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**UNITED STATES OF AMERICA  
BEFORE THE  
FEDERAL ENERGY REGULATORY COMMISSION**

**TRANSMISSION RELAY LOADABILITY        )  
RELIABILITY STANDARD                    )**       **Docket No. RM08-13-000**

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

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**I. INTRODUCTION**

The North American Electric Reliability Corporation (“NERC”)<sup>1</sup> is pleased to provide these comments in response to the Federal Energy Regulatory Commission’s (“FERC”) Notice of Proposed Rulemaking for the Transmission Relay Loadability Reliability Standard (“NOPR”).<sup>2</sup> NERC commends FERC’s determination to approve the Transmission Relay Loadability Reliability Standard PRC-023-1 that NERC proposed in accordance with Section 215(d)(1) of the Federal Power Act (“FPA”)<sup>3</sup> and Section 39.5 of FERC’s regulations.<sup>4</sup> While NERC generally supports FERC’s proposal to approve the proposed Transmission Relay Loadability Reliability Standard, NERC responds to some of the specific proposals included in FERC’s NOPR.

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<sup>1</sup> The Federal Energy Regulatory Commission (“FERC”) certified NERC as the electric reliability organization (“ERO”) in its order issued on July 20, 2006 in Docket No. RR06-1-000. *North American Electric Reliability Corporation*, “Order Certifying North American Electric Reliability Corporation as the Electric Reliability Organization and Ordering Compliance Filing,” 116 FERC ¶ 61,062 (July 20, 2006).

<sup>2</sup> *Transmission Relay Loadability Reliability Standard*, 127 FERC ¶ 61,175 (2009) (“NOPR”).

<sup>3</sup> §16 U.S.C. 824o.

<sup>4</sup> 18 C.F.R. § 39.5 (2006); see NERC’s Filing to FERC in Docket No. RM08-13-000, dated July 30, 2008.

## **II. NOTICES AND COMMUNICATIONS**

Notices and communications with respect to this filing may be addressed to:

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## **III. BACKGROUND**

### **A. Regulatory Framework**

Through its enactment of the Energy Policy Act of 2005 (“the Act”), Congress entrusted FERC 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 electric reliability organization (“ERO”) that would be charged with developing and enforcing mandatory Reliability Standards, subject to FERC approval.<sup>5</sup> Section 215 of the Act provides that all users, owners and operators of the bulk power system in the United States will be subject to FERC approved Reliability Standards. On July 20, 2006, FERC certified NERC as the ERO.<sup>6</sup> Pursuant to Section 215 of the Act, the ERO is charged with developing mandatory and enforceable Reliability Standards, which are

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<sup>5</sup> 16 U.S.C. §824o (2005).

<sup>6</sup> *Rules Concerning Certification of the Electric Reliability Organization: Procedures for the Establishment, Approval and Enforcement of Electric Reliability Standards*, Order No. 672, 71 FR 8662 (February 17, 2006), FERC Stats. & Regs. ¶ 31,204 (2006), *order on reh’g*, Order No. 672-A, 71 FR 19814 (April 18, 2006), FERC Stats. & Regs. ¶ 31,212 (2006).

subject to FERC review and approval.<sup>7</sup> Upon approval by FERC, the Reliability Standards may be enforced by the ERO, subject to FERC oversight, or FERC can independently enforce these Reliability Standards.<sup>8</sup>

#### **B. Basis for Approval of Proposed Reliability Standards**

Under Section 215(d) of the Act, FERC is authorized to approve proposed Reliability Standards if FERC determines that the proposed standards are “just, reasonable, not unduly discriminatory or preferential, and in the public interest.”<sup>9</sup> When evaluating proposed Reliability Standards, the statute directs FERC to give “due weight” to the technical expertise of the ERO, but FERC is not to defer to the ERO on matters affecting competition.<sup>10</sup> Order No. 672 provides guidance on the factors FERC will consider when determining whether proposed reliability standards meet the statutory criteria.<sup>11</sup>

#### **C. Reliability Standards Development Procedure**

As described in more detail in NERC’s petition for approval of the proposed Transmission Relay Loadability Reliability Standard PRC-023-1, this standard was developed and approved by industry stakeholders using NERC’s *Reliability Standards Development Procedure*, and was approved by the NERC Board of Trustees on February 12, 2008. NERC requested Commission approval of this proposed Reliability Standard on July 30, 2008.

#### **D. Overview of the PRC-023-1 Reliability Standard**

The development of the Transmission Relay Loadability Reliability Standard is a significant step toward improving the reliability of the bulk power system in North America, because it addresses key August 14, 2003 blackout recommendations regarding relay loadability

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<sup>7</sup> 16 U.S.C. § 824o.

<sup>8</sup> *Id.*

<sup>9</sup> *Id.*

<sup>10</sup> See 18 C.F.R. § 39.5(c)(1) and Order No. 672 at PP 40, 249.

<sup>11</sup> Order No. 672 at PP 320-338.

issues. Relay loadability refers to the ability of protective relays to restrain operation for load (power flow) conditions.<sup>12</sup> Because protective relays can respond only to measured voltage and current, they must be set so that they will detect the electrical faults for which they must operate but not operate unnecessarily for non-fault load (power flow) conditions. The proposed PRC-023-1 Reliability Standard requires certain Transmission Owners, Generator Owners, and Distribution Providers to set protective relays to prescribed limits for the purpose of protecting systems while ensuring that settings do not contribute to cascading outages. Additionally, the proposed Reliability Standard requires Transmission Owners, Generator Owners, and Distribution Providers to establish agreements with Planning Coordinators regarding which transmission lines operated at voltages of 100 kV to 200 kV will be subject to the requirements of this Reliability Standard. The protective relays should detect and operate properly for all fault conditions,<sup>13</sup> and not unnecessarily limit transmission loadability, thus allowing system operators the flexibility and time to maintain system reliability.

Relay loadability issues were determined to have played a pivotal role in accelerating and spreading the early part of the cascading outage in Ohio and Michigan during the August 14, 2003 blackout.<sup>14</sup> Similar relay loadability is also known to have exacerbated a number of system disturbances since the Northeast Blackout of 1965. During the 2003 blackout, a substantial

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<sup>12</sup> Additionally, in the NOPR, FERC defines “Redundancy” in footnote 7 as the primary component having a “twin” component that operates to isolate the fault in the same manner at approximately the same time. FERC goes on to state that the Transmission Planner may assume that, at any given time, either the primary component or its redundant component will be operable and therefore the system will clear the contingency in the time associated with the primary protection. In fact, NERC notes that Redundancy can mean this, but the redundant component may also have a different response which may clear the fault adequately but not in precisely the same time as the primary protection.

<sup>13</sup> A fault is an event occurring on an electric system such as a short circuit, a broken wire, or an intermittent connection.

<sup>14</sup> See 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, April 2004 (“Final Task Force Report”), available at <http://www.ferc.gov/industries/electric/indus-act/blackout.asp>; see also, NERC Final Blackout Recommendations, p.6, July 13, 2004, available at <http://www.nerc.com/docs/docs/blackout/section5.pdf>.

number of lines tripped, not due to electrical faults, but due to relay loadability issues, many of them before the blackout entered the unrecoverable cascading stage.

The proposed Transmission Relay Loadability Reliability Standard was developed by industry stakeholders and approved by the NERC Board of Trustees with the goal of specifically addressing Recommendation 8a of the NERC Blackout Report<sup>15</sup> and Recommendation 21.A of the Final Task Force Report. 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 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.

U.S. Canada Power System Outage Task Force Recommendation 21.A specifically added the following:

Task Force: Recommends that NERC broaden the review to include operationally significant 115 kV and 138 kV lines, e.g., lines that are part of monitored flowgates or interfaces. Transmission owners should also look for zone 2 relays set to operate like zone 3s.

As a result of these recommendations, industry stakeholders and NERC developed a Reliability Standard that specifically addresses the recommendations included in the NERC Blackout Report and the Final Task Force Report. The proposed Reliability Standard applies to load responsive phase protection systems applied to: (1) all transmission lines operated at 200 kV and above; (2) transmission lines operated at 100 kV to 200 kV as designated by the Planning Coordinator as critical to the reliability of the bulk power system; (3) transformers with low-

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<sup>15</sup> August 14, 2003 Blackout: NERC Actions to Prevent and Mitigate the Impacts of Future Cascading Blackouts (2004) (“NERC Blackout Report”).

voltage terminals connected at 200 kV and above; and (4) transformers with low-voltage terminals connected at 100 kV to 200 kV as designated by the Planning Coordinators as critical to the reliability of the bulk power system.

