UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Relay Performance During Stable Swings Reliability Standard	**)** **)**	**Docket No. RM15-8-000**

COMMENTS OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION IN RESPONSE TO NOTICE OF PROPOSED RULEMAKING

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The North American Electric Reliability Corporation ("NERC")[1] hereby provides these comments in response to the Federal Energy Regulatory Commission's ("FERC" or the "Commission") September 17, 2015, Notice of Proposed Rulemaking ("NOPR")[2] proposing to approve Reliability Standard PRC-026-1 (*Relay Performance During Stable Power Swings*).

I. BACKGROUND

On December 31, 2014, NERC submitted a petition for approval of proposed Reliability Standard PRC-026-1, including the associated implementation plan and proposed Violation Risk Factors and Violation Severity Levels, as just, reasonable, not unduly discriminatory or preferential, and in the public interest. The proposed Reliability Standard was submitted in compliance with Order No. 733,[3] in which the Commission directed NERC, pursuant to section 215 (d)(5) of the Federal Power Act, to develop a new Reliability Standard that requires the use

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[1] The Federal Energy Regulatory Commission certified NERC as the Electric Reliability Organization ("ERO") in its order issued on July 20, 2006, in Docket No. RR06-1-000. *N. Am. Elec. Rel. Corp.*, 116 FERC ¶ 61,062 (2006).

[2] *Relay Performance During Stable Power Swings Reliability Standard*, 152 FERC ¶ 61,200 (2015) ("NOPR").

[3] *Transmission Relay Loadability Reliability Standard*, Order No. 733, 130 FERC ¶ 31,221 (2010), *order on reh'g and clarification*, Order No. 733-A, 134 FERC ¶ 61, 127 (2011), *order on reh'g and clarification*, Order No. 733-B, 136 FERC ¶ 61, 185 (2011).

of protective relay systems that can differentiate between faults and stable power swings and, when necessary, retirement of protective relay systems that cannot meet this requirement.[4]

The Commission proposes to approve Reliability Standard PRC-026-1 and states that the Reliability Standard addresses the "directive from Order No. 733 by helping to prevent the unnecessary tripping of bulk electric system elements in response to stable power swings."[5] In the NOPR, the Commission requested comments regarding the potential burden of modifying the applicability of proposed Reliability Standard PRC-026-1 to include relays with a time delay of 15 cycles or greater in instances where either (1) an element has been identified by a Planning Coordinator as potentially susceptible to power swings, or (2) an entity becomes aware of a Bulk Electric System element that tripped in response to a stable or unstable power swing due to the operation of its protective relay(s), even if the element was not previously identified by the Planning Coordinator.[6]

II. NOTICES AND COMMUNICATIONS

Notices and communications with respect to this filing may be addressed to the following:[7]

4 Order No. 733, 130 ¶ FERC 61, 221 at P 150.
5 NOPR at P 13.
6 *Id.* at P 2.
7 Persons to be included on the Commission's service list are identified by an asterisk. NERC respectfully requests a waiver of Rule 203 of the Commission's regulations, 18 C.F.R. § 385.203 (2013), to allow the inclusion of more than two persons on the service list in this proceeding.

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III. COMMENTS

NERC supports the Commission's proposal to approve Reliability Standard PRC-026-1 as submitted. The standard is applicable to the Planning Coordinator; and Generator Owner and Transmission Owner that apply load-responsive protective relays on generators, transformers, and transmission lines. Load-responsive protective relays that are set to trip instantaneously (i.e., without intentional time-delay) are at greatest risk to power swings and are those relays that PRC-026-1 fundamentally addresses. The proposed standard includes in its applicability section load-responsive protective relays which could trip instantaneously or with a time delay of less than 15 cycles on load current (i.e., "load-responsive") including, but not limited to: phase distance, phase overcurrent, out-of-step tripping, or loss-of-field according to PRC-026-1 – Attachment A. The 15 cycle threshold achieves a balance between the burden to the applicable entities and risk to the Bulk Electric System (BES) such that load-responsive protective relays are expected to not trip for a stable power swing. The 15 cycle threshold provides a practical and reasonable margin to ensure load-responsive protective relays with as little as a one or two cycle

intentional time delay would be applicable to the standard. The 15 cycle threshold in the standard was developed based upon engineering judgment through the standard development process.

