UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

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

INFORMATIONAL FILING OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION IN RESPONSE TO ORDER 733-A ON REHEARING, CLARIFICATION, AND REQUEST FOR AN EXTENSION OF TIME

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I. INTRODUCTION

The North American Electric Reliability Corporation ("NERC")[1] hereby submits an informational filing in response to the Federal Energy Regulatory Commission's ("FERC" or "Commission") Order No. 733-A Order on Rehearing, Clarification, and Request for an Extension of Time regarding Order No. 733[2] concerning Reliability Standard PRC-023-1. In Order No. 733-A, FERC granted several requests for clarification, granted rehearing in part, and denied rehearing in part of Final Rule Order No. 733. FERC also granted the request of NERC to extend compliance with the Final Rule by 24 months.[3]

NERC submits to the Commission, for informational purposes only, this filing addressing certain aspects of the August 14, 2003 blackout investigation relative to operation of protective relays in response to stable power swings. This filing draws heavily upon the April 2004 *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14, 2003 Blackout in the United States and Canada: Causes and Recommendations*, (the "Blackout Report"),[4] as well as unpublished findings of the blackout investigation team derived from analyses that occurred subsequent to the publication of the Blackout Report.

On August 14, 2003 an electrical event began in Ohio that would blackout an estimated 50 million people and over 60,000 megawatts of generation across the Northeast, the Great Lakes region, and reach well into Canada. The following day, President George W. Bush and Prime Minister Jean Chrétien directed that a joint U.S.-Canada Power System Outage Task Force

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[1] 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 (2006).
[2] *Transmission Relay Loadability Reliability Standard*, Order No. 733, 130 FERC ¶ 61,221 (2010) ("Order No. 733").
[3] Order No. 733 at P 1.
[5] 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). Available at: https://reports.energy.gov/BlackoutFinal-Web.pdf.

be established to investigate the causes of the blackout and ways to reduce the possibility of future outages. The Task Force created three Working Groups to assist in its work—an Electric System Working Group (ESWG), a Nuclear Working Group (NWG), and a Security Working Group (SWG). The Working Groups were made up of state and provincial representatives, federal employees, and contractors working for the U.S. and Canadian government agencies represented on the Task Force. Additionally, NERC fielded a number of technical task teams to support the working groups. At times, over 100 industry subject matter experts and members of the technical staffs of NERC and the regional reliability organizations participated in the investigation.

In April of 2004 the Task Force released the *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,* (the "Blackout Report") that dissected the factors that led to the blackout.[5] Following the Blackout Report's release, a subset of the Electric System Working Group continued its analysis of the August 14, 2003 blackout to further understand the contributing factors that led to the massive event. This informational filing focuses on the unpublished detailed technical analysis of NERC's Modeling and Studies, Transmission Performance, and Generation Performance Task Teams.[6] Those teams provided the powerflow, relaying, and dynamic performance analysis of what happened to the system itself and how it

[5] 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). Available at: https://reports.energy.gov/BlackoutFinal-Web.pdf.

[6] The following industry subject matter expert teams made significant contributions to the report:

- Transmission Performance Task Team
- Generation Performance Task Team
- Modeling and Studies Task Team
  - MAAC-ECAR-NPCC (MEN) Study Committee Working Group
  - VACAR-ECAR-MAAC Study Committee Working Group
  - NPCC Working Group on Inter-Area Dynamics (SS-38)
  - MEN Major System Disturbance Task Force

performed on August 14, and developed most of the technical information that supports this filing.

NERC does not intend to challenge the Commission directive for NERC to develop a reliability standard addressing the subject of protective relay operations due to power swings nor does it request by this filing any other action by the Commission in this docket.

II. NOTICES AND COMMUNICATIONS

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

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*Persons to be included on the Commission's service list are indicated with an asterisk. NERC requests waiver of FERC's rules and regulations to permit the inclusion of more than two people on the service list.

III. DISCUSSION

In a July 30, 2008 filing,[7] NERC submitted Reliability Standard PRC-023-1 to the Commission for approval. On May 21, 2009, FERC issued a Notice of Proposed Rulemaking in which it proposed to approve the PRC-023-1 standard and direct modifications to the standard.[8] On August 17, 2009, NERC submitted comments in response to the NOPR supporting its

[7] *See* NERC, *Petition of the North American Electric Reliability Corporation for Approval of PRC-023-1 Reliability Standard,* Docket No. RM08-13-000 (July 30, 2008)
[8] Transmission Relay Loadability Standard, 127 FERC ¶ 61,175 (May 21, 2009) ("NOPR")

original petition.[9] On March 18, 2010, FERC issued a final rule Order No. 733 in which it approved PRC-023-1 and directed modifications. On April 19, 2010, NERC submitted a Request for Clarification or Rehearing of Order No. 733.[10] FERC issued Order 733-A on February 17, 2011.[11]

In this filing, NERC seeks to introduce and clarify for informational purposes only, certain aspects of the August 14, 2003 blackout investigation relative to operation of protective relays in response to stable power swings. Some of these clarifications are documented in the April 2004 *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*, while other clarifications are based on unpublished findings of the blackout investigation team derived from analyses that occurred subsequent to April 2004. NERC does not intend to challenge the Commission directive for NERC to develop a reliability standard addressing the subject of protective relay operations due to power swings but rather provide additional insight on this subject.

