UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

North American Electric Reliability Corporation	**)** **)**	**Docket No. _____**

PETITION OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION FOR APPROVAL OF PROPOSED RELIABILITY STANDARD PRC-025-1 (GENERATOR RELAY LOADABILITY)

Gerald W. Cauley
President and Chief Executive Officer
North American Electric Reliability Corporation
3353 Peachtree Road, N.E.
Suite 600, North Tower
Atlanta, GA 30326
(404) 446-2560
(404) 446-2595 – facsimile

Charles A. Berardesco
Senior Vice President and General Counsel
Holly A. Hawkins
Assistant General Counsel
William H. Edwards
Counsel
Brady A. Walker
Associate Counsel
North American Electric Reliability Corporation
1325 G Street, N.W., Suite 600
Washington, D.C. 20005
(202) 400-3000
(202) 644-8099 – facsimile
charlie.berardesco@nerc.net
holly.hawkins@nerc.net
william.edwards@nerc.net
brady.walker@nerc.net

Counsel for the North American Electric Reliability Corporation

September 30, 2013

TABLE OF CONTENTS

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

North American Electric Reliability Corporation	**)** **)**	**Docket No. _____**

PETITION OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION FOR APPROVAL OF PROPOSED RELIABILITY STANDARD PRC-025-1 (GENERATOR RELAY LOADABILITY)

Pursuant to Section 215(d)(1) of the Federal Power Act ("FPA")[1] and Section 39.5[2] of the Federal Energy Regulatory Commission's ("FERC" or "Commission") regulations, the North American Electric Reliability Corporation ("NERC")[3] hereby submits proposed Reliability Standard PRC-025-1 – Generator Relay Loadability for Commission approval. NERC requests that the Commission approve proposed Reliability Standard PRC-025-1 (**Exhibit A**) and find that the proposed Reliability Standard is just, reasonable, not unduly discriminatory or preferential, and in the public interest.[4] NERC also requests approval of the associated implementation plan (**Exhibit B**) and Violation Risk Factor ("VRF") and Violation Severity Level ("VSL") (included in **Exhibit A** and explained in **Exhibit E**). Proposed PRC-025-1 was developed to respond to Commission directives in Order No. 733[5] to address generator protective relay loadability.

---

1 16 U.S.C. § 824o (2006).

2 18 C.F.R. § 39.5 (2013).

3 The Commission certified NERC as the electric reliability organization ("ERO") in accordance with Section 215 of the FPA on July 20, 2006. *N. Am. Elec. Reliability Corp.*, 116 FERC ¶ 61,062 (2006).

4 Unless otherwise designated, all capitalized terms shall have the meaning set forth in the *Glossary of Terms Used in NERC Reliability Standards*, *available at* http://www.nerc.com/files/Glossary_of_Terms.pdf

5 *Transmission Relay Loadability Standard*, Order No. 733, 130 FERC ¶ 61,221, at P 104-08 (2010), *order on reh'g and clarification*, Order No. 733-A, 134 FERC ¶ 61,127, *order on reh'g and clarification*, Order No. 733-B, 136 FERC ¶ 61,185 (2011).

NERC submits proposed Reliability Standard PRC-025-1 to meet the Commission's September 30, 2013 deadline[6] to develop a new generator relay loadability Reliability Standard; however, NERC requests the Commission delay its approval of proposed Reliability Standard PRC-025-1 until proposed Reliability Standard PRC-023-3 – Transmission Relay Loadability is submitted to the Commission as a supplement to this petition. Proposed PRC-023-3 will be presented to the Board for approval in November 2013 and filed with the Commission by the end of the year. During the development of proposed Reliability Standard PRC-025-1, clarifying changes to PRC-023-2 were identified by the standard drafting team as necessary to establish a bright-line between the applicability of load-responsive protective relays in the transmission and generator relay loadability Reliability Standards. As a result, a supplemental Standard Authorization Request was approved by the Standards Committee at its January 16-17, 2013 meeting to authorize the standard drafting team to make the corresponding changes. NERC requests the Commission take concurrent action on the proposed Reliability Standards PRC-025-1 and PRC-023-3 to preserve consistency between proposed Reliability Standards PRC-025 and PRC-023.

As required by Section 39.5(a)[7] of the Commission's regulations, this petition presents the technical basis and purpose of proposed Reliability Standard PRC-025-1, a summary of the development history (**Exhibit F**), and a demonstration that the proposed Reliability Standard meets the criteria identified by the Commission in Order No. 672[8] (**Exhibit C**). Proposed

---

[6] NERC was granted a one-year extension of time until September 30, 2013 to develop a new generator relay loadability standard. *See Notice of Extension of Time*, Docket No. RM08-13-001 (issued Feb. 15, 2012).

