

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

March 17, 2020

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Re: Supplement to March 11, 2020 Joint Petition of the North American Electric Reliability Corporation and Texas Reliability Entity, Inc. for Approval of Proposed Regional Reliability Standard BAL-001-TRE-2 – Primary Frequency Response in the ERCOT Region
Docket pending

Dear Ms. Bose:

On March 11, 2020, the North American Electric Reliability Corporation (“NERC”) and Texas Reliability Entity, Inc. (“Texas RE”) filed a petition for approval of proposed regional Reliability Standard BAL-001-TRE-2 – Primary Frequency Response in the ERCOT Region. As of the date of this letter, this petition has not yet been docketed.

Exhibit D to the petition contains the record of development for the proposed regional standard. The materials from NERC’s posting of the proposed regional standard were inadvertently omitted from Exhibit D. NERC and Texas RE respectfully request that the Commission accept this filing which supplements Exhibit D with the materials from NERC’s posting.

Respectfully submitted,

/s/ Lauren A. Perotti

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Texas Reliability Entity (Texas RE)				
BAL-001-TRE-2	Primary Frequency Response in the ERCOT Region	Texas RE Standards	11/22/19 – 01/06/20	<div><div>Info (1)</div><div>BAL-001-TRE-2</div><div>Clean (2) Redline (3)</div><div>Summary of Changes (4)</div><div>Implementation Plan (5)</div><div>Unofficial Comment Form (Word) (6)</div><div>Submit Comments</div><div>Comments Received (7)</div></div>

NERCNORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Regional Reliability Standards Announcement

Texas Reliability Entity | BAL-001-TRE-2

Comment Period Open through January 6, 2020

[Now Available](#)

The Texas Reliability Entity (Texas RE) requested that NERC post Regional Reliability Standard **BAL-001-TRE-2** for industry review and comment in accordance with the NERC Rules of Procedure.

Background

Texas RE received a Standard Authorization Request seeking: (i) to remove the governor deadband and droop setting requirements for steam turbines in a combined cycle train and (ii) clarification of the responsible entity for Frequency Measurable Event exclusion requests.

The Texas RE drafting team summarized all of the revisions made to Regional Reliability Standard BAL-001-TRE-2, including template edits, in the [Summary of Changes](#).

Commenting

Use the [Standards Balloting and Commenting System \(SBS\)](#) to submit comments. Contact [Wendy Muller](#) regarding issues with the SBS. The form must be submitted by **8 p.m. Eastern, Monday, January 6, 2020**. An unofficial Word version of the comment form is posted on the [Regional Reliability Standards Under Development](#) page.

- Contact NERC IT support directly at <https://support.nerc.net/> (Monday – Friday, 8 a.m. - 5 p.m. Eastern) for problems regarding accessing the SBS due to a forgotten password, incorrect credential error messages, or system lock-out.
- Passwords expire every **6 months** and must be reset.
- The SBS **is not** supported for use on mobile devices.
- Please be mindful of ballot and comment period closing dates. We ask to **allow at least 48 hours** for NERC support staff to assist with inquiries. Therefore, it is recommended that users try logging into their SBS accounts **prior to the last day** of a comment/ballot period.

Regional Reliability Standards Development Process

Section 300 of [NERC's Rules of Procedures of the Electric Reliability Organization](#) governs the regional reliability standards development process. Although the technical aspects of this Regional Reliability Standard have been vetted through WECC's Regional Standards development process, the final approval process for a Regional Reliability Standard requires NERC publicly to notice and request comment on the criteria outlined in the unofficial comment form.

Documents and information about this project are available on the [Texas RE Standards](#) page.

For more information or assistance, contact Senior Reliability Standards Analyst, [Nasheema Santos](#) (via email) or at (404) 446-2564.

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BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

A. Introduction

1. **Title:** Primary Frequency Response in the ERCOT Region
2. **Number:** BAL-001-TRE-2
3. **Purpose:** To maintain Interconnection steady-state frequency within defined limits.
4. **Applicability:**
 - 4.1. **Functional Entities:**
 - 4.1.1 Balancing Authority
 - 4.1.2 Generator Owners
 - 4.1.3 Generator Operators
 - 4.2. **Exemptions**
 - 4.2.1 Existing generating facilities regulated by the U.S. Nuclear Regulatory Commission prior to the Effective Date are exempt from Standard BAL-001-TRE-2.
 - 4.2.2 Generating units/generating facilities while operating in synchronous condenser mode are exempt from Standard BAL-001-TRE-2.
 - 4.2.3 Any generators that are not required by the Balancing Authority to provide primary frequency response are exempt from this standard.
5. **Effective Date:** See Implementation Plan for Regional Standard BAL-001-TRE-2.
6. **Background:** The ERCOT Interconnection was initially given a waiver of BAL-001 R2 (Control Performance Standard CPS2). In FERC Order 693, NERC was directed to develop a Regional Standard as an alternate means of assuring frequency performance in the ERCOT Interconnection. NERC was explicitly directed to incorporate key elements of the existing Protocols, Section 8.5. This required governors to be in service and performing with an un-muted response to assure an Interconnection minimum Frequency Response to a Frequency Measurable Event (FME) (that starts at $t(0)$).

This Regional Standard provides requirements related to identifying Frequency Measureable Events, calculating the Primary Frequency Response of each resource in the Region, calculating the Interconnection minimum Frequency Response and monitoring the actual Frequency Response of the Interconnection, setting Governor deadband and droop parameters, and providing Primary Frequency Response performance requirements.

Under this standard, two Primary Frequency Response (PFR) performance measures are calculated: “initial” and “sustained.” The initial PFR performance (R9) measures the actual response compared to the expected response in the period from 20 to 52

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

seconds after an FME starts. The sustained PFR performance (R10) measures the best actual response between 46 and 60 seconds after t(0) compared to the expected response based on the system frequency at a point 46 seconds after t(0).

In this Regional Standard the term “resource” is synonymous with “generating unit/generating facility”.

B. Requirements and Measures

- R1.** The Balancing Authority shall identify Frequency Measurable Events (FMEs), and within 14 calendar days after each FME the Balancing Authority shall notify the Compliance Enforcement Authority and make FME information (time of FME (t(0)), pre-perturbation average frequency, post- perturbation average frequency) publicly available. *[Violation Risk Factor – Lower] [Time Horizon – Operations Assessment]*
- M1.** The Balancing Authority shall have evidence it reported each FME to the Compliance Enforcement Authority and that it made FME information publicly available within 14 calendar days after the FME as required in Requirement R1.
- R2.** The Balancing Authority shall calculate the Primary Frequency Response of each generating unit/generating facility in accordance with this standard and the Primary Frequency Response Reference Document.¹ This calculation shall provide a 12-month rolling average of initial and sustained Primary Frequency Response performance. This calculation shall be completed each month for the preceding 12 calendar months. *[Violation Risk Factor = Lower] [Time Horizon = Operations Assessment]*
 - 2.1.** The performance of a combined cycle facility will be determined using an expected performance droop of 5.78%.
 - 2.2.** The calculation results shall be submitted to the Compliance Enforcement Authority and made available to the Generator Owner by the end of the month in which they were completed.
 - 2.3.** If a generating unit/generating facility has not participated in a minimum of (8) eight FMEs in a 12-month period, its performance shall be based on a rolling eight FME average response.

¹ The Primary Frequency Response Reference Document contains the calculations that the Balancing Authority will use to determine Primary Frequency Response performance of generating units/generating facilities. This reference document is a Texas RE-controlled document that is subject to revision by the Texas RE Board of Directors.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

- M2.** The Balancing Authority shall have evidence it calculated and reported the rolling average initial and sustained Primary Frequency Response performance of each generating unit/generating facility monthly as required in Requirement R2.
- R3.** The Balancing Authority shall determine the Interconnection minimum Frequency Response (IMFR) in December of each year for the following year, and make the IMFR, the methodology for calculation and the criteria for determination of the IMFR publicly available. *[Violation Risk Factor = Lower] [Time Horizon = Operations Planning]*
- M3.** The Balancing Authority shall demonstrate that the IMFR was determined in December of each year per Requirement R3. The Balancing Authority shall demonstrate that the IMFR, the methodology for calculation and the criteria for determination of the IMFR are publicly available.
- R4.** After each calendar month in which one or more FMEs occurs, the Balancing Authority shall determine and make publicly available the Interconnection's combined Frequency Response performance for a rolling average of the last six (6) FMEs by the end of the following calendar month. *[Violation Risk Factor = Medium] [Time Horizon = Operations Planning]*
- M4.** The Balancing Authority shall provide evidence that the rolling average of the Interconnection's combined Frequency Response performance for the last six (6) FMEs was calculated and made public per Requirement R4.
- R5.** Following any FME that causes the Interconnection's six-FME rolling average combined Frequency Response performance to be less than the IMFR, the Balancing Authority shall direct any necessary actions to improve Frequency Response, which may include, but are not limited to, directing adjustment of Governor deadband and/or droop settings. *[Violation Risk Factor = Medium] [Time Horizon = Operations Planning]*
- M5.** The Balancing Authority shall provide evidence that actions were taken to improve the Interconnection's Frequency Response if the Interconnection's six-FME rolling average combined Frequency Response performance was less than the IMFR, per Requirement R5.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

R6. Each Generator Owner shall set its Governor parameters as follows:

- 6.1.** Limit Governor deadbands within those listed in Table 6.1, unless directed otherwise by the Balancing Authority.

Table 6.1 Governor Deadband Settings

Generator Type	Max. Deadband
Steam and Hydro Turbines with Mechanical Governors	+/- 0.034 Hz
All Other Generating Units/Generating Facilities*	+/- 0.017 Hz

- 6.2.** Limit Governor droop settings such that they do not exceed those listed in Table 6.2, unless directed otherwise by the Balancing Authority.

Table 6.2 Governor Droop Settings

Generator Type	Max. Droop % Setting
Hydro	5%
Combustion Turbine (Simple Cycle and Single-Shaft Combined Cycle)	5%
Combustion Turbine (Combined Cycle)	4%
Steam Turbine*	5%
Diesel	5%
DC Tie Providing Ancillary Services	5%
Variable Renewable (Non-Hydro)	5%

*Requirements R6.1, R6.2, and R6.3 are not applicable to steam turbine(s) of a combined-cycle resource.

- 6.3.** For digital and electronic Governors, once frequency deviation has exceeded the Governor deadband from 60.000 Hz, the Governor setting shall follow the slope derived from the formula below.

Where

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

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

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

MWGCS is the maximum megawatt control range of the Governor control system. For mechanical Governors, droop will be proportional from the deadband by design. *[Violation Risk Factor = Medium] [Time Horizon = Operations Planning]*

- M6.** Each Generator Owner shall have evidence that it set its Governor parameters in accordance with Requirement R6. Examples of evidence include but are not limited to:
- Governor test reports
 - Governor setting sheets
 - Performance monitoring reports
- R7.** Each Generator Owner shall operate each generating unit/generating facility that is connected to the interconnected transmission system with the Governor in service and responsive to frequency when the generating unit/generating facility is online and released for dispatch, unless the Generator Owner has a valid reason for operating with the Governor not in service and the Generator Operator has been notified that the Governor is not in service. *[Violation Risk Factor = Medium] [Time Horizon = Real-time Operations]*
- M7.** Each Generator Owner shall have evidence that it notified the Generator Operator as soon as practical each time it discovered a Governor not in service when the generating unit/generating facility was online and released for dispatch. Evidence may include but not be limited to: operator logs, voice logs, or electronic communications.
- R8.** Each Generator Operator shall notify the Balancing Authority as soon as practical but within 30 minutes of the discovery of a status change (in service, out of service) of a Governor. *[Violation Risk Factor = Medium][Time Horizon = Real-time Operations]*
- M8.** Each Generator Operator shall have evidence that it notified the Balancing Authority within 30 minutes of each discovery of a status change (in service, out of service) of a Governor.
- R9.** Each Generator Owner shall meet a minimum 12-month rolling average initial Primary Frequency Response performance of 0.75 on each generating unit/generating facility, based on participation in at least eight FMEs.
- 9.1.** The initial Primary Frequency Response performance shall be the ratio of the Actual Primary Frequency Response to the Expected Primary Frequency Response during the initial measurement period following the FME.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

9.2. If a generating unit/generating facility has not participated in a minimum of eight FMEs in a 12-month period, performance shall be based on a rolling eight-FME average.

9.3. A generating unit/generating facility's initial Primary Frequency Response performance during an FME may be excluded from the rolling average calculation by the Balancing Authority due to a legitimate operating condition that prevented normal Primary Frequency Response performance. Examples of legitimate operating conditions that may support exclusion of FMEs include, but are not limited to:

- Operation at or near auxiliary equipment operating limits (such as boiler feed pumps, condensate pumps, pulverizers, and forced draft fans);
- Data telemetry failure. The Balancing Authority may request raw data from the Generator Owner as a substitute.

[Violation Risk Factor = Medium] [Time Horizon = Operations Assessment]

M9. Each Generator Owner shall have evidence that each of its generating units/generating facilities achieved a minimum rolling average of initial Primary Frequency Response performance level of at least 0.75 as described in Requirement R9. Each Generator Owner shall have documented evidence of any FMEs where the generating unit performance was excluded from the rolling average calculation.

R10. Each Generator Owner shall meet a minimum 12-month rolling average sustained Primary Frequency Response performance of 0.75 on each generating unit/generating facility, based on participation in at least eight FMEs. *[Violation Risk Factor = Medium] [Time Horizon = Operations Assessment]*

10.1. The sustained Primary Frequency Response performance shall be the ratio of the Actual Primary Frequency Response to the Expected Primary Frequency Response during the sustained measurement period following the FME.

10.2. If a generating unit/generating facility has not participated in a minimum of eight FMEs in a 12-month period, performance shall be based on a rolling eight-FME average.

10.3. A generating unit/generating facility's sustained Primary Frequency Response performance during an FME may be excluded from the rolling average calculation by the Balancing Authority due to a legitimate operating condition that prevented normal Primary Frequency Response performance. Examples of legitimate operating conditions that may support exclusion of FMEs include, but are not limited to:

- Operation at or near auxiliary equipment operating limits (such as boiler

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

feed pumps, condensate pumps, pulverizers, and forced draft fans);

- Data telemetry failure. The Balancing Authority may request raw data from the Generator Owner as a substitute.

M10. Each Generator Owner shall have evidence that each of its generating units/generating facilities achieved a minimum rolling average of sustained Primary Frequency Response performance of at least 0.75 as described in Requirement R10. Each Generator Owner shall have documented evidence of any Frequency Measurable Events where generating unit performance was excluded from the rolling average calculation.

C. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority: “Compliance Enforcement Authority” means NERC or the Regional Entity, or any entity as otherwise designated by an Applicable Governmental Authority, in their respective roles of monitoring and/or enforcing compliance with mandatory and enforceable Reliability Standards in their respective jurisdictions.

1.2. Compliance Monitoring Period and Reset Time Frame: If a generating unit/generating facility completes a mitigation plan and implements corrective action(s) to meet requirements R9 and R10 of the standard, and if approved by the BA and Compliance Enforcement Authority, then the generating unit/generating facility may begin a new rolling event average performance on the next performance during an FME. This will count as the first event in the performance calculation and the entity will have an average frequency performance score after 12 successive months or eight events per R9 and R10.

1.3. Evidence Retention: The following evidence retention period(s) identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full-time period since the last audit.

The applicable entity 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.

The Balancing Authority, Generator Owner, and Generator Operator 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:

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

- The Balancing Authority shall retain a list of identified FMEs and shall retain FME information since its last compliance audit for Requirement R1, Measure M1.
- The Balancing Authority shall retain all monthly PFR performance reports since its last compliance audit for Requirement R2, Measure M2.
- The Balancing Authority shall retain all annual IMFR calculations, and related methodology and criteria documents, relating to time periods since its last compliance audit for Requirement R3, Measure M3.
- The Balancing Authority shall retain all data and calculations relating to the Interconnection's combined Frequency Response performance, and all evidence of actions taken to increase the Interconnection's combined Frequency Response performance, since its last compliance audit for Requirements R4 and R5, Measures M4 and M5.
- Each Generator Operator shall retain evidence since its last compliance audit for Requirement R8, Measure M8.
- Each Generator Owner shall retain evidence since its last compliance audit for Requirements R6, R7, R9 and R10, Measures M6, M7, M9 and M10.

If an entity is found non-compliant, it shall retain information related to the non-compliance until found compliant, or for the duration specified above, whichever is longer.

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

1.4. Compliance Monitoring and Enforcement Program: As defined in the NERC Rules of Procedure, "Compliance Monitoring and Enforcement Program" refers to the identification of the processes that will be used to evaluate data or information for the purpose of assessing performance or outcomes with the associated Reliability Standard.

Compliance Audits

Self-Certifications

Spot Checking

Compliance Violation Investigations

Self-Reporting

Complaints

Violation Severity Levels

R #	Violation Severity Levels			
	Lower VSL	Moderate VSL	High VSL	Severe VSL
R1.	The Balancing Authority reported an FME more than 14 days but less than 31 days after identification of the event.	The Balancing Authority reported an FME more than 30 days but less than 51 days after identification of the event.	The Balancing Authority reported an FME more than 50 days but less than 71 days after identification of the event.	The Balancing Authority reported an FME more than 70 days after identification of the event.
R2.	The Balancing Authority submitted a monthly report more than one month but less than 51 days after the end of the reporting month.	The Balancing Authority submitted a monthly report more than 50 days but less than 71 days after the end of the reporting month.	The Balancing Authority submitted a monthly report more than 70 days but less than 91 days after the end of the reporting month.	The Balancing Authority failed to submit a monthly report within 90 days after the end of the reporting month.
R3.	The Balancing Authority did not make the calculation and criteria for determination of the IMFR publicly available.	The Balancing Authority did not make the IMFR publicly available.	The Balancing Authority did not calculate the IMFR for the following year in December.	The Balancing Authority did not calculate the IMFR for a calendar year.
R4.	N/A	N/A	The Balancing Authority did not make public the six-FME rolling average Interconnection combined Frequency Response by the end of the following month.	The Balancing Authority did not calculate the six-FME rolling average Interconnection combined Frequency Response for any month in which an FME occurred.
R5.	N/A	N/A	N/A	The Balancing Authority did not take action to improve

				Frequency Response when the Interconnection's rolling-average combined Frequency Response performance was less than the IMFR.
R6.	Any Governor parameter setting was $> 10\%$ and $\leq 20\%$ outside setting range specified in R6.	Any Governor parameter setting was $> 20\%$ and $\leq 30\%$ outside setting range specified in R6.	Any Governor parameter setting was $> 30\%$ and $\leq 40\%$ outside setting range specified in R6.	Any Governor parameter setting was $> 40\%$ outside setting range specified in R6, – OR – an electronic or digital Governor was set to step into the droop curve.
R7.	N/A	N/A	N/A	The Generator Owner operated with its Governor out of service and did not notify the Generator Operator upon discovery of its Governor out of service.
R8	The Generator Operator notified the Balancing Authority of a change in Governor status between 31 minutes and one hour after the General Operator was notified of the discovery of the change.	The General Operator notified the Balancing Authority of a change in Governor status more than 1 hour but within 4 hours after the Generator Operator was notified of the discovery of the change.	The Generator Operator notified the Balancing Authority of a change in Governor status more than 4 hours but within 24 hours after the Generator Operator was notified of the discovery of the change.	The Generator Operator failed to notify the Balancing Authority of a change in Governor status within 24 hours after the Generator Operator was notified of the discovery of the change.

R9	A Generator Owner's rolling average initial Primary Frequency Response performance per R9 was < 0.75 and \geq 0.65.	A Generator Owner's rolling average initial Primary Frequency Response performance per R9 was < 0.65 and \geq 0.55.	A Generator Owner's rolling average initial Primary Frequency Response performance per R9 was < 0.55 and \geq 0.45.	A Generator Owner's rolling average initial Primary Frequency Response performance per R9 was < 0.45.
R10	A Generator Owner's rolling average sustained Primary Frequency Response performance per R10 was < 0.75 and \geq 0.65.	A Generator Owner's rolling average sustained Primary Frequency Response performance per R10 was < 0.65 and \geq 0.55.	A Generator Owner's rolling average sustained Primary Frequency Response performance per R10 was < 0.55 and \geq 0.45.	A Generator Owner's rolling average sustained Primary Frequency Response performance per R10 was < 0.45.

D. Regional Variances

None

E. Associated Documents

Regional Standard BAL-001-TRE-2 Implementation Plan

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region**Version History**

Version	Date	Action	Change Tracking
1	8/15/2013	Adopted by NERC Board of Trustees	
1	1/16/2014	FERC Order issued approving BAL-001-TRE-1. (Order becomes effective April 1, 2014.)	
2	MM/DD/YY YY		<p>Removed the requirement Governor droop and deadband settings for Steam Turbine(s) of combined cycle resources.</p> <p>Edited Requirements R9.3 and R10.3 to reflect the current process and legitimate operating conditions for submitting an FME exclusion request.</p> <p>Removed Attachment 1, which is the implementation plan for Regional Standard BAL-001-TRE-1.</p>

Standard Attachments

1. Attachment 1 – Primary Frequency Response Reference Document, including Flow Charts A and B.
 - a. This document provides implementation details for calculating Primary Frequency Response performance as required by Requirements R2, R9 and R10. This reference document is a Texas RE-controlled document that is subject to revision by the Texas RE Board of Directors. It is not part of the FERC-approved regional standard.
 - b. The following process will be used to revise the Primary Frequency Response Reference Document. A Primary Frequency Response Reference Document revision request may be submitted to the Texas RE Reliability Standards Manager, who will present the revision request to the Texas RE Member Representatives Committee (MRC) for consideration. The revision request will be posted in accordance with MRC procedures. The MRC shall discuss the revision request in a public meeting, and will accept and consider verbal and written comments pertaining to the request. The MRC will make a recommendation to the Texas RE Board of Directors, which may adopt the revision request, reject it, or adopt it with modifications. Any approved revision to the Primary Frequency Response Reference Document shall be filed with NERC and FERC for informational purposes.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Attachment 1**Primary Frequency Response Reference Document**

**Texas Reliability Entity, Inc.
BAL-001-TRE-2
Requirements R2, R9, and R10
Performance Metric Calculations**

I. Introduction

This Primary Frequency Response Reference Document provides a methodology for determining the Primary Frequency Response (PFR) performance of individual generating units/generating facilities following Frequency Measurable Events (FMEs) in accordance with Requirements R2, R9 and R10. Flowcharts in Attachment A (Initial PFR) and Attachment B (Sustained PFR) show the logic and calculations in graphical form, and they are considered part of this Primary Frequency Response Reference Document. Several Excel spreadsheets implementing the calculations described herein for various types of generating units are available¹ for reference and use in understanding and performing these calculations.