NERC recognizes that Recommendation 21 of the Final Task Force Report addresses proposals to make more effective and wider use of system protection measures and is broader than the relay loadability issue (Recommendation 21.A) addressed by the proposed Transmission Relay Loadability Reliability Standard.<sup>16</sup> Since 2003, NERC has taken a number of actions to address Recommendations 21.B and 21.C. The Transmission Issues Subcommittee (“TIS”) performed a survey of the industry to ascertain then current practices concerning undervoltage load shedding (UVLS), and prepared the *Guidelines for Developing an Undervoltage Load Shedding (UVLS) Evaluation Program*, which was approved by the Planning Committee in September 2006.<sup>17</sup> To address Recommendation 21.C, the Planning Committee charged the System Protection and Control Task Force (“SPCTF”) with reviewing all of the protection standards. As a result of those reviews, a number of Standards Authorization Requests were issued to modify existing standards and propose new standards. This has resulted in the NERC System Protection Initiative, a comprehensive initiative designed to coordinate many valuable, ongoing efforts to improve the performance of power system protection and control systems, and thereby limit the scope and severity of future system disturbances. That initiative includes: protection system redundancy; protection system coordination; generator frequency and voltage

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<sup>16</sup> See Final Task Force Report, Recommendation 21, which includes recommendations by the U.S. Canada Power System Outage Task Force to NERC to evaluate the following: A) Zone 3 Relays; B) the applicability of under-voltage load shedding capability in load centers that could become unstable as a result of insufficient reactive power following credible multiple-contingency events; and C) NERC’s Planning Standard III, System Protection and Control, to determine the goals and principles needed to establish an integrated approach to relay protection for generators and transmission lines and the use of under-frequency and under-voltage load shedding programs.

<sup>17</sup> See *Guidelines for Developing an Undervoltage Load Shedding (UVLS) Evaluation Program*, available at [http://www.nerc.com/docs/pc/tis/UVLS\\_Guidelines\\_approved\\_by\\_PC.pdf](http://www.nerc.com/docs/pc/tis/UVLS_Guidelines_approved_by_PC.pdf).

protection relay coordination; transmission and generation protection system misoperations; and protection system maintenance.<sup>18</sup>

#### **IV. DISCUSSION**

##### **A. Introduction**

Implementation of Reliability Standard PRC-023-1 will achieve a significant improvement in the reliability of the bulk power system. Therefore, NERC is generally supportive of FERC's proposal to approve PRC-023-1. However, certain proposals in the NOPR are of significant concern. NERC discusses each of these proposals in this response to FERC's NOPR.

##### **B. Applicability of Proposed Reliability Standard PRC-023-1**

###### **1. Applicability of PRC-023-1 to Entities with Facilities Operated or Connected at 100 kV to 200 kV that are Critical to the Reliability of the Bulk Power System**

In its petition for approval of Reliability Standard PRC-023-1, NERC proposed that Reliability Standard PRC-023-1 apply to Transmission Owners, Generator Owners, and Distribution Providers with load-responsive phase protection systems, as described in Attachment A to PRC-023-1. The proposed standard consists of three requirements. The first two requirements, proposed Requirements R1 and R2 of the Reliability Standard, will apply to Transmission Owners, Generator Owners, and Distribution Providers with transmission lines or transformers with low-voltage terminals operated or connected at 200 kV and above. Proposed Requirement R3, will require Planning Coordinators to identify the transmission lines operated at 100 kV to 200 kV and transformers with low voltage terminals connected at 100 kV to 200 kV

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<sup>18</sup> See April 24, 2009 letter from NERC CEO Rick Sergel to the NERC Board of Trustees and Stakeholders Regarding the System Protection Initiative, available at [http://www.nerc.com/fileUploads/File/News/spi-letter\\_24Apr09.pdf](http://www.nerc.com/fileUploads/File/News/spi-letter_24Apr09.pdf).

that are critical to the reliability of the bulk power system that must meet Requirement R1 to prevent potential cascade tripping that may occur when protective relay settings limit transmission loadability. NERC noted in its filing that PRC-023-1 should not be applicable to all facilities operated at above 100 kV (absent a determination of criticality), because doing so would increase implementation costs by approximately two orders of magnitude without corresponding reliability benefits.

In the NOPR, FERC expresses concern that NERC's proposal does not automatically apply to transmission lines operated at 100 kV or above or transformers with low-voltage terminals connected at 100 kV and above.<sup>19</sup> FERC states that the Planning Coordinator's process for determining the facilities operated at 100 kV to 200 kV that are critical to the reliability of the bulk power system may not be robust enough to identify all such critical facilities because Requirement R3 uses an "add in" approach to identify facilities operated at 100 kV to 200 kV.<sup>20</sup> FERC notes that this "add in" approach may not result in a comprehensive study to identify applicable facilities and, at the outset, will effectively exempt a large percentage of bulk power system facilities that should otherwise be subject to the Reliability Standard.<sup>21</sup> Additionally, FERC notes that, while NERC offered a general explanation of why it proposed that PRC-023-1 apply only to facilities operated at 200 kV and above, it does not provide a technical analysis to support this "add in" approach in Requirement 3.

Therefore, FERC proposes in the NOPR that NERC modify PRC-023-1 to make it applicable to all facilities operated or connected at or above 100 kV.<sup>22</sup> Additionally, FERC notes that there might be a few limited examples of facilities operated at 100 kV to 200 kV that are not

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<sup>19</sup> NOPR at P 39.

<sup>20</sup> NOPR at P 40.

<sup>21</sup> *Id.*

<sup>22</sup> NOPR at P 43.

critical to the reliability of the bulk power system and therefore requested comments on whether an exception process should be implemented that would be considered on a case-by-case basis for these facilities.<sup>23</sup>

NERC disagrees with FERC's suggested proposal to make PRC-023-1 applicable to all facilities operated or connected at 100 kV and above, with case-by-case exceptions for those facilities operated or connected at 100 kV to 200 kV. Instead NERC urges FERC to limit implementation of the proposed Transmission Relay Loadability Reliability Standard to facilities operating or connected at 100 kV to 200 kV only to those determined by the respective Planning Coordinator to be critical to the reliability of the bulk power system and necessary to prevent potential cascade tripping that may occur when protective relay settings limit transmission loadability. Based on substantive industry research and analysis, the Reliability Standard development team and the NERC Board of Trustees determined that, in order to ensure reliability of the bulk power system, the proposed Reliability Standard should apply to all transmission lines operated at and transformers with low-voltage terminals connected at 200 kV and above, and those transmission lines operated at and transformers with low-voltage terminals connected at 100 kV to 200 kV that are designated by their respective Planning Coordinators as critical to the reliability of the bulk power system. This determination was driven by analyses performed after the August 2003 blackout.<sup>24</sup>

Analyses performed after the August 14, 2003 blackout by NERC and by the U.S.—Canada Power System Outage Task Force revealed that, of the 18 transmission lines that tripped

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<sup>23</sup> *Id.*

<sup>24</sup> See, NERC Technical Analysis of the August 14, 2003 Blackout, *What Happened, Why, and What Did We Learn?* July 13, 2004, available at [http://www.nerc.com/docs/docs/blackout/NERC\\_Final\\_Blackout\\_Report\\_07\\_13\\_04.pdf](http://www.nerc.com/docs/docs/blackout/NERC_Final_Blackout_Report_07_13_04.pdf); see also, NERC Blackout Report.

by impedance relays (at 14 different times) during the blackout,<sup>25</sup> six were 345 kV lines (3 in Ohio and 3 in Michigan), 10 were 138 kV transmission lines (6 in Ohio and 4 in Michigan), one was a 138/69-kV transformer (Ohio), and one was a 69 kV line (Ohio). It is important to note that, in all cases, the 345 kV transmission lines tripped before the 138 kV lines in their near vicinity tripped. In some cases, generation also tripped before the 138 kV lines tripped. Had the 345 kV lines not tripped, the cascade of the 138 kV system would not have happened because the tripping of the 138 kV lines was a direct result of the 345 kV lines tripping.

