

Frequency Measurable Event (FME): Frequency Deviation used to evaluate generating unit/generating facility Primary Frequency Response performance and that meets one of the following conditions:

- i) a Frequency Deviation that has a pre-perturbation [the 16-second period of time before $t(0)$] average frequency to post-perturbation [the 34-second period of time starting 20 seconds after $t(0)$] average frequency absolute deviation greater than 100 mHz (the 100 mHz value may be adjusted by the BA to capture 30 to 40 events per year). See Attachment 1 for detailed criteria for this measurement.

or

- ii) a change in a generating unit/generating facility, DC tie or firm load pre-perturbation average megawatt output to post-perturbation average megawatt output absolute deviation greater than 550 MW (the 550 MW value may be adjusted by the BA to capture 30 to 40 events per year). See Attachment 1 for detailed criteria for this measurement.

Governor: The electronic, digital or mechanical device that implements Primary Frequency Response of generating units/generating facilities or other system elements.

Primary Frequency Response: The immediate proportional increase or decrease in real power output provided by generating units/generating facilities and the natural real power dampening response provided by Load in response to system Frequency Deviations. This response is in the direction that stabilizes frequency.

A. Introduction

1. **Title:** Real Power Balancing Control Performance
2. **Number:** BAL-001-TRE-1
3. **Purpose:** To maintain Interconnection steady-state frequency within defined limits by balancing real power demand and supply in real-time. This regional standard replaces the CPS2 Waiver that was approved for ERCOT by NERC on November 21, 2002. Specifically, this standard replaces requirement 2 of BAL-001-0a per FERC Order 693.
4. **Applicability:**
 - 4.1. Balancing Authorities (BA), Generator Owners (GO)
 - 4.2. Existing facilities regulated by the U.S. Nuclear Regulatory Commission are exempt from Standard BAL-001-TRE-01.
5. **(Proposed) Effective Date:** After final regulatory approval and with the three-year implementation plan to allow generating unit/generating facility time to meet the requirements. See outline of implementation plan in Attachment 3.

B. Requirements

- R1. The BA shall identify Frequency Measurable Events and submit a report to the Compliance Enforcement Authority for each Frequency Measurable Event identified. *[Violation Risk Factor = Medium] [Time Horizon = Operations Assessment]*
- R2. The BA shall calculate the 12-month rolling average Primary Frequency Response performance of each generating unit/generating facility using the Primary Frequency Response Evaluation Tool (Attachment 2). If the generating unit/generating facility has not participated in a minimum of (8) eight Frequency Measurable Events in a 12-month period, performance shall be based on a rolling eight Frequency Measurable Event average response. *[Violation Risk Factor = Medium] [Time Horizon = Operations Assessment]*
- R3. Each GO shall set the Governor parameters as follows: *[Violation Risk Factor = High] [Time Horizon = Operations Planning]*
 - 3.1. Limit Governor deadbands within those listed in Table 3.1.

Table 3.1 Governor Deadband Settings

Governor Type	Max. Deadband
Mechanical	+/- 0.036 Hz
Electronic	+/- 0.01666 Hz
Digital	+/- 0.01666 Hz

- 3.2. Ensure that Governor droop settings do not exceed those listed in Table 3.2.

Table 3.2 Governor Droop Settings

Resource Type	Max. Droop % Setting
Hydro	5%
Nuclear	5%
Coal and Lignite	5%
Combustion Turbine (Simple Cycle)	5%
Combustion Turbine (Combined Cycle)	4%
Steam Turbine (Simple Cycle)	5%
Steam Turbine (Combined Cycle)	5%
Diesel	5%
Wind Turbine	5%
DC Tie Providing Ancillary Services	5%
Renewable (Non-Hydro)	5%

3.3. For digital and electronic Governors, once frequency deviation has exceeded the Governor deadband from 60.000 Hz, ensure that the resource Governor follows the slope derived from the formula below.

$$\text{For 5\% Droop: Slope} = \frac{MW_{GCS}}{(3.0 \text{ Hz} - \text{Governor Deadband Hz})}$$

$$\text{For 4\% Droop: Slope} = \frac{MW_{GCS}}{(2.4 \text{ Hz} - \text{Governor Deadband Hz})}$$

Where: MW_{GCS} is the maximum megawatt control range of the Governor control system.

