NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

FERC Order 786 Directives

NERC System Analysis and Modeling Subcommittee (SAMS) White Paper

Overview of FERC Order 786

In Section 215 of the Federal Power Act, the Federal Energy Regulatory Commission (FERC) approved the NERC TPL-001-4 standard submitted by NERC. The standard introduces reliability improvements regarding the planning assessment used to ensure reliability of the Bulk Power System (BPS). FERC issued Order No. 786 on October 17, 2013, including two directives to NERC:

- **Paragraph 40:** TPL-001-4 includes a provision to allow Transmission Planners (TPs) and Planning Coordinators (PCs) to plan for non-consequential load loss following a single contingency using qualitative and quantitative parameters. However, the Commission "directs NERC to modify Reliability Standard TPL-001-4 to address the concern that the standard could exclude planned maintenance outages of significant facilities from future planning assessments and…change the TPL-001-4, Requirement R1 Violation Risk Factor from medium to high".
- **Paragraph 89:** In Order No. 693, NERC was directed by the commission to develop a modification "to require assessment of outages of critical long lead time equipment, consistent with the entity's spare equipment strategy." This led to Requirement R2, Part 2.1.5 in TPL-001-4 addressing steady-state conditions to determine system response when critical equipment is unavailable for a prolonged period of time. The Commission did not direct a change [to TPL-001-4] and instead directs NERC to consider a similar spare equipment strategy for stability analysis upon the next review cycle of Reliability Standard TPL-001-4.

The NERC Project 2015-10 TPL Single Points of Failure Standards Authorization Request (SAR) Drafting Team (DT) has requested that these directives be reviewed and input provided back by October 2016 when the Standard Drafting Team (SDT) will be meeting for the first time. The NERC System Analysis and Modeling Subcommittee (SAMS) has been directed to provide a technical analysis of these two directives to the NERC Planning Committee. This analysis will provide feedback and input to the SDT for discussions related to relevant changes to TPL-001-4 to address the FERC directives.

FERC Directive – Paragraph 40

FERC Order 786, Paragraph 40, states:

> "Pursuant to section 215(d)(5) of the FPA, we direct NERC to modify Reliability Standard TPL-001-4 to address the concern that the six month threshold could exclude planned maintenance outages of significant facilities from future planning assessments."

FERC finds that "planned maintenance outages of less than six months in duration may result in relevant impacts during one or both of the seasonal off-peak periods" and that "prudent transmission planning should consider maintenance outages at those load levels". FERC argues that "a properly planned transmission system should ensure the known, planned removal of facilities (i.e., generation, transmission or protection system facilities) for maintenance purposes" should not result in "loss of non-consequential load or detrimental impacts to system reliability such as cascading, voltage instability or uncontrolled islanding". This includes the removal of a single element from the system for the purposes of planned maintenance in the near-term or long-term transmission planning timeframes. These outages "should not be treated as multiple contingency conditions" and should be "reflected in initial system conditions as compared to the existing standards".

FERC directs NERC to "modify Reliability Standard TPL-001-4 to address the concern that the six month threshold could exclude planned maintenance outages of significant facilities from future planning assessments". The Commission's directive is to "include known generator and transmission planned maintenance outages in planning assessments, not hypothetical planned outages". FERC states that NERC has flexibility in addressing the identified concerns, and outlines three "acceptable approaches", including:

1. "eliminating the six-month threshold altogether";
2. "decreasing the threshold to fewer months to include additional significant planned outages"; or
3. "including parameters on what constitutes a significant planned outage based for example on MW or facility ratings."