Based on these results, the Reliability Standard development team and NERC focused its development of the proposed Reliability Standard on transmission lines operated at 230 kV and above with regard to relay loadability. Recommendation 21.A in the U.S.—Canada Power System Outage Task Force Report, which was issued after the NERC Blackout Report, added operationally significant 138 kV lines as a point of focus. Therefore, the Reliability Standard development team and NERC included those transmission lines operating at 100 kV to 200 kV that are designated by Planning Coordinators as critical to the reliability of the bulk power system within the scope of the proposed Reliability Standard. Although the U.S.—Canada Power System Outage Task Force included 138 kV lines in its analysis, these were included primarily to demonstrate examples of monitored flowgates or interfaces between systems.<sup>26</sup>

In response to direction from the NERC Planning Committee, there were two relay review programs developed by the NERC SPCTF to address the loadability issues identified in the August 2003 blackout. These relay review programs formed the basis for what ultimately became PRC-023-1. The first, *EHV Transmission System Relay Loadability Review*, called the “Zone 3 Review,” directed by Recommendation 8a in the NERC Final Report, evaluated line

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<sup>25</sup> See NERC Blackout Report at pg. 81.

<sup>26</sup> Final Blackout Report at P 158.

loadability across Canada and the United States for lines and transformers operated at 230 kV and above. The second, *Protection System Review Program – Beyond Zone 3*, referred to as the “Beyond Zone 3 Review,” directed by Recommendation 21.A in the U.S.—Canada Power System Outage Task Force Report, focused on transmission lines operated at 200 kV and above, and operationally significant circuits operated below 200 kV that included other phase relay functions. Therefore, because the purpose of the Transmission Relay Loadability Reliability Standard is to minimize the possibility that protective relaying would accelerate large-scale, interregional blackouts, NERC’s proposed Reliability Standard focuses on those lines that operate at 200 kV and above, and those operated at 100 kV to 200 kV that are critical to the reliability of the bulk power system, rather than on every line operating at 100 kV to 200 kV.

When the NERC Board of Trustees approved the “Beyond Zone 3 Review” in August 2005, it called for the Regional Entities to determine the operationally significant circuits operated at 100 kV to 200 kV in their respective regions. The SPCTF at that time provided the Regional Entities the following suggested criteria to assist in that determination: “For the purpose of relay loadability reviews, the SPCTF offers the following suggestions to the Regional Reliability Organizations for classifying circuits as operationally significant:

- All circuits that are elements of flowgates in the Eastern Interconnection, Commercially Significant Constraints in the Texas Interconnection, or Rated Paths in the Western Interconnection. This includes both the monitored and outage element for OTDF sets.
- All circuits that are elements of system operating limits (SOLs) and interconnection reliability operating limits (IROLs), including both monitored and outage elements.
- All circuits that are directly related to off-site power supply to nuclear plants. Any circuit whose outage causes unacceptable voltages on the off-site power bus at a nuclear plant must be included, regardless of its proximity to the plant.

- All circuits of the first 5 limiting elements (monitored and outaged elements) for transfer interfaces determined by regional and interregional transmission reliability studies. If fewer than 5 limiting elements are found before reaching studied transfers, all should be listed.
- Other circuits determined and agreed to by the reliability authority/coordinator and the Regional Reliability Organizations.”

Under the voluntary process in place at the time, NERC charged the regions with determining the operationally significant circuits for the “Beyond Zone 3 Review.” Since then, as the Standards Process has evolved, it is no longer acceptable to charge the regions with such a task. Therefore, in the proposed PRC-023 Standard, the task to determine the 100 kV to 200 kV circuits that are critical to the reliability of the bulk power system was assigned to the Planning Coordinator.

NERC recognizes the need for consistent criteria across North American for making these determinations regarding 100 kV to 200 kV circuits. NERC also emphasizes that these determinations are different from the determinations regarding “critical assets” under the Critical Infrastructure Protection standards. The two determinations serve different purposes.

NERC proposes that it work through the industry to develop minimum criteria for the Planning Coordinators to determine the 100 kV to 200 kV circuits that are critical to the reliability of the bulk power system for Requirement R3 of Reliability Standard PRC-023-1.<sup>27</sup> The critical circuit determination criteria will be provided to the Planning Coordinators prior to the implementation of requirement R3 of PRC-023 for circuits operated at 100 kV to 200 kV. This may require a modification to the PRC-023 Implementation Plan for R3 applicability to those voltages. If necessary, NERC will develop and submit a modified implementation plan applicable to those voltages for Commission approval.

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<sup>27</sup> That proposed procedure is NOT to be confused with the *Security Guideline for the Electricity Sector: Identifying Critical Assets* associated with the CIP standards.

The “Zone 3 Review” and the “Beyond Zone 3 Review” demonstrated the following results:

- In the initial “Zone 3 Review”, 10,914 terminals operating at 200 kV and above were examined. Of these, 2,182 terminals (20 percent) were non-conforming to the loadability criteria, with 297 granted technical exceptions (from Requirements R1.2 through R1.13 of PRC-023-1), and 1,885 terminals required mitigation. Mitigation included setting changes (1,520) and equipment change-outs, or additions (287).
- The second stage review, referred to as “Beyond Zone 3 Review”, looked at all phase protection relays applied to trip directly or as a backup on the bulk power system, other than Zone 3, and the lower voltage “critical circuit” protection system review cited in Recommendation 21.A in the U.S.—Canada Power System Outage Task Force Report. In this review, 12,273 terminals operating at 200 kV and above and operationally significant circuits operated below 200 kV that included other (non Zone 3) phase relay functions were examined. Many of these were the same terminals examined in the initial “Zone 3 Review”. Of the 12,273 terminals examined, 2,802 terminals (22.8 percent) were found to be non-conforming with the loadability criteria, with 206 granted technical exceptions (from Requirements R1.2 through R1.13 of PRC-023-1). Mitigation included settings changes (2,230) and equipment change-outs or additions (294).

The review and mitigation efforts for the “Zone 3 Review” and the “Beyond Zone 3 Review” took over three years to complete, from July 2004 through December 2007, with some temporary exceptions for mitigation continuing into 2008 where the work was delayed when outages could not be easily scheduled.

NERC recently conducted a survey of the industry to ascertain the breadth of a similar review for all lines operating at 100 kV to 200 kV. The following is a summary of the survey result analysis from the 114 Transmission Owners operating lines at 100 kV to 200 kV that responded:

- It is estimated that there are about 53,000 terminals in North America in the 100 kV to 200 kV class. Survey respondents reported 22,750 terminals operating at 100 kV to 200 kV – linearly extrapolating that number (from the respondents representing 36% of the registered Transmission Owners) to the overall registered Transmission Owner population would bring the total number of terminals in this category to 63,860, which compares well with the 35,586 lines (potentially 71,172 terminals) in the 2009 summer powerflow representations of the four interconnections of North America. However, because the powerflow representations are for line segments, and 100 kV to 200 kV class lines are often tapped or in configurations of 3 terminals, that value should be discounted by 25 percent, or 53,379 terminals. Therefore, the estimate was conservatively capped at 53,000 terminals.
- Review of the 53,000 terminals operating at 100 kV to 200 kV would require close to 340,000 man-hours, at a cost approaching \$41 million. Respondents estimated an average 6.4 man-hours at an average loaded cost of \$120/hour for each terminal reviewed. The man-hours estimated indicate that this review would require the full-time dedication of qualified protection engineers for far more than the 24 months allocated in the current proposed PRC-023-1 implementation plan.
- It is estimated that about 11,400 terminals operating at 100 kV to 200 kV could be non-conforming to the proposed PRC-023-1 criteria, based on earlier reviews of the 200 kV and above terminals (21.5% of the terminals reviewed). The time required for that number of terminals to complete mitigation plans could take five to ten years, even if the majority required only setting changes. Completion of such work requires outages of the facility, which must be carefully coordinated in order to not degrade reliability during the outages. Such outages for equipment change-outs would be protracted. Given the relative age and the more prevalent application of electro-mechanical relays on the 100 kV to 200 kV class circuits, this value could easily be much higher.
- Using a conservative estimate, assuming that ten percent of the 100 kV to 200 kV class terminals reviewed (5,300 terminals based on the estimate of 53,000 total terminals) require equipment replacement, the costs could be about \$590 million, based on the average estimate from the survey of \$111,500 per terminal. This represents about 18 times as many terminals as those in the “Beyond Zone 3” terminals operating at 200 kV or above that would require equipment replacement. The number of equipment replacements necessary for the class of terminals in the 100 kV to 200 kV range is expected to be far higher than the 2.5 percent of those in the 200 kV and above category that will be required to replace equipment. Some respondents estimate as many as 80 percent of their 100 kV to 200 kV terminals would have to be replaced, citing the age of most of their equipment as a factor for replacement. Additionally, many of the protection packages on this equipment are still electro-mechanical. Although a more conservative 10 percent was chosen, it could easily be a far greater number.

- It is estimated that there are about 2,400 operationally significant circuits operated at 100kV to 200kV, based on the results of the survey. Applying similar analysis from the survey to that voltage class, there may be about 500 of those terminals that need mitigation, with 240 of those requiring equipment replacement (105 of those reviewed).