This Primary Frequency Response Reference Document is not considered to be a part of the regional standard. This document is maintained by Texas RE and subject to modifications as approved by the Texas RE Board of Directors, without being required to go through the formal Standard Development Process.

Revision Process: The following process will be used to revise the Primary Frequency Response Reference Document. A Primary Frequency Response Reference Document revision request may be submitted to the Texas RE Reliability Standards Manager, who will present the revision request to the Texas RE Member Representatives Committee (MRC) for consideration. The MRC shall discuss the revision request in a public meeting, and will accept and consider verbal and written comments pertaining to the request. The MRC will make a recommendation to the Texas RE Board of Directors, which may adopt the revision request, reject it, or adopt it with modifications. Any approved revision to the Primary Frequency Response Reference Document shall be filed with NERC and FERC for informational purposes.

As used in this document the following terms are defined as shown:

High Sustained Limit (HSL) for a generating unit/generating facility: The limit established by the GO/GOP, continuously updatable in Real-Time, that describes the maximum sustained energy production capability of a generating unit/generating facility.

Low Sustained Limit (LSL) for a generating unit/generating facility: The limit established by the GO/GOP, continuously updatable in Real-Time, that describes the minimum sustained energy production capability of a generating unit/generating facility.

In this regional standard, the term “resource” is synonymous with “generating unit/generating facility”.

¹ These spreadsheets are available at www.TexasRE.org.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

II. Initial Primary Frequency Response Calculations**Requirement 9**

- R9.** Each Generator Owner shall meet a minimum 12-month rolling average initial Primary Frequency Response performance of 0.75 on each generating unit/generating facility, based on participation in at least eight FMEs.
- 9.1.** The initial Primary Frequency Response performance shall be the ratio of the Actual Primary Frequency Response to the Expected Primary Frequency Response during the initial measurement period following the FME.
- 9.2.** If a generating unit/generating facility has not participated in a minimum of eight FMEs in a 12-month period, performance shall be based on a rolling eight FME average response.
- 9.3.** A generating unit/generating facility's initial Primary Frequency Response performance during an FME may be excluded by the Balancing Authority from the rolling average calculation due to a legitimate operating condition that prevented normal Primary Frequency Response performance. Examples of legitimate operating conditions that may support exclusion of FMEs include, but are not limited to:
- Operation at or near auxiliary equipment operating limits (such as boiler feed pumps, condensate pumps, pulverizers, and forced draft fans);
 - Data telemetry failure. The Balancing Authority may request raw data from the Generator Owner as a substitute.

Initial Primary Frequency Response Performance Calculation Methodology

This portion of this PFR Reference Document establishes the process used to calculate initial Primary Frequency Response performance for each Frequency Measurable Event (FME), and then average the events over a 12-month period (or 8-event minimum) to establish whether a resource is compliant with Requirement R9.

This process calculates the initial Per Unit Primary Frequency Response of a resource [$P.U.PFR_{Resource}$] as a ratio between the Adjusted Actual Primary Frequency Response ($APFR_{Adj}$), adjusted for the pre-event ramping of the unit, and the Final Expected Primary Frequency Response ($EPFR_{final}$) as calculated using the Pre-perturbation and Post-perturbation time periods of the initial measure.

This comparison of actual performance to a calculated target value establishes, for each type of resource, the initial Per Unit Primary Frequency Response [$P.U.PFR_{Resource}$] for any Frequency Measurable Event (FME).

Initial Primary Frequency Response performance requirement

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

Where $P.U.PFR_{Resource}$ is the per unit measure of the initial Primary Frequency Response of a resource during identified FMEs.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

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

Where P.U.PFR_{Resource} for each FME is limited to values between 0.0 and 2.0.

The Adjusted Actual Primary Frequency Response (APFR_{Adj}) and the Final Expected Primary Frequency Response (EPFR_{final}) are calculated as described below.

EPFR Calculations use droop and deadband values as stated in Requirement R6 with the exception of combined-cycle facilities while being evaluated as a single resource (MW production of both the combustion turbine generator and the steam turbine generator are included in the evaluation) where the evaluation droop will be 5.78%.²

Actual Primary Frequency Response (APFR_{adj})

The adjusted Actual Primary Frequency Response (APFR_{adj}) is the difference between Post-perturbation Average MW and Pre-perturbation Average MW, including the ramp magnitude adjustment.

$$APFR_{adj} = MW_{\text{post-perturbation}} - MW_{\text{pre-perturbation}} - \text{Ramp Magnitude}$$

Where:

Pre-perturbation Average MW: Actual MW averaged from T-16 to T-2

$$MW_{\text{pre-perturbation}} = \frac{\sum_{T-16}^{T-2} MW}{\# \text{ Scans}}$$

Post-perturbation Average MW: Actual MW averaged from T+20 to T+52

$$MW_{\text{post-perturbation}} = \frac{\sum_{T+20}^{T+52} MW}{\# \text{ Scans}}$$

² The effective droop of a typical combined-cycle facility with governor settings per Requirement R6 is 5.78%, assuming a 2-to-1 ratio between combustion turbine capacity and steam turbine capacity. Use 5.78% effective droop in all combined-cycle performance calculations.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Ramp Adjustment: The Actual Primary Frequency Response number that is used to calculate P.U.PFR is adjusted for the ramp magnitude of the generating unit/generating facility during the pre-perturbation minute. The ramp magnitude is subtracted from the APFR.

$$\text{Ramp Magnitude} = (\text{MW}_{T-4} - \text{MW}_{T-60}) * 0.59$$

$(\text{MW}_{T-4} - \text{MW}_{T-60})$ represents the MW ramp of the generator resource/generator facility for a full minute prior to the event. The factor 0.59 adjusts this full minute ramp to represent the ramp that should have been achieved during the post-perturbation measurement period.

Expected Primary Frequency Response (EPFR)

For all generator types, the *ideal* Expected Primary Frequency Response ($\text{EPFR}_{\text{ideal}}$) is calculated as the difference between the $\text{EPFR}_{\text{post-perturbation}}$ and the $\text{EPFR}_{\text{pre-perturbation}}$.

$$\text{EPFR}_{\text{ideal}} = \text{EPFR}_{\text{post-perturbation}} - \text{EPFR}_{\text{pre-perturbation}}$$

When the frequency is outside the Governor deadband and above 60Hz:

$$\text{EPFR}_{\text{pre-perturbation}}$$

$$= \left[\frac{(\text{HZ}_{\text{pre-perturbation}} - 60.0 - \text{deadband}_{\text{max}})}{(60 \times \text{droop}_{\text{max}} - \text{deadband}_{\text{max}})} \times (-1) \times (\text{HSL} - \text{PA Capacity}) \right]$$

$$\text{EPFR}_{\text{post-perturbation}}$$

$$= \left[\frac{(\text{HZ}_{\text{post-perturbation}} - 60.0 - \text{deadband}_{\text{max}})}{(60 \times \text{droop}_{\text{max}} - \text{deadband}_{\text{max}})} \times (-1) \times (\text{HSL} - \text{PA Capacity}) \right]$$

When the frequency is outside the Governor deadband and below 60Hz:

$$\text{EPFR}_{\text{pre-perturbation}}$$

$$= \left[\frac{(\text{HZ}_{\text{pre-perturbation}} - 60.0 + \text{deadband}_{\text{max}})}{(60 \times \text{droop}_{\text{max}} - \text{deadband}_{\text{max}})} \times (-1) \times (\text{HSL} - \text{PA Capacity}) \right]$$

$$\text{EPFR}_{\text{post-perturbation}}$$

$$= \left[\frac{(\text{HZ}_{\text{post-perturbation}} - 60.0 + \text{deadband}_{\text{max}})}{(60 \times \text{droop}_{\text{max}} - \text{deadband}_{\text{max}})} \times (-1) \times (\text{HSL} - \text{PA Capacity}) \right]$$

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

For each formula, when frequency is within the Governor deadband the appropriate EPFR value is zero. The $deadband_{max}$ and $droop_{max}$ quantities come from Requirement R6.

Where:

Pre-perturbation Average Hz: Actual Hz averaged from T-16 to T-2

$$Hz_{pre - perturbation} = \frac{\sum_{T-16}^{T-2} Hz}{\# Scans}$$

Post-perturbation Average Hz: Actual Hz averaged from T+20 to T+52

$$Hz_{post - perturbation} = \frac{\sum_{T+20}^{T+52} Hz}{\# Scans}$$

Capacity and NDC (Net Dependable Capacity) are used interchangeably and the term Capacity will be used in this document. Capacity is the official reported seasonal capacity of the generating unit/generating facility. The Capacity for wind-powered generators is the real time HSL of the wind plant at the time the FME occurred.

Power Augmentation: For Combined Cycle facilities, Capacity is adjusted by subtracting power augmentation (PA) capacity, if any, from the HSL. Other generator types may also have power augmentation that is not frequency responsive. This could be “over-pressure” operation of a steam turbine at valves wide open or operating with a secondary fuel in service. The GO should provide the BA with documentation and conditions when power augmentation is to be considered in PFR calculations.

EPFR_{final} for Combustion Turbines and Combined Cycle Facilities

$$EPFR_{final} = EPFR_{ideal} + (Hz_{post-perturbation} - 60.0) \times 10 \times 0.00276 \times (HSL - PA Capacity)$$

Note: The 0.00276 constant is the MW/0.1 Hz change per MW of Capacity and represents the MW change in generator output due to the change in mass flow through the combustion turbine due to the speed change of the turbine during the post-perturbation measurement period. This factor is based on empirical data from a major 2003 event as measured on multiple combustion turbines in ERCOT.

EPFR_{final} for Steam Turbine

$$EPFR_{final} = (EPFR_{ideal} + MW_{adj}) \times \frac{Throttle Pressure}{Rated Throttle Pressure}$$

Where:

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

$$MW_{adj} = EPFR_{ideal} \times \frac{K}{\text{Rated Throttle Pressure}} \times (HSL - PA \text{ Capacity}) \times \text{Steam Flow Change Factor} \times -1$$

Where:

$$\% \text{ Steam Flow} = \frac{MW_{\text{post-perturbation}}}{(HSL - PA \text{ Capacity})}$$

$$\text{Steam Flow Change Factor} = \frac{\% \text{ Steam Flow}}{0.5}$$

Throttle Pressure = Interpolation of Pressure curve at $MW_{\text{pre-perturbation}}$

The Rated Throttle Pressure and the Pressure curve, based on generator MW output, are provided by the GO to the BA. This pressure curve is defined by up to six pair of Pressure and MW breakpoints where the Rated Throttle Pressure and MW output, where Rated Throttle Pressure is achieved, is the first pair and the Minimum Throttle Pressure and MW output, where the Minimum Throttle Pressure is achieved, as the last pair of breakpoints. If fewer breakpoints are needed, the pair values will be repeated to complete the six pair table.

The K factor is used to model the stored energy available to the resource. The value ranges between 0.0 and 0.6 psig per MW change when responding during a FME. The GO can measure the drop in throttle pressure when the resource is operating near 50% output of the steam turbine during a FME and provide this ratio of pressure change to the BA. K is then adjusted based on rated throttle pressure and resource capacity. An additional sensitivity factor, the Steam Flow Change Factor, is based on resource loading (% steam flow) and further modifies the MW adjustment. This sensitivity factor will decrease the adjustment at resource outputs below 50% and increase the adjustment at outputs above 50%. The GO should determine the fixed K factor for each resource that generally results in the best match between EPFR and APFR (resulting in the highest P.U.PFR_{Resource}). For any generating unit, K will not change unless the steam generator is significantly reconfigured.

EPFR_{final} for Other Generating Units/Generating Facilities

$$EPFR_{final} = EPFR_{ideal} + X$$

Where X is an adjustment factor that may be applied to properly model the delivery of PFR. The X factor will be based on known and accepted technical or physical limitations of the resource. X may be adjusted by the BA and may be variable across the operating range of a resource. X shall be zero unless the BA accepts an alternative value.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

III. Sustained Primary Frequency Response Calculations

Requirement 10

R10. The Generator Owner shall meet a minimum 12-month rolling average sustained Primary Frequency Response performance of 0.75 on each generating unit/generating facility, based on participation in at least eight FMEs.

10.1 The sustained Primary Frequency Response performance shall be the ratio of the Actual Primary Frequency Response to the Expected Primary Frequency Response during the sustained measurement period following the FME.

10.2 If a generating unit/generating facility has not participated in a minimum of eight FMEs in a 12-month period, performance shall be based on a rolling eight-FME average.

10.3 A generating unit/generating facility's sustained Primary Frequency Response performance during an FME may be excluded by the Balancing Authority from the rolling average calculation due to a legitimate operating condition that prevented normal Primary Frequency Response performance. Examples of legitimate operating conditions that may support exclusion of FMEs include, but are not limited to:

- Operation at or near auxiliary equipment operating limits (such as boiler feed pumps, condensate pumps, pulverizers, and forced draft fans);
- Data telemetry failure. The Balancing Authority may request raw data from the Generator Owner as a substitute.

Sustained Primary Frequency Response Performance Calculation Methodology

This portion of this PFR Reference Document establishes the process used to calculate sustained Primary Frequency Response performance for each Frequency Measurable Event (FME), and then average the events over a 12-month period (or 8-event minimum) to establish whether a resource is compliant with Requirement R10.

This process calculates the Per Unit Sustained Primary Frequency Response of a resource $[P.U.SPFR_{Resource}]$ as a ratio between the maximum actual unit response at any time during the period from T+46 to T+60, adjusted for the pre-event ramping of the unit, and the *Final* Expected Primary Frequency Response (EPFR) value at time T+46.³

This comparison of actual performance to a calculated target value establishes, for each type of resource, the Per Unit Sustained Primary Frequency Response $[P.U.SPFR_{Resource}]$ for any Frequency Measurable Event (FME).

Sustained Primary Frequency Response performance requirement:

The standard requires an average performance over a period of 12 months (including at least 8 measured events) that is ≥ 0.75 .

³ The time designations used in this section refer to relative time after an FME occurs. For example, "T+46" refers to 46 seconds after the frequency deviation occurred.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

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

$Avg_{Period} [P.U.SPFR_{Resource}]$ is either:

- the average of each resource's sustained Primary Frequency Response performances $[P.U.SPFR_{Resource}]$ during all of the assessable Frequency Measurable Events (FMEs), for the most recent rolling 12 month period; or
- if the unit has not experienced at least 8 assessable FMEs in the most recent 12 month period, the average of the unit's last 8 sustained Primary Frequency Response performances when the unit provided frequency response during a Frequency Measurable Event.

Sustained Primary Frequency Response Calculation (P.U.SPFR)

$$P.U.SPFR_{Resource} = \frac{\text{Actual Sustained Primary Frequency Response}_{Adj}}{\text{Expected Sustained Primary Frequency Response}_{final}}$$

$P.U.SPFR_{Resource}$ is the per unit (P.U.) measure of the sustained Primary Frequency Response of a resource during identified Frequency Measurable Events. For any given event $P.U.SPFR_{Resource}$ for each FME will be limited to values between 0.0 and 2.0.

Actual Sustained Primary Frequency Response (ASPFR) Calculations

$$ASPFR = MW_{MaximumResponse} - MW_{pre-perturbation}$$

Where:

Pre-perturbation Average MW: Actual MW averaged from T-16 to T-2.

$$MW_{pre-perturbation} = \frac{\sum_{T-16}^{T-2} MW}{\#Scans}$$

And:

$MW_{MaximumResponse}$ = maximum MW value telemetered by a unit from T+46 through T+60 during low frequency events and the minimum MW value telemetered by a unit from T+46 through T+60 during a high frequency event.

Actual Sustained Primary Frequency Response, Adjusted ($ASPFR_{Adj}$)

$$ASPFR_{Adj} = ASPFR - RampMW_{Sustained}$$

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

RampMW Sustained (MW) – The Standard requires a unit/facility to sustain its response to a Frequency Measureable Event. An adjustment available in determining a unit's sustained Primary Frequency Response performance ($P.U.SPFR_{Resource}$) is to account for the direction in which a resource was moving (increasing or decreasing output) when the event occurred $T=t(0)$. This is the *RampMW Sustained* adjustment:

$$RampMW \text{ Sustained} = (MW_{T-4} - MW_{T-60}) \times 0.821$$

Note: The terminology “ MW_{T-4} ” refers to MW output at 4 seconds before the Frequency Measureable Event (FME) occurs at $T=t(0)$.

By subtracting a reading at 4 seconds before, from a reading at 60 seconds before, the formula calculates the MWs a generator moved in the minute (56 seconds) prior to $T=t(0)$. The formula is then modified by a factor to indicate where the generator would have been at $T+46$, had the event not occurred: the “*RampMW Sustained*.” It does this by multiplying the MW change over 56 seconds before the event ($MW_{T-4} - MW_{T-60}$) by a modifier. This extrapolates to an equivalent number of MWs the generator would have changed if it had been allowed to continue on its ramp

$$\frac{46 \text{ seconds}}{56 \text{ seconds}} \text{ or } 0.821.$$

to $T+46$ unencumbered by the FME. The modifier is

Expected Sustained Primary Frequency Response (ESPFR) Calculations

The Expected Sustained Primary Frequency Response ($ESPFR_{final}$) is calculated using the actual frequency at $T+46$, HZ_{T+46} .

This $ESPFR_{final}$ is the MW value a unit should have responded with if it is properly sustaining the output of its generating unit/generating facility in response to an FME. Determination of this value begins with establishing where it would be in an ideal situation; considers proper droop and dead-band values established in Requirement R6, High Sustainable Limit (HSL), Low Sustainable Limit (LSL) and actual frequency. It then allows for adjusting the value to compensate for the various types of Limiting Factors each generating units / generating facilities may have and any Power Augmentation Capacity (PA Capacity) that may be included in the HSL/LSL.

Establishing the Ideal Expected Sustained Primary Frequency Response

For all generator types, the ideal Expected Sustained Primary Frequency Response ($ESPFR_{ideal}$) is calculated as the difference between the $ESPFR_{T+46}$ and the $EPFR_{pre-perturbation}$. The $EPFR_{pre-perturbation}$ is the same $EPFR_{pre-perturbation}$ value used in the Initial measure of R9.

$$ESPFR_{ideal} = ESPFR_{T+46} - EPFR_{pre-perturbation}$$

When the frequency is outside the Governor deadband and above 60Hz:

$$ESPFR_{T+46} = \left[\frac{(HZ_{T+46} - 60 - deadband_{max})}{(droop_{max} \times 60 - deadband_{max})} \times (HSL - PA \text{ Capacity}) \times (-1) \right]$$

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

When the frequency is outside the Governor deadband and below 60Hz:

$$ESPFR_{T+46} = \left[\frac{(HZ_{T+46} - 60 + deadband_{max})}{(droop_{max} \times 60 - deadband_{max})} \times (HSL - PA \text{ Capacity}) \times (-1) \right]$$

Capacity and Net Dependable Capability (NDC) are used interchangeably and the term Capacity will be used in this document. Capacity is the official reported seasonal capacity of the generating unit/generating facility. The capacity for wind-powered generators is the real-time HSL of the wind plant at the time the FME occurred. The $deadband_{max}$ and $droop_{max}$ quantities come from Requirement R6.

For Combined Cycle facilities, determination of Capacity includes subtracting Power Augmentation (PA) Capacity, if any, from the original HSL. Other generator types may also have Power Augmentation that is not frequency responsive. This could be “over-pressure” operation of a steam turbine at valves wide open or operating with a secondary fuel in service. The GO is required to provide the BA with documentation and identify conditions when this augmentation is in service.

ESPFR_{final} for Combustion Turbines and Combined Cycle Facilities

$$ESPFR_{final} = ESPFR_{ideal} + (HZ_{T+46} - 60) * 10 * 0.00276 * (HSL - PACapacity)$$

Note: The 0.00276 constant is the MW/0.1 Hz change per MW of Capacity and represents the MW change in generator output due to the change in mass flow through the combustion turbine due to the speed change of the turbine at HZ_{T+46} . (This is based on empirical data from a major 2003 event as measured on multiple combustion turbines in ERCOT.)

ESPFR_{final} for Steam Turbine

$$ESPFR_{final} = (ESPFR_{ideal} + MW_{Adj}) \times \frac{Throttle \text{ Pressure}}{Rated \text{ Throttle Pressure}}$$

Where:

$$MW_{Adj} = ESPFR_{ideal} \times \frac{K}{Rated \text{ Throttle Pressure}} \times (HSL - PACapacity) \times Steam \text{ Flow Change Factor} \times (-1)$$

Where:

$$\% \text{ Steam Flow} = \frac{MW_{post-perturbation}}{(HSL - PA \text{ Capacity})}$$

$$Steam \text{ Flow Change Factor} = \frac{\% \text{ Steam Flow}}{0.5}$$

Throttle Pressure = Interpolation of Pressure curve at $MW_{pre-perturbation}$

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

The Rated Throttle Pressure and the Pressure curve, based on generator MW output, are provided by the GO to the BA. This pressure curve is defined by up to six pair of Pressure and MW breakpoints where the Rated Throttle Pressure and MW output where Rated Throttle Pressure is achieved is the first pair and the Minimum Throttle Pressure and MW output where the Minimum Throttle Pressure is achieved as the last pair of breakpoints. If fewer breakpoints are needed, the pair values will be repeated to complete the six pair table.

The K factor is used to model the stored energy available to the resource and ranges between 0.0 and 0.6 psig per MW change when responding during a FME. The GO can measure the drop in throttle pressure, when the resource is operating near 50% output of the steam turbine during a FME and provide this ratio of pressure change to the BA. K is then adjusted based on rated throttle pressure and resource capacity. An additional sensitivity factor, the Steam Flow Change Factor, is based on resource loading (% steam flow) and further modifies the MW adjustment. This sensitivity factor will decrease the adjustment at resource outputs below 50% and increase the adjustment at outputs above 50%. The GO should determine the fixed K factor for each resource that generally results in the best match between ESPFR and ASPFR (resulting in the highest P.U.SPFR_{Resource}). For any generating unit, K will not change unless the steam generator is significantly reconfigured.

ESPFR_{final} for Other Generating Units/Generating Facilities

$$ESPFR_{final} = ESPFR_{ideal} + X$$

Where X is an adjustment factor that may be applied to properly model the delivery of PFR. The X factor will be based on known and accepted technical or physical limitations of the resource. X may be adjusted by the BA and may be variable across the operating range of a resource. X shall be zero unless the BA accepts an alternative value.

