NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Managing Transmission Line Ratings Technical Conference
Federal Energy Regulatory Commission
Remarks of Howard L. Gugel, Vice President and Director of Engineering and Standards
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Introduction

Good morning, my name is Howard Gugel and I am the vice president and director of engineering and standards at the North American Electric Reliability Corporation (NERC). NERC's mission, as the Electric Reliability Organization (ERO), is to assure the reliability and security of the bulk power system (BPS) in North America. I have been at NERC for about ten years and, prior to NERC, served in areas of transmission planning, operations, and maintenance for several electric utilities. I have 30 years of experience working with the electricity industry and am pleased to speak with you today about NERC's perspective on dynamic line ratings. I hope to appropriately communicate to you NERC's support for the benefits of dynamic line ratings, while simultaneously noting areas of caution that require attention and sometimes pre-emptory mitigation to avoid inadvertent compromise of reliability.

History

The concept and supporting technologies to provide temperature adjusted conductor ratings has been around for two to three decades. Many transmission owners have different line rating values for summer and winter, and some also have short term and emergency ratings to allow operation with less margin from the actual line thermal constraints for relatively brief time periods and/or extraordinary circumstances, at times even allowing some acceptable loss of element life (whether this might be for the conductor, a line trap, terminal equipment, etc.), while still maintaining both employee and public safety. These ratings are used in both planning and operating studies to evaluate pre- and post-contingency operating conditions.

In the 1990s, research and pilot projects were initiated to implement dynamic line ratings (DLR), also known as real-time thermal ratings (RTTR). There are two categories of dynamic line ratings computation methods. Direct measurement methods use devices that are directly coupled to the line. These devices measure various parameters including temperature, tension, sag and/or clearance from which the thermal rating is determined. Indirect measurement methods use weather stations, such as wind speed and direction, and modeling to estimate thermal rating.

It is important to note that the overall rating of a transmission line goes far beyond just the conductor temperature; all circuit elements must be included. Other things that have a direct bearing on a circuit rating included current transformer ratings, in-line disconnect switch ratings, circuit breaker ratings, and system protection relay settings. Relay settings played significant roles in blackouts, including the 1965

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Northeast Blackout, and led to the development and implementation of NERC Standard PRC-023 on relay loadability.

Additionally, in the 2003 blackout, discrepancies in line ratings between some transmission owners and the transmission operators or reliability coordinators caused significant confusion. In one case, there were three separate ratings for a circuit. The discrepancies were further exacerbated by the limitations of a short (~10 feet) copper "strain bus" within a substation. Although it was very short, its lower current carrying capacity (than the line's conductor) was recognized as the current-carrying limit of the circuit. Disturbances like these demonstrated the need for standards to provide for consistent ratings. As I'll discuss later, these standards allow for use of dynamic line ratings subject to the requirements of the standards, but some considerations should occur prior to implementation

Standards

The purpose of NERC Reliability Standard FAC-008-3 is "(t)o ensure that Facility Ratings used in the reliable planning and operation of the Bulk Electric System (BES) are determined based on technically sound principles. A Facility Rating is essential for the determination of System Operating Limits." As such, the standard requires generator owners and transmission owners to have a documented methodology for determining facility ratings for its facilities that are consistent with at least one of the following:

- Ratings provided by equipment manufacturers or obtained from equipment manufacturer specifications such as nameplate rating.
- One or more industry standards developed through an open process such as the Institute of Electrical and Electronics Engineers (IEEE) or the International Council on Large Electric Systems (CIGRE).
- A practice that has been verified by testing, performance history or engineering analysis.

Further, they are required to document the underlying assumptions, design criteria, and methods used to determine the facility ratings, including identification of how ambient conditions were considered. While FAC-008-3 does not require entities to vary facility ratings based on different ambient conditions, it does require the consideration of ambient conditions. It further does not prohibit an entity from establishing dynamic ratings on any of its facilities, provided that the documented methodology explains how the ratings are established.

Another limitation for line ratings is found in the testing criteria for Standard PRC-023. Those criteria are used to determine if a circuit could ever get highly loaded enough under various operating conditions as to require mitigation of relay loadability limitations for that circuit. Similar testing criteria would be appropriate for any transmission circuit being considered for application of dynamic line ratings; some circuits cannot be physically loaded anywhere near their thermal limitations under any foreseeable operating conditions because of terminal equipment limitations.

Considerations

While the NERC reliability standards allow for an entity to implement dynamic line ratings, there are many considerations that should occur prior to implementing dynamic line ratings. For example, an entity must

know and understand how substation equipment may affect the capacity of transmission lines. A 1200 amp switch or current transformer may be the limiting element of a transmission line (rather than the conductor itself), and as such may limit the usefulness of implementation of dynamic capacity capability on that circuit. In addition, there are limitations on how dynamic ratings can be used in planning studies, since they are highly dependent on specific ambient conditions that are not available at all hours. This will also impact how system operating limits can be established, and how available transfer capability can be calculated.

Dynamic line ratings can be used to provide system operators a little extra margin that may only be needed a few hours out of every year. How those dynamic line ratings are communicated in real time operations is a priority consideration. Reliability coordinators, transmission operators, and the operational study groups supporting them must have ratings on adjacent transmission systems to understand interactions including parallel flow impacts. Clearly they must have visibility of these ratings as they change up or down.

These communication and control channels will need to be cyber secure. Adulterating real time facility ratings information could degrade the situational awareness of system operators, potentially affecting the reliable operation of the bulk power system. Since information gathered would adversely impact the reliable operation of the BES within 15 minutes of the activation or exercise of the compromise, and that information would be provided to a reliability coordinator and/ or a transmission operator, it may cause a transmission line that previously was determined to be a low impact to be a higher impact.

Finally, the methodology for establishing line ratings often incorporate a margin into them that can accommodate many unknowns as well as some “knowns” that are not quantified exactly. An adequate capacity safety margin is essential to ensuring that the bulk power system does not operate in an unknown state. This was a key finding in the investigation of the 2003 blackout, and was a driver in the establishment of both FAC-003 and PRC-023.

Thank you for your consideration and I look forward to providing input to the discussion of the panel.