[7] 18 C.F.R. § 39.5(a) (2013).

[8] The Commission specified in Order No. 672 certain general factors it would consider when assessing whether a particular Reliability Standard is just and reasonable. *See Rules Concerning Certification of the Electric Reliability Organization; and Procedures for the Establishment, Approval, and Enforcement of Electric Reliability Standards*, Order No. 672, FERC Stats. & Regs. ¶ 31,204, at P 262, 321-37, *order on reh'g*, Order No. 672-A, FERC Stats. & Regs. ¶ 31,212 (2006).

Reliability Standard PRC-025-1 was approved by the NERC Board of Trustees on August 15, 2013.[9]

I. EXECUTIVE SUMMARY

Proposed Reliability Standard PRC-025-1 addresses generator Facilities protective relay loadability. The proposed Reliability Standard is designed to prevent generator tripping when conditions do not pose a direct risk to the generator and associated equipment and will reduce the risk of unnecessary generator tripping—events that increase the severity of disturbances.

Proposed PRC-025-1 requires Generator Owners, Transmission Owners, and Distribution Providers to apply an appropriate setting for load-responsive relays based on calculations or simulations for conditions established in Attachment 1 of the proposed Reliability Standard. The Attachment 1 criteria are representative of the short-term conditions during which generation Facilities have, in the past, disconnected when otherwise capable of providing Reactive Power resources. By minimizing these risks, proposed Reliability Standard PRC-025-1 serves the important reliability goal of limiting the risk for severe power system disturbances.

II. NOTICES AND COMMUNICATIONS

Notices and communications with respect to this filing may be addressed to the following:[10]

[9] *See NERC Board of Trustees Agenda Item 7b, available at* http://www.nerc.com/gov/bot/BOT%20May%209%202013%20%20Boston%20MA/7b-Board%20Write-up%20Phase%202%20Relay%20Loadability%20Generation%20-%20PRC-025-1.pdf.

[10] 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.

Charles A. Berardesco*
Senior Vice President and General Counsel
Holly A. Hawkins*
Assistant General Counsel
William H. Edwards*
Counsel
Brady A. Walker*
Associate Counsel
North American Electric Reliability Corporation
1325 G Street, N.W., Suite 600
Washington, D.C. 20005
(202) 400-3000
(202) 644-8099 – facsimile
charlie.berardesco@nerc.net
holly.hawkins@nerc.net
william.edwards@nerc.net
brady.walker@nerc.net

Mark G. Lauby*
Vice President and Director of Standards
Howard Gugel*
Director of Standards Development
North American Electric Reliability Corporation
3353 Peachtree Road, N.E.
Suite 600, North Tower
Atlanta, GA 30326
(404) 446-2560
(404) 446-2595 – facsimile
mark.lauby@nerc.net
howard.gugel@nerc.net

III. BACKGROUND

A. Regulatory Framework

By enacting the Energy Policy Act of 2005,[11] Congress entrusted the Commission with the duties of approving and enforcing rules to ensure the reliability of the Nation's Bulk-Power System, and with the duties of certifying an ERO that would be charged with developing and enforcing mandatory Reliability Standards, subject to Commission approval. Section 215(b)(1)[12] of the FPA states that all users, owners, and operators of the Bulk-Power System in the United States will be subject to Commission-approved Reliability Standards. Section 215(d)(5)[13] of the FPA authorizes the Commission to order the ERO to submit a new or modified Reliability Standard. Section 39.5(a)[14] of the Commission's regulations requires the ERO to file with the Commission for its approval each Reliability Standard that the ERO proposes should become

[11] 16 U.S.C. § 824o (2006).
[12] *Id.* § 824(b)(1).
[13] *Id.* § 824o(d)(5).
[14] 18 C.F.R. § 39.5(a) (2013).

mandatory and enforceable in the United States, and each modification to a Reliability Standard that the ERO proposes should be made effective.

The Commission has the regulatory responsibility to approve Reliability Standards that protect the reliability of the Bulk-Power System and to ensure that such Reliability Standards are just, reasonable, not unduly discriminatory or preferential, and in the public interest. Pursuant to Section 215(d)(2) of the FPA[15] and Section 39.5(c)[16] of the Commission's regulations, the Commission will give due weight to the technical expertise of the ERO with respect to the content of a Reliability Standard.