IV. Limits on Calculation of Primary Frequency Response Performance (Initial and Sustained):

If the generating unit/generating facility is operating within 2% of its (HSL – PA Capacity) or within 5 MW (whichever is greater) from its applicable operating limit (high or low) at the time an FME occurs (pre-perturbation), then that resource's Primary Frequency Response performance is not evaluated for that FME.

For frequency deviations below 60 Hz (Hz_{Post-perturbation} < 60 if:

$$MW_{pre-perturbation} \geq \min[(HSL - PA\ Capacity) \times 0.98], [(HSL - PA\ Capacity) - 5\ MW]$$

then Primary Frequency Response is not evaluated for this FME.

For frequency deviations above 60 Hz (Hz_{Post-perturbation} > 60, if:

$$MW_{pre-perturbation} \leq \max[(LSL + ((HSL - PA\ Capacity) \times 0.02)), (LSL + 5\ MW)]$$

then Primary Frequency Response is not evaluated for this FME.

Final Expected Primary Frequency Response (EPFR_{final}) is greater than Operating Margin:

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Caps and limits exist for resources operating with adequate reserve margin to be evaluated (at least 2% of (HSL less PA Capacity) or 5 MW), but with Expected Primary Frequency Response_{final} greater than the actual margin available.

1. The P.U.PFR_{Resource} will be set to the greater of 0.75 or the calculated P.U.PFR_{Resource} if all of the following conditions are met:
 - a. The generating unit/generating facility's pre-perturbation operating margin (appropriate for the frequency deviation direction) is greater than 2% of its (HSL less PA Capacity) and greater than 5 MW; and
 - b. The Expected Primary Frequency Response_{final} is greater than the generating unit/generating facility's available frequency responsive Capacity⁴; and
 - c. The generating unit/generating facility's APFR_{adj} response is in the correct direction.
2. When calculation of the P.U.PFR_{Resource} uses the resource's (HSL less PA Capacity) as the maximum expected output, the calculated P.U.PFR_{Resource} will not be greater than 1.0.
3. When calculation of the P.U.PFR_{Resource} uses the resource's LSL as the minimum expected output, the calculated P.U.PFR_{Resource} will not be greater than 1.0.
4. If the APFR_{Adj} is in the wrong direction, then P.U.PFR_{Resource} is 0.0.
5. These caps and limits apply to both the Initial and Sustained Primary Frequency Response measures.

⁴ In this circumstance, when frequency is below 60 Hz, the EPFR_{final} is set to operating margin based on HSL (adjusted for any augmentation capacity) AND when frequency is above 60 Hz, the EPFR_{final} is set to operating margin based on LSL for the purpose of calculating PUPFR_{resource}.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

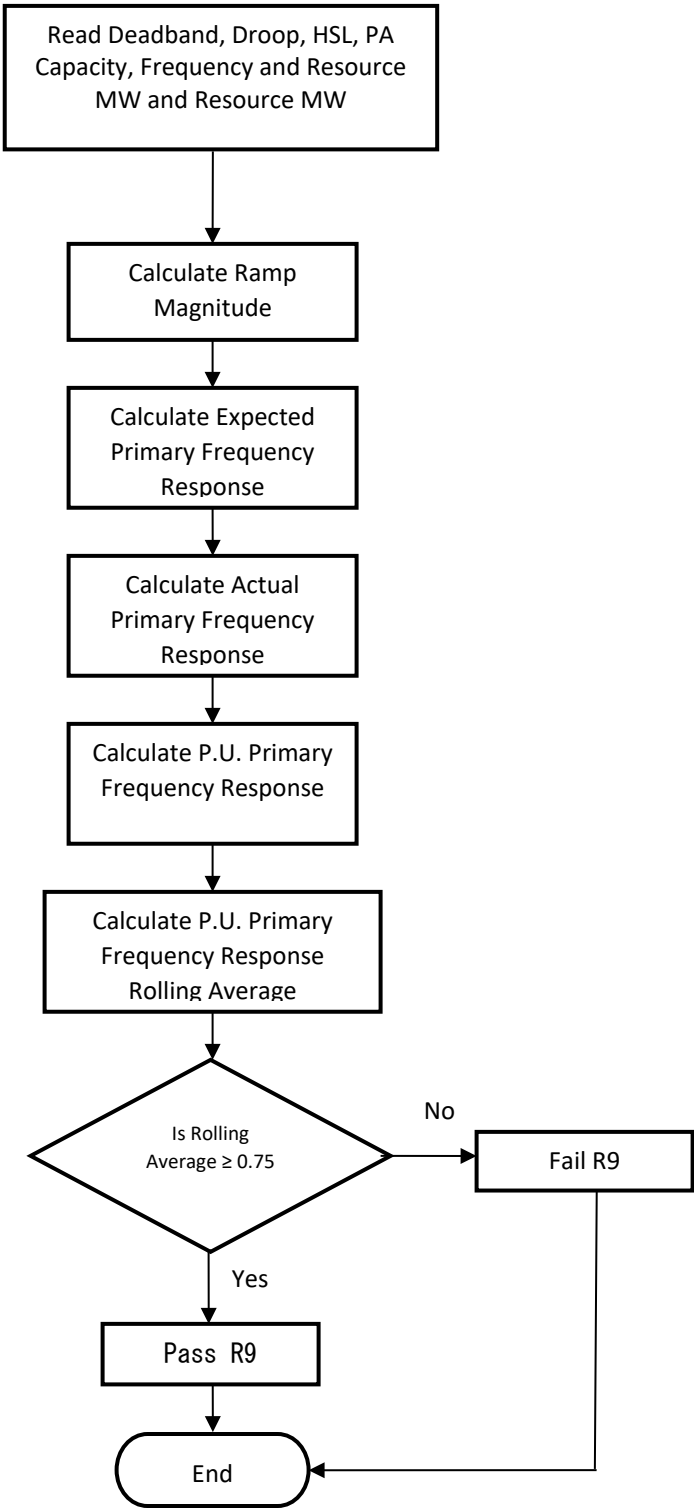
**Attachment A to
Primary Frequency Response Reference Document**

**Initial Primary Frequency Response Methodology for
BAL-001-TRE-2**

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

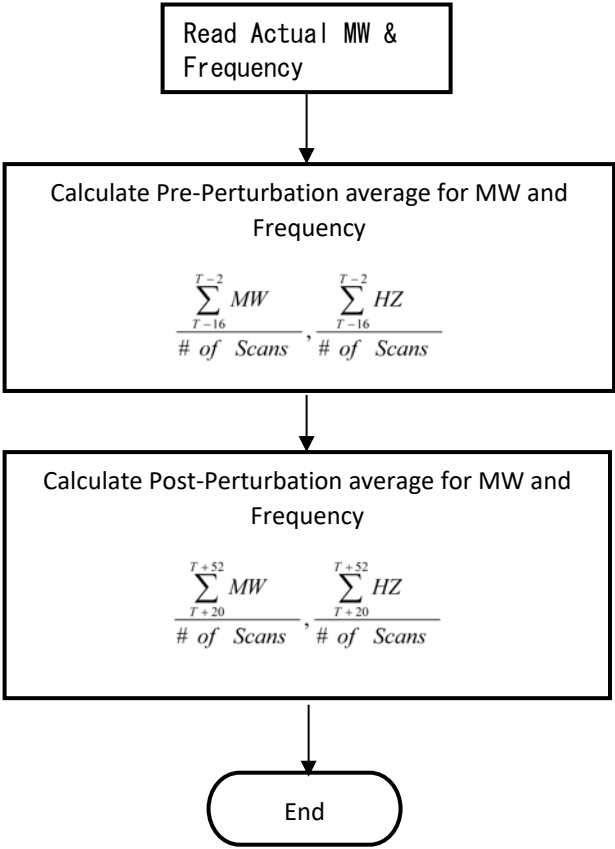
Primary Frequency Response Measurement and Rolling Average Calculation – Initial Response

PA=Power Augmentation
HSL=High Sustained Limit



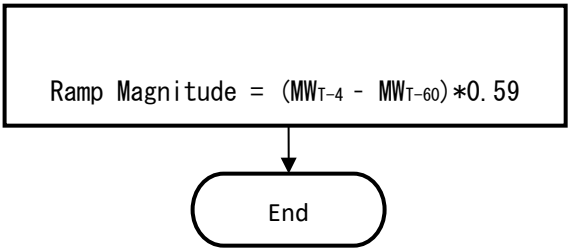
BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Pre/Post-Perturbation Average MW and Average Frequency Calculations



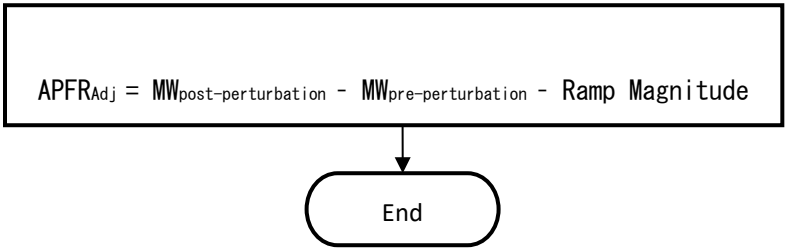
BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Ramp Magnitude Calculation



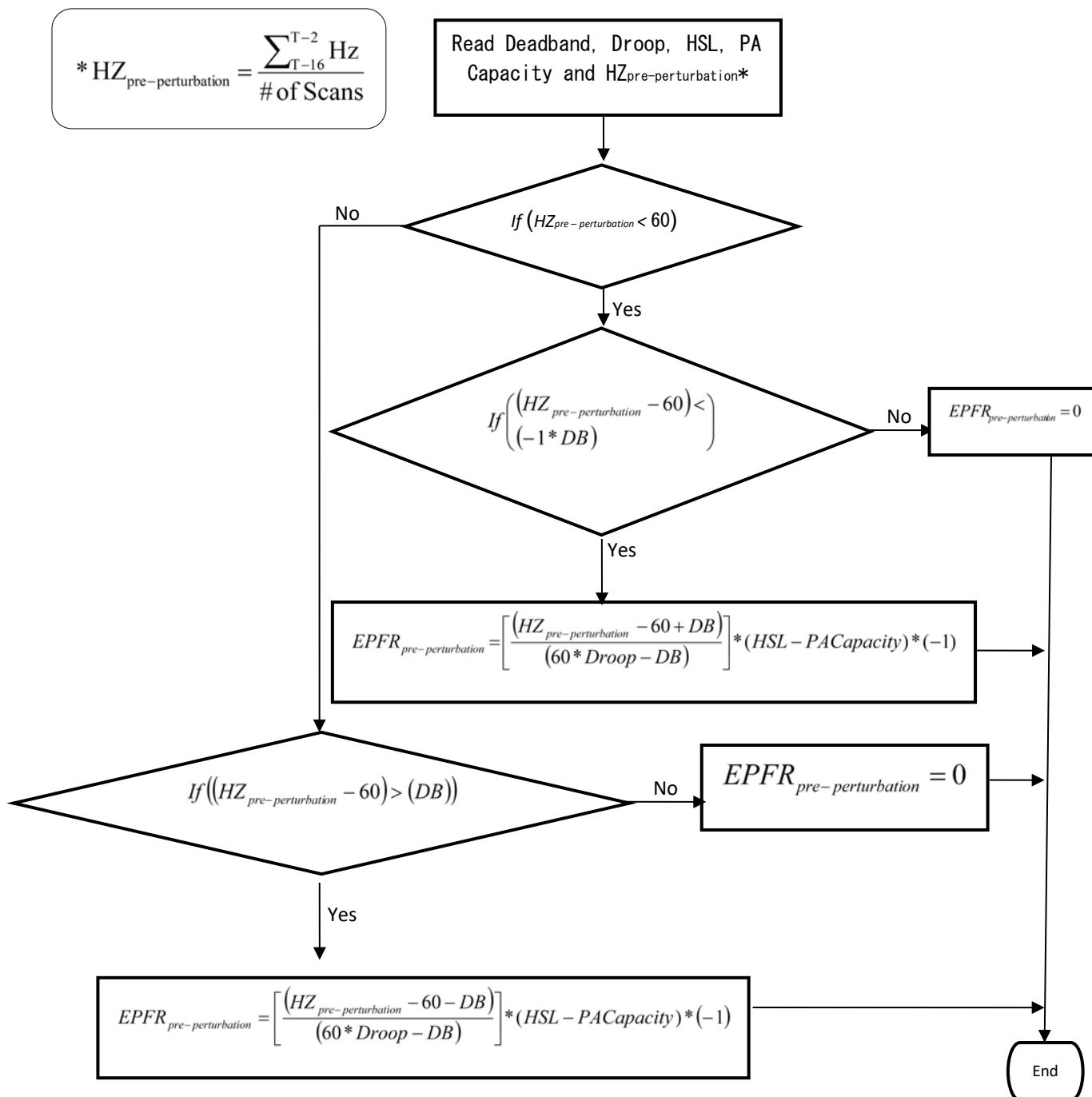
($MW_{T-4} - MW_{T-60}$) represents the MW ramp of the generator resource/generator facility for a full minute prior to the event. The factor 0.59 adjusts this full minute ramp to represent the ramp that should have been achieved during the post-perturbation measurement period.

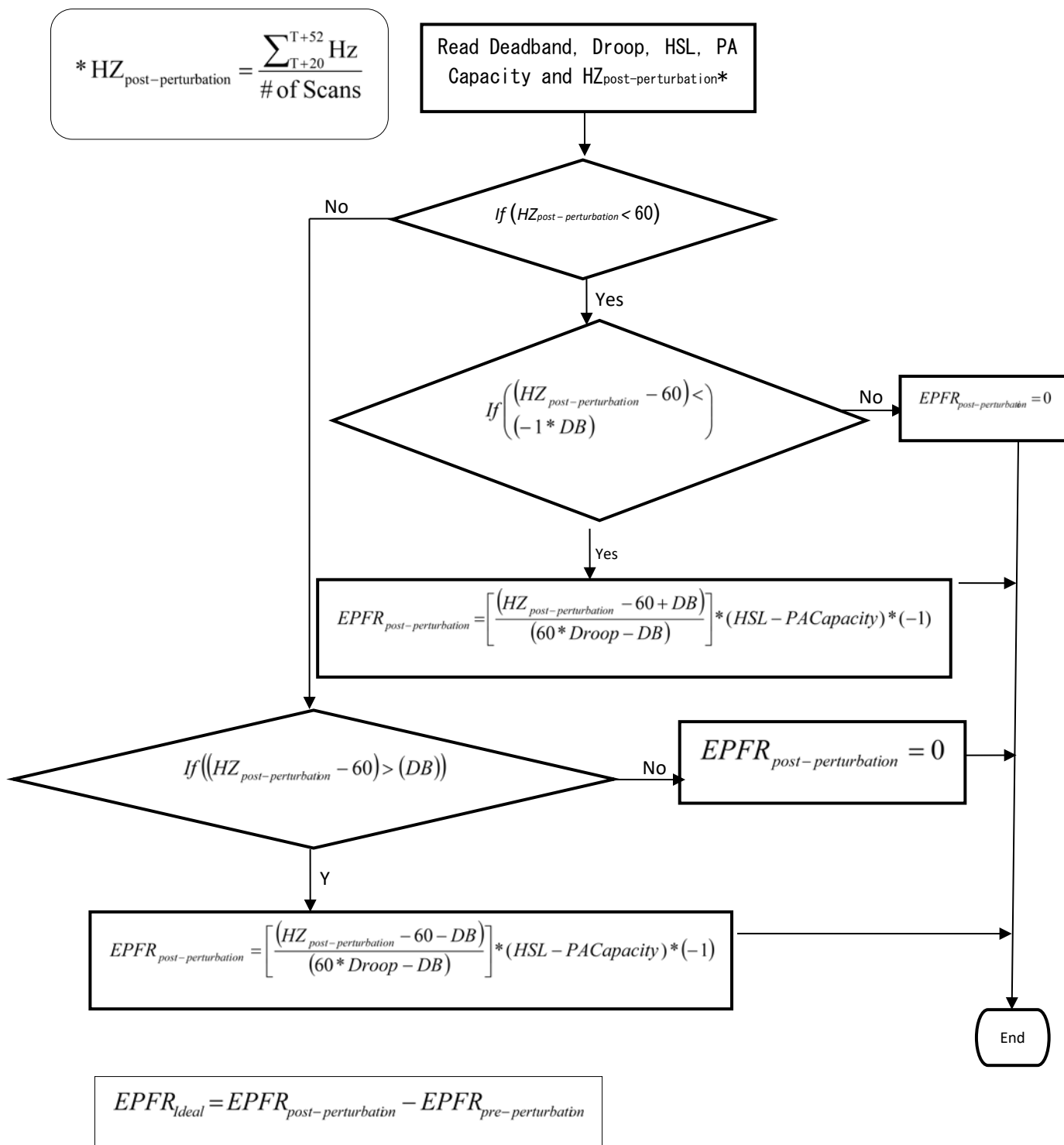
Actual Primary Frequency Response (APFR_{Adj})



BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region**Expected Primary Frequency Response Calculation**

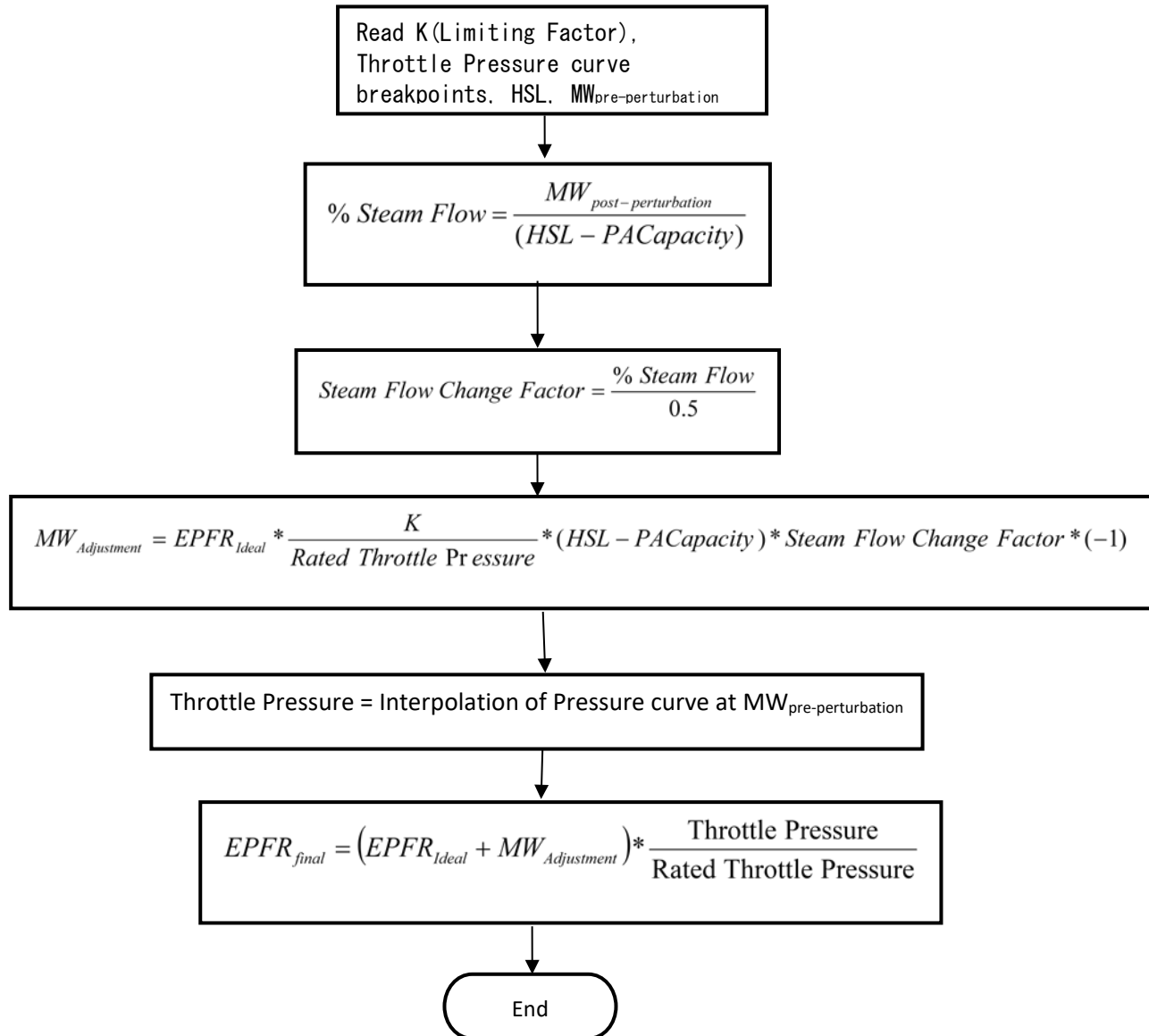
Use the maximum droop and maximum deadband as required by R6. For Combined Cycle Facility evaluation as a single resource (includes MW production of the steam turbine generator), the EPFR will use 5.78% droop in all calculations.



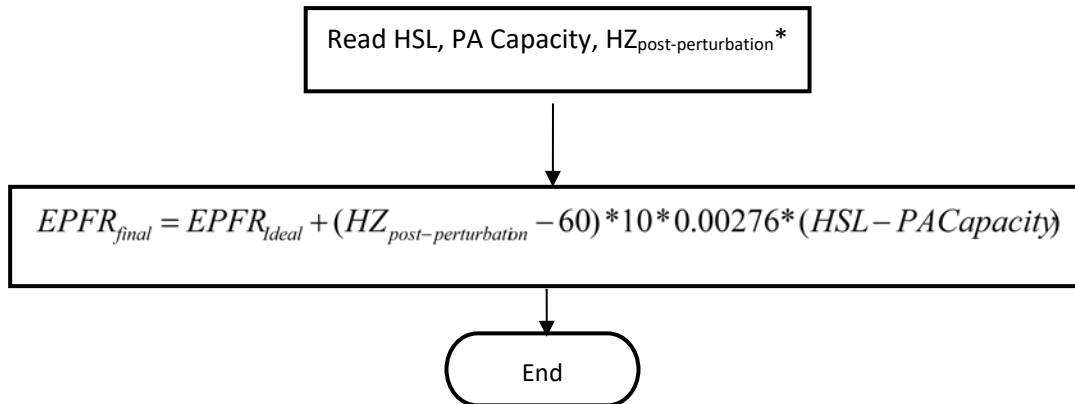
BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

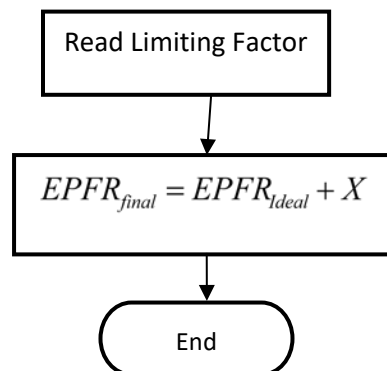
Adjustment for Steam Turbine



BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Adjustment for Combustion Turbines and Combined Cycle Facilities

0.00276 is the MW/0.1 Hz change per MW of Capacity and represents the MW change in generator output due to the change in mass flow through the combustion turbine due to the speed change of the turbine during the post-perturbation measurement period. (This factor is based on empirical data from a major 2003 event as measured on multiple combustion turbines in ERCOT.)