NERC responds below to the Commission's question regarding what the increased burden would be if load-responsive protective relays set with an intentional time delay of 15 cycles or greater (i.e., zones 2, 3, 4, etc.) become applicable to PRC-026-1. The question applies to load-responsive protective relays that trip BES Elements due to stable or unstable power swings identified in either Requirement R1, Criterion 4 by the Planning Coordinator through a valid Planning Assessment and Requirement R2, Part 2.2 by the Generator Owner or Transmission Owner following an actual event.

Planning Coordinator

For the Planning Coordinator, there would be no increase in burden anticipated by the proposed question. The Planning Coordinator is required by Reliability Standard TPL-001-4 (*Transmission System Planning Performance Requirements*),[8] Requirement R4 to perform contingency analyses based on computer simulation models for the Stability portion of the annual Planning Assessment. The analyses determine whether the BES meets the performance requirements listed in TPL-001-4, Table 1 based on the Contingency list the Planning Coordinator identified that is expected to produce more severe System impacts on its portion of the BES. The Contingency analyses must simulate the removal of all elements that the Protection System and other automatic controls are expected to disconnect for each Contingency without operator intervention. The analyses must include the impact of subsequent tripping of

[8] TPL-001-4 was approved by the Commission in Order No.786 (*see*, 145 FERC ¶61,051) (October 17, 2013), and will become enforceable on January 1, 2016.

Transmission lines and transformers where transient swings (i.e., stable or unstable power swings) cause Protection System operation based on generic or actual relay models. The Planning Assessment will reveal Elements with load-responsive protective relays having time delays of 15 cycles or greater that trip due to power swings. If these tripping Elements cause a violation of the performance criteria of TPL-001-4, the Planning Coordinator is required to mitigate these conditions through a Corrective Action Plan (CAP).[9] Therefore, mitigation of tripping under TPL-001-4 appropriately addresses the Commission's concern related to an Element that has been identified by a Planning Coordinator as potentially susceptible to power swings.

Requirement R1, Criterion 4 of proposed PRC-026-1 requires the Planning Coordinator to report to the applicable Generator Owner and/or Transmission Owner any Element tripping, regardless of time delay, due to stable and/or unstable power swings that are identified in a valid Planning Assessment. The intent of this criterion is to ensure a method of capturing any stable or unstable power swing that the Planning Coordinator observes as tripping Elements in addition to the locations that are expected to be susceptible to power swings as mandated by Requirement R1, Criteria 1, 2, and 3.

Generator Owner and Transmission Owner

Unlike the Planning Coordinator, requiring load-responsive protective relays with time delays of 15 cycles or greater stands to place additional burden on the Generator Owner and Transmission Owner for any Elements that are identified using Requirement R1, Criterion 4. For the Generator Owner and Transmission Owner, the increase in burden is dependent upon the

[9] A Corrective Action Plan is defined in the *NERC Glossary of Terms* as "A list of actions and an associated timetable for implementation to remedy a specific problem." The *NERC Glossary of Terms* is *available at* http://www.nerc.com/pa/Stand/Pages/default.aspx.

Elements identified by the Planning Coordinator in Requirement R1, Criterion 4 and Elements identified by the Generator Owner and Transmission Owner in Requirement R2, Part 2.2 as described in the following two subsections.

Requirement R1, Criterion 4

Any additional burden on the Generator Owner and Transmission Owner would be determined by the increase in the quantity of load-responsive protective relays applied to that Element beyond what is proposed in PRC-026-1 (i.e. load-responsive protective relays with time delays of 15 cycles or greater). Since PRC-026-1 primarily addresses instantaneous and any other relays with an intentional time delay less than 15 cycles, an increase in the burden could be on the order of two or three times in magnitude to address zone 2 (not communication-aided) and application of reverse zone 3 and/or forward zone 4 remote back-up time delayed elements.