B. NERC Reliability Standards Development Procedure

The proposed Reliability Standard was developed in an open and fair manner and in accordance with the Commission-approved Reliability Standard development process.[17] NERC develops Reliability Standards in accordance with Section 300 (Reliability Standards Development) of its Rules of Procedure and the NERC Standard Processes Manual.[18] In its ERO Certification Order, the Commission found that NERC's proposed rules provide for reasonable notice and opportunity for public comment, due process, openness, and a balance of interests in developing Reliability Standards and thus satisfies certain of the criteria for approving Reliability Standards. The development process is open to any person or entity with a legitimate interest in the reliability of the Bulk-Power System. NERC considers the comments of all stakeholders, and

---

[15] 16 U.S.C. § 824o(d)(2).

[16] 18 C.F.R. § 39.5(c)(1).

[17] Order No. 672 at P 334 ("Further, in considering whether a proposed Reliability Standard meets the legal standard of review, we will entertain comments about whether the ERO implemented its Commission-approved Reliability Standard development process for the development of the particular proposed Reliability Standard in a proper manner, especially whether the process was open and fair. However, we caution that we will not be sympathetic to arguments by interested parties that choose, for whatever reason, not to participate in the ERO's Reliability Standard development process if it is conducted in good faith in accordance with the procedures approved by FERC.").

[18] The NERC Rules of Procedure are available at http://www.nerc.com/AboutNERC/Pages/Rules-of-Procedure.aspx. The NERC Standard Processes Manual is available at http://www.nerc.com/comm/SC/Documents/Appendix_3A_StandardsProcessesManual.pdf.

a vote of stakeholders and the NERC Board of Trustees is required to approve a Reliability Standard before the Reliability Standard is submitted to the Commission for approval.

C. History of Project 2010-13 Relay Loadability

a) PRC-023-1 — Transmission Relay Loadability

NERC developed Reliability Standard PRC-023-1 to address key August 14, 2003 blackout[19] recommendations regarding relay loadability issues. Relay loadability issues were found to have played a pivotal role in accelerating and spreading the early part of the cascading outage in Ohio and Michigan during the blackout. Relay loadability refers to the ability of protective relays to restrain operation for load conditions. As protective relays can respond only to measured voltage and current, they must be set such that they will detect the faults for which they must operate while avoiding unnecessary operation under non-fault load conditions.

The currently-effective PRC-023-1 Reliability Standard required certain Transmission Owners, Generator Owners and Distribution Providers to set protective relays to maintain reliable protection for all fault conditions while meeting specified criteria to ensure settings do not contribute to cascading outages.

Reliability Standard PRC-023-1 specifically addresses Recommendation 8A[20] approved by the NERC Board of Trustees in February 2004, and the U.S.-Canada Power System Outage

---

[19] U.S.-Canada Power System Outage Task Force, *Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations*, at 80 (2004) ("2003 Blackout Report").

[20] NERC, *August 14, 2003 Blackout: NERC Actions to Prevent and Mitigate the Impacts of Future Cascading Blackouts*, at 13 (Feb. 10, 2004). Recommendation 8a of the NERC Blackout Report provides:

> All transmission owners shall, no later than September 30, 2004, evaluate the zone 3 relay settings on all transmission lines operating at 230 kV and above for the purpose of verifying that each zone 3 relay is not set to trip on load under extreme emergency conditions. In each case that a zone 3 relay is set so as to trip on load under extreme conditions, the transmission operator shall reset, upgrade, replace, or otherwise mitigate the overreach of those relays as soon as possible and on a priority basis, but no later than December 31, 2005. Upon completing analysis of its application of zone 3 relays, each transmission owner may no later than December 31, 2004, submit justification to NERC for applying zone 3 relays outside of these

Task Force's Recommendation 21A,[21] "Make More Effective and Wider Use of System Protection Measures," as included in the 2003 Blackout Report.