Adjustment for Other Units

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

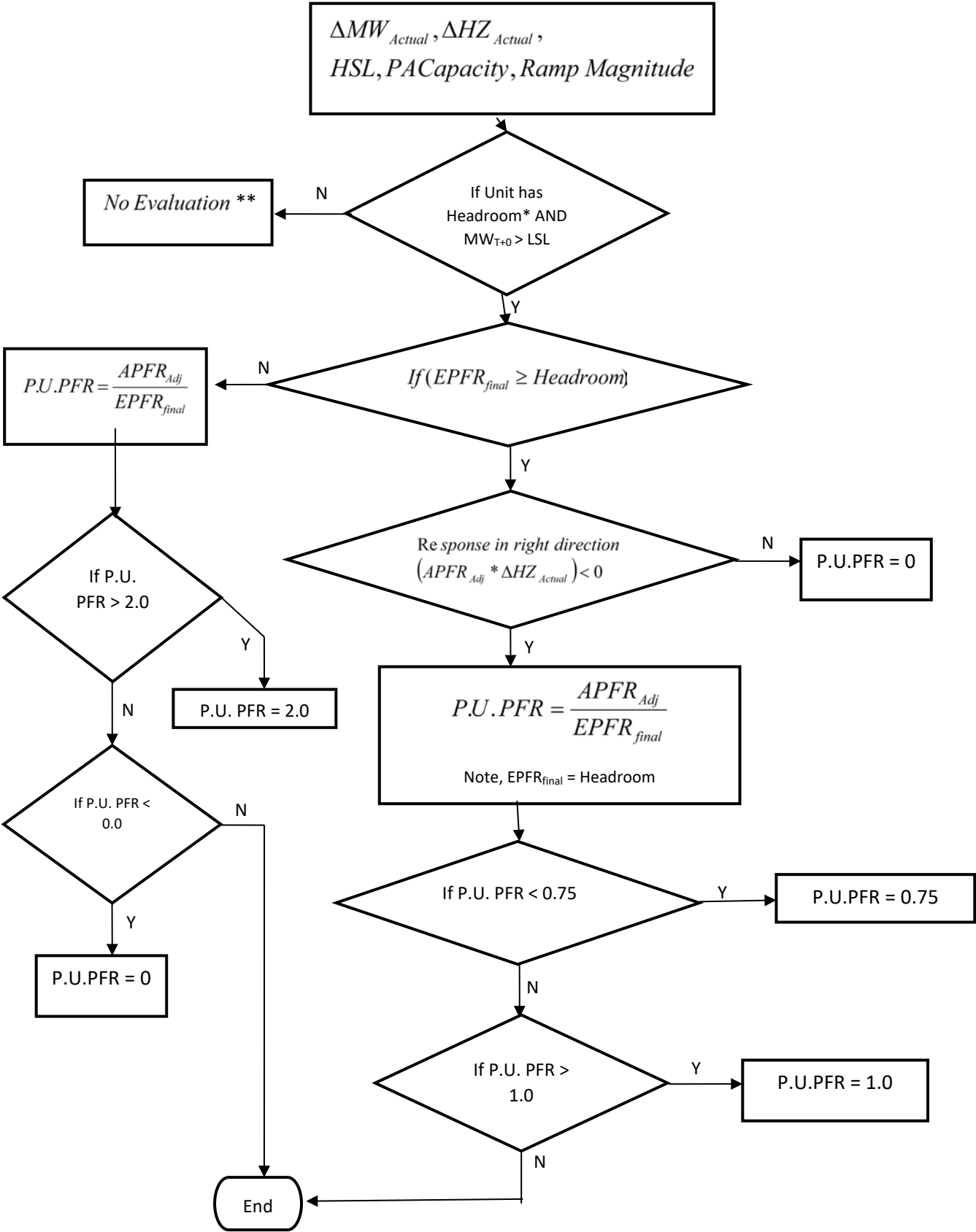
$$* \text{HZ}_{\text{post-perturbation}} = \frac{\sum_{T+20}^{T+52} \text{HZ}_{\text{Actual}}}{\# \text{ of Scans}}$$

This adjustment Factor X will be developed to properly model the delivery of PFR due to known and approved technical limitations of the resource. X may be adjusted by the BA and may be variable across the operating range of a resource.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

P.U. Initial Primary Frequency Response Calculation

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region



BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

*Check for adequate up headroom, low frequency events. Headroom must be greater than either 5MW or 2% of (HSL less PA Capacity), whichever is larger. If a unit does not have adequate up headroom, the unit is considered operating at full capacity and will not be evaluated for low frequency events.

Check for adequate down headroom, high frequency events. Headroom must be greater than either 5MW or 2% of (HSL less PA Capacity), whichever is larger. If a unit does not have adequate down headroom, the unit is considered operating at low capacity and will not be evaluated for high frequency events.

For low frequency events:

$$Headroom = HSL - PACapacity - MW_{T-2}$$

For high frequency events:

$$Headroom = MW_{T-2} - LSL$$

**No further evaluation is required for Sustained Primary Frequency Response. This event will not be included in the Rolling Average calculation of either Initial or Sustained Primary Frequency Response.

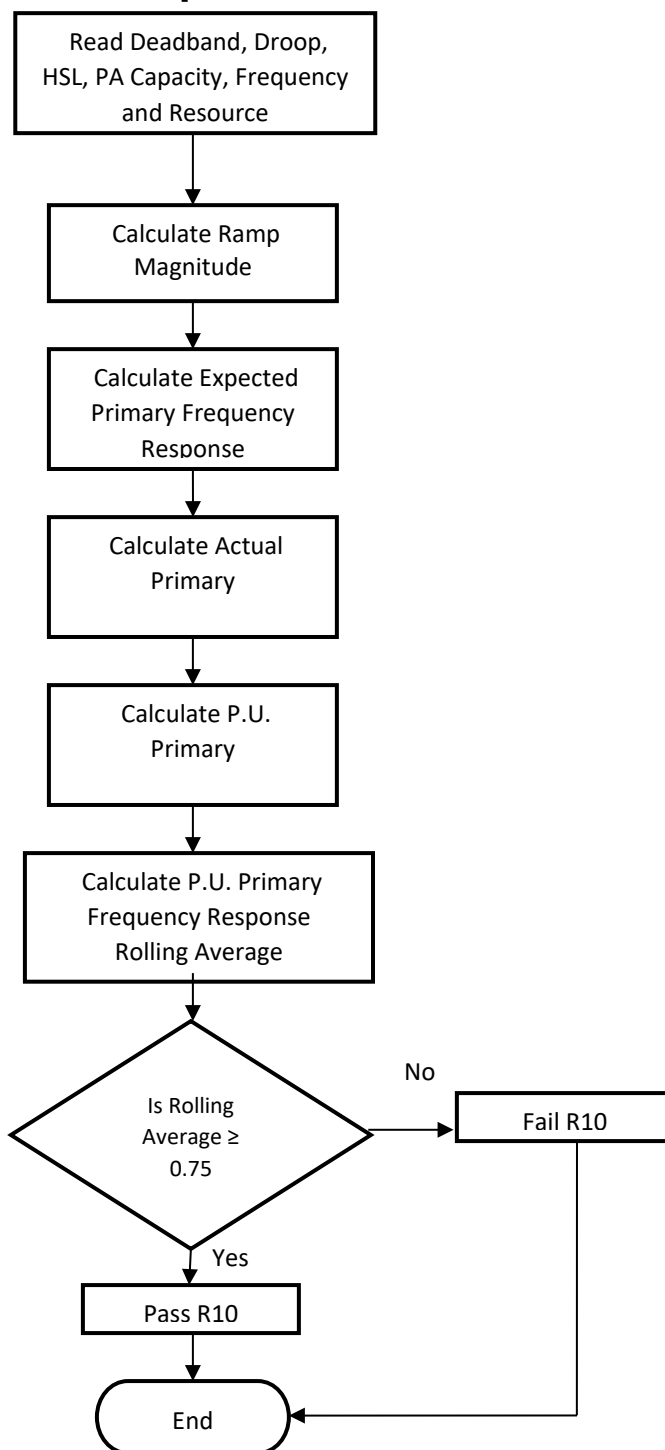
T = Time in Seconds

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

**Attachment B to
Primary Frequency Response Reference Document**

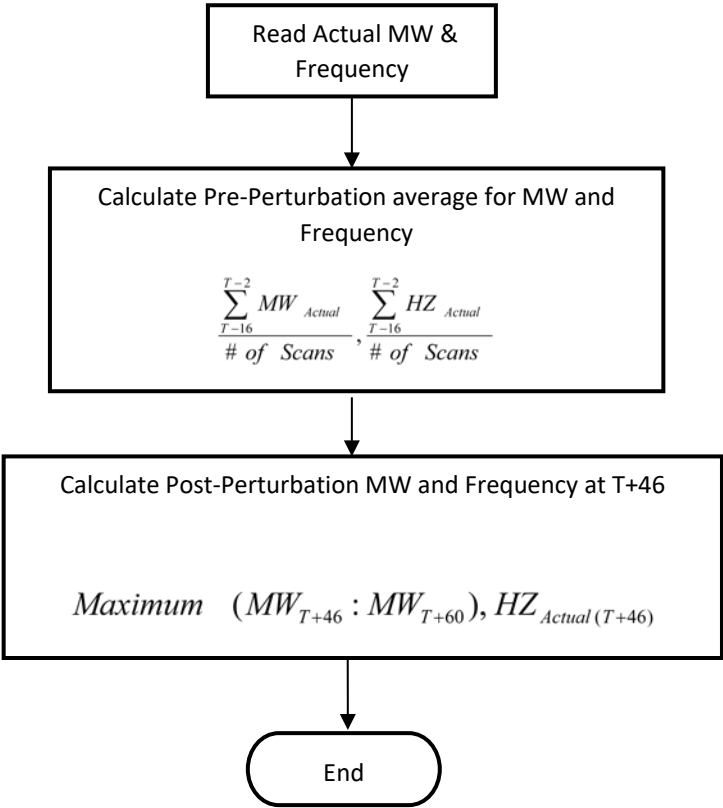
**Sustained Primary Frequency Response Methodology for
BAL-001-TRE-2**

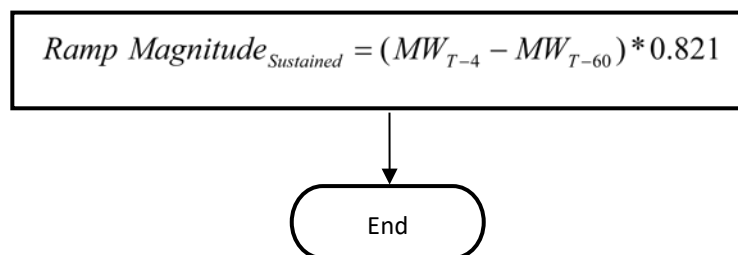
BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Primary Frequency Response Measurement and Rolling Average Calculation—Sustained Response

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Pre/Post-Perturbation Average MW and Average Frequency Calculations

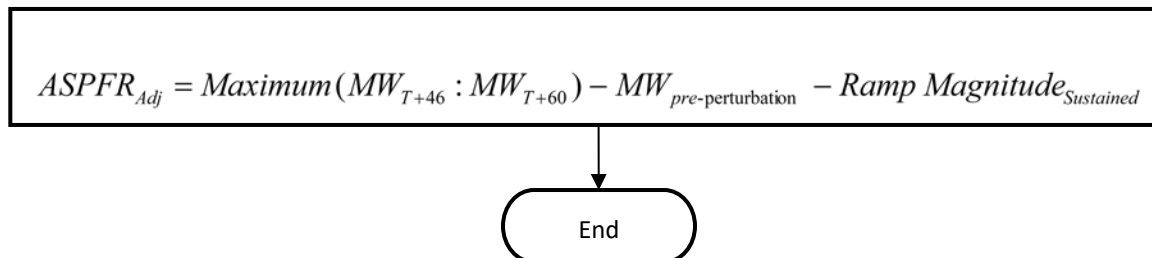


BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region**Ramp Magnitude Calculation - Sustained**

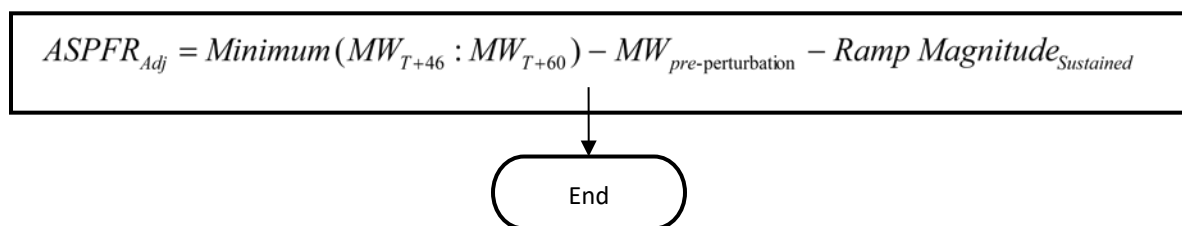
$(MW_{T-4} - MW_{T-60})$ represents the MW ramp of the generator resource/generator facility for a full minute prior to the event. The factor 0.821 adjusts this full minute ramp to represent the ramp the generator would have changed the system had it been allowed to continue on its ramp to T+46 unencumbered.

Actual Sustained Primary Frequency Response (ASPFR_{adj})

For low frequency events:

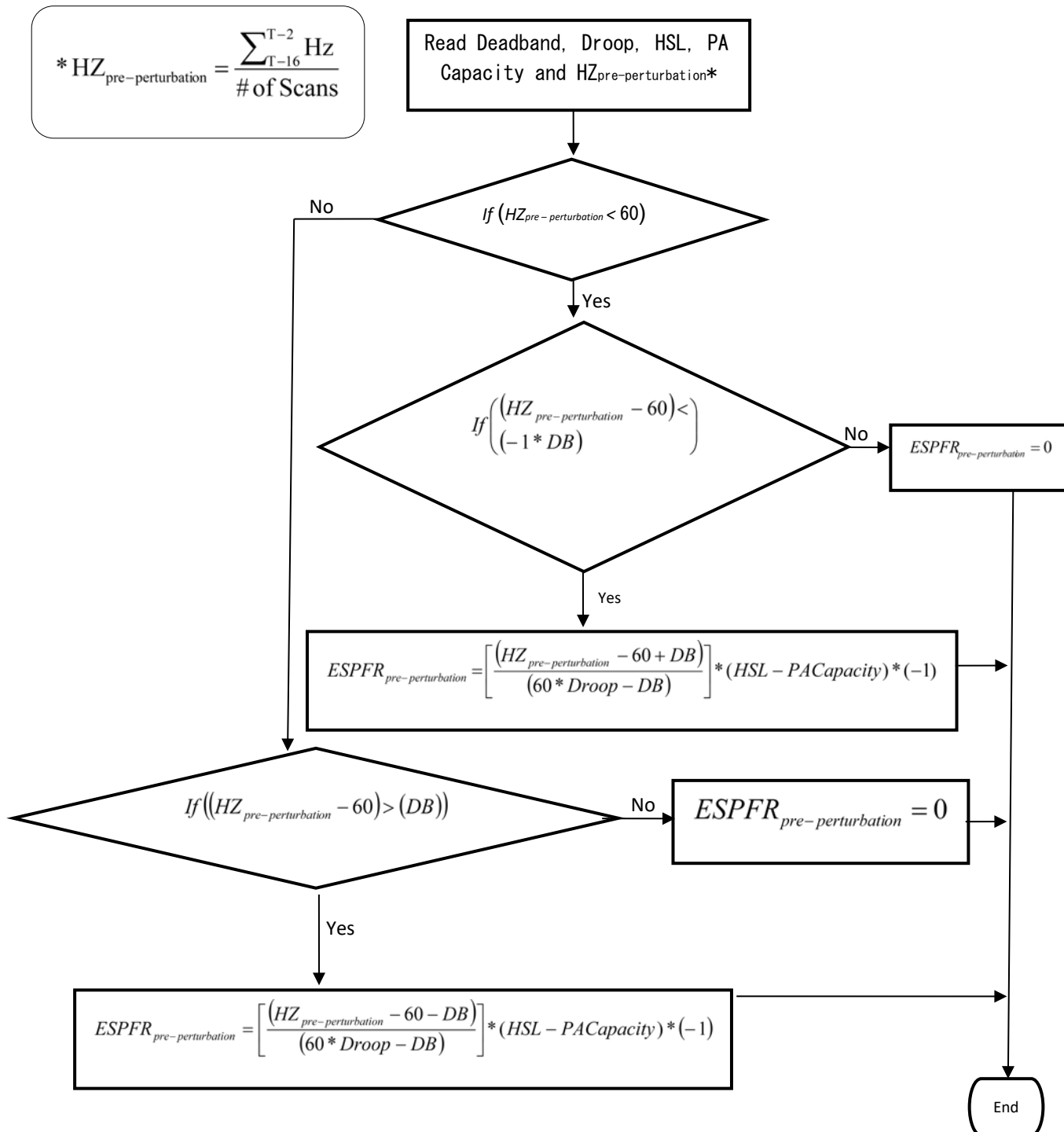


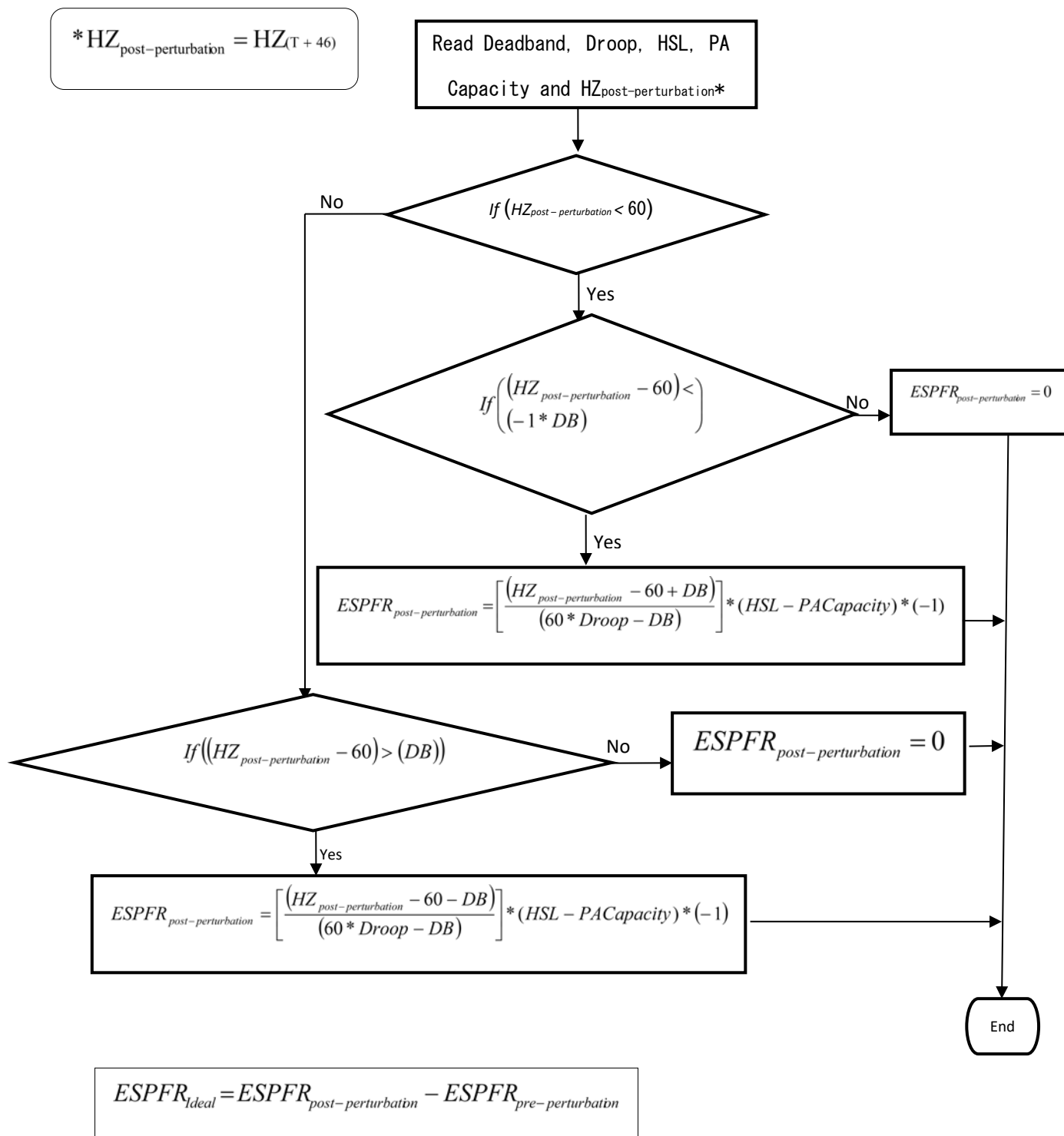
For high frequency events:

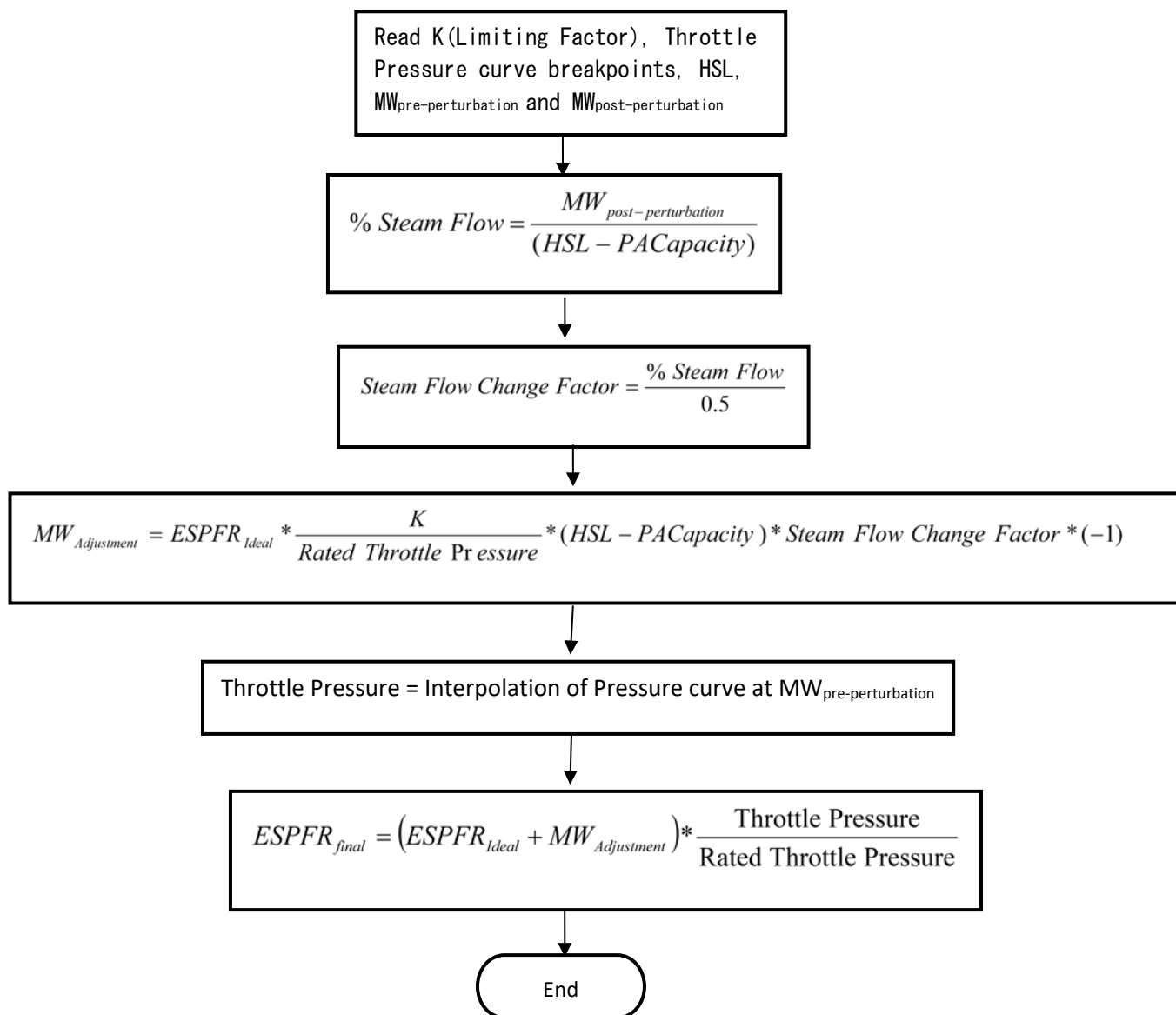
**Expected Sustained Primary Frequency Response Calculation**

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Use the droop and deadband as required by R6. For Combined Cycle Facility evaluation as a single resource (includes MW production of the steam turbine generator), the EPFR will use 5.78% droop in all calculations.