The cost of performing the earlier loadability reviews for circuits operating at 200 kV and above was substantial (*i.e.*, close to 150,000 man-hours and almost \$18 million was expended, based on the man-hours and cost estimates in the survey<sup>28</sup> of the industry). Additionally, where mitigation included equipment change-outs or additions, almost \$65 million was spent, averaging a total cost of \$111,500 per terminal. However, as noted above, the costs that would be incurred to conduct a similar survey and mitigation of terminals operating at 100 kV to 200 kV would far exceed the costs incurred to analyze terminals operating at 200 kV and above.

Although the industry routinely performs system analyses to determine which circuits may be limiting for transfer capabilities, import limitations, and stability, an entirely new study would have to be created to justify exclusion of facilities in the 100 kV to 200 kV class circuits, as proposed in the NOPR. Under the proposed implementation plan for PRC-023-1, the time to develop such a study was not considered in developing implementation dates.

Based on the results of the recent survey, it is evident that including all 100 kV to 200 kV class circuits in the scope of the Reliability Standard, subject to case-by-case exceptions, is not a modification that should be made within the scope of this Reliability Standard. Furthermore, analyses from studies conducted in response to the August 2003 Blackout demonstrate that inclusion of 100 kV to 200 kV lines is not necessary for purposes of PRC-023-1 because, had procedures such as those introduced in the proposed Reliability Standard been in place at the

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<sup>28</sup> Industry estimated 6.4 man-hours per terminal with an average loaded cost of \$120/hour per terminal reviewed. Also, the average cost of terminal equipment replacements was estimated at \$111,500.

time of the blackout to prevent tripping of the 345 kV lines, transmission lines operating at 100 kV to 200 kV would not have tripped.

Expanding the scope of PRC-023-1 as proposed in the NOPR would produce little additional reliability benefit and could be extremely costly. Accordingly, NERC urges FERC to accept NERC's exercise of its technical expertise and judgment reflected in the proposal to limit applicability of the proposed Reliability Standard to those lines that operate at 200 kV and above, and to those operating at 100 kV to 200 kV that are deemed by the respective Planning Coordinator to be critical to the reliability of the bulk power system, rather than on every line operating between 100 kV and 200 kV.

**2. Applicability of PRC-023-1 to Facilities Below 100 kV Included on the NERC Compliance Registry.**

In the NOPR, FERC states that facilities that have been identified as necessary for the reliable operation of the bulk power system, as identified in the NERC Compliance Registry, should be made subject to the proposed Reliability Standard.<sup>29</sup> Additionally, FERC states that NERC's Statement of Compliance Registry Criteria defines entities with transmission facilities operated below 100 kV that are designated by a Regional Entity as critical to reliability as transmission owners/transmission operators subject to the requirements of the compliance registry and therefore to the requirements of the Reliability Standards.<sup>30</sup> FERC notes that this is an acknowledgement by NERC that there are facilities operated below 100 kV that are critical to the reliability of the bulk power system.<sup>31</sup> Accordingly, FERC states that NERC failed to provide a sufficient technical record to justify the exemption of facilities operated below 100 kV that have been identified by the Regional Entity as necessary to the reliability of the bulk power

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<sup>29</sup> NOPR at P 44.

<sup>30</sup> *Id.*

<sup>31</sup> *Id.*

system and therefore requests comments on whether the proposed Reliability Standard should include these facilities.<sup>32</sup>

NERC disagrees with FERC's proposal that the proposed Reliability Standard should include facilities operated below 100 kV that are included on the NERC Compliance Registry. The NOPR mischaracterizes the nature and purpose of the NERC Compliance Registry. The Reliability Standards determine the applicability of functional entities that are then specifically identified through the registration process. NERC's Compliance Registry delineates the selection criteria employed by NERC and the Regional Entities to determine which organizations should be registered as owners, operators, or users of the bulk power system because they are material to the reliability of the bulk power system. NERC's Statement of Compliance Registry Criteria<sup>33</sup> specifically describes how NERC will identify organizations that may be candidates for registration and assign them to the compliance registry. While NERC's Statement of Compliance Registry Criteria includes registration criteria for smaller or relatively (electrically) isolated organizations as Load-Serving Entities, Distribution Providers, Generation Owners, Generation Operators, or Transmission Owners and Transmission Operators, this document does not define applicability of Reliability Standards to particular facilities owned and/or operated by these registered entities. The purpose of the Compliance Registry is to identify which entities are considered users, owners, and operators of the bulk power system. The Compliance Registry does not register particular facilities. Each Reliability Standard itself defines its applicability to certain types of facilities. In the proposed Transmission Relay Loadability Reliability Standard, the Applicability section specifies which functional entities and facilities are subject to the technical requirements contained within the Reliability Standard.

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<sup>32</sup> NOPR at P 45.

<sup>33</sup> See NERC's *Statement of Compliance Registry Criteria*, available at [http://www.nerc.com/files/Statement\\_Compliance\\_Registry\\_Criteria-V5-0.pdf](http://www.nerc.com/files/Statement_Compliance_Registry_Criteria-V5-0.pdf).

Therefore, inclusion on the NERC Compliance Registry is not in itself a requirement that the entity comply with all NERC Reliability Standards for all of the facilities it owns and operates. Compliance with specific Reliability Standards is provided in the Applicability section of each standard. Accordingly, NERC recommends that FERC accept NERC's Reliability Standard as proposed and not expand the scope of the standard by extending it to all those who are included on the NERC Compliance Registry by virtue of owning facilities that are considered material to the reliability of the bulk power system. However, NERC agrees that FERC's proposal to include operationally significant circuits operated below 100 kV as determined by the Regional Entity or the Reliability Coordinator may have merit. That proposal would require further study. Any such expansion of the scope of PRC-023-1 would need to be developed through NERC's standards development process.

### **3. Applicability of PRC-023-1 to Generator Step-Up and Auxiliary Transformers**

In the NOPR, FERC notes that generator step-up transformer relay loadability was intentionally omitted from PRC-023-1, because, according to NERC, generator step-up loadability merits particular attention in the area of generator protection, and therefore it would be inappropriate to include it in a transmission relay loadability standard without consideration of the overall generator protection system in place.<sup>34</sup> In the NOPR, FERC states that its intent is that NERC will address in a timely manner the reliability objectives relevant to relay loadability, which include generator step-up and auxiliary transformers.<sup>35</sup> Therefore, FERC requests comments on whether it should direct NERC to modify the proposed Reliability Standard to address generator step-up and auxiliary transformer loadability, or whether generator step-up and

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<sup>34</sup> NOPR at P 46.

<sup>35</sup> NOPR at P 48.

auxiliary transformer loadability should be addressed in a separate Reliability Standard.<sup>36</sup>

Additionally, FERC requests comments regarding a reasonable timeframe for developing a modification or separate Reliability Standard to address generator step-up and auxiliary transformer loadability.<sup>37</sup>

During the development of the proposed Transmission Relay Loadability Reliability Standard, NERC's System Protection and Control Subcommittee (SPCS) of the Planning Committee formed a team of relay engineers with generating station protection experience. These subject matter experts researched the performance of generators during stressed system conditions with the IEEE Excitation Subcommittee and with senior engineers at a major US manufacturer of generators. As a result of this coordinated research, the experts conducting the research proposed technical requirements for all generator protective relaying functions that require coordination with the transmission system. An SPCS reference document is being developed on this topic and is scheduled to be presented for approval to NERC's Planning Committee in September 2009. This document is intended to be used as a reference document for the Project 2007-06 standard drafting team (or its successor), which is working on revisions to the PRC-001-2 – System Protection Coordination Reliability Standard to provide technical guidance for developing associated Reliability Standard requirements applicable to generator protection systems. Once provided to the team, NERC projects delivery of standards regarding this issue to be presented for FERC approval within two years.

NERC believes that the loadability issue of generator backup relays is just one facet of the total system protection coordination requirement between generators and transmission lines. NERC recommends that all coordination issues between generators and transmission lines,

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<sup>36</sup> *Id.*

<sup>37</sup> *Id.*

including the issue of generator step-up and auxiliary transformer relay loadability, reside in one standard, PRC-001-2, which is currently undergoing revision in Project 2007-06.