The Commission issued a Notice of Proposed Rulemaking ("NOPR") proposing to approve Reliability Standard PRC-023-1 on May 21, 2009.[22] The Commission approved Reliability Standard PRC-023-1 in Order No. 733. Also in the Final Rule, the Commission directed NERC to: (1) make certain modifications to the approved Reliability Standard PRC-023-1; (2) submit a timeline for NERC's development of a new Reliability Standard to address generator protective relay loadability; and (3) develop a new Reliability Standard addressing the issue of protective relay operation due to power swings.[23]

b) Project 2010-13

To respond to the directives in Order No. 733, NERC proposed to address the Commission's directives in three phases in Project 2010-13. Phase I focused on making specific modifications[24] to Reliability Standard PRC-023-1 identified in Order No. 733. Phase I was completed and the revised Reliability Standard PRC-023-2[25] became mandatory on July 1, 2012. Phase II has focused on developing a new Reliability Standard to address generator relay loadability as proposed in this petition. Phase III will focus on developing requirements that address relay operations due to power swings. Phase III is currently under development and is tentatively scheduled to be completed by December 2014. The NERC Planning Committee, on

---

recommended parameters. The Planning Committee shall review such exceptions to ensure they do not increase the risk of widening a cascading failure of the power system.

21 2003 Blackout Report at 156-59.

22 *Transmission Relay Loadability Standard*, Notice of Proposed Rulemaking, 127 FERC ¶ 61,175 (2009).

23 Order No. 733 at P 104-P 108.

24 *Id.* at P 47.

25 *Transmission Relay Loadability* Standard, Order No. 759, 138 FERC ¶ 61,197 (2012) ("Order No. 759").

August 19, 2013, approved a System Protection and Control Subcommittee report[26], developed with support from the System Analysis and Modeling Subcommittee, intended to inform the development process.

IV. JUSTIFICATION FOR APPROVAL

As discussed in detail in **Exhibit C**, proposed Reliability Standard PRC-025-1 satisfies the Commission's criteria in Order No. 672 and is just, reasonable, not unduly discriminatory or preferential, and in the public interest. The reliability benefits of proposed Reliability Standard PRC-025-1 are discussed below along with an explanation of how the proposed Reliability Standard satisfies the Commission's directives related to generator relay loadability in Order 733. Also included is a detailed explanation of the content of Reliability Standard PRC-025-1 and associated changes in proposed Reliability Standard PRC-023-3, which is currently in formal development.

A. Reliability Benefits and Technical Explanation of Proposed Reliability Standard PRC-025-1

Analyses of power system disturbances over the last twenty-five years have found generators to have tripped unnecessarily—an occurrence that has the potential to extend the scope and duration of a disturbance. During the recovery phase of a disturbance, the disturbance may exhibit a "voltage disturbance" behavior pattern, wherein system voltage is widely depressed. In order to support the system during this phase of a disturbance, proposed Reliability Standard PRC-025-1 establishes criteria for setting load-responsive relays such that individual generators may provide Reactive Power within their dynamic capability during transient time periods. Premature or unnecessary tripping of generators during this period can

[26] *Protection System Response to Power Swings*, NERC System Protection and Control Subcommittee, .approved by the NERC Planning Committee on August 19, 2013.

increase the severity of the voltage disturbance making it essential to assure this dynamic capability is available to support system recovery.

Proposed Reliability Standard PRC-025-1 establishes a risk-based Requirement in which the Generator Owner, Transmission Owner, or Distribution Provider that applies load-responsive relays must identify the type of protective relay and its application, and apply an appropriate setting based on its calculations or simulations of conditions established in Attachment 1 to proposed Reliability Standard PRC-025-1.

NERC's proposed Reliability Standard PRC-025-1 addresses the issue of generator relay loadability by establishing a new Reliability Standard for load-responsive protective relays applied on generating Facilities for the conditions, namely depressed voltages, observed during the August 2003 blackout. Proposed Reliability Standard PRC-025-1 includes criteria for load-responsive protective relays on generator step-up ("GSU") transformers and on unit auxiliary transformers ("UAT") that supply station service power to support the on-line operation of generating units or generating plants. These transformers are referred to as station power, UATs, or station service transformer(s) and are used to provide overall auxiliary power to the generator station when the generator is running. Loss of these transformers will result in the removal of the generator from service.

The *Guidelines and Technical Justification* can be found in the Application Guidelines section the proposed Reliability Standard (**Exhibit A**). The document provides analysis of protective functions and generator performance addressed within this Reliability Standard. The relay setting criteria are based on the system conditions observed during the August 2003 Blackout. The criteria for relays applied on synchronous generators, GSU transformers, and Elements that connect the GSU transformer(s) to the Transmission system are based on the

response of the synchronous generator to depressed Transmission System voltage. Under this condition the generator will respond by increasing its Reactive Power output to support its terminal voltage – a response known as field-forcing. The criteria for relays applied on these Elements are similar because relays applied on each of these Elements are challenged by the loadability condition resulting from the increased generator output. An allowance is made for relays applied on the transmission side of the GSU transformer to account for Reactive Power losses in the transformer.