Order 786 brings up the following points regarding this topic:

- Planned maintenance outages less than six months may result in impacts during peak and off-peak periods;
- Planned outages during those times should be considered to allow for a single element to be taken out of service without compromising the ability to meet demand;
- Criticality of elements taken out for maintenance could result in N-1 outage and loss of non-consequential load or impact to reliability;
- Planned outages are not "hypothetical outages" and should not be treated as multiple contingencies in the planning standard (should be addressed in N-0 base case);
- Relying on Category P3 and P6 is not sufficient and does not cover maintenance outages;
- The Near-Term Transmission Planning Horizon requires annual assessments using Year One or year two, and year five, and known planned facility outages of less than six months should be addressed so long as their planned start times and durations may be anticipated as occurring for some period of time during the planning time horizon.

NERC SAMS Assessment – Paragraph 40 – Planned Maintenance Outages

NERC SAMS Recommendation: The NERC SAMS recommends modifying NERC Reliability Standards IRO-017-1 and TPL-001-4 to address the directive by FERC. IRO-017-1 should be used as the vehicle to assure that all types of known scheduled outages are being reviewed and coordinated to mitigate reliability impact, as the most cost-effective means to address the intent of the NERC directives. The coordination process developed pursuant to IRO-017-1 Requirement R1 should be used to direct how ***all*** known scheduled outages are reviewed and the actions that must be taken. The following objectives should be added to R1:

- Describe how the review of known scheduled outages by the RC, PC, TO, and TP will be integrated into transmission plan development.
- Describe whether, how, and which known scheduled outages should be included in the Near Term Assessment of the Planning Horizon required by TPL-001-4.
- Describe how emerging challenges and the inability to schedule outages will be communicated from the TO and RC to the TP and PC to be addressed in a future Corrective Action Plan pursuant to TPL-001-4.

TPL-001-4 Requirement 1.1.2 should be modified by removing "with a duration of at least six months" and adding language referencing the outage coordination process developed in IRO-017-1 Requirement R1 as described above.

Objectives

There are key objectives that must be met to ensure outages are appropriately considered in the Planning and Operations Horizons, including:

- **Objective #1: Planning for Sufficient Transmission Capacity to Allow Reliable Facility Maintenance**
  The transmission system should be designed with sufficient transmission capacity and adequacy such that each facility can be maintained while meeting reliability criteria. While outages are planned and coordinated around operational constraints, the system must have sufficient capacity to ensure outages can be taken on critical Facilities regardless of outage duration or timeframe.
- **Objective #2: Outage Coordination with RC and PC**
  Reliable operation of the BPS requires proper and thorough outage coordination in a manner and timeframe that allows for the appropriate analysis of impact and development of mitigating measures. This process is fundamentally an Operations activity since operating entities generally evaluate and grant these outages based on actual system conditions rather than build specifically to support them. Major planned outages are studied by Operations Engineers in the seasonal assessments (less than one year out) and studied in Next Day and Next Week short-term assessments. Operations engineers are suited to perform this analysis since they have direct communication with grid operators, maintenance crews, and near-term system topology and reliability issues.
- **Objective #3: Impacts of Construction-Related Outages Considered in Transmission Plans**
  The impacts of significant known scheduled outages in the Planning Horizon should be considered in the development of transmission plans and coordinated with the RC and PC. While the system is operated around many construction-related or maintenance outages, some critical Facilities should be studied in the Planning Horizon Assessments to ensure reliability is maintained for these longer-term outages. The most effective means of ensuring that these plans are representative of actual future operating conditions is to ensure coordination with the RC and PC.

Considerations

To understand the relationship between outage coordination and Transmission Planning Assessments, and how those relate to the FERC Order 786 directive and the current state of NERC Reliability Standards, the following considerations are provided:

