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DRAFT

Time Error Correction and Reliability White Paper

Recommendation of the Balancing Authority Reliability-based Controls 2 Periodic Review Team to Retire BAL-004-0 – Time Error Correction

The Balancing Authority Reliability-based Controls 2 Periodic Review Team (BARC 2 PRT) was tasked with reviewing certain Reliability Standards and developing recommendations that each Reliability Standard be (1) reaffirmed as is (i.e., no changes needed); (2) revised (which may include revising or retiring one or more requirements); or (3) retired. After an extensive review, the BARC 2 PRT is recommending that Reliability Standard BAL-004-0 be retired and that manual Time Error Correction (TEC) be eliminated as a continent-wide NERC requirement. The accompanying North American Energy Standard Board (NAESB) business practice standard, WEQ Manual Time Error Correction Business Practice Standard – WEQ-006, should also be retired.

This white paper reviews the history of manual TEC and BAL-004-0, outlines the key considerations of the BARC 2 PRT in developing its recommendation, and assesses whether TEC supports the reliability of the Bulk Power System (BPS).

History of Time Error Correction

Invention of the Synchronous Motor Clock and Market Penetration

In 1916, Henry E. Warren invented the self-starting synchronous motor and three years later the motor was used for the production of the Telechron Clock. The Telechron Clock was a synchronous electric clock, which used alternating current electricity to measure time. Its accuracy depended on the frequency of the power grid. To incentivize electric system operators to regulate frequency in a way that kept the clocks running accurately, the Warren Clock Company, which was manufacturing the Telechron Clock at the time, gave electric clocks to electric system operators. The idea worked and system operators began regulating the frequency as desired by the Warren Clock Company.

During the 1920s, other companies developed synchronous motor clocks and used the same marketing strategy, giving electric clocks to system operators. As the penetration of the synchronous electric clock increased, the electric revenue from the electric clock motors increased enough to justify the relatively small cost required of electric system operators to regulate system time by modifying system frequency. This additional revenue ensured that manual TEC would be an ongoing service provided by the electric utility industry.

Time Error Correction Practice and Improvements in Clock Accuracy

As the electric industry expanded and interconnected, the service of providing manual TEC was incorporated into the industry's general operating practice. The current form of manual TEC is a legacy commercial practice that originated in the 1920s as a commercial service and was never related to the reliability of the electric grid. While documentation is available from as late as 1976 that synchronous electric clocks were still being used for important applications, by 1969, alternative methods of keeping accurate time penetrated the market and gradually displaced the electric clock. For example, the introduction of the first mass-produced quartz watch provided a more reliable and less expensive method to keep accurate time. Additionally, 15 years later, the United States made available for free the Global Positioning System, which is a space-based satellite navigation system that provides location and time information.

History of BAL-004-0

Reliability Standard BAL-004-0 – Time Error Correction became mandatory and enforceable on June 18, 2007. It contains four requirements:

- **R1** Only a Reliability Coordinator shall be eligible to act as an Interconnection Time Monitor. A single Reliability Coordinator in each Interconnection shall be designated by the NERC Operating Committee to serve as Interconnection Time Monitor.
- **R2** The Interconnection Time Monitor shall monitor Time Error and shall initiate or terminate corrective action orders in accordance with the NAESB Time Error Correction Procedure.
- **R3** Each Balancing Authority, when requested, shall participate in a Time Error Correction by one of the following methods:
    - **R3.1** The Balancing Authority shall offset its frequency schedule by 0.02 Hertz, leaving the Frequency Bias Setting normal; or
    - **R3.2** The Balancing Authority shall offset its Net Interchange Schedule (MW) by an amount equal to the computed bias contribution during a 0.02 Hertz Frequency Deviation (i.e. 20% of the Frequency Bias Setting).
- **R4** Any Reliability Coordinator in an Interconnection shall have the authority to request the Interconnection Time Monitor to terminate a Time Error Correction in progress, or a scheduled Time Error Correction that has not begun, for reliability considerations.
    - **R4.1** Balancing Authorities that have reliability concerns with the execution of a Time Error Correction shall notify their Reliability Coordinator and request the termination of a Time Error Correction in progress.

On July 11, 2007, a Standard Authorization Request (SAR) was submitted to NERC, proposing to revise BAL-004-0 to:

- Remove inappropriate compliance requirements on Reliability Coordinators who voluntarily agree to serve as Interconnection Time Monitors.

- Remove inappropriate compliance requirements on the NERC Operating Committee (OC), which is not a user, owner, or operator of the BPS.
- Remove inappropriate requirements to follow NAESB business practices.