The criteria for relays applied on asynchronous generators, their GSU transformers, and Elements that connect the GSU transformer(s) to the Transmission system are based on the response of the asynchronous generator to depressed Transmission System voltage. Asynchronous generators do not have excitation systems and will not respond to a disturbance with the same magnitude of apparent power that a synchronous generator will respond. However, asynchronous generators will support the system during a disturbance and the criteria account for the generator response and any static or dynamic Reactive Power devices that contribute to the power flow. The criteria for relays applied on these Elements are the same because relays applied on each of these Elements are challenged by the loadability condition resulting from the increased generator output. An allowance is not made for relays applied on the transmission side of the GSU transformer because the Reactive Power losses are not significant for asynchronous generators.

The criteria for relays applied on UAT transformers are based on the increased current requirements of station service load during a depressed voltage condition. In this the case the current is based on the generator terminal voltage associated with a depressed system voltage. A conservative allowance is provided to avoid complex calculations for this load condition. As an

alternative, entities may base the setting on actual current measured when the generator is operating at its maximum gross output.

Generator Owners, Transmission Owners, and Distribution Providers may at times find the relay setting criteria are in conflict with their desired protection goals. In such cases, it is suggested that entities consider the requirement within this Reliability Standard and its desired protection goals, and perform modifications to its protective relays or protection philosophies as necessary to achieve both.

B. Commission Directives Addressed

Proposed Reliability Standard PRC-025-1 addresses and meets the Commission's directives in Order No. 733 related to generator relay loadability as outlined below.

a) Proposed Reliability Standard PRC-025-1 is aligned with the Requirements and expected outcome of PRC-023-1

The Commission declined to adopt its NOPR proposal to require the previously approved Reliability Standard PRC-023-1 to address issues of generator step-up and auxiliary transformer loadability.[27] The Commission stated that "it does not matter if generator step-up and auxiliary transformer loadability is addressed in a separate Reliability Standard, so long as the ERO addresses the issue in a timely manner and in a way that is coordinated with the Requirements and expected outcome of PRC-023-1."[28] In Order No. 733, the Commission also stated:

> We also expect that the ERO will develop the Reliability Standard addressing generator relay loadability as a new Standard, with its own individual timeline, and not as a revision to an existing Standard. While we agree that PRC-001-1 requires, among other things, the coordination of generator and transmission protection systems, we think that generator relay loadability, like transmission relay loadability, should be addressed in its own Reliability

[27] *Id.* at P 104.
[28] *Id.*

> Standard if it is not to be addressed with transmission relay loadability.[29]

During the development of proposed Reliability Standard PRC-025-1, the standard drafting team and industry stakeholders identified potential compliance overlap and reliability gaps between Reliability Standard PRC-023-2 and proposed Reliability Standard PRC-025-1. Reliability Standard PRC-023-2 and proposed Reliability Standard PRC-025-1 overlap with regard to the application of load-responsive protective relays on transmission lines that connect the generating plant or generating units to the Transmission System. Proposed Reliability Standard PRC-025-1 introduced criteria for relays applied at the terminals of these lines. At the same time Requirement R1, Criterion 6 of Reliability Standard PRC-023-2 requires entities to "set transmission line relays applied on transmission lines connected to generation stations remote to load so they do not operate at or below 230% of aggregated generation nameplate capability." The compliance overlap would result in a finding of a non-compliance with both Reliability Standards—generation and transmission—unless revisions are made to avoid overlap—two sets of Requirements applying to the same relay—between the two Reliability Standards.

Coordinating changes to Reliability Standard PRC-023-2 are necessary to properly align proposed Reliability Standard PRC-025-1 with Reliability Standard PRC-023-2. First, Requirement R1, Criterion 6 of PRC-023-2 was removed and the applicability section of PRC-023-2 was revised to exclude "Elements that connect the GSU transformer(s) to the Transmission system that are used exclusively to export energy directly from a Bulk Electric System generating unit or generating plant." These changes avoid overlap with the requirements in PRC-025-1 that apply to these Facilities.

[29] *Id.* at P 106.

Second, PRC-025-1 was developed to include relay loadability requirements for all load responsive protective relays applied at the terminals of generators and GSU transformers. Corresponding modifications are being developed to revise the applicability of PRC-023-3 and to remove section 2.4 of Attachment A to avoid overlap or gaps between the two proposed Reliability Standards. The applicability sections for the two proposed Reliability Standards are based on the location where the relays are applied and are independent of the intended protection function.