More specifically, there are two approaches to setting the Device 21 Impedance relay function that will be considered in the development of revisions to Reliability Standard PRC-001-2. One is to provide remote backup protection for the power system in the event of a single relay failure on transmission elements directly connected to the generator's high voltage bus. This first approach requires a setting of 120% of the longest line including the effects of infeed (apparent impedance). The second approach is to protect the generator thermally for through-faults. IEEE Standard C37.102 recommends a setting of 150% to 200% of the generator capability curve for this second approach. In the second approach, transmission system owners provide their own relay failure protection. In both approaches, the SPCS recommends that loadability be evaluated as follows: for loadability, the setting, including a reasonable margin, should not exceed a load impedance which is calculated from generator terminal voltage and stator current. The generator terminal voltage is calculated from a generator step-up transformer high side voltage of 0.85 per unit. The stator current is calculated using the generator's maximum real power output and a generator field current of 209% of the exciter capability per IEEE standard or a higher value of field current if specified by the exciter manufacturer.

Accordingly, NERC recommends that FERC accept NERC's proposal to address generator step-up and auxiliary transformer loadability in a separate Reliability Standard rather than as part of the proposed PRC-023-1 Reliability Standard. As noted above, significant developmental work has already been accomplished to address the issue of loadability affecting generator step-up and auxiliary transformers. The System Protection and Control Subcommittee will submit the Technical Reference Document *Power Plant and Transmission System*

*Protection Coordination* to the Planning Committee for approval at its September 2009 meeting. That Technical Reference represents the technical justification for ongoing revisions to PRC-001, containing a lengthy discussion on the complex coordination issues on generator step-up loadability.

**C. Need to Address Additional Issues**

In the NOPR, FERC notes that the currently proposed PRC-023-1 only addresses issues related to load increases and overloads (loadability).<sup>38</sup> However, FERC notes that in its view, in order to ensure reliable operation of the system, it is necessary to address both the reach of zone 3/zone 2 relays applied as remote circuit breaker failure and backup protection, and issues related to load increases, overload, and stable power swings that occur under recognized system conditions.<sup>39</sup> NERC addresses these issues in the section below.

**1. Zone 3/Zone 2 Relays Applied as Remote Circuit Breaker Failure and Backup Protection**

In the NOPR, FERC states its concern that zone 3/zone 2 relays will operate because of line load or overload in extreme contingency conditions even in the absence of a fault, and that the large setting of zone 3/zone 2 relays makes them susceptible to operating in the absence of a fault under abnormal system conditions.<sup>40</sup> FERC states that this occurs because under abnormal system conditions, such as very high loading and large, but stable power swings, the current and voltage as measured by the impedance relay may fall within the very large magnitude and phase setting of the relay, and when this occurs, the relay is susceptible to operation.<sup>41</sup> Therefore, FERC notes that given the U.S.—Canada Power System Outage Task Force’s conclusions about

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<sup>38</sup> NOPR at P 49.

<sup>39</sup> *Id.*

<sup>40</sup> NOPR at P 52.

<sup>41</sup> *Id.*

the role zone3/zone 2 relays played in the spread of the cascade in the 2003 blackout, it is FERC's view that the ERO should develop a maximum allowable relay reach for zone 3/zone 2 relays applied as remote circuit breaker failure and backup protection.<sup>42</sup> Accordingly, FERC requests comments on whether it should direct the ERO to develop a maximum allowable reach, and if so, whether it should direct the ERO to develop a modification to PRC-023-1 or a new Reliability Standard to address this issue.<sup>43</sup>

NERC respectfully disagrees with FERC's proposal, and urges FERC not to direct NERC to develop a maximum allowable reach for zone 3/zone 2 relays applied as remote breaker failure and backup protection. FERC relies on the U.S.—Canada Power System Outage Task Force's conclusions regarding the role zone 3/zone 2 played in the spread of the cascade in the 2003 blackout to justify its proposal in the NOPR. However, the U.S.—Canada Power System Outage Task Force's observations vis-à-vis zone 3 relays, which are addressed in Recommendation 21.A of the Task Force's Final Blackout Report, support NERC's Recommendation 8a regarding changes to the application of zone 3 relays. PRC-023 adequately establishes loadability limits applicable to all relays independent of their application based on physical system parameters and limitations such as equipment thermal ratings and maximum power transfer limits. Therefore, PRC-023 already establishes that zone 3/zone 2 relays applied as remote breaker failure may be set to reach no farther than zone 3/zone 2 relays applied only for primary protection of a transmission line, and establishes relay loadability as a prime boundary condition. In other words, proposed Reliability Standard PRC-023-1 applies to all transmission lines. Establishing a shorter maximum reach for zone3/zone 2 relays applied as remote breaker failure, as suggested in the NOPR, may actually degrade reliability. Specifically,

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<sup>42</sup> NOPR at P 53.

<sup>43</sup> *Id.*

if the level of backup protection provided for failure of breakers and protection systems is reduced, the probability that faults will not be cleared will increase, thereby resulting in serious system stability problems in most cases. Therefore, reliability may actually be degraded by reducing the level of backup protection for failure of breakers and protection systems because there will be less protective coverage even though loadability has been satisfied in accordance with the proposed standard.

Accordingly, because the proposed PRC-023-1 Reliability Standard already establishes sufficient requirements for any load-responsive relay, regardless of its function, it is unnecessary for NERC to revise the proposed Reliability Standard to include a maximum allowable relay reach for zone3/zone 2 relays applied as remote circuit breaker failure and backup protection. The proposed Reliability Standard as written applies to all transmission lines, not just two terminal lines, thereby ensuring that reliability is adequately protected.

## **2. Protective Relays Operating Unnecessarily due to Stable Power Swings**

In the NOPR, FERC notes that, although zone3/zone 2 relays operated during the 2003 blackout according to their settings and specifications, the inability of these relays to distinguish between a dynamic, but stable power swing and an actual fault contributed to the cascade.<sup>44</sup> FERC states that because the proposed Reliability Standard addresses only the unnecessary operation of protective relays caused by high loading conditions, and does not address unnecessary operation caused by stable power swings, it is concerned that relays set according to the requirements of PRC-023-1 could still operate unnecessarily because of stable power

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<sup>44</sup> NOPR at P 58; NERC notes that there is no evidence that any lines that tripped during the August 2003 disturbance due to stable power swings contributed to the cascade. Detailed analysis performed by NPCC (not publicly available) showed that the tripping of the Homer City-Watercure and Homer City-Stolle Rd 345 kV lines on a stable power swing did not affect the separation of NPCC from the Eastern Interconnection that occurred six seconds later. NERC's detailed analysis (not publically available) of those trips also showed that they would have tripped six seconds later due to the unstable swing when New England separated from New York.

swings.<sup>45</sup> FERC states that, in its view, a protective relay system that cannot refrain from operating under non-fault conditions because of a technological impediment is unable to achieve the performance required for reliable operation.<sup>46</sup> Therefore, FERC requests comments on whether it should either direct the ERO to develop a Reliability Standard or a modification that requires applicable entities to use protective relays systems that can differentiate between faults and stable power swings, and phase out protective relay systems that cannot meet this requirement.<sup>47</sup>

Reliability of the power system requires secure protective relay settings to avoid operation during stable power swings and dependable tripping for faults and unstable power swings. Design of protection systems that satisfy these requirements requires careful consideration of both the type of protective relay system and the protective relay settings. Protective relay systems do exist that are immune to operation during stable power swings; however, it is important that a Reliability Standard does not promote the application of such systems at the expense of degrading the ability of protective relay systems to detect unstable power swings.

Two alternatives exist for the protection system designer to prevent protective relay operation during stable power swings. The first alternative is to select a protection system that is immune to tripping for all power swings such as current differential or phase comparison. While such a design ensures that the protection system will differentiate between faults and stable swings, that kind of protection system provides no ability to detect unstable power swings. The second alternative is to utilize an impedance-based protection system design that relies on careful selection of the protective relay trip characteristic including the shape (mho circle, lens, *etc.*) and

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<sup>45</sup> NOPR at P 58.

<sup>46</sup> NOPR at P 60.

<sup>47</sup> *Id.*

sensitivity to differentiate between faults, stable swings, and unstable swings. Selection of the trip characteristic requires coordination between the protection system designer and the transmission planner based on fault coordination and transient stability studies.

FERC is appropriately concerned with the effect of stable power swings upon load responsive relays. NERC acknowledges that proposed Reliability Standard PRC-023-1 is designed to address the steady-state aspects of relay loadability, but it also has beneficial effects in the reliability performance for stable power swings. The modifications of relay characteristics and settings modifying relaying characteristics to increase steady state loadability to comply with the proposed standard's requirements inherently decrease the likelihood that those relays will trip on stable swings. However, to properly address the myriad of possible protective relay responses to stable power swings within a Reliability Standard would require significant additional effort and careful consideration to develop clear and measurable requirements that promote the overall reliability of the power system while avoiding unintended consequences. Notably, considerable preparatory technical studies and evaluation analysis would need to occur so that appropriate technical requirements may be developed for development of an appropriate standard. Development of a Reliability Standard would require significant effort and careful consideration to develop clear and measurable standards requirements that promote the overall reliability of the power system while avoiding unintended consequences.