For the Transmission Owner, inclusion of load responsive protective relays with time delays of 15 cycles or greater could require an upgrade to the protection at each end of an Element with communication-aided protection to address zone 2. General industry practice is to set the zone 2 load-responsive protective relay time delayed element above the 15 cycle threshold proposed by PRC-026-1. Additionally, inclusion of load responsive relays with time delays of 15 cycles or greater may require power swing blocking (PSB) application on the reverse zone 3 and/or forward zone 4 remote back-up time delayed elements. Reverse zone 3 and/or forward zone 4 time delayed relay elements are applied at some line Element terminals to provide remote back-up protection for multiple protection system failures. These relay elements are typically set to reach much further than zone 2 time delayed relay elements, and typically have time delays of 40 cycles or greater. These relay elements, as typically set, will not be able to comply with PRC-026-1, Attachment B criteria. For these load-responsive protective relay

elements to meet the Attachment B criteria, their reaches may have to be significantly reduced, which will limit their effectiveness in providing dependable remote back-up protection. More likely, PSB relaying will have to be applied to block the reverse zone 3 and/or forward zone 4 remote back-up time delayed relay elements. If the relay is electromechanical, then a separate PSB relay will have to be installed, or the relay package at the line terminal will have to be upgraded to modern microprocessor relaying at a significant cost to ensure dependable tripping for faults. It is not common in the industry to apply PSB relaying to zone 3/zone 4 relays as they are generally not expected to be responsive to tripping for stable power swings due to their long time delay.

For the Generator Owner, inclusion of load responsive relays with time delays of 15 cycles or greater could unintentionally require non-standard loss-of-field (LOF) settings for generator protection, which protect generators from damage during a loss-of-field condition. Requiring LOF load-responsive protective relays that operate in time delays greater than 15 cycles to be applicable to PRC-026-1 could result in a loss of dependable tripping during a LOF condition. The outer LOF tripping zones typically have time delays of 15 cycles or greater and will not meet the PRC-026-1, Attachment B criteria using traditional industry accepted methods of applying settings. Inclusion of the LOF load-responsive protective relays that have time delays of 15 cycles or greater could require a reduction of the outer LOF zone reaches or require unconventional PSB of the LOF elements.

Requirement R2, Part 2.2

Reliability Standards that address relay loadability (e.g., PRC-023 and PRC-025) decrease the likelihood of a load-responsive protective relay tripping for a stable power swing. As described in NERC's petition, the largest reach of a zone 2 relay allowed by PRC-023-3 occurs when using the maximum power transfer criteria as shown in Requirement R1, Criterion

3 of PRC-023-3. If this criterion is used, the smallest system angle at the intersection of the swing trajectory with the zone 2 element is 108.8 degrees. Using Equation 1 from the PRC-026-1 Application Guidelines, assuming the stable swing begins to retreat at the stability boundary of 120 degrees, the slowest calculated slip rate that the zone 2 element could trip for using a time delay of 15 cycles is: $F_{slip} = 2 * (120 – 108.8) * 60 / (360 * 15) = 0.249$ Hz. Stable power swings that approach the stability boundary of 120 degrees will most likely be traveling at a slip rate of more than 0.25 Hz, and therefore, are not likely to cause tripping of the zone 2 time delayed relay element.

Any actual event that includes tripping of an Element due to a power swing is likely to be the result of a large event where instability, uncontrolled separation(s) or cascading outages occur. Placing an additional burden on the Generator Owner and Transmission Owner to address load-responsive protective relays with a time delay of 15 cycles and greater could require the owners to upgrade or replace more of its protection equipment than is technically necessary, thus increasing the burden. The likelihood of having a reoccurrence of the specific circumstances of a large actual event would be rare; and would therefore impose additional burden on the Generator Owner or Transmission Owner with little benefit to reliability.

Tripping unnecessarily other than a Fault due to an actual stable power swing would be classified as a Misoperation under PRC-004-4 (*Protection System Misoperation Identification and Correction*).[10] In addressing a Misoperation under PRC-004-4, the Generator Owner and Transmission Owner are required to develop a CAP or declare why such actions would not improve reliability. At a minimum, the Generator Owner and Transmission Owner are required to meet the reliability criteria of the proposed PRC-026-1 requirements. This means that any

[10] The PRC-004-4 standard was approved by the Commission on May 29, 2015 (*see*, 151 FERC ¶61,186), and will become enforceable on July 1, 2016.

load-responsive protective relay set with a time delay less than 15 cycles must meet the proposed PRC-026-1, Attachment B criteria. Under PRC-004-4, the Generator Owner and Transmission Owner are required to develop a CAP to address the cause(s) of the Misoperation, for example, tripping due to load-responsive protective relays set with a time delay of 15 cycles or greater, unless reliability would not be improved. This is responsive to the Commission's second question concerning burden by allowing the Generator Owner and Transmission Owner to mitigate reoccurrence without unnecessarily broadening the applicability of the proposed PRC-026-1 standard to include load-responsive protective relays with time delays of 15 cycles or greater. At a minimum, the Generator Owner and Transmission Owner must meet the PRC-026-1 criteria following an actual event regardless of the actions taken under PRC-004-4.