The revised BAL-004-1 received 94.10% weighted segment approval on December 4, 2007, and was adopted by NERC's Board of Trustees on March 26, 2008. NERC filed a petition with the Federal Energy Regulatory Commission (FERC) on April 7, 2009, requesting approval for the revised BAL-004-1. In response, FERC issued a Notice of Proposed Rulemaking (NOPR) proposing to remand BAL-004-1 for further consideration. The NOPR requested that NERC:

- Change R2 to indicate that the Interconnection Time Monitor, designated according to a process described in a FERC approved document, is responsible for initiating or terminating a TEC in a reliable manner.
- Explain the circumstances under which the Time Monitor should start or end a TEC.

Between 2010 and 2012, NERC filed a series of petitions to defer action on the BAL-004-1 NOPR as it worked with the NERC OC to explore the possibility of eliminating manual TEC, starting with a field trial. In May and June of 2011, NERC held a webinar and issued a press release laying out a schedule to do a field trial in which manual TEC would have been stopped for a period of time. NERC's intention was to begin a phased elimination of TEC in ERCOT in August 2011.

After the webinar and issuance of the press release, and in part because NERC received feedback from private citizens, industry, and government entities expressing concern about the field trial, the trial was not conducted.

On August 16, 2012, the NERC Board of Trustees withdrew its adoption of BAL-004-1, stating that:

- No Interconnection Time Monitor has ever incurred a violation.
- The NERC OC is not a registered entity, and therefore compliance actions are not a concern. Thus, it is acceptable to keep the OC reference in the Reliability Standard.
- There are no significant issues with the reference to NAESB in R2.
- Work on BARC 2 will begin in 2014.

BAL-004-0 remains mandatory and enforceable.

Key Considerations for BAL-004-0 Retirement

Manual TEC does not support the reliability of the BPS.

Industry agrees that the practice of manual TEC does not support reliability, and is instead a low-value commercial service that does not rise to the level of a mandatory and enforceable Reliability Standard. [1] For instance, in an industry survey performed by the Balancing Authority Reliability-based Controls 1 Standard Drafting Team between September 12 and October 13, 2008, approximately 77% of respondents supported the discontinuation of manual TEC. Further, when revisions to BAL-004-0 were developed in the proposed BAL-004-1, "the underlying driver was that it was commonly understood that manual TECs were a commercial task."[2]

The reliability of an Interconnection is in part the result of the frequency at which the Interconnection operates. In North America, the system is designed to operate within a safe range, with 60 Hz as the center point of that range. Under and over frequency limits have been set to protect the equipment of both the providers and the users on the Interconnection from failure. The BARC 2 PRT maintains that elimination of manual TEC actually will allow the Interconnection to be operated closer to the design frequency of 60 Hz more often.

A Reliability Standard focused on manual TEC is only necessary for ensuring that manual TEC is implemented consistently across an Interconnection. Because there is no additional benefit to reliability from the implementation of manual TEC, the BARC 2 PRT recommends the retirement of BAL-004-0.

The elimination of manual TEC is not expected to impact Inadvertent Interchange accumulations.
In a FERC Order 693 directive related to BAL-004-0, FERC directed NERC "to perform whatever research it and the industry believe is necessary to provide a sound technical basis for either continuing with the present practice [of TEC] or identifying an alternative practice that is more effective and helps reduce inadvertent interchange." However, Time Error and Inadvertent Interchange are not necessarily linked. In fact, positive Time Error could be decreasing and at the same time, the magnitude of the Inadvertent Interchange account for one Balancing Authority could be increasing in support of Interconnection frequency (negative balance getting larger), and the magnitude of the Inadvertent Interchange account for another Balancing Authority could be decreasing, also in support of Interconnection frequency (positive balance getting smaller). Both actions in this example contribute to reducing the Time Error.

Time Error relates to frequency drift of an Interconnection; whereas Inadvertent Interchange is an energy (MW) exchange at the Balancing Authority level in an Interconnection with multiple controlling entities. Frequency drift is related to an imbalance between load and generation, which may be influenced by factors including metering error, scheduling error, and the inability to continuously match load and generation. Given the dynamics of load, generation, and Interconnection frequency, it is not possible for

[1] Minutes from the March 6-7, 2012 meeting of the Operating Committee. Posted at: http://www.nerc.com/comm/OC/Agendas%20Highlights%20and%20Minutes%20DL/Agendas,%20Highlights,%20and%20Minutes%20-%202012/Operating_Committee_Meeting_Minutes_Mar_6-7_2011_R1.pdf