Accordingly, NERC proposes that PRC-023-1 remain focused on steady-state relay loadability, and that stable power swing response be specifically addressed in a Reliability Standard other than PRC-023-1. Additional technical research on the effect of stable power swings needs to be coordinated within NERC, IEEE and other organizations before it is addressed in a NERC Reliability Standard. Given the amount of time that will be necessary to

coordinate this research with other organizations, NERC requests that FERC approve the PRC-023-1 Reliability Standard as proposed and provide NERC adequate time to address the use of protective relay systems that can differentiate between faults and stable power swings through its Reliability Standards development process.

**D. Concerns with the Implementation of Certain Criteria Under Requirement R1**

In the NOPR, FERC noted its concern that some criteria established in Requirement R1 might accommodate the use of protective relays for certain system configurations where the protective relays may not be appropriate or help achieve the reliability objective of the proposed Reliability Standard.<sup>48</sup> Specifically, FERC noted its concern with the implementation of criteria established by Requirements R1.2 (Transmission Line Established 15-Minute Rating), R1.10 (Transformer Overcurrent Protection), and R1.12 (Long Line Relay Loadability).<sup>49</sup> NERC addresses each of FERC's concerns below.

**1. Requirement R1.2**

In the NOPR, FERC states that PRC-023-1, Requirement R1.2 might conflict with Requirement R4 of existing Reliability Standard TOP-004-1 (Transmission Operations), which states that "if a transmission operator enters an unknown operating state, it will be considered to be in an emergency and shall restore operations to respect proven reliability power system limits within 30 minutes."<sup>50</sup> FERC notes its concern that the Transmission Operator (or any other reliability entity affected by the facility) might conclude that it has 30 minutes to restore the system to normal, when in fact it has only 15 minutes, because the relay settings for certain transmission facilities have been set to operate at the 15-minute rating in accordance with PRC-

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<sup>48</sup> NOPR at P 62.

<sup>49</sup> *Id.*

<sup>50</sup> NOPR at P 64.

023-1 Requirement R1.2.<sup>51</sup> FERC notes that this may have an adverse impact on system reliability, because the operator might not take Requirement R1.2 into consideration.<sup>52</sup> Accordingly, FERC proposes that Reliability Standards PRC-023-1 and TOP-004-1 give a Transmission Operator the same amount of time to restore the system to normal operations;<sup>53</sup> develop a new requirement that Transmission Owners, Generation Owners, and Distribution Providers give their Transmission Operators a list of transmission facilities that implement Requirement R1.2; or propose an equally effective and efficient approach to avoid this potential conflict.<sup>54</sup> FERC requests comments on each of its proposals.<sup>55</sup>

Requirement R1.2 of the proposed Reliability Standard sets transmission line relays so they do not operate at or below 115% of the highest seasonal 15-minute Facility Rating of a circuit (expressed in amperes). Footnote 2 of this proposed Requirement provides that when a 15-minute rating has been calculated and published for use in real-time operations, the 15-minute rating can be used to establish the loadability requirement for the protective relays. The purpose of this footnote is to inform the user that, if it decides to implement Requirement 1.2 of the standard, there must be a procedure that operators follow and are trained to implement. For example, some system operators have within their processes and procedures the use of a 15-minute rating for operators to implement during system contingencies, establishing an explicitly more stringent requirement than that established in TOP-004-1.

Page 3 of the Loadability reference document provides the following for Requirement R1.2:

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<sup>51</sup> *Id.*

<sup>52</sup> *Id.*

<sup>53</sup> NOPR at P 65.

<sup>54</sup> *Id.*

<sup>55</sup> *Id.*

In situations where detailed studies have been performed to establish 15-minute ratings on a transmission line, the 15-minute rating can be used to establish the loadability requirement for the protective relays.

Because footnote 2 of proposed PRC-023-1 emphasizes that the 15-minute rating may be used for relay loadability calculations only if such rating has been calculated and published for use in real-time operations, this reflects a commitment on the part of the entity to operate to the 15-minute rating and respond to rating violations within that 15-minute period. In cases where an entity has committed to operate to the 15-minute rating and respond to rating violations within that 15-minute period, NERC asserts that the proposed PRC-023-1 Reliability Standard is appropriate. Those entities that use the 15-minute rating are fully capable of operating within this constraint. Accordingly, NERC urges FERC to adopt this aspect of the proposed Reliability Standard and not direct a further change.

## **2. Requirement R1.10**

In the NOPR, FERC expressed concern with NERC's proposed Requirement R1.10, which allows facility owners to determine the ratings of their facilities based on a number of factors, and to use verified methodologies to determine expected temperatures and other parameters needed to establish a rating.<sup>56</sup> FERC states that, in cases where a transmission line terminates in a transformer, the Transmission Owner can avoid installing a bus and local circuit breaker on both sides of the transformer.<sup>57</sup> However, transformers that have been subjected to currents over their maximum rating have been recorded as failing violently and resulting in substantial fires.<sup>58</sup> FERC notes that this negatively impacts reliability and raises safety

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<sup>56</sup> NOPR at P 66.

<sup>57</sup> NOPR at P 68.

<sup>58</sup> *Id.*

concerns.<sup>59</sup> Therefore, FERC proposes in the NOPR to direct the ERO to submit a modification that requires any entity that implements Requirement R1.10 to verify from the facility owner that the limiting piece of equipment is capable of sustaining the anticipated current for the longest clearing time associated with the fault.<sup>60</sup> FERC notes that in cases where the facility owner cannot verify that ability, the facility owner should apply either different protection systems, or change the topology to avoid this configuration to be in compliance with PRC-023-1.<sup>61</sup>

The basis for all technical requirements within PRC-023 and its reference document are intentionally consistent with IEEE Standards and Guides. The C37.91-2008, IEEE Guide for Protecting Power Transformers (hereafter referred to as “the Guide”), is the primary source of technical information that was used in preparing Requirement R1.10.

The C37.91-2008, Section 8.6 Backup and External Fault Protection and Section 8.6.1 Overcurrent Relays, provides the following with respect to the settings of transformer phase overcurrent protection:

8.6. Protection of a transformer against damage due to the failure to clear an external fault should always be carefully considered. This damage usually manifests itself as internal, thermal, or mechanical damage caused by fault current flowing through the transformer. The curves in Annex A show through-fault-current duration curves to limit damage to the transformer. Through-faults that can cause damage to the transformer include restricted faults or those some distance away from the station. The fault current, in terms of the transformer rating, tends to be low (approximately 0.5 to 5.0 times transformer rating) and the bus voltage tends to remain at relatively high values. The fault current will be superimposed on load current, compounding the thermal load on the transformer. Several factors will influence the decision as to how much and what kind of backup is required for the transformer under consideration. Significant factors are the operating experience with regard to clearing remote faults, the cost effectiveness to provide this coverage considering the size and location of the transformer, and the general protection philosophies used by the utility.

8.6.1. When overcurrent relays are used for transformer backup, their sensitivity is limited because they should be set above maximum load current. Separate ground relays may be applied with the phase relays to provide better sensitivity for some ground faults. Usual

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<sup>59</sup> *Id.*

<sup>60</sup> NOPR at P 69.

<sup>61</sup> *Id.*

considerations for setting overcurrent relays are described in 8.3. When overcurrent relays are applied to the high-voltage side of transformers with three or more windings, they should have pickup values that will permit the transformer to carry its rated load plus margin for overload. ... When two or more transformers are operated in parallel to share a common load, the overcurrent relay settings should consider the short-time overloads on one transformer upon loss of the other transformer. Relays on individual transformers may require pickup levels greater than twice the forced cooled rating of the transformer to avoid tripping.

Annex A of the Guide contains through-fault duration curves for various size power transformers. These curves provide fault current durations as plotted against transformer base current. Annex A states:

Overcurrent protective devices, such as relays and fuses, have well-defined operating characteristics that relate fault-current magnitudes to operating time. It is desirable that the characteristic curves for these devices are coordinated with comparable curves, applicable to transformers (see IEEE Std C57.109, IEEE Guide for Liquid-Immersed Transformer Through-Fault-Current Duration), which reflects their through-fault withstand capability.