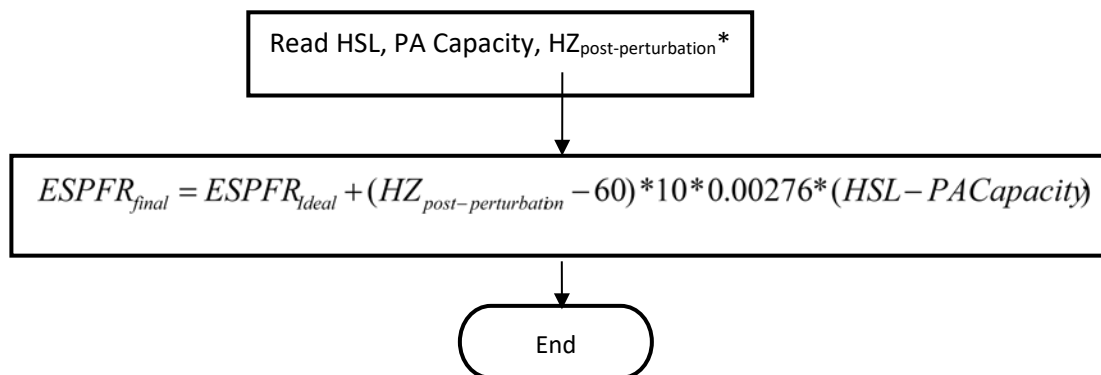


BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

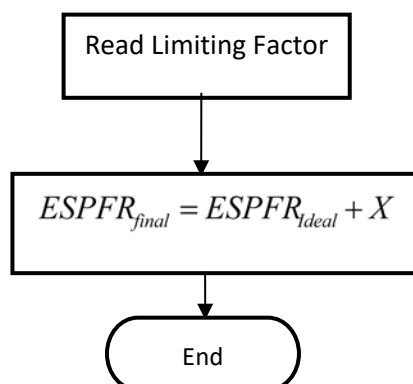
BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region**Adjustment for Steam Turbine**

$MW_{post-perturbation}$ = Maximum (MW_{T+46} : MW_{T+60}) for low frequency events.

$MW_{post-perturbation}$ = Minimum (MW_{T+46} : MW_{T+60}) for high frequency events.

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region**Adjustment for Combustion Turbines and Combined Cycle Facilities**

0.00276 is the MW/0.1 Hz change per MW of Capacity and represents the MW change in generator output due to the change in mass flow through the combustion turbine due to the speed change of the turbine during the post-perturbation measurement period. (This factor is based on empirical data from a major 2003 event as measured on multiple combustion turbines in ERCOT.)

Adjustment for Other Units

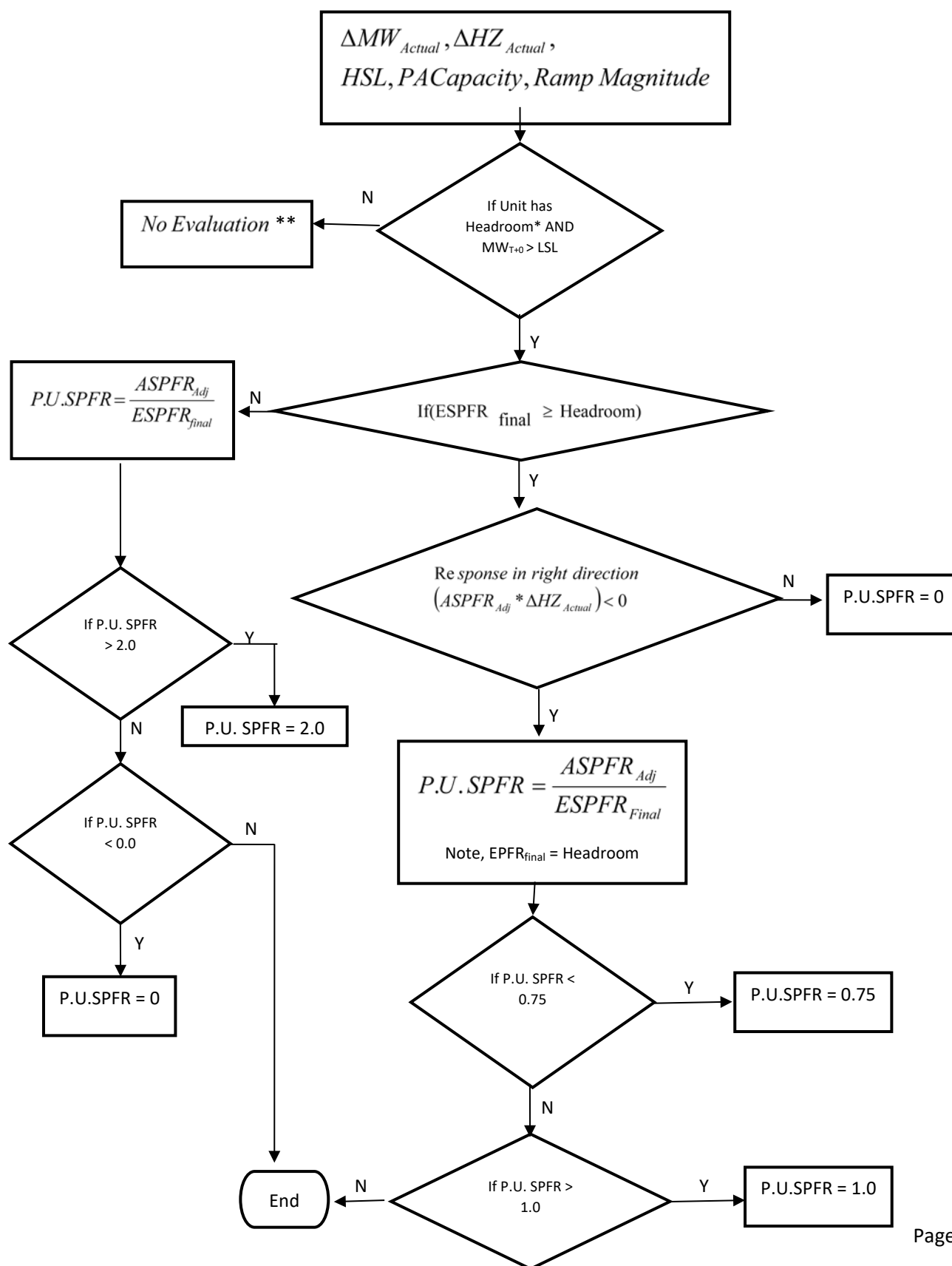
* $HZ_{Actual} = HZ_{(T + 46)}$

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

This adjustment Factor X will be developed to properly model the delivery of PFR due to known and approved technical limitations of the resource. X may be adjusted by the BA and may be variable across the operating range of a resource.

P.U. Sustained Primary Frequency Response Calculation

$$* HZ_{\text{Actual}} = HZ_{(T + 46)}$$

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

*Check for adequate up headroom, low frequency events. Headroom must be greater than either 5MW or 2% of (HSL less PA Capacity), whichever is larger. If a unit does not have adequate up headroom, the unit is considered operating at full capacity and will not be evaluated for low frequency events.

Check for adequate down headroom, high frequency events. Headroom must be greater than either 5MW or 2% of (HSL less PA Capacity), whichever is larger. If a unit does not have adequate down headroom, the unit is considered operating at low capacity and will not be evaluated for high frequency events.

For low frequency events:

$$Headroom = HSL - PACapacity - MW_{T-2}$$

For high frequency events:

$$Headroom = MW_{T-2} - LSL$$

**No further evaluation is required for Sustained Primary Frequency Response. This event will not be included in the Rolling Average calculation of either Initial or Sustained Primary Frequency Response.

T = Time in Seconds

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

Revision History

Version	Date	Action	Change Tracking
1	7/25/2011	Approved by SDT and submitted to Texas RE RSC for approval to post for regional ballot	
1.1	12/7/2012	Approved by SDT for submission to Texas RE RSC for approval to post for second regional ballot.	Changed sustained measure from average over event recovery period to point at 46 seconds after FME, and other changes to respond to field trial results, comments, and corrections.
1.1	3/6/2013	Texas RE RSC approves submittal to Texas RE Board	
1.1	4/23/2013	Texas RE Board approves submittal to NERC and FERC	
1.1	9/18/2013	NERC and Texas RE file Petition for approval to FERC	
1.1	1/16/2014	Approved by FERC	
1.2	5/21/2015	Texas RE Board approves revisions to Attachment 2 Primary Frequency Response Reference Document	<p>For clarification and consistency of the equations used in the Attachment, changes performed to:</p> <ul style="list-style-type: none"> - “T” in the equations refers to the start of the Frequency Measurable Event. - “T-2” nomenclature utilized for clarity rather than “t(-2)” (applicable to numerous equations) - Removed floating x in $EPFR_{final}$ for Steam Turbine equation - Corrected sign convention for Expected Sustained Primary Frequency Response to match the calculation for expected primary frequency response. Corrected Adjusted MW for $ESPFR_{final}$ for Steam Turbine by multiplying -1 to calculate proper value. - On Steam Flow Change Factor removed floating x and reinserted PA Capacity. - Clarified Footnote 5 for scenario of high frequency event for setting LSL as operating margin (similar to HSL for low frequency events). - Clarified in flowcharts for both P.U. Initial Primary & Sustained

BAL-001-TRE-2 — Primary Frequency Response in the ERCOT Region

			<p>Frequency Response Calculations:</p> <ul style="list-style-type: none"> ○ Unit needs to have Headroom and be above LSL to be scored. ○ Cap EPFR_{final} at value of Headroom on unit - Per RSC 5/11/2015, all references to “Final” were changed to “final”. - Per RSC 5/11/2015, P.U.PFR and P.U.S.PFR removed italics in flowcharts.
1.3	11/14/2016	RSC approves minor changes to Attachment 2 Primary Frequency Response Reference Document	Replaced Reliability Standards Committee with Members Representative Committee to conform with changes to the Texas RE bylaws and regional standards development process.
1.3	12/07/2016	Texas RE Board approves minor changes to Attachment 2 Primary Frequency Response Reference Document.	Replaced Reliability Standards Committee with Members Representative Committee to conform with changes to the Texas RE bylaws and regional standards development process.
2.0	MM/DD/YYYY		<p>Removed the requirement for Governor droop and deadband settings for Steam turbines of combined cycle resources.</p> <p>Edited Requirements R9.3 and R10.3 to reflect the current process for submitting an exclusion request.</p> <p>Removed Attachment 1, which is the implementation plan for Regional Standard BAL-001-TRE-1. Changed numbering on Attachment 2 to Attachment 1</p>

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

A. Introduction

1. **Title:** Primary Frequency Response in the ERCOT Region
2. **Number:** BAL-001-TRE-21
3. **Purpose:** To maintain Interconnection steady-state frequency within defined limits.
4. **Applicability:**

4.1. Functional Entities:

- 4.1.1 Balancing Authority
- 4.1.2 Generator Owners
- 4.1.3 Generator Operators

4.2. Exemptions

- 4.2.1 Existing generating facilities regulated by the U.S. Nuclear Regulatory Commission prior to the Effective Date are exempt from Standard BAL-001-TRE-21.
- 4.2.2 Generating units/generating facilities while operating in synchronous condenser mode are exempt from Standard BAL-001-TRE-21.
- 4.2.3 Any generators that are not required by the Balancing Authority to provide primary frequency response are exempt from this standard.

5. **Effective Date:** See Implementation Plan for Regional Standard BAL-001-TRE-2.
6. **Background:** The ERCOT Interconnection was initially given a waiver of BAL-001 R2 (Control Performance Standard CPS2). In FERC Order 693, NERC was directed to develop a Regional Standard as an alternate means of assuring frequency performance in the ERCOT Interconnection. NERC was explicitly directed to incorporate key elements of the existing Protocols, Section 5.98.5. This required governors to be in service and performing with an un-muted response to assure an Interconnection minimum Frequency Response to a Frequency Measurable Event (FME) (that starts at t(0)).

This Regional Standard provides requirements related to identifying Frequency Measureable Events, calculating the Primary Frequency Response of each resource in the Region, calculating the Interconnection minimum Frequency Response and monitoring the actual Frequency Response of the Interconnection, setting Governor deadband and droop parameters, and providing Primary Frequency Response performance requirements.

Under this standard, two Primary Frequency Response (PFR) performance measures are calculated: “initial” and “sustained.” The initial PFR performance (R9) measures the actual response compared to the expected response in the period from 20 to 52

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

seconds after an FME starts. The sustained PFR performance (R10) measures the best actual response between 46 and 60 seconds after t(0) compared to the expected response based on the system frequency at a point 46 seconds after t(0).

In this [Regional Standard](#) the term “resource” is synonymous with “generating unit/generating facility”.

B. Requirements and Measures

- R1.** The Balancing Authority shall identify Frequency Measurable Events (FMEs), and within 14 calendar days after each FME the Balancing Authority shall notify the Compliance Enforcement Authority and make FME information (time of FME (t(0)), pre-perturbation average frequency, post- perturbation average frequency) publicly available. *[Violation Risk Factor – Lower] [Time Horizon – Operations Assessment]*
- M1.** The Balancing Authority shall have evidence it reported each FME to the Compliance Enforcement Authority and that it made FME information publicly available within 14 calendar days after the FME as required in Requirement R1.
- R2.** The Balancing Authority shall calculate the Primary Frequency Response of each generating unit/generating facility in accordance with this standard and the Primary Frequency Response Reference Document.¹ This calculation shall provide a 12-month rolling average of initial and sustained Primary Frequency Response performance. This calculation shall be completed each month for the preceding 12 calendar months. *[Violation Risk Factor = Lower] [Time Horizon = Operations Assessment]*
 - 2.1.** The performance of a combined cycle facility will be determined using an expected performance droop of 5.78%.
 - 2.2.** The calculation results shall be submitted to the Compliance Enforcement Authority and made available to the Generator Owner by the end of the month in which they were completed.
 - 2.3.** If a generating unit/generating facility has not participated in a minimum of (8) eight FMEs in a 12-month period, its performance shall be based on a rolling eight FME average response.

¹ The Primary Frequency Response Reference Document contains the calculations that the Balancing Authority will use to determine Primary Frequency Response performance of generating units/generating facilities. This reference document is a Texas RE-controlled document that is subject to revision by the Texas RE Board of Directors.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

- M2.** The Balancing Authority shall have evidence it calculated and reported the rolling average initial and sustained Primary Frequency Response performance of each generating unit/generating facility monthly as required in Requirement R2.
- R3.** The Balancing Authority shall determine the Interconnection minimum Frequency Response (IMFR) in December of each year for the following year, and make the IMFR, the methodology for calculation and the criteria for determination of the IMFR publicly available. *[Violation Risk Factor = Lower] [Time Horizon = Operations Planning]*
- M3.** The Balancing Authority shall demonstrate that the IMFR was determined in December of each year per [per](#) Requirement R3. The Balancing Authority shall demonstrate that the IMFR, the methodology for calculation and the criteria for determination of the IMFR are publicly available.
- R4.** After each calendar month in which one or more FMEs occurs, the Balancing Authority shall determine and make publicly available the Interconnection's combined Frequency Response performance for a rolling average of the last six (6) FMEs by the end of the following calendar month. *[Violation Risk Factor = Medium] [Time Horizon = Operations Planning]*
- M4.** The Balancing Authority shall provide evidence that the rolling average of the Interconnection's combined Frequency Response performance for the last six (6) FMEs was calculated and made public per Requirement R4.
- R5.** Following any FME that causes the Interconnection's six-FME rolling average combined Frequency Response performance to be less than the IMFR, the Balancing Authority shall direct any necessary actions to improve Frequency Response, which may include, but are not limited to, directing adjustment of Governor deadband and/or droop settings. *[Violation Risk Factor = Medium] [Time Horizon = Operations Planning]*
- M5.** The Balancing Authority shall provide evidence that actions were taken to improve the Interconnection's Frequency Response if the Interconnection's six-FME rolling average combined Frequency Response performance was less than the IMFR, per Requirement R5.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

R6. Each Generator Owner shall set its Governor parameters as follows:

- 6.1.** Limit Governor deadbands within those listed in Table 6.1, unless directed otherwise by the Balancing Authority.

Table 6.1 Governor Deadband Settings

Generator Type	Max. Deadband
Steam and Hydro Turbines with Mechanical Governors	+/- 0.034 Hz
All Other Generating Units/Generating Facilities*	+/- 0.017 Hz

- 6.2.** Limit Governor droop settings such that they do not exceed those listed in Table 6.2, unless directed otherwise by the Balancing Authority.

Table 6.2 Governor Droop Settings

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

~~**Steam Turbines of combined cycle resources are required to comply with Requirements R6.1, R6.2 and R6.3. Compliance with Requirements R9 and R10 will be determined through evaluation of the combined cycle facility using an expected performance droop of 5.78%.~~

*Requirements R6.1, R6.2, and R6.3 are not applicable to steam turbine(s) of a combined cycle resource.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

- 6.3.** For digital and electronic Governors, once frequency deviation has exceeded the Governor deadband from 60.000 Hz, the Governor setting shall follow the slope derived from the formula below.

Where

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

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

MWGCS is the maximum megawatt control range of the Governor control system. For mechanical Governors, droop will be proportional from the deadband by design. *[Violation Risk Factor = Medium] [Time Horizon = Operations Planning]*

- M6.** Each Generator Owner shall have evidence that it set its Governor parameters in accordance with Requirement R6. Examples of evidence include but are not limited to:
- Governor test reports
 - Governor setting sheets
 - Performance monitoring reports
- R7.** Each Generator Owner shall operate each generating unit/generating facility that is connected to the interconnected transmission system with the Governor in service and responsive to frequency when the generating unit/generating facility is online and released for dispatch, unless the Generator Owner has a valid reason for operating with the Governor not in service and the Generator Operator has been notified that the Governor is not in service. *[Violation Risk Factor = Medium] [Time Horizon = Real-time Operations]*
- M7.** Each Generator Owner shall have evidence that it notified the Generator Operator as soon as practical each time it discovered a Governor not in service when the generating unit/generating facility was online and released for dispatch. Evidence may include but not be limited to: operator logs, voice logs, or electronic communications.
- R8.** Each Generator Operator shall notify the Balancing Authority as soon as practical but within 30 minutes of the discovery of a status change (in service, out of service) of a Governor. *[Violation Risk Factor = Medium][Time Horizon = Real-time Operations]*

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

- M8.** Each Generator Operator shall have evidence that it notified the Balancing Authority within 30 minutes of each discovery of a status change (in service, out of service) of a Governor.
- R9.** Each Generator Owner shall meet a minimum 12-month rolling average initial Primary Frequency Response performance of 0.75 on each generating unit/generating facility, based on participation in at least eight FMEs.
- 9.1.** The initial Primary Frequency Response performance shall be the ratio of the Actual Primary Frequency Response to the Expected Primary Frequency Response during the initial measurement period following the FME.
- 9.2.** If a generating unit/generating facility has not participated in a minimum of eight FMEs in a 12-month period, performance shall be based on a rolling eight-FME average.
- 9.3.** A generating unit/generating facility's initial Primary Frequency Response performance during an FME may be excluded from the rolling average calculation by the Balancing Authority due to a legitimate operating condition that prevented normal Primary Frequency Response performance. Examples of legitimate operating conditions that may support exclusion of FMEs include, but are not limited to:
- Operation at or near auxiliary equipment operating limits (such as boiler feed pumps, condensate pumps, pulverizers, and forced draft fans);
 - Data telemetry failure. The ~~Compliance Enforcement Authority~~ Balancing Authority may request raw data from the Generator Owner as a substitute.