R4. The GO shall meet a minimum 12-month rolling average initial Primary Frequency Response performance on each generating unit/generating facility based on an eight (8) Frequency Measurable Event minimum participation. If the generating unit/generating facility has not participated in a minimum of eight Frequency Measurable Events in a 12-month period, performance shall be based on a rolling eight Frequency Measurable Event average response. [*Violation Risk Factor = Medium*] [*Time Horizon = Operations Assessment*]

$$\text{Avg}_{\text{Period}}[\text{P.U. PFR}_{\text{Resource}}] \geq 0.75$$

Where: $\text{P.U. PFR}_{\text{Resource}}$ is the per unit measure of the Primary Frequency Response of a Resource during identified Frequency Measurable Events.

$$P.U.PFR_{Resource} = \frac{Actual\ Primary\ Frequency\ Response}{Expected\ Primary\ Frequency\ Response}$$

Expected Primary Frequency Response (EPFR): This is calculated when the frequency deviation exceeds the deadband.

$$Expected\ MW\ Change = \left[\frac{(HZ_{actual} - 60.0 + deadband)}{(60 * droop - deadband)} \times (-1) \times (Capacity) \right]$$

EPFR for Combustion Turbine

$$Expected\ MW\ Change + (HZ_{actual} - 60.0) \times 10 \times 0.00276 \\ \times Generation\ Resource\ Capacity$$

EPFR for Steam Turbine

$$(Expected\ MW\ Change + Stored\ Energy\ Loss + Steam\ Expansion\ Loss) \\ \times \frac{Actual\ Throttle\ Pressure}{Rated\ Throttle\ Pressure}$$

$$Stored\ Energy\ Loss = \left[Expected\ MW\ Change \times K \times \left(\frac{Capacity}{PSIG_{Rated}} \right) \right]$$

$$Where\ K = \frac{Change\ in\ Pressure\ (\Delta PSIG)}{Change\ in\ MW\ (\Delta MW)} \text{ is in the range of } 0.0 \rightarrow 0.5$$

Steam Expansion Loss

$$= \left[Expected\ MW\ Change \times 2 \times MW_{post-perturbation} \times \left(\frac{K}{PSIG_{Rated}} \right) \right]$$

Actual Primary Frequency Response (APFR): This is the difference between Pre-perturbation Average MW and Post-perturbation Average MW.

$$Actual\ Primary\ Frequency\ Response = MW_{pre-perturbation} - MW_{post-perturbation}$$

Pre-perturbation Average MW: Actual MW averaged from t(-16) to t(-2)

$$MW_{pre-perturbation} = \frac{\sum_{t(-16)}^{t(-2)} MW}{8}$$

Post-perturbation Average MW: Actual MW averaged from t(20) to t(52)

$$MW_{post-perturbation} = \frac{\sum_{t(20)}^{t(52)} MW}{17}$$

- R5. The GO shall meet a minimum 12-month rolling average sustained Primary Frequency Response performance on each generating unit/generating facility based on an eight (8) Frequency Measurable Event minimum participation. If the generating unit/generating facility has not participated in a minimum of eight Frequency Measurable Events in a 12-month period, performance shall be based on a rolling eight Frequency Measurable Event average response. [*Violation Risk Factor = Medium*] [*Time Horizon = Operations Assessment*]

Event Recovery Time (ERT): Time at which Frequency Returns to Pre-perturbation Frequency or Scheduled Frequency, whichever is lower

