extreme Events

Steady State & Stability

For all extreme events evaluated:

a. Simulate the removal of all elements that Protection Systems and automatic controls are expected to disconnect for each Contingency.

b. Simulate Normal Clearing unless otherwise specified.

Stability

1. With an initial condition of a single generator, Transmission circuit, single pole of a DC line, shunt device, or transformer forced out of service, apply a 3Ø fault on another single generator, Transmission circuit, single pole of a different DC line, shunt device, or transformer prior to System adjustments.
2. Local or wide area events affecting the Transmission System such as:
   a. 3Ø fault on generator with stuck breaker[10] ~~or a relay failure[13]~~ resulting in Delayed Fault Clearing.
   b. 3Ø fault on Transmission circuit with stuck breaker[10] ~~or a relay failure[13]~~ resulting in Delayed Fault Clearing.
   c. 3Ø fault on transformer with stuck breaker[10] ~~or a relay failure[13]~~ resulting in Delayed Fault Clearing.
   d. 3Ø fault on bus section with stuck breaker[10] ~~or a relay failure[13]~~ resulting in Delayed Fault Clearing.
   e. 3Ø fault on generator with failure of a non-redundant component of a Protection System[13] resulting in Delayed Fault Clearing.
   f. 3Ø fault on Transmission circuit with failure of a non-redundant component of a Protection System[13] resulting in Delayed Fault Clearing.
   g. 3Ø fault on transformer with failure of a non-redundant component of a Protection System[13] resulting in Delayed Fault Clearing.
   h. 3Ø fault on bus section with failure of a non-redundant component of a Protection System[13] resulting in Delayed Fault Clearing.
   ~~e.~~i. 3Ø internal breaker fault.
   ~~f.~~j. Other events based upon operating experience, such as consideration of initiating events that experience suggests may result in wide area disturbances

M14B Administrative Updates for TPL-001-5.1

- Updated references from TPL-001-4 to TPL-001-5.1
- Revised Manual language to align with updated requirements in TPL-001-5.1
  - Maintenance Outage Analysis
  - Spare Equipment Analysis
  - P5 Planning Event
    - Non-redundant components of a protection system
- Updated **Attachment I: Steady State & Stability Performance Planning Events** table to align with TPL requirements

Examples of Administrative Updates

- For full text updates, see accompanying redline of Manual 14B

2.3.11 Spare Equipment Strategy Review

PJM will annually evaluate ~~th~~an entity's~~e~~ spare equipment strategy that could result in the unavailability of major transmission equipment that has a lead time of one year or more (such as a transformer). Steady state analysis is performed for the P0, P1 and P2 planning event categories and stability analysis is performed for the P1 and P2 planning event categories defined in Table 1 of NERC TPL-001-5.1 with the conditions that the system is expected to experience during the possible unavailability of the long lead time equipment.~~and assess the impact of this possible unavailability on system performance using NERC category P0, P1 and P2 contingency categories identified in Table 1 of NERC TPL-001-4. This assessment will consider the conditions that the system is expected to experience during the possible unavailability of the long lead time equipment.~~

H.1.2 Load Flow Modeling Requirements

In addition to the guidelines set forth by NERC and the ERAG MMWG procedural manual, PJM uses several specific procedures in establishing the base case so that it represents the best starting point for the annual RTEP analysis.

Generator step-up transformers

Generator models should represent the physical plant lay-out to the extent possible, explicitly modeling generator step-up transformers (GSUs) and Station Service loads (aka Auxiliary loads). This applies to units above 20 MW and connected to the BES system, consistent with BES requirements. Plants consisting of multiple units aggregating to 75 MW or more also require explicit representation of GSUs and station service loads.

Modeling of Outages

Known outages of Generation or Transmission Facilities are selected based on a documented technical rationale and ~~with a duration of at least six months~~ will be included under those system peak or off-peak conditions in the appropriate base case model. PJM may not model these outages in every case that is used for RTEP analysis, but will select appropriate scenarios to asses these changes. PJM will perform analysis on the P0 and P1 planning event categories for steady state analysis and the P1 planning event category for stability analysis as defined in Table 1 of TPL-001-5.1. Additionally PJM will analyze a subset of maintenance outages submitted through eDart under those system peak or off-peak conditions.