[Violation Risk Factor = Medium] [Time Horizon = Operations Assessment]

- M9.** Each Generator Owner shall have evidence that each of its generating units/generating facilities achieved a minimum rolling average of initial Primary Frequency Response performance level of at least 0.75 as described in Requirement R9. Each Generator Owner shall have documented evidence of any FMEs where the generating unit performance ~~should be~~ was excluded from the rolling average calculation.
- R10.** Each Generator Owner shall meet a minimum 12-month rolling average sustained Primary Frequency Response performance of 0.75 on each generating unit/generating facility, based on participation in at least eight FMEs. *[Violation Risk Factor = Medium] [Time Horizon = Operations Assessment]*

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

10.1. The sustained Primary Frequency Response performance shall be the ratio of the Actual Primary Frequency Response to the Expected Primary Frequency Response during the sustained measurement period following the FME.

10.2. If a generating unit/generating facility has not participated in a minimum of eight FMEs in a 12-month period, performance shall be based on a rolling eight- FME average.

10.3. A generating unit/generating facility's sustained Primary Frequency Response performance during an FME may be excluded from the rolling average calculation by the Balancing Authority due to a legitimate operating condition that prevented normal Primary Frequency Response performance. Examples of legitimate operating conditions that may support exclusion of FMEs include, but are not limited to:

- Operation at or near auxiliary equipment operating limits (such as boiler feed pumps, condensate pumps, pulverizers, and forced draft fans);
- Data telemetry failure. The Balancing Authority Compliance Enforcement Authority may request raw data from the Generator Owner as a substitute.

M10. Each Generator Owner shall have evidence that each of its generating units/generating facilities achieved a minimum rolling average of sustained Primary Frequency Response performance of at least 0.75 as described in Requirement R10. Each Generator Owner shall have documented evidence of any Frequency Measurable Events where generating unit performance should be was excluded from the rolling average calculation.

C. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority: "Compliance Enforcement Authority" means NERC or the Regional Entity, or any entity as otherwise designated by an Applicable Governmental Authority, in their respective roles of monitoring and/or enforcing compliance with mandatory and enforceable Reliability Standards in their respective jurisdictions.

1.2. Compliance Monitoring Period and Reset Time Frame: If a generating unit/generating facility completes a mitigation plan and implements corrective action(s) to meet requirements R9 and R10 of the standard, and if approved by the BA and Compliance Enforcement Authority, then the generating unit/generating facility may begin a new rolling event average performance on the next performance during an FME. This will count as the first event in the performance calculation and the entity will have an average frequency performance score after 12 successive months or eight events per R9 and R10.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

1.3. Evidence Retention: The following evidence retention period(s) identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full-time period since the last audit.

The applicable entity 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.

The Balancing Authority, Generator Owner, and Generator Operator 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:

- The Balancing Authority shall retain a list of identified [Frequency Measurable Events](#) ~~FMEs~~ and shall retain FME information since its last compliance audit for Requirement R1, Measure M1.
- The Balancing Authority shall retain all monthly PFR performance reports since its last compliance audit for Requirement R2, Measure M2.
- The Balancing Authority shall retain all annual IMFR calculations, and related methodology and criteria documents, relating to time periods since its last compliance audit for Requirement R3, Measure M3.
- The Balancing Authority shall retain all data and calculations relating to the Interconnection's [combined](#) Frequency Response [performance](#), and all evidence of actions taken to increase the Interconnection's [combined](#) Frequency Response [performance](#), since its last compliance audit for Requirements R4 and R5, Measures M4 and M5.
- Each Generator Operator shall retain evidence since its last compliance audit for Requirement R8, Measure M8.
- Each Generator Owner shall retain evidence since its last compliance audit for Requirements R6, R7, R9 and R10, Measures M6, M7, M9 and M10.

If an entity is found non-compliant, it shall retain information related to the non-compliance until found compliant, or for the duration specified above, whichever is longer.

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

1.4. Compliance Monitoring and Enforcement Program: As defined in the NERC Rules of Procedure, “Compliance Monitoring and Enforcement Program” refers to the identification of the processes that will be used to evaluate data or information for the purpose of assessing performance or outcomes with the associated Reliability Standard.

Compliance Audits

Self-Certifications

Spot Checking

Compliance Violation Investigations

Self-Reporting

Complaints

Violation Severity Levels

R #	Violation Severity Levels			
	Lower VSL	Moderate VSL	High VSL	Severe VSL
R1.	The Balancing Authority reported an FME more than 14 days but less than 31 days after identification of the event.	The Balancing Authority reported an FME more than 30 days but less than 51 days after identification of the event.	The Balancing Authority reported an FME more than 50 days but less than 71 days after identification of the event.	The Balancing Authority reported an FME more than 70 days after identification of the event.
R2.	The Balancing Authority submitted a monthly report more than one month but less than 51 days after the end of the reporting month.	The Balancing Authority submitted a monthly report more than 50 days but less than 71 days after the end of the reporting month.	The Balancing Authority submitted a monthly report more than 70 days but less than 91 days after the end of the reporting month.	The Balancing Authority failed to submit a monthly report within 90 days after the end of the reporting month.
R3.	The Balancing Authority did not make the calculation and criteria for determination of the IMFR publicly available.	The Balancing Authority did not make the IMFR publicly available.	The Balancing Authority did not calculate the IMFR for the following year in December.	The Balancing Authority did not calculate the IMFR for a calendar year.
R4.	N/A	N/A	The Balancing Authority did not make public the six-FME rolling average Interconnection combined Frequency Response by the end of the following month.	The Balancing Authority did not calculate the six-FME rolling average Interconnection combined Frequency Response for any month in which an FME occurred.
R5.	N/A	N/A	N/A	The Balancing Authority did not take action to improve

				Frequency Response when the Interconnection's rolling-average combined Frequency Response performance was less than the IMFR.
R6.	Any Governor parameter setting was $> 10\%$ and $\leq 20\%$ outside setting range specified in R6.	Any Governor parameter setting was $> 20\%$ and $\leq 30\%$ outside setting range specified in R6.	Any Governor parameter setting was $> 30\%$ and $\leq 40\%$ outside setting range specified in R6.	Any Governor parameter setting was $> 40\%$ outside setting range specified in R6, – OR – an electronic or digital Governor was set to step into the droop curve.
R7.	N/A	N/A	N/A	The Generator Owner operated with its Governor out of service and did not notify the Generator Operator upon discovery of its Governor out of service.
R8	The Generator Operator notified the Balancing Authority of a change in Governor status between 31 minutes and one hour after the General Operator was notified of the discovery of the change.	The General Operator notified the Balancing Authority of a change in Governor status more than 1 hour but within 4 hours after the Generator Operator was notified of the discovery of the change.	The Generator Operator notified the Balancing Authority of a change in Governor status more than 4 hours but within 24 hours after the Generator Operator was notified of the discovery of the change.	The Generator Operator failed to notify the Balancing Authority of a change in Governor status within 24 hours after the Generator Operator was notified of the discovery of the change.

R9	A Generator Owner's rolling average initial Primary Frequency Response performance per R9 was < 0.75 and \geq 0.65.	A Generator Owner's rolling average initial Primary Frequency Response performance per R9 was < 0.65 and \geq 0.55.	A Generator Owner's rolling average initial Primary Frequency Response performance per R9 was < 0.55 and \geq 0.45.	A Generator Owner's rolling average initial Primary Frequency Response performance per R9 was < 0.45.
R10	A Generator Owner's rolling average sustained Primary Frequency Response performance per R10 was < 0.75 and \geq 0.65.	A Generator Owner's rolling average sustained Primary Frequency Response performance per R10 was < 0.65 and \geq 0.55.	A Generator Owner's rolling average sustained Primary Frequency Response performance per R10 was < 0.55 and \geq 0.45.	A Generator Owner's rolling average sustained Primary Frequency Response performance per R10 was < 0.45.

D. Regional Variances

None

E. Associated Documents

Regional Standard BAL-001-TRE-2 Implementation Plan

BAL-001-TRE-~~21~~ — Primary Frequency Response in the ERCOT Region**Version History**

Version	Date	Action	Change Tracking
1	8/15/2013	Adopted by NERC Board of Trustees	
1	1/16/2014	FERC Order issued approving BAL-001-TRE-1. (Order becomes effective April 1, 2014.)	
<u>2</u>	<u>MM/DD/YYYY</u>		<p><u>Removed the requirement Governor droop and deadband settings for Steam Turbine(s) of combined cycle resources.</u></p> <p><u>-Edited Requirements R9.3 and R10.3 to reflect the current process and legitimate operating conditions for submitting an FME exclusion request.</u></p> <p><u>Removed Attachment 1, which is the implementation plan for Regional Standard BAL-001-TRE-1.</u></p>

Standard Attachments

~~1. Attachment 1 – Implementation Plan.~~

12. Attachment 12 – Primary Frequency Response Reference Document, including Flow Charts A and B.

- a. This document provides implementation details for calculating Primary Frequency Response performance as required by Requirements R2, R9 and R10. This reference document is a Texas RE-controlled document that is subject to revision by the Texas RE Board of Directors. It is not part of the FERC-approved regional standard.
- b. The following process will be used to revise the Primary Frequency Response Reference Document. A Primary Frequency Response Reference Document revision request may be submitted to the Texas RE Reliability Standards Manager, who will present the revision request to the Texas RE Member Representatives Committee (MRC) for consideration. The revision request will be posted in accordance with MRC procedures. The MRC shall discuss the revision request in a public meeting, and will accept and consider verbal and written comments pertaining to the request. The MRC will make a recommendation to the Texas RE Board of Directors, which may adopt the revision request, reject it, or adopt it with modifications. Any approved revision to the Primary Frequency Response Reference Document shall be filed with NERC and FERC for informational purposes.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

Attachment 12**Primary Frequency Response Reference Document**

Texas Reliability Entity, Inc.
BAL-001-TRE-12
Requirements R2, R9, and R10
Performance Metric Calculations

I. Introduction

This Primary Frequency Response Reference Document provides a methodology for determining the Primary Frequency Response (PFR) performance of individual generating units/generating facilities following Frequency Measurable Events (FMEs) in accordance with Requirements R2, R9 and R10. Flowcharts in Attachment A (Initial PFR) and Attachment B (Sustained PFR) show the logic and calculations in graphical form, and they are considered part of this Primary Frequency Response Reference Document. Several Excel spreadsheets implementing the calculations described herein for various types of generating units are available¹ for reference and use in understanding and performing these calculations.

This Primary Frequency Response Reference Document is not considered to be a part of the regional standard. This document ~~will be~~ maintained by Texas RE and ~~will be~~ subject to modifications as approved by the Texas RE Board of Directors, without being required to go through the formal Standard Development Process.

Revision Process: The following process will be used to revise the Primary Frequency Response Reference Document. A Primary Frequency Response Reference Document revision request may be submitted to the Texas RE Reliability Standards Manager, who will present the revision request to the Texas RE Member Representatives Committee (MRC) for consideration. The MRC shall discuss the revision request in a public meeting, and will accept and consider verbal and written comments pertaining to the request. The MRC will make a recommendation to the Texas RE Board of Directors, which may adopt the revision request, reject it, or adopt it with modifications. Any approved revision to the Primary Frequency Response Reference Document shall be filed with NERC and FERC for informational purposes.

As used in this document the following terms are defined as shown:

High Sustained Limit (HSL) for a generating unit/generating facility: The limit established by the GO/GOP, continuously updatable in Real-Time, that describes the maximum sustained energy production capability of a generating unit/generating facility.

Low Sustained Limit (LSL) for a generating unit/generating facility: The limit established by the GO/GOP, continuously updatable in Real-Time, that describes the minimum sustained energy production capability of a generating unit/generating facility.

In this regional standard, the term “resource” is synonymous with “generating unit/generating facility”.

¹ These spreadsheets are available at www.TexasRE.org.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region**II. Initial Primary Frequency Response Calculations****Requirement 9**

R9. Each Generator Owner shall meet a minimum 12-month rolling average initial Primary Frequency Response performance of 0.75 on each generating unit/generating facility, based on participation in at least eight FMEs.

9.1. The initial Primary Frequency Response performance shall be the ratio of the Actual Primary Frequency Response to the Expected Primary Frequency Response during the initial measurement period following the FME.

9.2. If a generating unit/generating facility has not participated in a minimum of eight FMEs in a 12-month period, performance shall be based on a rolling eight-FME average response.

9.3. A generating unit/generating facility's initial Primary Frequency Response performance during an FME may be excluded by the Balancing Authority from the rolling average calculation due to a legitimate operating condition that prevented normal Primary Frequency Response performance. Examples of legitimate operating conditions that may support exclusion of FMEs include but are not limited to:

- Operation at or near auxiliary equipment operating limits (such as boiler feed pumps, condensate pumps, pulverizers, and forced draft fans);
- Data telemetry failure. The Compliance Enforcement Authority Balancing Authority may request raw data from the Generator Owner as a substitute.

Initial Primary Frequency Response Performance Calculation Methodology

This portion of this PFR Reference Document establishes the process used to calculate initial Primary Frequency Response performance for each Frequency Measurable Event (FME), and then average the events over a 12-month period (or 8-event minimum) to establish whether a resource is compliant with Requirement R9.

This process calculates the initial Per Unit Primary Frequency Response of a resource [$P.U.PFR_{Resource}$] as a ratio between the Adjusted Actual Primary Frequency Response ($APFR_{Adj}$), adjusted for the pre-event ramping of the unit, and the Final Expected Primary Frequency Response ($EPFR_{final}$) as calculated using the Pre-perturbation and Post-perturbation time periods of the initial measure.

This comparison of actual performance to a calculated target value establishes, for each type of resource, the initial Per Unit Primary Frequency Response [$P.U.PFR_{Resource}$] for any Frequency Measurable Event (FME).

Initial Primary Frequency Response performance requirement

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

where Where $P.U.PFR_{Resource}$ $P.U.PFR_{Resource}$ is the per unit measure of the initial Primary Frequency Response of a resource during identified FMEs.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

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

~~where~~ Where P.U.PFR_{Resource} for each FME is limited to values between 0.0 and 2.0.

The Adjusted Actual Primary Frequency Response (APFR_{Adj}) and the Final Expected Primary Frequency Response (EPFR_{final}) are calculated as described below.

EPFR Calculations use droop and deadband values as stated in Requirement R6 with the exception of combined-cycle facilities while being evaluated as a single resource (MW production of both the combustion turbine generator and the steam turbine generator are included in the evaluation) where the evaluation droop will be 5.78%.²

Actual Primary Frequency Response (APFR_{adj})

The adjusted Actual Primary Frequency Response (APFR_{adj}) is the difference between Post-perturbation Average MW and Pre-perturbation Average MW, including the ramp magnitude adjustment.

$$APFR_{\text{adj}} = MW_{\text{post-perturbation}} - MW_{\text{pre-perturbation}} - \text{Ramp Magnitude}$$

~~where~~ Where:

Pre-perturbation Average MW: Actual MW averaged from T-16 to T-2

$$MW_{\text{pre-perturbation}} = \frac{\sum_{T-16}^{T-2} MW}{\# \text{ Scans}}$$

Post-perturbation Average MW: Actual MW averaged from T+20 to T+52

$$MW_{\text{post-perturbation}} = \frac{\sum_{T+20}^{T+52} MW}{\# \text{ Scans}}$$

² The effective droop of a typical combined-cycle facility with governor settings per Requirement R6 is 5.78%, assuming a 2-to-1 ratio between combustion turbine capacity and steam turbine capacity. Use 5.78% effective droop in all combined-cycle performance calculations.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

Ramp Adjustment: The Actual Primary Frequency Response number that is used to calculate P.U.PFR is adjusted for the ramp magnitude of the generating unit/generating facility during the pre-perturbation minute. The ramp magnitude is subtracted from the APFR.

$$\text{Ramp Magnitude} = (\text{MW}_{T-4} - \text{MW}_{T-60}) * 0.59$$

$(\text{MW}_{T-4} - \text{MW}_{T-60})$ represents the MW ramp of the generator resource/generator facility for a full minute prior to the event. The factor 0.59 adjusts this full minute ramp to represent the ramp that should have been achieved during the post-perturbation measurement period.

Expected Primary Frequency Response (EPFR)

For all generator types, the *ideal* Expected Primary Frequency Response ($\text{EPFR}_{\text{ideal}}$) is calculated as the difference between the $\text{EPFR}_{\text{post-perturbation}}$ and the $\text{EPFR}_{\text{pre-perturbation}}$.

$$\text{EPFR}_{\text{ideal}} = \text{EPFR}_{\text{post-perturbation}} - \text{EPFR}_{\text{pre-perturbation}}$$

When the frequency is outside the Governor deadband and above 60Hz:

$$\text{EPFR}_{\text{pre-perturbation}}$$

$$= \left[\frac{(\text{HZ}_{\text{pre-perturbation}} - 60.0 - \text{deadband}_{\text{max}})}{(60 \times \text{droop}_{\text{max}} - \text{deadband}_{\text{max}})} \times (-1) \times (\text{HSL} - \text{PA Capacity}) \right]$$

$$\text{EPFR}_{\text{post-perturbation}}$$

$$= \left[\frac{(\text{HZ}_{\text{post-perturbation}} - 60.0 - \text{deadband}_{\text{max}})}{(60 \times \text{droop}_{\text{max}} - \text{deadband}_{\text{max}})} \times (-1) \times (\text{HSL} - \text{PA Capacity}) \right]$$

When the frequency is outside the Governor deadband and below 60Hz:

$$\text{EPFR}_{\text{pre-perturbation}}$$

$$= \left[\frac{(\text{HZ}_{\text{pre-perturbation}} - 60.0 + \text{deadband}_{\text{max}})}{(60 \times \text{droop}_{\text{max}} - \text{deadband}_{\text{max}})} \times (-1) \times (\text{HSL} - \text{PA Capacity}) \right]$$

$$\text{EPFR}_{\text{post-perturbation}}$$

$$= \left[\frac{(\text{HZ}_{\text{post-perturbation}} - 60.0 + \text{deadband}_{\text{max}})}{(60 \times \text{droop}_{\text{max}} - \text{deadband}_{\text{max}})} \times (-1) \times (\text{HSL} - \text{PA Capacity}) \right]$$

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

For each formula, when frequency is within the Governor deadband the appropriate EPFR value is zero. The $deadband_{max}$ and $droop_{max}$ quantities come from Requirement R6.

Where:

Pre-perturbation Average Hz: Actual Hz averaged from T-16 to T-2

$$Hz_{pre - perturbation} = \frac{\sum_{T-16}^{T-2} Hz}{\# Scans}$$

Post-perturbation Average Hz: Actual Hz averaged from T+20 to T+52

$$Hz_{post - perturbation} = \frac{\sum_{T+20}^{T+52} Hz}{\# Scans}$$

Capacity and NDC (Net Dependable Capacity) are used interchangeably and the term Capacity will be used in this document. Capacity is the official reported seasonal capacity of the generating unit/generating facility. The Capacity for wind-powered generators is the real time HSL of the wind plant at the time the FME occurred.

Power Augmentation: For Combined Cycle facilities, Capacity is adjusted by subtracting power augmentation (PA) capacity, if any, from the HSL. Other generator types may also have power augmentation that is not frequency responsive. This could be “over-pressure” operation of a steam turbine at valves wide open or operating with a secondary fuel in service. The GO should provide the BA with documentation and conditions when power augmentation is to be considered in PFR calculations.

EPFR_{final} for Combustion Turbines and Combined Cycle Facilities

$$EPFR_{final} = EPFR_{ideal} + (Hz_{post-perturbation} - 60.0) \times 10 \times 0.00276 \times (HSL - PA Capacity)$$

Note: The 0.00276 constant is the MW/0.1 Hz change per MW of Capacity and represents the MW change in generator output due to the change in mass flow through the combustion turbine due to the speed change of the turbine during the post-perturbation measurement period. This factor is based on empirical data from a major 2003 event as measured on multiple combustion turbines in ERCOT.

EPFR_{final} for Steam Turbine

$$EPFR_{final} = (EPFR_{ideal} + MW_{adj}) \times \frac{Throttle Pressure}{Rated Throttle Pressure}$$

where Where:

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

$$MW_{adj} = EPFR_{ideal} \times \frac{K}{\text{Rated Throttle Pressure}} \times (HSL - PA \text{ Capacity}) \times \text{Steam Flow Change Factor} \times -1$$

~~where~~Where:

$$\% \text{ Steam Flow} = \frac{MW_{\text{post-perturbation}}}{(HSL - PA \text{ Capacity})}$$

$$\text{Steam Flow Change Factor} = \frac{\% \text{ Steam Flow}}{0.5}$$

Throttle Pressure = Interpolation of Pressure curve at MW_{pre-perturbation}

The Rated Throttle Pressure and the Pressure curve, based on generator MW output, are provided by the GO to the BA. This pressure curve is defined by up to six pair of Pressure and MW breakpoints where the Rated Throttle Pressure and MW output, where Rated Throttle Pressure is achieved, is the first pair and the Minimum Throttle Pressure and MW output, where the Minimum Throttle Pressure is achieved, as the last pair of breakpoints. If fewer breakpoints are needed, the pair values will be repeated to complete the six pair table.

The K factor is used to model the stored energy available to the resource. The value ranges between 0.0 and 0.6 psig per MW change when responding during a FME. The GO can measure the drop in throttle pressure when the resource is operating near 50% output of the steam turbine during a FME and provide this ratio of pressure change to the BA. K is then adjusted based on rated throttle pressure and resource capacity. An additional sensitivity factor, the Steam Flow Change Factor, is based on resource loading (% steam flow) and further modifies the MW adjustment. This sensitivity factor will decrease the adjustment at resource outputs below 50% and increase the adjustment at outputs above 50%. The GO should determine the fixed K factor for each resource that generally results in the best match between EPFR and APFR (resulting in the highest P.U.PFR_{Resource}). For any generating unit, K will not change unless the steam generator is significantly reconfigured.

EPFR_{final} for Other Generating Units/Generating Facilities

$$EPFR_{final} = EPFR_{ideal} + X$$

~~where~~Where X is an adjustment factor that may be applied to properly model the delivery of PFR. The X factor will be based on known and accepted technical or physical limitations of the resource. X may be adjusted by the BA and may be variable across the operating range of a resource. X shall be zero unless the BA accepts an alternative value.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

III. Sustained Primary Frequency Response Calculations**Requirement 10**

R10. The Generator Owner shall meet a minimum 12-month rolling average sustained Primary Frequency Response performance of 0.75 on each generating unit/generating facility, based on participation in at least eight FMEs.