- **Outage Duration**
  The duration of planned maintenance outages can range from hours to many months or years. The impact that these outages can have on reliable operation of the BPS are irrespective[1] of the duration of these outages. Outages of a couple hours can have a greater reliability risk than outages of many months depending on many factors including the criticality of the Facility removed from service, local electrical topology and online resources, and other operating characteristics of that specific part of the BPS. While longer-term planned outages are most typically associated with construction, shorter-term planned outages are most typically associated with normal maintenance of Facilities.
- **Accuracy of Longer-Term Assessments of Short-Term Outages**
  Longer-term assessment of short-term outages or even longer-term outages is often considered an "academic exercise" for the following reasons:
  - There are often many concurrent outages in the operating timeframe that result in system conditions drastically different from those assumed in the Planning Assessments. This further stresses the need for coordination with the RC and PC.
  - Outage coordination establishes the ability to reschedule and redesign outages.
  - Different TOs and RCs have alternative outage methods (e.g., live line, temporary structures) that must be accounted for from a wide-area perspective, as part of the functions of the Reliability Coordinator.
  - There may be many opportunities for operating adjustments or procedures (reflects options particularly for shorter duration outages) to address outage management. These operating adjustments or procedures are not captured in the Planning Assessments due to their short-term timeframes.
- **FERC Order 786 Pre-Dates IRO-017**
  The directives in FERC Order 786 directing NERC to address this issue in TPL-001-4 pre-date the development of IRO-017-1. IRO-017-1 was developed specifically to recognize the importance of outage coordination. It is imperative that the directives in FERC Order 786 be put into context with respect to this new NERC Reliability Standard which addresses this topic specifically.
- **Regional Differences**
  Regional differences in network topology, generation resource mix, seasonal load variation, and organizational structure result in different outage coordination methods and procedures. However, all these methods and procedures have the same objective of facilitating maintenance while sustaining reliability of the BPS.

Recommendations

NERC SAMS recommends the following modifications to NERC Reliability Standards IRO-017-1 and TPL-001-4:

- The most cost-effective means to address the intent of the NERC directives is to use IRO-017-1 as the vehicle to assure that all types of known scheduled outages are being reviewed and coordinated to mitigate reliability impact.
- Use the coordination process developed pursuant to IRO-017-1 Requirement R1 to direct how ALL known scheduled outages are reviewed and the actions that must be taken. The following objectives should be added to R1:

[1] While longer duration outages are generally worse for system reliability, any contingency may cause reliability issues based on the criticality and impact of the Element removed from service.

  - Describe how the review of known scheduled outages by the RC, PC, TO, and TP will be integrated into the Near Term Assessment of the Planning Horizon required by TPL-001-4, and whether and which of these known scheduled outages will be studied in this Assessment.
  - Describe how emerging challenges and the inability to schedule outages will be communicated from the TO and RC to the TP and PC to be addressed in a future Corrective Action Plan pursuant to TPL-001-4.
- Modify the TPL-001-4 Requirement 1.1.2 by removing "with a duration of at least six months" and adding language referencing the outage coordination process developed in IRO-017-1 Requirement R1.

FERC Directive – Paragraph 89

FERC Order 786, Paragraph 89, states:

> "The spare equipment strategy for steady state analysis under Reliability Standard TPL-001-4, Requirement R2, Part 2.1.5 requires that steady state studies 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. The Commission believes that a similar spare equipment strategy for stability analysis should exist that requires studies to be performed for P0, P1 and P2 categories with the conditions that the system is expected to experience during the possible unavailability of the long lead time equipment… [T]he Commission will not direct a change and instead directs NERC to consider a similar spare equipment strategy for stability analysis upon the next review cycle of Reliability Standard TPL-001-4."

FERC states that they are "not persuaded by the explanation of NERC and others that a similar spare equipment strategy for stability analysis would cause unjustified burden because stability analysis is already required under category P6. The Commission notes that the category P2 contingencies studied under the spare equipment strategy for steady state analysis are different than the contingencies studied under category P6. For example, under the spare equipment strategy for steady state, a planner would study a long lead time piece of equipment out of service (e.g., a transformer) along with a bus section fault contingency (i.e., category P2, event 2). The study of this same condition for stability analysis under category P6 is not addressed.