[2] Minutes from the March 6-7, 2012 meeting of the Operating Committee.

any Balancing Authority to have an Area Control Error (ACE) of zero except by chance, so Inadvertent Interchange, positive and negative, is a fact of operation. In addition, the difference between the reliability requirement to ramp Interchange schedules and the business practice to account for Interchange schedules after the fact as "block schedules" (ramp not included) will also result in some amount of Inadvertent Interchange being accumulated, even if the Balancing Authority could perfectly operate to a zero ACE throughout the hour. Like frequency drift, Inadvertent Interchange is influenced by all the factors that cause an imbalance between load and generation. Eliminating manual TEC will not impact Inadvertent Interchange accumulations.

Comments from non-technical parties outside the industry have impacted reliability decisions related to TEC in the past.

When NERC and the NERC OC began exploring the possibility of conducting a field trial to eliminate manual TEC, they received feedback from private citizens, industry, and government representatives expressing concern about the impact of eliminating manual TEC. For example, these individuals expressed concern that eliminating manual TEC could affect billing meters or traffic lights that might rely on grid frequency.

However, grid frequency is not the appropriate source for alignment to official time; there are other more appropriate sources available for that service. The National Institute of Standards and Technology and the U.S. Naval Observatory, for instance, maintain a website (www.time.gov) that could be used to correct time periodically, including after power outages. Manual TEC should not be required for the purpose of providing accurate time for synchronous electric clocks. Similarly, commercial or industrial processes dependent upon an exact duration of time could not rely on synchronous electric clocks, as any duration of time determined by such clocks can never be exact.

Other NERC Reliability Standards already require operation within a reliable frequency range.

NERC's suite of BAL Reliability Standards is designed to assure a safe and reliable Interconnection operating within a safe frequency range. For instance, BAL-003-1 – Frequency Response and Frequency Bias Setting, which will become enforceable on April 1, 2015, requires that frequency is maintained within defined bounds. This Reliability Standard ensures that each of the Interconnections have sufficient Frequency Response[3] to guard against underfrequency load shedding due to a credible event in that Interconnection. It ensures that Balancing Authorities provide the Frequency Response necessary to ensure that frequency does not reach the point where coordinated underfrequency load shedding relays are set to curtail load through a measurement methodology that ensures consistency across the industry for both Frequency Response and Frequency Bias Setting calculations. Similarly, the stated purpose of

[3] Frequency Response is a measure of an Interconnection's ability to stabilize frequency immediately following the sudden loss of generation or load. Power system operators manage or control frequency primarily through adjustments to the output of generators with the goal of restoring balance between generation and load. Failure to maintain frequency can disrupt the operation of equipment and initiate disconnection of power plant equipment to prevent them from being damaged, which could lead to wide-spread blackouts.

BAL-001-2 – Real Power Balancing Control Performance, which was filed with FERC for approval on April 2, 2014, is to control Interconnection frequency within defined limits.

Revising BAL-004-0 would not enhance the reliability of the BPS.
In minutes from its March 6-7, 2012 meeting, the NERC OC states that "there is a general consensus that the conduct of manual TECs is a commercial service and does not rise to the level of a reliability standard, with the exception of setting bounds on the magnitude of frequency offset."[4] But, recognizing that there are other ways to lessen the impact of manual TECs, the NERC OC did not pass a motion to move forward with a field trial to test the impact of eliminating Manual TECs.

When considering possible recommendations for BAL-004-0, the BARC 2 PRT discussed the option of revising BAL-004-0 to reduce the offset to allow for manual TEC to be implemented for a full load cycle over a consistent time period and lessen the burden on Interconnection Time Monitors. However, the BARC 2 PRT determined that would not support the reliability of the BPS. Conducting manual TEC in any form directly contradicts NERC Reliability Principle 2: "The frequency and voltage of interconnected bulk power systems shall be controlled within defined limits through the balancing of real and reactive power supply and demand." The practice of using manual TEC to place the Interconnection closer to the settings for automatic underfrequency load shedding does not support or enhance reliability. Therefore, in line with NERC's efforts to eliminate standards that do not promote reliability, BAL-004-0 should be retired.

Summary

Manual TEC is a commercial service that does not support reliability, and accurate time can be procured from alternative sources. Accordingly, BAL-004-0 – Time Error Correction and the associated NAESB WEQ Manual Time Error Correction Business Practice Standard – WEQ-006 should be retired.

[4] Minutes from the March 6-7, 2012 meeting of the Operating Committee.