10.1 The sustained Primary Frequency Response performance shall be the ratio of the Actual Primary Frequency Response to the Expected Primary Frequency Response during the sustained measurement period following the FME.

10.2 If a generating unit/generating facility has not participated in a minimum of eight FMEs in a 12-month period, performance shall be based on a rolling eight-FME average.

10.3 A generating unit/generating facility's sustained Primary Frequency Response performance during an FME may be excluded by the Balancing Authority from the rolling average calculation due to a legitimate operating condition that prevented normal Primary Frequency Response performance. Examples of legitimate operating conditions that may support exclusion of FMEs include, but are not limited to:

- Operation at or near auxiliary equipment operating limits (such as boiler feed pumps, condensate pumps, pulverizers, and forced draft fans);
- Data telemetry failure. The Balancing Authority Compliance Enforcement Authority may request raw data from the Generator Owner as a substitute.

Sustained Primary Frequency Response Performance Calculation Methodology

This portion of this PFR Reference Document establishes the process used to calculate sustained Primary Frequency Response performance for each Frequency Measurable Event (FME), and then average the events over a 12-month period (or 8-event minimum) to establish whether a resource is compliant with Requirement R10.

This process calculates the Per Unit Sustained Primary Frequency Response of a resource $[P.U.SPFR_{Resource}]$ as a ratio between the maximum actual unit response at any time during the period from T+46 to T+60, adjusted for the pre-event ramping of the unit, and the *Final* Expected Primary Frequency Response (EPFR) value at time T+46.³

This comparison of actual performance to a calculated target value establishes, for each type of resource, the Per Unit Sustained Primary Frequency Response $[P.U.SPFR_{Resource}]$ for any Frequency Measurable Event (FME).

Sustained Primary Frequency Response performance requirement:

The standard requires an average performance over a period of 12 months (including at least 8 measured events) that is ≥ 0.75 .

³ The time designations used in this section refer to relative time after an FME occurs. For example, "T+46" refers to 46 seconds after the frequency deviation occurred.

BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

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

$Avg_{Period} [P.U.SPFR_{Resource}]$ is either:

- the average of each resource's sustained Primary Frequency Response performances $[P.U.SPFR_{Resource}]$ during all of the assessable Frequency Measurable Events (FMEs), for the most recent rolling 12 month period; or
- if the unit has not experienced at least 8 assessable FMEs in the most recent 12 month period, the average of the unit's last 8 sustained Primary Frequency Response performances when the unit provided frequency response during a Frequency Measurable Event.

Sustained Primary Frequency Response Calculation (P.U.SPFR)

$$P.U.SPFR_{Resource} = \frac{\text{Actual Sustained Primary Frequency Response}_{Adj}}{\text{Expected Sustained Primary Frequency Response}_{final}}$$

$P.U.SPFR_{Resource}$ is the per unit (P.U.) measure of the sustained Primary Frequency Response of a resource during identified Frequency Measurable Events. For any given event $P.U.SPFR_{Resource}$ for each FME will be limited to values between 0.0 and 2.0.

Actual Sustained Primary Frequency Response (ASPFR) Calculations

$$ASPFR = MW_{MaximumResponse} - MW_{pre-perturbation}$$

~~where~~Where:

Pre-perturbation Average MW: Actual MW averaged from T-16 to T-2.

$$MW_{pre-perturbation} = \frac{\sum_{T-16}^{T-2} MW}{\#Scans}$$

~~and~~And:

$MW_{MaximumResponse}$ = maximum MW value telemetered by a unit from T+46 through T+60 during low frequency events and the minimum MW value telemetered by a unit from T+46 through T+60 during a high frequency event.

Actual Sustained Primary Frequency Response, Adjusted ($ASPFR_{Adj}$)

$$ASPFR_{Adj} = ASPFR - RampMW_{Sustained}$$

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

RampMW Sustained (MW) – The Standard requires a unit/facility to sustain its response to a Frequency Measureable Event. An adjustment available in determining a unit's sustained Primary Frequency Response performance ($P.U.SPFR_{Resource}$) is to account for the direction in which a resource was moving (increasing or decreasing output) when the event occurred $T=t(0)$. This is the *RampMW Sustained* adjustment:

$$RampMW \text{ Sustained} = (MW_{T-4} - MW_{T-60}) \times 0.821$$

Note: The terminology “ MW_{T-4} ” refers to MW output at 4 seconds before the Frequency Measureable Event (FME) occurs at $T=t(0)$.

By subtracting a reading at 4 seconds before, from a reading at 60 seconds before, the formula calculates the MWs a generator moved in the minute (56 seconds) prior to $T=t(0)$. The formula is then modified by a factor to indicate where the generator would have been at $T+46$, had the event not occurred: the “*RampMW Sustained*.” It does this by multiplying the MW change over 56 seconds before the event ($MW_{T-4} - MW_{T-60}$) by a modifier. This extrapolates to an equivalent number of MWs the generator would have changed if it had been allowed to continue on its ramp

$$\frac{46 \text{ seconds}}{56 \text{ seconds}} \text{ or } 0.821.$$

to $T+46$ unencumbered by the FME. The modifier is

Expected Sustained Primary Frequency Response (ESPFR) Calculations

The Expected Sustained Primary Frequency Response ($ESPFR_{final}$) is calculated using the actual frequency at $T+46$, HZ_{T+46} .

This $ESPFR_{final}$ is the MW value a unit should have responded with if it is properly sustaining the output of its generating unit/generating facility in response to an FME. Determination of this value begins with establishing where it would be in an ideal situation; considers proper droop and dead-band values established in Requirement R6, High Sustainable Limit (HSL), Low Sustainable Limit (LSL) and actual frequency. It then allows for adjusting the value to compensate for the various types of Limiting Factors each generating units / generating facilities may have and any Power Augmentation Capacity (PA Capacity) that may be included in the HSL/LSL.

Establishing the Ideal Expected Sustained Primary Frequency Response

For all generator types, the ideal Expected Sustained Primary Frequency Response ($ESPFR_{ideal}$) is calculated as the difference between the $ESPFR_{T+46}$ and the $EPFR_{pre-perturbation}$. The $EPFR_{pre-perturbation}$ is the same $EPFR_{pre-perturbation}$ value used in the Initial measure of R9.

$$ESPFR_{ideal} = ESPFR_{T+46} - EPFR_{pre-perturbation}$$

When the frequency is outside the Governor deadband and above 60Hz:

$$ESPFR_{T+46} = \left[\frac{(HZ_{T+46} - 60 - deadband_{max})}{(droop_{max} \times 60 - deadband_{max})} \times (HSL - PA \text{ Capacity}) \times (-1) \right]$$

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

When the frequency is outside the Governor deadband and below 60Hz:

$$ESPFR_{T+46} = \left[\frac{(HZ_{T+46} - 60 + deadband_{max})}{(droop_{max} \times 60 - deadband_{max})} \times (HSL - PA \text{ Capacity}) \times (-1) \right]$$

Capacity and Net Dependable Capability (NDC) are used interchangeably and the term Capacity will be used in this document. Capacity is the official reported seasonal capacity of the generating unit/generating facility. The capacity for wind-powered generators is the real-time HSL of the wind plant at the time the FME occurred. The $deadband_{max}$ and $droop_{max}$ quantities come from Requirement R6.

For Combined Cycle facilities, determination of Capacity includes subtracting Power Augmentation (PA) Capacity, if any, from the original HSL. Other generator types may also have Power Augmentation that is not frequency responsive. This could be “over-pressure” operation of a steam turbine at valves wide open or operating with a secondary fuel in service. The GO is required to provide the BA with documentation and identify conditions when this augmentation is in service.

ESPFR_{final} for Combustion Turbines and Combined Cycle Facilities

$$ESPFR_{final} = ESPFR_{ideal} + (HZ_{T+46} - 60) * 10 * 0.00276 * (HSL - PACapacity)$$

Note: The 0.00276 constant is the MW/0.1 Hz change per MW of Capacity and represents the MW change in generator output due to the change in mass flow through the combustion turbine due to the speed change of the turbine at HZ_{T+46} . (This is based on empirical data from a major 2003 event as measured on multiple combustion turbines in ERCOT.)

ESPFR_{final} for Steam Turbine

$$ESPFR_{final} = (ESPFR_{ideal} + MW_{Adj}) \times \frac{Throttle \text{ Pressure}}{Rated \text{ Throttle Pressure}}$$

~~where~~Where:

$$MW_{Adj} = ESPFR_{ideal} \times \frac{K}{Rated \text{ Throttle Pressure}} \times (HSL - PACapacity) \times Steam \text{ Flow Change Factor} \times (-1)$$

~~w~~Where:

$$\% \text{ Steam Flow} = \frac{MW_{post-perturbation}}{(HSL - PA \text{ Capacity})}$$

$$Steam \text{ Flow Change Factor} = \frac{\% \text{ Steam Flow}}{0.5}$$

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

Throttle Pressure = Interpolation of Pressure curve at $MW_{pre-perturbation}$

The Rated Throttle Pressure and the Pressure curve, based on generator MW output, are provided by the GO to the BA. This pressure curve is defined by up to six pair of Pressure and MW breakpoints where the Rated Throttle Pressure and MW output where Rated Throttle Pressure is achieved is the first pair and the Minimum Throttle Pressure and MW output where the Minimum Throttle Pressure is achieved as the last pair of breakpoints. If fewer breakpoints are needed, the pair values will be repeated to complete the six pair table.

The K factor is used to model the stored energy available to the resource and ranges between 0.0 and 0.6 psig per MW change when responding during a FME. The GO can measure the drop in throttle pressure, when the resource is operating near 50% output of the steam turbine during a FME and provide this ratio of pressure change to the BA. K is then adjusted based on rated throttle pressure and resource capacity. An additional sensitivity factor, the Steam Flow Change Factor, is based on resource loading (% steam flow) and further modifies the MW adjustment. This sensitivity factor will decrease the adjustment at resource outputs below 50% and increase the adjustment at outputs above 50%. The GO should determine the fixed K factor for each resource that generally results in the best match between ESPFR and ASPFR (resulting in the highest P.U.SPFR_{Resource}). For any generating unit, K will not change unless the steam generator is significantly reconfigured.

ESPFR_{final} for Other Generating Units/Generating Facilities

$$ESPFR_{final} = ESPFR_{ideal} + X$$

~~where~~ Where X is an adjustment factor that may be applied to properly model the delivery of PFR. The X factor will be based on known and accepted technical or physical limitations of the resource. X may be adjusted by the BA and may be variable across the operating range of a resource. X shall be zero unless the BA accepts an alternative value.

IV. Limits on Calculation of Primary Frequency Response Performance (Initial and Sustained):

If the generating unit/generating facility is operating within 2% of its (HSL – PA Capacity) or within 5 MW (whichever is greater) from its applicable operating limit (high or low) at the time an FME occurs (pre-perturbation), then that resource's Primary Frequency Response performance is not evaluated for that FME.

For frequency deviations below 60 Hz ($Hz_{Post-perturbation} < 60$ if:

$$MW_{pre-perturbation} \geq \min([(HSL - PA\ Capacity) \times 0.98], [(HSL - PA\ Capacity) - 5\ MW])$$

then Primary Frequency Response is not evaluated for this FME.

For frequency deviations above 60 Hz ($Hz_{Post-perturbation} > 60$, if:

$$MW_{pre-perturbation} \leq \max[(LSL + [(HSL - PA\ Capacity) \times 0.02]), (LSL + 5\ MW)]$$

then Primary Frequency Response is not evaluated for this FME.

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

Final Expected Primary Frequency Response (EPFR_{final}) is greater than Operating Margin:

Caps and limits exist for resources operating with adequate reserve margin to be evaluated (at least 2% of (HSL less PA Capacity) or 5 MW), but with Expected Primary Frequency Response_{final} greater than the actual margin available.

1. The P.U.PFR_{Resource} will be set to the greater of 0.75 or the calculated P.U.PFR_{Resource} if all of the following conditions are met:
 - a. The generating unit/generating facility's pre-perturbation operating margin (appropriate for the frequency deviation direction) is greater than 2% of its (HSL less PA Capacity) and greater than 5 MW; and
 - b. The Expected Primary Frequency Response_{Final} is greater than the generating unit/generating facility's available frequency responsive Capacity⁴; and
 - c. The generating unit/generating facility's APFR_{adj} response is in the correct direction.
2. When calculation of the P.U.PFR_{Resource} uses the resource's (HSL less PA Capacity) as the maximum expected output, the calculated P.U.PFR_{Resource} will not be greater than 1.0.
3. When calculation of the P.U.PFR_{Resource} uses the resource's LSL as the minimum expected output, the calculated P.U.PFR_{Resource} will not be greater than 1.0.
4. If the APFR_{Adj} is in the wrong direction, then P.U.PFR_{Resource} is 0.0.
5. These caps and limits apply to both the Initial and Sustained Primary Frequency Response measures.

⁴ In this circumstance, when frequency is below 60 Hz, the EPFR_{final} is set to operating margin based on HSL (adjusted for any augmentation capacity) AND when frequency is above 60 Hz, the EPFR_{final} is set to operating margin based on LSL for the purpose of calculating PUPFR_{resource}.

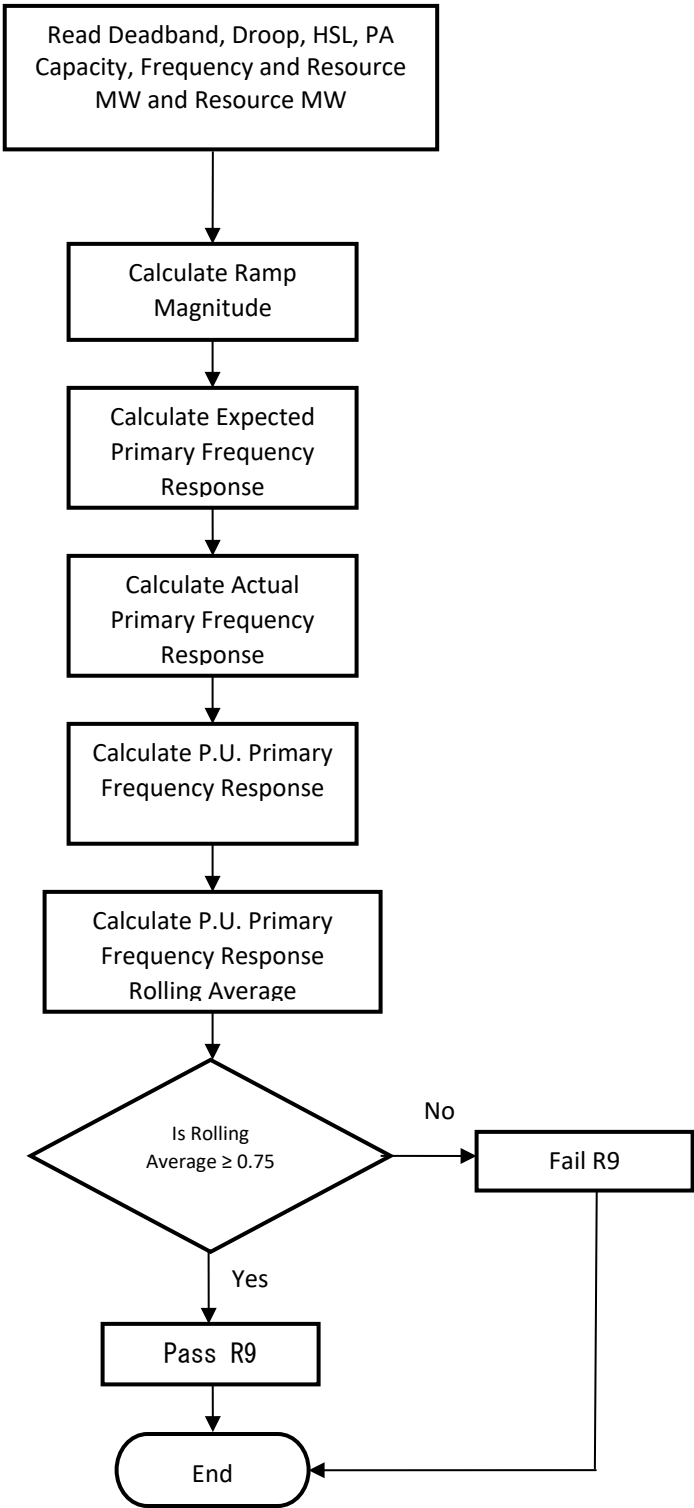
**Attachment A to
Primary Frequency Response Reference Document**

**Initial Primary Frequency Response Methodology for
BAL-001-TRE-~~21~~**

BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

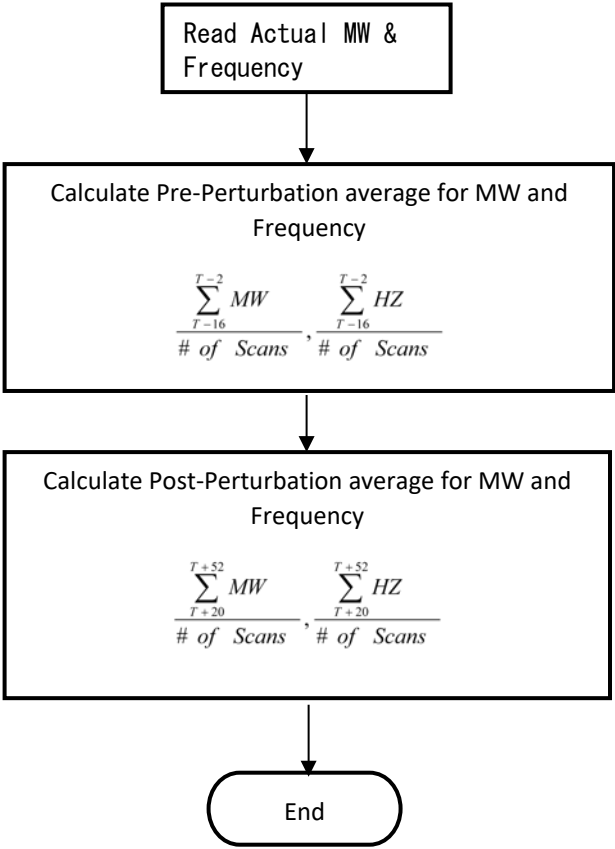
Primary Frequency Response Measurement and Rolling Average Calculation – Initial Response

PA=Power Augmentation
HSL=High Sustained Limit

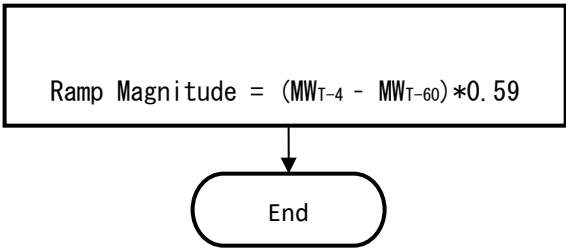


BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

Pre/Post-Perturbation Average MW and Average Frequency Calculations

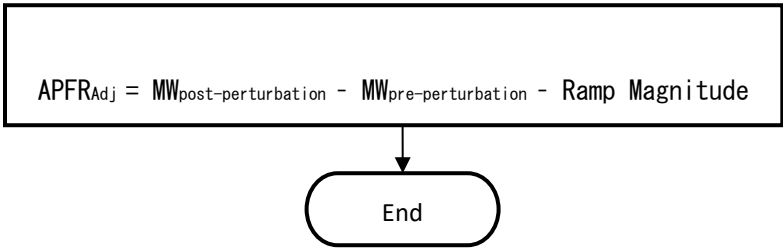


Ramp Magnitude Calculation



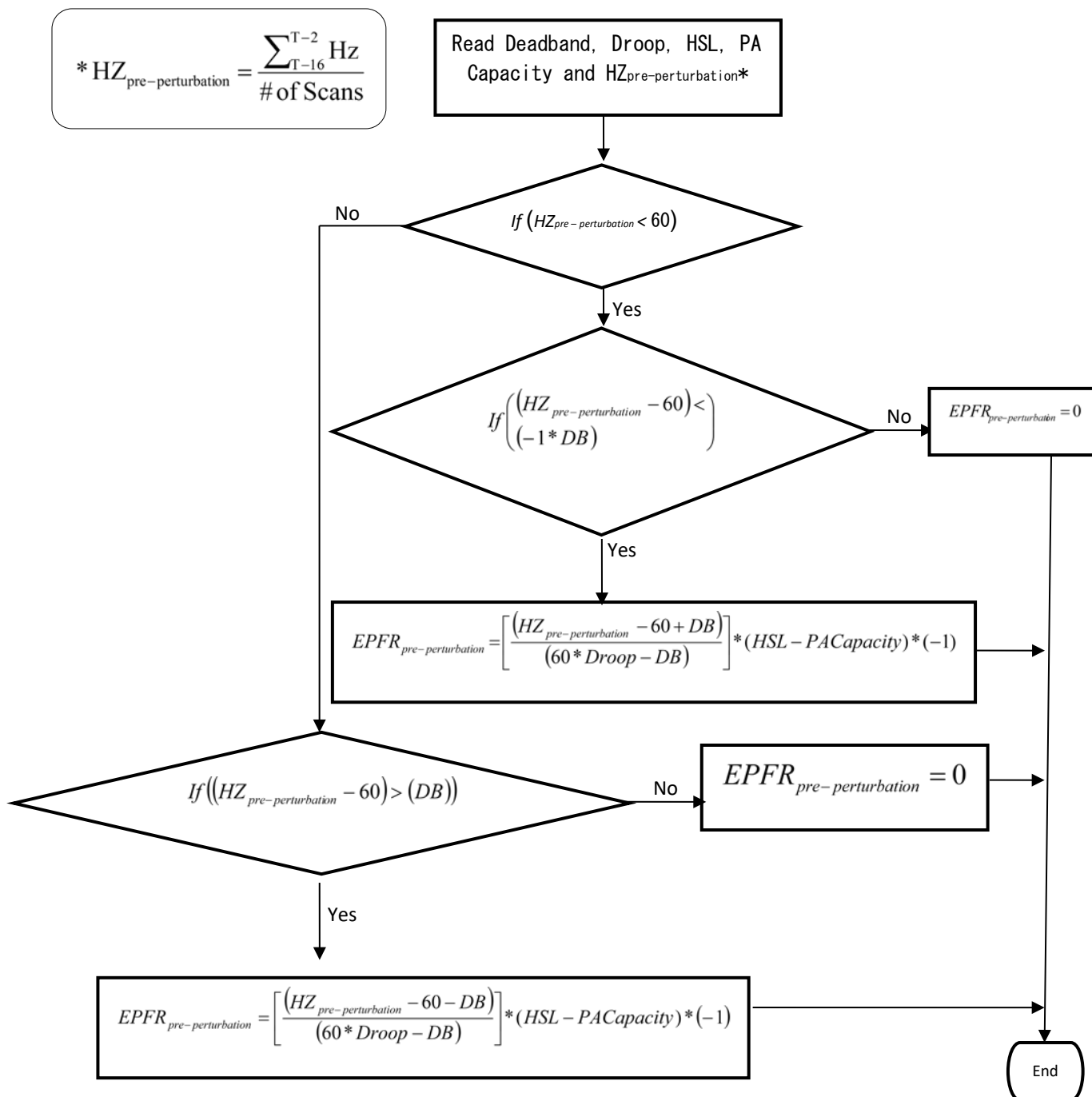
($MW_{T-4} - MW_{T-60}$) represents the MW ramp of the generator resource/generator facility for a full minute prior to the event. The factor 0.59 adjusts this full minute ramp to represent the ramp that should have been achieved during the post-perturbation measurement period.