Pre-perturbation Average MW: Actual MW averaged from t(-16) to t(-2)

$$MW_{pre-perturbation} = \frac{\sum_{t(-16)}^{t(-2)} MW}{8}$$

Post-perturbation Average MW: Actual MW averaged from t(20) to t(52)

$$MW_{post-perturbation} = \frac{\sum_{t(20)}^{t(52)} MW}{17}$$

MW_{ERT} = Instantaneous MW at ERT

$$\Delta MW = MW_{pre-perturbation} - MW_{ERT}$$

$$\#Scans = ERT - t(0) - 2$$

$$Expected\ 60\ Hz\ MW_t = \left(\frac{t}{2}\right) \left(\frac{\Delta MW}{\#Scans}\right) + MW_{pre-perturbation}$$

Initial Primary Frequency Response in P.U. (IPFR_{p.u.})

$$IPFR_{p.u.} = \frac{(MW_{post-perturbation} - MW_{pre-perturbation})}{EPFR}$$

$$If(IPFR_{p.u.} > 1.0) \text{ then } IPFR_{p.u.} = 1.0$$

$$If(IPFR_{p.u.} < 0.15) \text{ then } IPFR_{p.u.} = 0.0 \text{ (No evaluation is required)}$$

Event Average Expected MW

$$MW_{EAE} = \frac{\sum_{t(-2)}^{t(ERT)} (Expected\ 60\ Hz\ MW_t + EPFR_t \times IPFR_{p.u.})}{\#Scans}$$

Event Average Actual MW

$$MW_{EAA} = \frac{\sum_{t(-2)}^{t(ERT)} (MW_t)}{\#Scans}$$

$$P.U. PFR_{Resource} = \frac{MW_{EAA}}{MW_{EAE}}$$

$$Avg_{Period}[P.U. PFR_{Resource}] \geq 0.75$$

C. Measures

- M1.** The BA shall have evidence it reported each Frequency Measurable Event to the Compliance Enforcement Authority within 30 days of the FME as required in R1. The data provided to the Compliance Enforcement Authority may include but is not limited to that listed in Attachment 1.
- M2.** The BA shall have evidence it reported the rolling average Primary Frequency Response performance of each generating unit/generating facility monthly to the Compliance Enforcement Authority as required in R2.
- M3.** The GO shall have evidence that it set the Governor parameters in accordance with R3. Examples of evidence include but are not limited to:
 - Governor test reports,
 - Governor setting sheets,
 - performance monitoring reports.
- M3.1** The GO shall have evidence that it set the Governor deadbands as required in Table 3.1 in Requirement R.3.
- M3.2** The GO shall have evidence that the accepted Governor droop characteristics did not exceed the settings in Table 3.2 in Requirement R3.
- M3.3** The GO shall have evidence that when frequency deviation has exceeded the Governor deadband from 60.00 Hz the Governor follows the approved slopes derived from the prescribed formulas for 4% droop and 5% droop.
- M4.** Each GO shall have evidence that each of its generating units/generating facilities achieved a minimum performance level of 0.75 P.U. PFR_{Resource} per R4 and documented evidence of any Frequency Measurable Events where generating unit performance should be excluded.
- M5.** Each GO shall have evidence that each of its generating units/generating facilities sustained a minimum performance level of 0.75 P.U. PFR_{Resource} per R5 and

documented evidence of any Frequency Measurable Events where generating unit performance should be excluded. On a single event, if $M4$ is <0.15 P.U. $PFR_{Resource}$, then $M5$ is not measured.

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

Texas Regional Entity

1.1. Compliance Monitoring Period and Reset Time Frame

- 1.1.1** If a generating unit/generating facility fails any requirement or measure of this standard, the GO will submit mitigation plans for the failing generating unit/generating facility with a timeline not to exceed 90 days from the notification of failing performance.
- 1.1.2** Each generating unit/generating facility will have a rolling event average performance as stated in R4 and R5 of this Standard. If a generating unit/generating facility completes a mitigation plan and implements corrective action that corrects past failing performance as measured by this standard, the rolling event average will be reset on the next successful performance during a Frequency Measurable Event and the generating unit/generating facility will begin a new rolling event average performance. If the generating unit/generating facility fails the next Frequency Measurable Event performance, the GO will submit a follow-up mitigation plan with a timeline not to exceed 30 days from the notification of failing performance.