Phase overcurrent devices must coordinate with the duration curves. The minimum current stated on the curves is two times transformer base current. PRC-023 states that if the owner uses these relays to protect the transformer for fault-initiated overcurrent, then loadability (a non-fault induced transformer loading) must be considered. A setting of 150% of the transformer nameplate rating or 115% of the highest operator established emergency rating will be in all cases less than 200% of the transformer forced-cooled nameplate rating. Therefore, the proposed PRC-023-1 Reliability Standard is consistent with C37.91 and C57.109 with regard to coordination of phase overcurrent protection with transformer through-fault durations.

NERC proposes that mitigation of thermal overloads is generally best left to operator response, not to automatic devices, so that the operator may take well-reasoned action that best supports reliable operation of the bulk power system while addressing the overload. Protective relaying on transformers is designed to protect against faults, not to protect against overloads. As such, overcurrent relays are typically only used for backup detection of through-faults outside

of the primary protective zone. A transformer subjected to a through-fault for an extended period of time may compromise its design. However, if an entity wishes to provide overload protection for its transformer, such protection should be provided by devices designed for that purpose and have response times appropriate for overload protection (*e.g.*, several seconds and longer). For the foregoing reasons, NERC urges FERC to approve this aspect of the proposed Reliability Standard without directing the modification suggested in the NOPR.

### **3. Requirement R1.12**

In the NOPR, FERC notes that Requirement R1.12 establishes relay loadability criteria when the desired transmission line capability is limited by the requirement to adequately protect the transmission line.<sup>62</sup> FERC states that, in these cases, the line distance relays are still required to provide adequate protection, but the implemented relay settings will limit the desired loading capability of the circuit. Therefore, FERC is concerned that because protective relay settings are allowed to limit the load-carrying capability of a transmission line, that line is not being utilized to its full potential in response to sudden increases in line loadings or power swings, *i.e.*, the natural response of the bulk-power system will be less robust in response to system disturbances.<sup>63</sup> As a result, FERC requested comments on whether the use of such a protection system is consistent with the reliability objectives of PRC-023-1, and whether FERC should direct a modification that would require entities that employ such a system to use a different protection relay system that would meet the reliability objective of the Reliability Standard.<sup>64</sup>

The reliability objectives of proposed Reliability Standard PRC-023-1 include providing reliable detection of all network faults and preventing undesired protective relay operation that

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<sup>62</sup> NOPR at P 70.

<sup>63</sup> NOPR at P 72.

<sup>64</sup> NOPR at P 73.

interferes with the system operator's ability to take remedial action. Use of Requirement R1.12 is restricted to cases where adequate line protection cannot be achieved without restricting the loadability of the protected transmission element.

During the events of August 14, 2003, transmission elements tripped while loaded below their Emergency Ratings without warning to the system operators who were unaware of any loading limitation due to relay setting limits. Requiring entities subject to the PRC-023-1 Reliability Standard to establish Facility Ratings based on the protective relay setting provides system operators with the information and the time necessary to take remedial action when loading on a transmission element exceeds its Normal Rating, by ensuring that the protected transmission element will not trip when loaded below its Emergency Rating. NERC therefore opposes the proposed FERC directive, and proposes that Requirement R1.12 remain in the proposed Reliability Standard in its current form.

**E. Requirement R3 and its Sub-Requirements**

FERC's NOPR proposed that, in light of FERC's proposal to direct the ERO to modify PRC-023-1 to make it applicable to all facilities operated at or above 100 kV, with the possibility of case-by-case exceptions, and to all facilities operated below 100 kV that are designated by the Regional Entity as critical to the reliability of the bulk power system, Planning Coordinators should maintain a list of 100 kV and above lines that are excluded from PRC-023-1. Additionally, FERC proposed that Requirement R3.3 of the Reliability Standard be modified to add the Regional Entity to the list of entities as required by Requirement R3.2.

For the reasons stated in response to FERC's proposal to make proposed Reliability Standard PRC-023-1 applicable to all facilities operated at or above 100 kV and to all facilities operated below 100 kV that are designated by the Regional Entity as critical to the reliability of

the bulk power system, NERC opposes FERC's proposed directive to require Planning Coordinators to maintain a list of 100 kV and above lines that are excluded from PRC-023-1. As discussed above, NERC contends that the proposed application of PRC-023-1 to all 100 kV and above lines, except in case-by-case bases, would be very costly without commensurate reliability benefits. However, NERC agrees that the Regional Entity should be added to the list of entities receiving the list of facilities developed in accordance with R3 of this standard from the Planning Coordinator to support both regional analysis activities and compliance monitoring activities. Doing so will aid in the overall coordination of planning and operational studies within and between these entities.

**F. Attachment A**

In the NOPR, FERC noted its concerns with two of the three sections in Attachment A of PRC-023-1. These two sections are discussed below.

**1. Section (2): Evaluation of Out-of-Step Blocking Schemes**

In the NOPR, FERC notes that Section (2) of Attachment A of NERC's proposed PRC-023-001 Reliability Standards states that the "[S]tandard includes out-of-step blocking schemes which shall be evaluated to ensure that they do not block trip for faults during the loading conditions defined within the requirements."<sup>65</sup> FERC notes, however, that "Requirements should be in the requirements section of a Reliability Standard to ensure compliance," and "[s]ince the ERO intends to require the evaluation of out-of-step blocking applications, language to this effect should be included as a requirement and not as a statement in an Attachment."<sup>66</sup> Therefore, FERC proposes to direct the ERO to modify PRC-023-1 by adding the statement in

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<sup>65</sup> NOPR at P 77.

<sup>66</sup> *Id.*

Section (2) of Attachment A as an additional requirement with the appropriate violation risk factor and violation severity level assignments.<sup>67</sup>

For the reasons stated in the NOPR, NERC appreciates FERC's proposal to include language requiring out-of-step blocking applications in a requirement of the proposed Reliability Standard PRC-023-1 rather than in Attachment A. Although NERC agrees that this modification is appropriate, any modification to the proposed Reliability Standard must be implemented through the full Reliability Standards development process. Accordingly, NERC proposes to implement FERC's directive in the next modification of Reliability Standard PRC-023-1 and requests that, for this iteration of the proposed Reliability Standard, FERC approve Attachment A as written.

## **2. Section (3): List of Protection Systems Excluded From the Standard**

In the NOPR, FERC notes that Section (3) of Attachment A lists certain protection systems that are excluded from the requirements of PRC-023-1. For example, FERC states that subsection 3.1 excludes from the requirements of PRC-023-1: (1) overcurrent elements that are enabled only during loss of potential conditions, and (2) elements that are enabled only during a loss of communications.<sup>68</sup> FERC states that this subsection could be interpreted to exclude certain protection systems that use communications to compare current quantities and directions at both ends of a transmission line, such as pilot wire protection or current differential protection systems supervised by fault detector relays.<sup>69</sup> FERC goes on to state that if supervising fault detector relays are excluded from PRC-023-1, and are set below the rating of the protected element, the loss of communications and heavy line loading conditions that approach the line

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<sup>67</sup> *Id.*

<sup>68</sup> NOPR at P 79.

<sup>69</sup> *Id.*

rating would cause these protective relays to operate and unnecessarily disconnect the line.<sup>70</sup>

Accordingly, FERC requests comments on whether the exclusions are technically justifiable and whether FERC should direct the ERO to modify PRC-023-1 by deleting specific subsections in Section (3) of Attachment A.<sup>71</sup> FERC also requests comments on whether it should direct the ERO to modify subsection 3.1 to clarify that it does not exclude from the requirements of PRC-023-1 such protection systems as described above and in Paragraph 79 of the NOPR.<sup>72</sup>

While NERC acknowledges that specific justification should be included on those items to be ultimately included in Section (3) of Attachment A to the proposed Reliability Standard, NERC does not agree with FERC's suggested exclusion of the items identified in Section (3). For example, FERC proposes, from Section 3 of Attachment A, the exclusion of supervising fault detector relays as an example of an exclusion that could cause systems to operate unnecessarily, thereby potentially causing cascading outages. However, the excluded elements either do not respond to load current, are in use only during very short periods of time to address short-term conditions, or supervise operation of other relay elements which themselves are subject to PRC-023-1. If the supervised relay element itself does not operate in these cases, the operation of the supervising element should have no impact on reliability.

Although communication systems are critical to the correct operation of pilot protection systems, if the communications system is lost, then the transmission element must be protected and may need to be tripped for low magnitude faults approaching load current. It is preferable to trip one line for loss of communications, than not trip at all, thereby causing mis-coordination and/or stability problems. The failure of a communication-based protection system is predominately an isolated event; therefore, FERC should not direct the removal of supervising

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<sup>70</sup> NOPR at P 80.