Addressing load-responsive protective relays under Requirement R2, Part 2.2 provides a reasonable assurance that the impacted Element will not trip in the future due to a stable power swing as discussed above. Likewise, should the Planning Coordinator identify in future studies the same Element that tripped due to an actual power swing, it will continue to be reported as an Element pursuant to Requirement R1, and the applicable Generator Owner and/or Transmission Owner will have an obligation to periodically evaluate the load-responsive protective relays on that Element.

This approach is consistent with the recommendations of the NERC System Protection and Control Subcommittee (SPCS) that are documented in the *Protection System Response to Power Swings*, August 2013 technical report.[11] The report recommends that the standard drafting team should consider certain criteria in establishing the applicability of the Reliability

[11] NERC System Protection and Control Subcommittee, Protection System Response to Power Swings, August 2013: http://www.nerc.com/comm/PC/System%20Protection%20and%20Control%20Subcommittee%20SPCS%2020/SPCS%20Power%20Swing%20Report_Final_20131015.pdf), p. 20 and 21.

Standard to limit applicability to only those transmission lines on which protective relays are most likely to trip during stable power swings (PRC-026-1, Requirement R1, Criteria 1-3). A fourth criteria (Requirement R1, Criterion 4) includes "[l]ines identified through other studies, including but not limited to, event analyses and transmission planning or operational planning assessments." This criterion captures tripping of Elements due to stable or unstable power swings in the planning environment that would not have been applicable to the first three criterion of PRC-026-1.

The SPCS document recommends that, based on its review of historical events, consideration of the trade-offs between dependability and security, and recognition of the indirect benefits of implementing a transmission relay loadability standard (PRC-023), a NERC Reliability Standard to address relay performance during stable swings is not needed, and could result in unintended adverse impacts to Bulk-Power System reliability.[12] Accordingly, a power swing that causes tripping during an actual event may not necessarily require all of the load-responsive relays to be evaluated for susceptibility. The approach proposed by the standard, applicable to load-responsive protective relays with a time delay less than 15 cycles as outlined in PRC-026-1, Attachment A, provides sufficient mitigation of the risk to tripping due to stable power swings while balancing the burden and risk to the BES.

IV. Conclusion

NERC reaffirms its support of the 15 cycle threshold as a practical time delay with sufficient technical basis to assure a proper balance between security and dependability. Load responsive protective relay elements with time delays of 15 cycles or greater that trip during

[12] *Id.* at p. 24.

TPL-001-4 simulated events or that trip during an actual stable power swing system event will be mitigated through a CAP pursuant to TPL-001-4 and PRC-004-4.

The proposed PRC-026-1 standard addresses instantaneous load-responsive protective relays which have the greatest risk to tripping due to a stable power swing. Furthermore, a time delay of less than 15 cycles provides a definite margin to ensure that the addition of only one or two cycles of intentional time delay, for example, would not prevent the load-responsive protective relay from being applicable to the standard and undermine the reliability objective. Therefore, the specified time delay of less than 15 cycles is reasonable and practical while limiting the burden on the applicable Generator Owner and Transmission Owner. The 15 cycle threshold inherently provides a balance between the burden and risk to applicable Elements that could trip in response to a stable or unstable power swing.

Respectfully submitted,

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Date: November 23, 2015

CERTIFICATE OF SERVICE

I hereby certify that I have served a copy of the foregoing document upon all parties listed on the official service list compiled by the Secretary in this proceeding. Dated at Washington, D.C. this 23rd day of November, 2015.

/s/ Holly A. Hawkins

Holly A. Hawkins

Associate Counsel for the North American Electric Reliability Corporation