TPL-001-5.1 Table 1

Attachment I: Steady State & Stability Performance Planning Events

I.1 NERC TPL-001-5.1 Table 1

Manual or automatic load shed is not permitted for any P0 - P7 condition.

NERC TPL-001 Events				PJM		
NERC Category	**Initial Condition**	**Event[1]**	**Fault Type[2]**	**Thermal Limits**	**Low Voltage Limit ****	**High Voltage Limit ****
P0 No Contingency	Normal System	None	N/A	Apply normal limits, the actual % may differ, depending on the TO zone	PJM Planning will use the same voltage limits that are used in PJM Operations for both voltage magnitude and voltage deviation. Emergency limits are used for normal, single contingencies and multiple contingencies. For Transmission Owner Criteria, PJM will default to the operations limits unless the TO limits are more conservative.	
P1 Single Contingency	Normal System	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6]	3Ø	Apply emergency limits, the actual % may differ, depending on the TO zone		
		5. Single Pole of a DC line	SLG			
P2 Single Contingency	Normal System	1. Opening of a line section w/o a fault[7]	N/A			
		2. Bus Section Fault	SLG			
		3. Internal Breaker Fault[8] (non-Bus-tie Breaker)	SLG			
		4. Internal Breaker Fault (Bus- tie Breaker) [8]	SLG			
P3 Multiple Contingency	Loss of generator unit followed by System adjustments [9]	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6]	3Ø	Normal limits after the 1st contingency, emergency limits after the 2nd contingency		
		5. Single pole of a DC line	SLG			
P4 Multiple Contingency *(Fault plus stuck breaker)[10]*	Normal System	Loss of multiple elements caused by a stuck breaker[10] (non-Bus-tie Breaker) Attempting to clear a Fault on one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6] 5. Bus Section	SLG	Apply emergency limits, the actual % may differ, depending on the TO zone		
		6. Loss of multiple elements caused by a stuck breaker[10] (Bus-tie Breaker) attempting to clear a Fault on the associated bus				
P5 Multiple Contingency *(Fault plus non-redundant component of a Protection System failure to operate)*	Normal System	Delayed Fault Clearing due to the failure of a non-redundant component of a Protection System[13] protecting the Faulted element to operate as designed, for one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6] 5. Bus Section	SLG			

NERC TPL-001 Events				PJM		
NERC Category	**Initial Condition**	**Event[1]**	**Fault Type[2]**	**Thermal Limits**	**Low Voltage Limit ****	**High Voltage Limit ****
P6 Multiple Contingency *(Two overlapping singles)*	Loss of one of the following followed by System adjustments.[9] 1. Transmission Circuit 2. Transformer[5] 3. Shunt Device[6] 4. Single pole of a DC line	Loss of one of the following: 1. Transmission Circuit 2. Transformer[5] 3. Shunt Device[6]	3Ø	Normal limits after the 1st contingency, emergency limits after the 2nd contingency		
		4. Single pole of a DC line	SLG			
P7 Multiple Contingency *(Common Structure)*	Normal System	The loss of any two adjacent (vertically or horizontally) circuits on common structure[11]	SLG	Apply emergency limits, the actual % may differ, depending on the TO zone		

13. ~~Applies to the following relay functions or types: pilot (#85), distance (#21), differential (#87), current (#50, 51, and 67), voltage (#27 & 59), directional (#32, & 67), and tripping (#86, & 94).~~ For purposes of this standard, non-redundant components of a Protection System to consider are as follows:

a. A single protective relay which responds to electrical quantities, without an alternative (which may or may not respond to electrical quantities) that provides comparable Normal Clearing times;

b. A single communications system associated with protective functions, necessary for correct operation of a communication-aided protection scheme required for Normal Clearing (an exception is a single communications system that is both monitored and reported at a Control Center);

c. A single station dc supply associated with protective functions required for Normal Clearing (an exception is a single station dc supply that is both monitored and reported at a Control Center for both low voltage and open circuit);

d. A single control circuitry (including auxiliary relays and lockout relays) associated with protective functions, from the dc supply through and including the trip coil(s) of the circuit breakers or other interrupting devices, required for Normal Clearing (the trip coil may be excluded if it is both monitored and reported at a Control Center).

Revision History

Version No.	Date	Description
1	7/19/2023	• Original slides posted

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