<sup>71</sup> *Id.*

<sup>72</sup> *Id.*

fault detector relays from the list of exclusions included in Section (3) of Attachment A. Accordingly, NERC requests FERC approve Section (3) of Attachment A to the proposed Reliability Standard in its entirety.

**G. Effective Date**

In the NOPR, FERC proposes to approve the implementation plan as it relates to facilities operated at 200 kV and above.<sup>73</sup> However, FERC notes that, in light of its proposal to direct the ERO to modify PRC-023-1 to make it applicable to all facilities operated at or above 100kV, with the possibility of case-by-case exceptions, and to all facilities operated below 100 kV that are designated by the Regional Entity as critical to the reliability of the bulk power system, FERC proposes to implement an effective date of 18 months following applicable regulatory approvals for facilities operated below 200kV.<sup>74</sup>

Additionally, in the NOPR, FERC proposes not to approve the temporary exemption of certain entities from enforcement actions while they come into compliance with PRC-023-1's requirements because, in FERC's view, it is best that discussions about potential enforcement actions be left out of a Reliability Standard and instead be handled by NERC's compliance and enforcement program.<sup>75</sup>

NERC disagrees with FERC's proposed implementation plan. If the proposed Reliability Standard is adopted in its entirety by FERC as currently drafted, the Planning Coordinator will require time to determine operationally significant circuits (calculated at 18 months in Paragraph 5.2 of the proposed implementation plan), after which the entity will need to evaluate those terminals and, if necessary, mitigate violations. Mitigation may require design and construction

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<sup>73</sup> NOPR at P 85.

<sup>74</sup> *Id.*

<sup>75</sup> NOPR at P 86.

of changes, which could easily take an additional 18 to 24 months. As a result, the total time required to implement the proposed Reliability Standard, if FERC adopts it in its entirety, would take, at a minimum, 36 to 42 months.

If the proposed Reliability Standard is modified to expand its scope in accordance with FERC's NOPR, such modifications will have to be reviewed and studied by the Reliability Standard drafting team. During this time, if mitigation measures are deemed necessary, projects may need to be designed, materials procured, and the project constructed. Because of concerns about system performance during peak-load conditions, such construction usually can only be done during light-load periods (such as during the March to May or the October to December time periods). For these reasons, FERC's proposed 18- month time period for implementation of modifications to the proposed Reliability Standard is not practical.

Additionally, if FERC's proposal to expand the scope of PRC-023-1 regarding applicability of the proposed Reliability Standard to terminals operating at 100 kV to 200 kV is adopted, it is estimated that approximately 11,400 terminals operating at 100 kV to 200 kV could be deemed to be non-conformant with the criteria included in proposed PRC-023-1, based on the industry survey and the level of non-conformance found in the earlier analyses of terminals operating at 200 kV and above. Mitigation of this many terminals could take up to 10 years to complete, even if the majority require only settings changes. Employees who possess the skills to conduct such mitigation at the impacted Transmission Owner and Generator Owner organizations are already fully engaged in the existing day-to-day operations at their entities, and would need to be re-assigned to fully address the necessary studies and other activities. This would cause negative impacts to the daily support typically provided. Additionally, the industry faces a dearth of qualified technicians and procuring these resources externally is not largely

feasible given their scarcity. Therefore, a study of existing conditions could easily take between 12 and 18 months or longer.

If non-conforming terminals can be modified by a simple re-adjustment, the necessary re-adjustments could take another 12 to 18 months. If equipment replacement is necessary, the design of replacement terminals could individually take between 3 and 6 months to complete, and the construction itself will have to be scheduled with available construction labor and scheduled outage availability. Absent a comprehensive industry study regarding the impacts of FERC's proposal to include all terminals operating at 100 kV to 200 kV in the scope of the Reliability Standard, it is difficult to suggest an appropriate Implementation period.

#### **H. Violation Risk Factors and Violation Severity Levels**

In the NOPR, FERC notes that NERC assigned Requirement R1 of the proposed Reliability Standard a high violation risk factor, Requirement R2 a medium violation risk factor, and Requirement R3 a medium violation risk factor.<sup>76</sup> However, FERC states that NERC's compliance and enforcement program requires it to assign a violation risk factor to each sub-requirement of a proposed Reliability Standard.<sup>77</sup> Additionally, FERC states that, in accordance with the NERC Sanction Guidelines, each requirement must have a violation risk factor and a violation severity level.<sup>78</sup> NERC addresses FERC's specific proposals with respect to violation risk factors and violation severity levels below.

##### **1. Violation Risk Factors**

In the NOPR, FERC notes its agreement with NERC that Requirement R1 should be assigned a high violation risk factor because the violation of R1 has the potential to cause

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<sup>76</sup> NOPR at P 90.

<sup>77</sup> *Id.*

<sup>78</sup> *Id.*

cascading outages like those that occurred during the 2003 blackout.<sup>79</sup> FERC states that, in its view, because the sub-requirements in Requirement R1 set forth criteria for compliance with Requirement R1, the reliability risk violation of any one of the sub-requirements is the same as with a violation of Requirement R1.<sup>80</sup> Therefore, FERC proposes to direct NERC to assign a high violation risk factor to each of the sub-Requirements R1.1 through R1.13.<sup>81</sup> NERC disagrees with FERC’s proposal to assign “high” violation risk factors to each of the sub-Requirements R1.1 through R1.13 because this would expose entities to double-jeopardy—that is, a violation of R1.10 could also result in a violation of R1 itself.

FERC issued its Final Rule on the Version Two Facilities Design, Connections and Maintenance Reliability Standards on March 20, 2009.<sup>82</sup> In that Final Rule, FERC encouraged NERC to “develop a new and comprehensive approach that would better facilitate the assignment of violation severity levels and violation risk factors both prospectively and to existing, Commission-approved Reliability Standards.”<sup>83</sup> FERC expressed the expectation that such an approach “include a more detailed description of the proposal to assign violation severity levels for main requirements that would apply to sub-requirements, as well as the specific condition under which its application would or would not be appropriate.”<sup>84</sup> Additionally, FERC noted that this approach will also be applied to Violation Risk Factors.<sup>85</sup> Although FERC states in the NOPR that “[a]s an initial matter, NERC’s compliance and enforcement program requires it to assign a violation risk factor to each sub-requirement of a proposed Reliability Standard,”<sup>86</sup>

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<sup>79</sup> NOPR at P 92.

<sup>80</sup> *Id.*

<sup>81</sup> *Id.*

<sup>82</sup> Version Two Facilities Design, Connections and Maintenance Reliability Standards, 126 FERC ¶ 61,255 (March 20, 2009) (“Order No. 722”).

<sup>83</sup> Order No. 722 at P 45.

<sup>84</sup> Order No. 722 at P 46.

<sup>85</sup> Order No. 722 at n.36.

<sup>86</sup> NOPR at P 90.

this requirement is not included in NERC's Rules of Procedure or in the Compliance Monitoring and Enforcement Program ("CMEP").

On August 10, 2009, NERC submitted to FERC an informational filing in response to Paragraphs 45 and 46 of Order No. 722. In its filing, NERC submitted a summary of the process used in determining the assignment of violation risk factors and violation severity levels.

Unlike previous violation risk factor and violation severity level assignments where each requirement and sub-requirement was assigned a separate violation risk factor and a set of violation severity levels, NERC has been implementing a modified approach in determining violation risk factors and violation severity levels. This approach applies a single violation risk factor to the requirement in its entirety and a single, comprehensive set of violation severity levels to categorize non-compliance with a main requirement and the components that contribute to the main requirement. This new approach ensures consistency in the determination of sanctions; improves clarity for the users, owners, and operators of the bulk power system; and provides increased effectiveness in administration and oversight of the standards. PRC-023-1 was developed using the modified approach. Thus, violation risk factors should not be assigned to the sub-requirements.

## **2. Violation Severity Levels**

FERC proposes in the NOPR to direct NERC to review the violation severity levels in the requirements of the proposed Reliability Standard in accordance with FERC's Violation Severity Level Order.<sup>87</sup> NERC agrees with FERC's proposal and will review the violation severity levels in accordance with FERC's NOPR and FERC's Violation Severity Level Order.

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<sup>87</sup> NOPR at PP 101, 104, and 106. See also, *North American Electric Reliability Corporation*, 123 FERC ¶ 61,284 at PP 19-36 (2008) ("Violation Severity Level Order").

## V. CONCLUSION

NERC respectfully requests that FERC adopt a final rule consistent with the comments set forth herein.

Respectfully submitted,

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**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 17th day of August, 2009.

/s/ Holly A Hawkins  
Holly A. Hawkins

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