1.2. Data Retention

The Balancing Authority and Generator Owner shall keep data or evidence to show compliance, as identified below, unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation:

- Each BA shall retain a list of identified Frequency Measurable Events since its last compliance audit for R1, M1.
- Each BA shall retain all monthly reports since its last compliance audit for R2, M2.
- Each GO shall retain evidence since last compliance audit for R3, M3.
- Each GO shall retain evidence since last compliance audit for R4, M4.
- Each GO shall retain evidence since last compliance audit for R5, M5.

The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent records.

1.3. Compliance Monitoring and Assessment Processes

Compliance Audits

- Self-Certifications
- Spot Checking
- Compliance Violation Investigations
- Self-Reporting
- Complaints
- Periodic Data Submittals as required
- Exception Reporting as necessary

1.4. Additional Compliance Information

N/A at this time

2. Violation Severity Levels

R #	Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	A Frequency Measurable Event is not reported > 30 days but ≤ 50 days of identification of the event	A Frequency Measurable Event is not reported > 50 days but ≤ 70 days of identification of the event	A Frequency Measurable Event is not reported > 70 days but ≤ 90 days of identification of the event	A Frequency Measurable Event is not reported > 90 days of identification of the event
R2	Monthly reports submitted > 30 days but ≤ 50 days from the end of the reporting month	Monthly reports submitted > 50 days but ≤ 70 days from the end of the reporting month	Monthly reports submitted > 70 days but ≤ 90 days from the end of the reporting month	Monthly reports submitted > 90 days from the end of the reporting month
R3	Any Governor parameter setting >10% and ≤20% outside setting range specified in R3	Any Governor parameter setting >20% and ≤30% outside setting range specified in R3	Any Governor parameter setting >30% and ≤40% outside setting range specified in R3	Any Governor parameter setting >40% outside setting range specified in R3 – OR – the electronic or digital Governor was set to step into the curve
R4	Rolling average per R4 is <0.75 and ≥0.65	Rolling average per R4 is <0.65 and ≥0.55	Rolling average per R4 is <0.55 and ≥0.45	Rolling average per R4 is <0.45
R5	Rolling average per R5 is <0.75 and ≥0.65	Rolling average per R5 is <0.65 and ≥0.55	Rolling average per R5 is <0.55 and ≥0.45	Rolling average per R5 is <0.45

E. Regional Variances

This is a regional variance to NERC Standard BAL-001-0a, specifically replacing R2. Instead of complying with R2 in BAL-001-0a (CPS2), the BA and GO in the ERCOT Interconnection maintain Interconnection steady-state frequency within defined limits by balancing real power

demand and supply in real-time by the methods, requirements, and measures described in this regional standard and associated attachments and documents.

F. Associated Documents

Version History

Version	Date	Action	Change Tracking

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Attachment 1

The type of data provided to the Compliance Enforcement Authority for analyzing each Frequency Measurable Event that has been identified by the BA may include but not limited to that listed below:

- (1) Interconnection Frequency;
- (2) Interconnection scheduled frequency used in the ACE equation;
- (3) Regulation Service deployed;
- (4) Responsive Reserve Service deployed;
- (5) Available Responsive Reserve Service (Nodal only);
- (6) Generating unit/generating facility megawatt value;
- (7) Control Error (Schedule CE in Zonal, Generation Resource Energy Deployment Performance (GREDP) in Nodal);
- (8) Generating unit/generating facility expected Primary Frequency Response;
- (9) Resource Regulation Service Allocation (Nodal only);
- (10) Resource Economic Base Point (Nodal only);
- (11) Resource High Operating Limit;
- (12) Resource Low Operating Limit;
- (13) Load Acting As Resource megawatt;
- (14) Load Acting As Resource deployed;
- (15) Resource Responsive Reserve Service Responsibility (Nodal only);
- (16) ERCOT Load;
- (17) Megawatt value for loss of individual generating unit/generating facility(s) or Load that triggered the Frequency Measurable Event;
- (18) Emergency Interruptible Load Service Deployed;
- (19) Time (synchronous time stamp to the nearest second for the data above).

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