The proposed applicability for PRC-025-1 includes that all relays that may operate in response to increased generator output during stressed system conditions, assuring that these relays are addressed in one Reliability Standard. The loadability challenge presented to relays applied at the terminals of generators and GSU transformers is different than the transmission relay loadability conditions observed during the August 2003 Blackout. The transmission relay loadability requirements are based on assuring relays do not operate unnecessarily to trip transmission elements during conditions of depressed transmission system voltage (0.85 per unit) and high transmission power factor angle (30 degrees). Since the objective is to keep transmission Elements in service when the Elements are not at risk of thermal overloading, the setting requirements are based on the Facility Rating. Similarly, the generator relay loadability requirements ensure relays do not operate unnecessarily to trip generating units during depressed Transmission System voltage. However, the voltage and power factor conditions that challenge relays applied at the terminals of generators and GSU transformers are significantly different. The voltage and power factor angle will be higher, particularly for synchronous generators, due to the increased Reactive Power output from the generator to support voltage at its terminals. For example, generator terminal voltage may approach 0.95 per unit during depressed

transmission system voltage and the power factor angle may approach 60 degrees. The generator relay loadability requirements, therefore, are based on the generator capability rather than the Facility Rating of the generator or GSU transformer.

The protective relays applied at the terminals of generators and GSU transformers will be challenged by the increased generator output during stressed system conditions regardless of the intended protection function; *e.g.*, whether they are applied to protect the generator or GSU transformer, or to provide backup protection for the Transmission System. Thus, to prevent unnecessary tripping of the generator, the relay loadability requirements for these relays must be independent of the intended protection function.

The applicability requirements in PRC-025-1 and corresponding applicability proposed in PRC-023-3 address the Commission's concern that all generator and GSU transformer load-responsive protective relays are subject to appropriate requirements in a Reliability Standard. Basing applicability on the physical location where the relay is applied provides the following advantages:

(i) Facilitates establishing generator relay loadability requirements based on the physics associated with increased generator output during stressed system conditions.

(ii) Avoids ambiguity whether the intended protection function is for the generating unit or the Transmission System. For example, a relay may be applied at the terminals of a generator to provide backup protection for the GSU transformer, but because the relay setting must "over-reach" the GSU transformer terminals the relay inherently provides backup protection for the high-voltage bus and close-in portions of transmission lines.

(iii) Provides clear division of applicability between the generator and transmission relay loadability Reliability Standards based on the physical location, independent of the entity that owns the relay.

b) Proposed Reliability Standard PRC-025-1 is Timely

In Order No. 733, the Commission directed "the ERO to submit to the Commission an updated and specific timeline to explain when it expects to develop and submit this proposed Standard." Further, the Commission stated it "will not hesitate to direct the development of a new Reliability Standard if the ERO fails to propose a Standard in a timely manner."[30] NERC submitted a specific timeline to the Commission. The Commission granted a one-year extension of time to develop Reliability Standard for generator relay loadability on February 15, 2012, allowing NERC until September 30, 2013 to complete the Reliability Standard pursuant to Order No. 733.[31] With this petition, NERC has timely submitted the proposed Reliability Standard.

c) Consideration of a Generic Rating Percentage for Generator Step-up Transformers

In Order No. 733, the Commission encouraged NERC to "consider whether a generic rating percentage can be established for generator step-up transformers and, if so, determine that percentage."[32] Proposed Reliability Standard PRC-025-1 establishes a Requirement that each Generator Owner, Transmission Owner, and Distribution Provider to apply settings on its load-responsive protective relays for GSU transformers.

For relays applied on the generator side of GSU transformers connected to synchronous generator units, the proposed Reliability Standard establishes settings based on 100 percent of the generator unit's maximum gross Real Power capability in megawatts (MW), as reported to

[30] *Id.* at P 103.

[31] *See Transmission Relay Loadability Reliability Standard*, Notice of Extension of Time Docket, No. RM08-13-001 (Feb. 15, 2012).