Order 733-A discusses tripping of fourteen transmission lines to support the directive pertaining to conditions in which relays misoperate due to stable power swings that were identified as propagating the cascade during the August 2003 blackout. The following discussion clarifies that these fourteen lines did not trip due to stable power swings; ten of these lines tripped in response to the steady-state loadability issue addressed by reliability standard PRC-023, while the last four lines tripped in response to dynamic instability of the power

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[9] *See* NERC, *Comments of the North American Electric Reliability Corporation in Response to Notice of Proposed Rulemaking* Docket No. RM08-13-000. (August 17, 2009)
[10] Request of the North American Electric Reliability Corporation for Clarification and, in the Alternative, Rehearing of Order No. 733, Docket No. RM08-13-000 (April 19, 2010)
[11] *Transmission Relay Loadability Reliability Standard*, 134 FERC 61,127, Order No. 733-A (2011) ("Order No. 733-A").

system. The discussion also identifies two transmission lines that did trip in response to stable power swings related to the reliability objective of the standard directed in Order 733-A.

The Blackout Report states that the system did not become dynamically unstable until at least after the Thetford-Jewell 345 kV transmission line trip.[12] However, subsequent analysis indicates that the system became dynamically unstable following tripping of the Argenta – Battle Creek and Argenta – Tompkins 345 kV transmission lines, about two seconds earlier than when the Blackout Report stated the system became dynamically unstable. The Argenta – Battle Creek and Argenta – Tompkins 345 kV lines were initially tripped at 16:10:36.203 and 16:10:36.310 respectively at the Argenta terminals only. Each line then autoreclosed, high-speed, 0.5 seconds after it tripped. After the initial trips of the two Argenta lines and before the reclose attempts, western and eastern Michigan began to slip out of synchronization with respect to each other, with the angles between the voltages at Argenta in western Michigan and Battle Creek and Tompkins in eastern Michigan increasing steadily. The angle between Argenta and Battle Creek was about 15 degrees prior to the line tripping. After tripping, the angle increased to 80 degrees just prior to the Argenta high-speed autoreclosing attempt on the Argenta – Battle Creek line. The angle between Argenta and Tompkins reached 120 degrees just prior to the Argenta high-speed autoreclosing attempt on the Argenta – Tompkins line. The rapid angular separation of these two systems indicates that the system became dynamically unstable about 2 seconds earlier than discussed in the Blackout Report.

Prior to the initial tripping of the Argenta – Battle Creek and Argenta – Tompkins lines, the angular separation across the system increased after each event and reached a new steady-state condition. While the Blackout Report indicates that fourteen lines tripped by zone 2 and

[12] Blackout Report at p. 82.

zone 3 relays "after each line overloaded,"[13] the subsequent analysis confirms that the line trips up to and including the initial trips of Argenta – Battle Creek and Argenta – Tompkins lines occurred as a result of heavy line loading, while the subsequent line trips were associated with the dynamic instability of the system. These findings indicate that the fourteen lines identified in Order 733 did not trip as a result of power swings and oscillations of increasing magnitude. While it is true that these relays reacted as though there was a fault in their protective zone even though there was no fault, the operations up to and including the initial trips of Argenta – Battle Creek and Argenta – Tompkins lines are associated with the steady-state loadability issue addressed by reliability standard PRC-023, while the subsequent operations are associated with dynamic instability that is beyond the scope of the standard directed in Order 733-A.

Although the fourteen line trips by zone 2 and zone 3 relays discussed in the Blackout Report did not occur as a result of stable power swings, the blackout investigation team did identify two transmission lines that tripped due to protective relay operation in response to stable power swings. These lines are the Homer City – Watercure 345 kV line that tripped at 16:10:39.501 and the Homer City – Stolle Road 345 kV line that tripped at 16:10:39.800. As the dynamic instability propagated across the system, a system separation occurred along the border between New York and the PJM Interconnection. Two swings occurred between the two systems. The first swing occurred at approximately 16:10:39.5 corresponding with tripping of the Homer City-Watercure and Homer City-Stolle Road 345 kV transmission lines. The second swing occurred approximately 4 seconds later corresponding with the New York-PJM separation completed by the Branchburg-Ramapo 500 kV trip.

The trips of the two Homer City lines were initiated by the zone 1 relays at the Homer City line terminals. The blackout investigation team performed a sensitivity analysis without

[13] Id, at p. 80.

tripping of the Homer City lines to identify how the system performance might have been different if the line trips had not occurred. The simulation demonstrates that the Homer City line trips occurred on a stable power swing. For both lines the simulated apparent impedance trajectory entered and exited the relay characteristic from the 1st quadrant on the R-X plane. An unstable swing would have been characterized by the apparent impedance trajectory entering from one side of the relay characteristic and exiting through the opposite side, indicating a pole slip between two portions of the system with the electrical center of the swing occurring on that line. Although the swing that tripped the Homer City lines was a stable swing, the simulation indicates that the second swing between New York and PJM would have resulted in a loss of synchronism between the two systems regardless of whether the Homer City lines tripped on the first swing. The simulation also indicates that the sequence of events following separation of the New York and PJM systems would have essentially the same end result, including the subsequent separations between New York and New England, western and eastern New York, and Ontario and western New York.

Since the New York and PJM separation and subsequent system separations would have occurred regardless of whether the Homer City – Watercure and Homer City – Stolle Road lines tripped on the stable swing, the protection system operations on these lines did not contribute significantly to the overall outcome of the August 14, 2003 system disturbance. However, protection system operation during stable powers swings could negatively impact system reliability under different operating conditions. NERC therefore supports the reliability objective associated with developing a standard to address operation of protective relays in response to stable power swings.

IV. CONCLUSION

NERC respectfully requests that the Commission accept these comments.

Respectfully submitted,

/s/ Andrew M. Dressel

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<u>CERTIFICATE OF SERVICE</u>

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 21st day of July, 2011.

<u>/s/ Andrew M. Dressel</u>
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Attorney for North American Electric Reliability Corporation