NERC SAMS Assessment – Paragraph 89 – Stability Analysis for Long Lead Time Outages

NERC SAMS Recommendation: The NERC SAMS recommends including a sub-requirement R2.4.4 to the next revision of TPL-001-4 that requires Stability analysis for contingencies P1 and P2 for long lead time equipment that does not have a spare equipment strategy in place to return that Element to service within one year (such as transformers). The recommended sub-requirement language states:

> "**2.4.4.** 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. The studies shall be performed for the 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."

Considerations

The NERC SAMS considered the following key points related to Paragraph 89 directive:

- Removal of Elements in the Planning Assessment for spare equipment strategy is only applicable for those Elements that have "a lead time of one year or more."
- Each long lead time Element that is removed from service creates a new operating condition considered the "normal" (P0) condition for Table 1. The applicable contingencies will be studied with that Element removed from service in the pre-contingency state for stability analysis. For example if a long-lead time transformer does not have a spare, it would be studied as a P1.3 event. Since P0 does not include an Event, P0 does not and should not be included in the Stability analysis section for long lead time Elements not included as part of a spare equipment strategy.
- System adjustments may need to be made to the powerflow base case to accurately reflect reasonable and expected operating conditions with that Element removed from service in the pre-contingency (P0) operating state.

- TPL-001-4 Requirement R4.1.1, related to P1 Events, requires that no generating unit pull out of synchronism. The outage of a long lead time Element followed by a P1 contingency should not result in a generating unit losing synchronism.
- TPL-001-4 Requirement R4.1.2, related to P2 Events, allows for generating units to pull out of synchronism. The outage of a long lead time Element followed by a P2 contingency should not result in tripping of any Transmission system Elements other than the generating unit and its directly connected Facilities.

Recommendations

Given these considerations, the following is recommended for Stability analysis for long lead time Elements not included as part of a spare equipment strategy:

- The outage of long lead time Elements has an equally important impact from a stability standpoint as it does from a steady-state standpoint.
- The Planning Coordinator and Transmission Planner must demonstrate that they have met the TPL-001-4 performance criteria for specified contingency events and contingency combinations thereof as per Table 1. This should include long lead time outages that can occur for equipment that does not have a spare equipment strategy.
- TPL-001-4 Requirement R4.1.1 requires that no generating unit pull out of synchronism while R4.1.2 allows for generating units to pull out of synchronism so long as the resulting instability does not result in tripping of any Transmission system Elements other than the generating unit and its directly connected Facilities. The outage of a long lead time Element followed by a P1 contingency should not result in a generating unit losing synchronism.
- While the P2 contingency allows for individual generating unit instability, the TP and PC must ensure that this instability does not result in tripping of any Transmission system Elements other than the generating unit and its directly connected Facilities and therefore should include P2 contingencies event.

Suggested Changes for Consideration by the SDT

TPL-001-4 Requirement R1 describes the requirements for Near-Term Transmission Planning Horizon Planning Assessments for steady state analysis. It states:

> "**2.1.** For the Planning Assessment, the Near-Term Transmission Planning Horizon portion of the steady state analysis shall be assessed annually and be supported by current annual studies or qualified past studies as indicated in Requirement R2, Part 2.6. Qualifying studies need to including the following conditions:"

Sub-requirement R2.1.5 addresses studying the loss of equipment with long lead time replacement due to the entity's spare equipment strategies. It states:

> "**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. The studies 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."

FERC Order 786 directs NERC to "consider a similar spare equipment strategy for stability analysis" and "believes that a similar spare equipment strategy for stability analysis should exist that requires studies to be performed for P0, P1 and P2 categories". The NERC SAMS agrees with the intent of the FERC directive, and proposes to include a sub-

requirement R2.4.4 to the revisions to TPL-001-4. The NERC SAMS provides a slight modification to this directive and proposes to not include P0 as part of the Stability analysis, as this is considered a steady-state operating condition with no actual contingency applied to the system. The NERC SAMS believes that the simplest approach is to mirror the language provided in Requirement R2.1.5, such as:

> "**2.4.4.** 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. The studies shall be performed for the 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."