[32] Order No. 733 at P 108.

the Transmission Planner, and Reactive Power capability, in megavoltampere-reactive (Mvar), equal to 150 percent of the MW value derived from the generator nameplate megavoltampere (MVA) rating at rated power factor. A similar generic criterion is established for relays applied at the high-side of GSU transformers connected to synchronous generators,

For relays applied at the generator side of GSU transformers connected to asynchronous generator units, the proposed Reliability Standard establishes settings based on 130 percent of the generator unit's aggregate installed maximum rated MVA output (including the Mvar output of any static or dynamic reactive power devices) of the aggregated generators at rated power factor. Asynchronous generator criteria also include inverter-based installations. A similar generic criterion is established for relays applied at the high-side of GSU transformers connected to asynchronous generators,

While these generic criteria achieve the goal of simplifying the calculations necessary to establish relay settings, these generic criteria are conservative to assure they provide adequate relay loadability for all applications. In some cases these generic criteria may be overly conservative due to limitations of the generating unit. To address such cases, proposed Reliability Standard PRC-025-1 provides multiple options for most applications, allowing entities to use simpler calculations yielding more restrictive settings, more complex calculations yielding less restrictive settings, or based on the modeled output of the generating plant or generating unit.

C. Requirement in Proposed Reliability Standard PRC-025-1

Proposed Reliability Standard PRC-025-1 establishes one Requirement for relay settings on each load-responsive protective relay. The Requirement is as follows:[33]

[33] A full technical justification is included in **Exhibit A**.

> R1. Each Generator Owner, Transmission Owner, and Distribution Provider shall apply settings that are in accordance with PRC-025-1 – Attachment 1: Relay Settings, on each load-responsive protective relay while maintaining reliable fault protection. *[Violation Risk Factor: High][Time Horizon: Long-Term Planning]*.

Requirement R1 is risk-based. For ease of use, a table providing the relevant criteria was developed including application, relay type, voltage to consider, and the pickup setting. The criteria table is listed in Attachment 1 of proposed Reliability Standard PRC-025-1. Based on the criteria table, an entity must set its load-responsive relay to the appropriate setting based on the entity's calculation or simulation for the specified conditions. Each responsible entity must be aware of each protective relay subject to the proposed Reliability Standard and set the relay using an appropriate option established in the criteria table. The proposed Reliability Standard furthers reliability by establishing setting criteria to prevent operation for short-term conditions during which generation Facilities are capable of providing the system with increased Reactive Power. It is under these circumstances that generation Facilities have historically been disconnected. In previous disturbance events, the disconnecting of generation Facilities has increased the severity of the event.

The basis for the proposed Reliability Standard's loadability criteria for relays applied at the terminals of synchronous generators or low-side of the GSU transformer are the dynamic generating unit loading values observed during the August 2003 blackout, other subsequent system events, and simulations of generating unit response to similar system conditions. The Reactive Power output observed during field-forcing in these events and simulations approaches a value equal to 150 percent of the Real Power (MW) capability of the generating unit when the generator is operating at its Real Power capability. In the System Protection and Control

Subcommittee technical reference document[34], two operating conditions were examined based on these events and simulations: (1) when the unit is operating at rated Real Power in MW with a level of Reactive Power output in Mvar which is equivalent to 150 percent times the rated MW value (representing some level of field-forcing); and (2) when the unit is operating at its declared low active Real Power operating limit (*e.g.*, 40 percent of rated Real Power, with a level of Reactive Power output in Mvar which is equivalent to 175 percent times the rated MW value (representing some additional level of field-forcing)).

Both conditions above are evaluated with the GSU transformer high-side voltage at 0.85 per unit. These load operating points are believed to be conservatively high levels of Reactive Power out of the generator with a 0.85 per unit high-side voltage which is based on these observations. However, the drafting team evaluated the benefit of defining two operating points and determined, for the purposes of this proposed Reliability Standard, that the second load point (40 percent) offered no additional benefit and only increased the complexity for an entity to determine how to comply with the Reliability Standard. Given the conservative nature of the criteria, which may not be achievable by all generating units, an alternate method is provided to determine the Reactive Power output by simulation. In addition, to account for Reactive Power losses in the GSU transformer, a reduced level of output of 120 percent times the rated MW value is provided for relays applied at the high-side of the GSU transformer and on Elements that connect a GSU transformer to the Transmission system and are used exclusively to export energy directly from a Bulk Electric System generating unit or generating plant.

[34] *Technical Reference Document: Power Plant and Transmission System Protection Coordination – Revision 1*, NERC System Protection and Control Subcommittee (Jul. 2010), available at http://www.nerc.com/docs/pc/spctf/Gen%20Prot%20Coord%20Rev1%20Final%2007-30-2010.pdf. The technical reference document was approved by the NERC Planning Committee on July 30, 2010.

The basis for the proposed Reliability Standard's loadability criteria for relays applied at the terminals of asynchronous generators or low-side of the GSU transformer is the expected dynamic generating unit loading for the same system conditions used for synchronous generators. Asynchronous generators do not have excitation systems and will not respond to a disturbance with the same magnitude of apparent power that a synchronous generator will respond. However, asynchronous generators will support the system during a disturbance.

The generator output used to determine settings is derived from 130 percent of the maximum aggregate nameplate MVA output at rated power factor including the Mvar output of any static or dynamic Reactive Power devices. This is determined by summing the total MW and Mvar capability of the generation equipment behind the relay and any static or dynamic Reactive Power devices that contribute to the power flow through the relay. This calculation approximates the stressed system conditions.

Asynchronous generators do not produce as much Reactive Power as synchronous generators; the voltage drop due to Reactive Power flow through the GSU transformer is not as significant. Therefore, the generator bus voltage can be conservatively estimated by reflecting the high-side nominal voltage to the generator-side based on the GSU transformer's turns ratio and the setting basis is the same for relays on either side of the GSU transformer, and for relays applied on Elements that connect a GSU transformer to the Transmission system and are used exclusively to export energy directly from a Bulk Electric System generating unit or generating plant.

The basis for the proposed Reliability Standard's loadability criteria for relays applied on UATs is based on the expected performance of station service load during depressed system voltage. The performance of the UAT loads during stressed system conditions is very difficult to

determine. Rather than requiring responsible entities to determine the response of UAT loads to depressed voltage, the technical experts writing the proposed Reliability Standard elected to increase the margin to 150 percent from that used elsewhere in this proposed Reliability Standard (e.g., 115 percent) and use a generator bus voltage of 1.0 per unit. A minimum pickup current based on 150 percent of maximum transformer nameplate MVA rating at 1.0 per unit generator bus voltage will provide adequate transformer protection based on IEEE C37.91[35] at full load conditions while providing sufficient relay loadability to prevent a trip of the UAT, and subsequent unit trip, due to increased UAT load current during stressed system voltage conditions.

Because of the various design and loading characteristics of UATs, two options are provided to accommodate an entity's protection philosophy while preventing the UAT transformer phase time overcurrent relays from operating during the dynamic conditions anticipated by this proposed Reliability Standard. These options are based on the transformer bus voltage corresponding to 1.0 per unit nominal voltage on the high-side winding of the UAT. For the first option, the overcurrent element shall be set greater than 150 percent of the calculated current derived from the UAT maximum nameplate MVA rating. This is a simple calculation that approximates the stressed system conditions. For the second option, the overcurrent element shall be set greater than 150 percent of the UAT measured current at the generator maximum gross MW capability reported to the Transmission Planner. This allows for a reduced setting pickup compared to the first option. This is a more involved calculation that approximates the stressed system conditions by allowing the entity to consider the actual load

[35] IEEE Guide for Protecting Power Transformers, *IEEE Std C37.91-2008 (Revision of IEEE Std C37.91-2000)* (2008).

placed on the UAT based on the generator's maximum gross MW capability reported to the Transmission Planner.

D. Enforceability of PRC-025-1

The proposed Reliability Standard PRC-025-1 contains a Measure that supports the Requirement by clearly identifying acceptable evidence of compliance and how the Requirement will be enforced. The Implementation Plan also discusses the documentation necessary to comply with the proposed Reliability Standard. The VSL provides further guidance on the way that NERC will enforce the Requirements of the proposed Reliability Standard. The VRF and VSL for the proposed Reliability Standard comport with NERC and Commission guidelines related to their assignment. The VSL has been developed based on the situations an auditor may encounter during a compliance audit. For a detailed review of the VRF, VSL, and the analysis of how the VRF and VSL were developed using these guidelines, see **Exhibit E**.

V. CONCLUSION

For the reasons set forth above, NERC respectfully requests that the Commission:

- approve the proposed Reliability Standard, the VRF and VSL (explained in **Exhibit E**), and other associated elements included in **Exhibit A**; and
- approve the implementation plan included in **Exhibit B**.

Respectfully submitted,

/s/ Brady A. Walker

Charles A. Berardesco
Senior Vice President and General Counsel
Holly A. Hawkins
Assistant General Counsel
William H. Edwards
Counsel
Brady A. Walker
Associate Counsel
North American Electric Reliability Corporation
1325 G Street, N.W., Suite 600
Washington, D.C. 20005
(202) 400-3000
(202) 644-8099 – facsimile
charlie.berardesco@nerc.net
holly.hawkins@nerc.net
william.edwards@nerc.net
brady.walker@nerc.net

Counsel for the North American Electric Reliability Corporation

Date: September 30, 2013