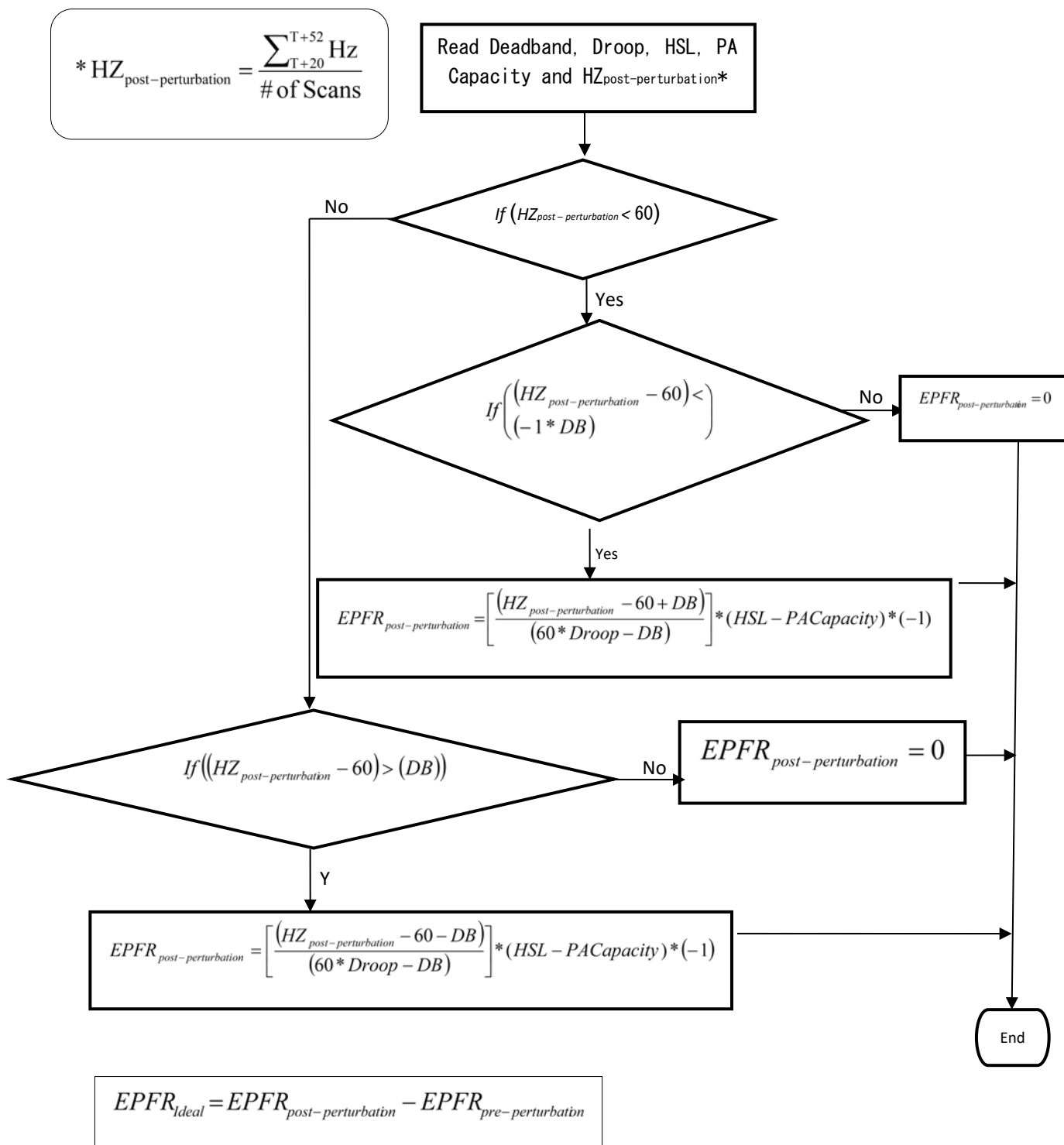
Actual Primary Frequency Response (APFR_{Adj})



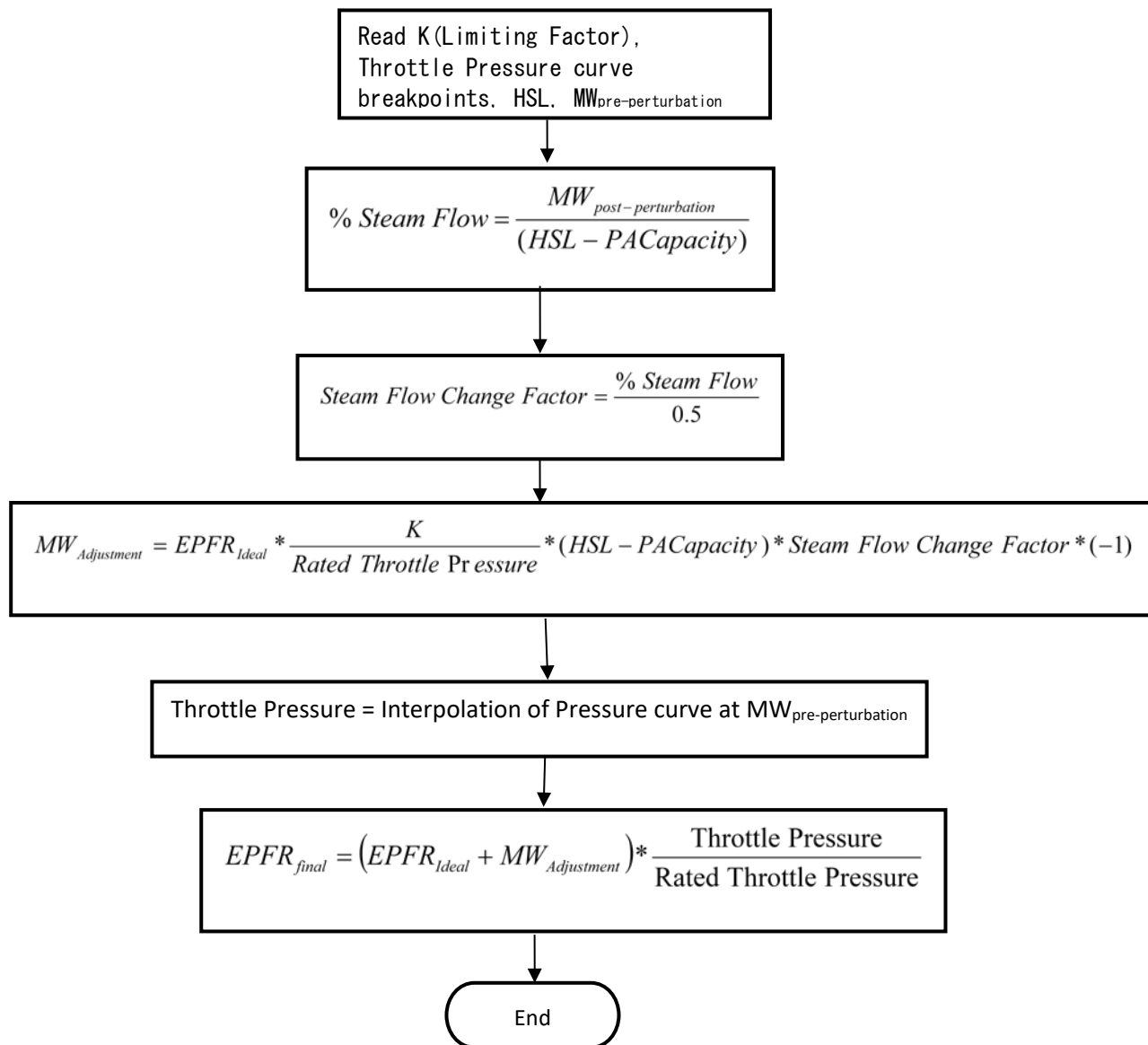
BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region**Expected Primary Frequency Response Calculation**

Use the maximum droop and maximum deadband as required by R6. For Combined Cycle Facility evaluation as a single resource (includes MW production of the steam turbine generator), the EPFR will use 5.78% droop in all calculations.



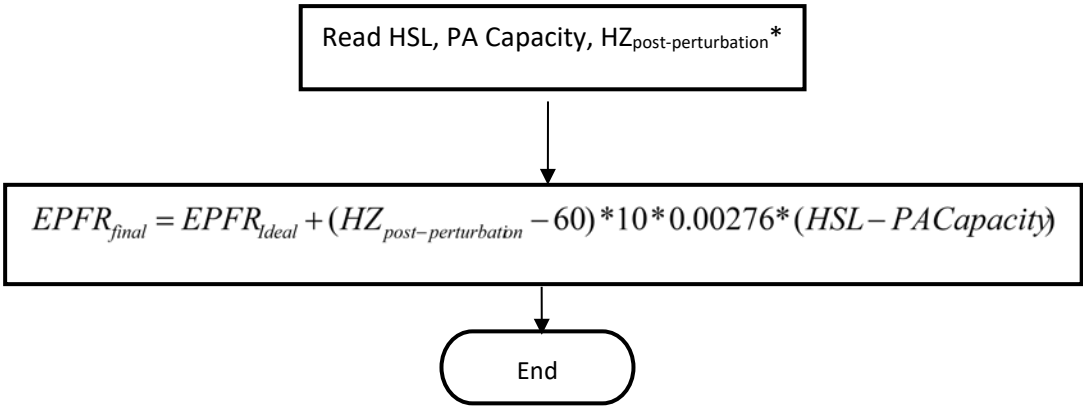
BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

Adjustment for Steam Turbine



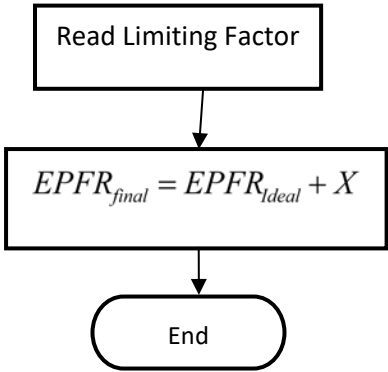
BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

Adjustment for Combustion Turbines and Combined Cycle Facilities



0.00276 is the MW/0.1 Hz change per MW of Capacity and represents the MW change in generator output due to the change in mass flow through the combustion turbine due to the speed change of the turbine during the post-perturbation measurement period. (This factor is based on empirical data from a major 2003 event as measured on multiple combustion turbines in ERCOT.)

Adjustment for Other Units



BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

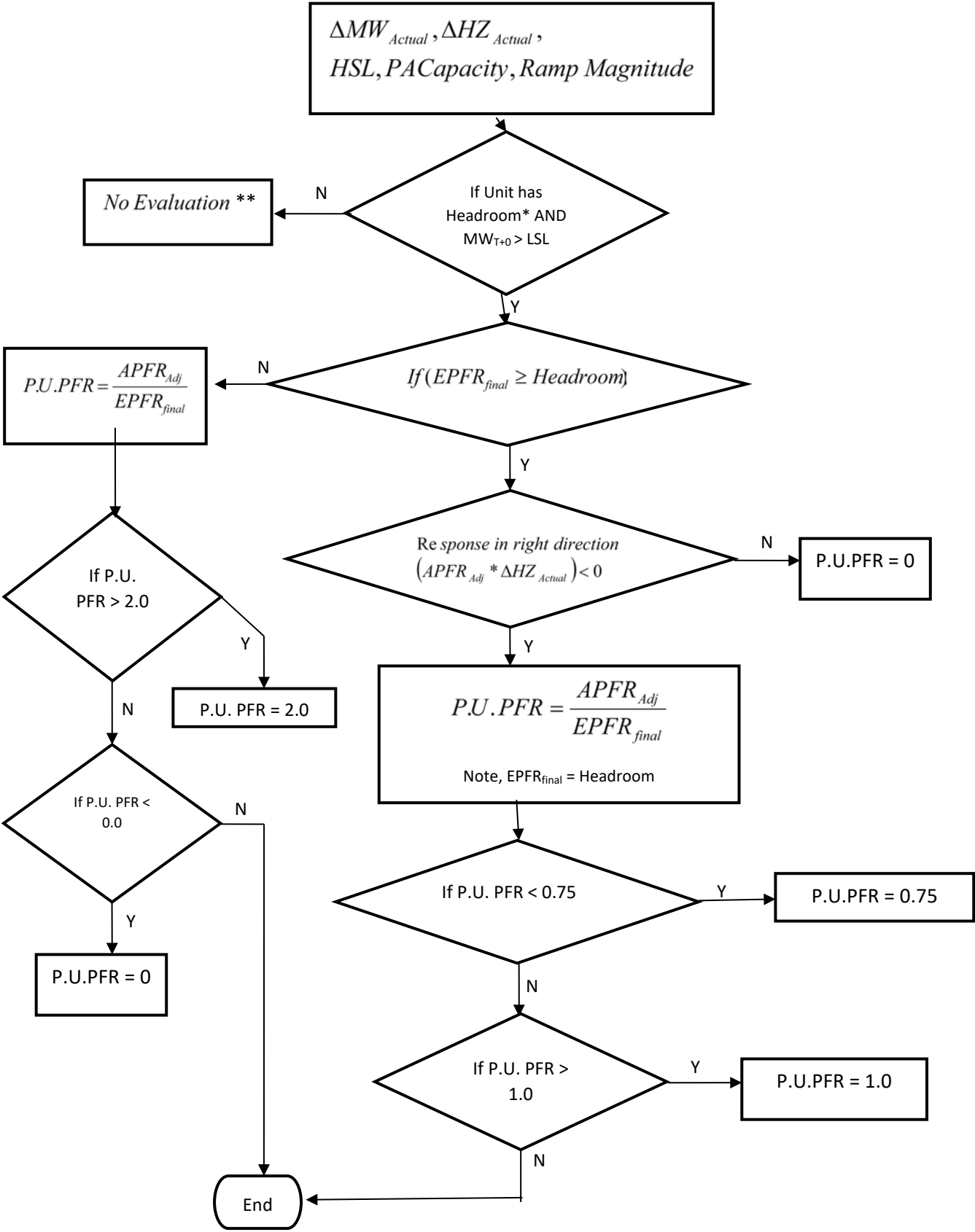
$$* \text{HZ}_{\text{post-perturbation}} = \frac{\sum_{T+20}^{T+52} \text{HZ}_{\text{Actual}}}{\# \text{ of Scans}}$$

This adjustment Factor X will be developed to properly model the delivery of PFR due to known and approved technical limitations of the resource. X may be adjusted by the BA and may be variable across the operating range of a resource.

BAL-001-TRE-~~21~~ — Primary Frequency Response in the ERCOT Region

P.U. Initial Primary Frequency Response Calculation

BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region



BAL-001-TRE-21 — Primary Frequency Response in the ERCOT Region

*Check for adequate up headroom, low frequency events. Headroom must be greater than either 5MW or 2% of (HSL less PA Capacity), whichever is larger. If a unit does not have adequate up headroom, the unit is considered operating at full capacity and will not be evaluated for low frequency events.

Check for adequate down headroom, high frequency events. Headroom must be greater than either 5MW or 2% of (HSL less PA Capacity), whichever is larger. If a unit does not have adequate down headroom, the unit is considered operating at low capacity and will not be evaluated for high frequency events.

For low frequency events:

$$Headroom = HSL - PACapacity - MW_{T-2}$$

For high frequency events:

$$Headroom = MW_{T-2} - LSL$$

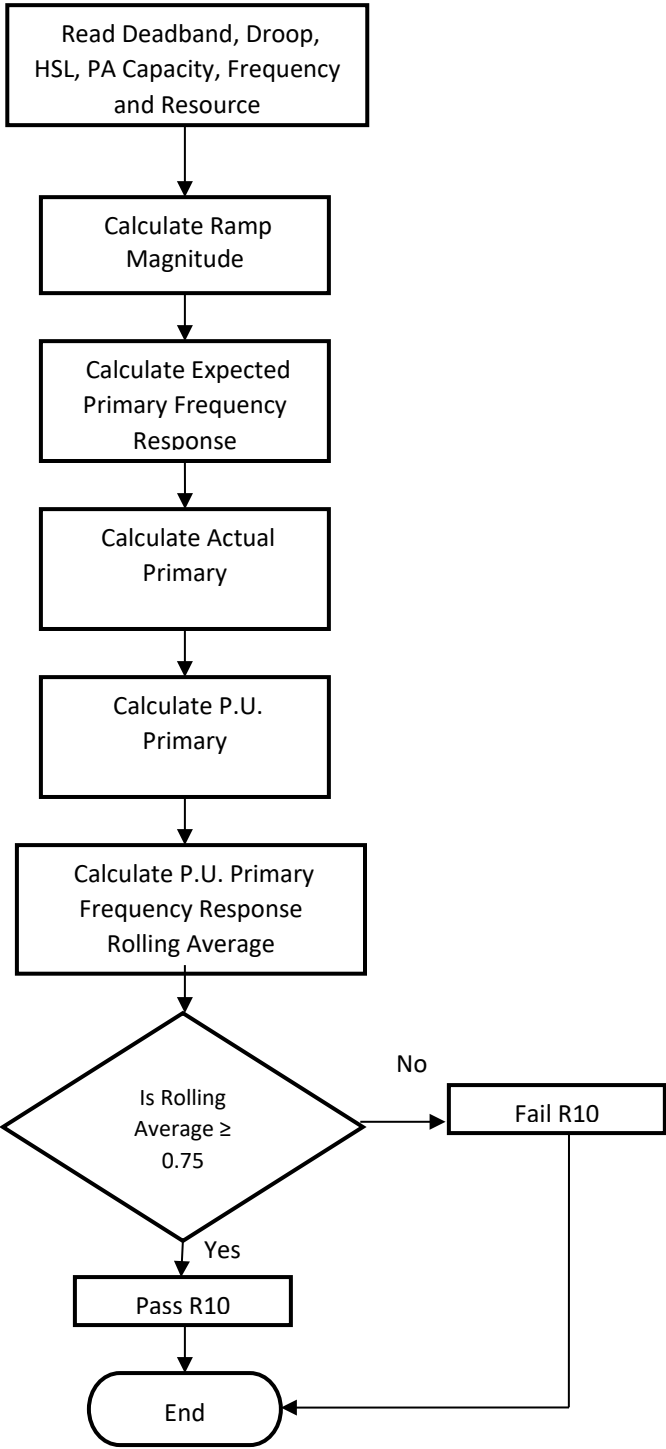
**No further evaluation is required for Sustained Primary Frequency Response. This event will not be included in the Rolling Average calculation of either Initial or Sustained Primary Frequency Response.

T = Time in Seconds

**Attachment B to
Primary Frequency Response Reference Document**

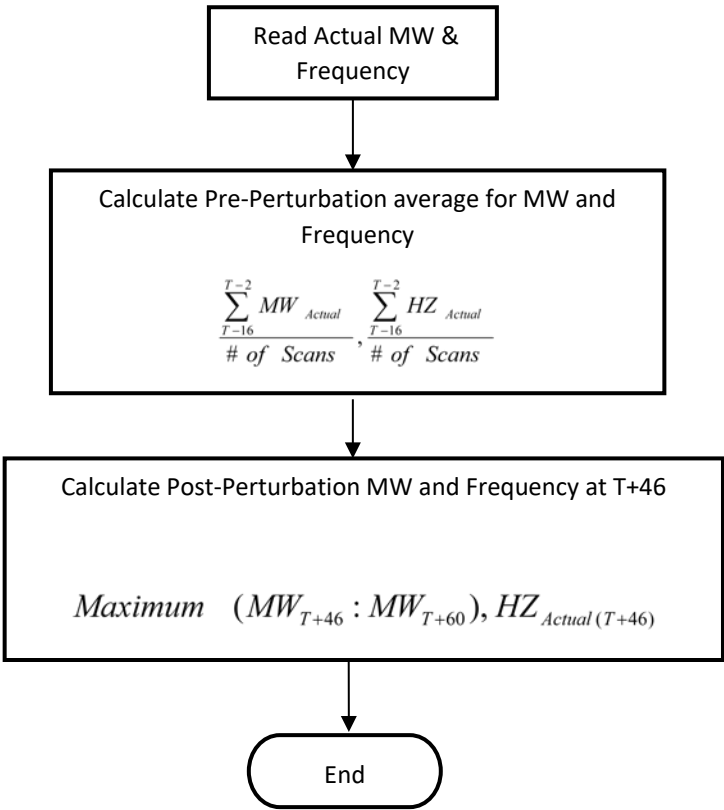
**Sustained Primary Frequency Response Methodology for
BAL-001-TRE-~~21~~**

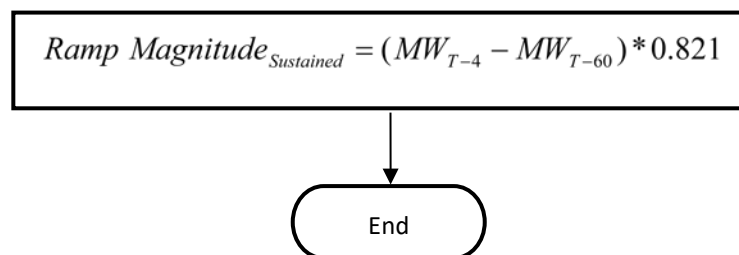
Primary Frequency Response Measurement and Rolling Average Calculation–Sustained Response



BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

Pre/Post-Perturbation Average MW and Average Frequency Calculations

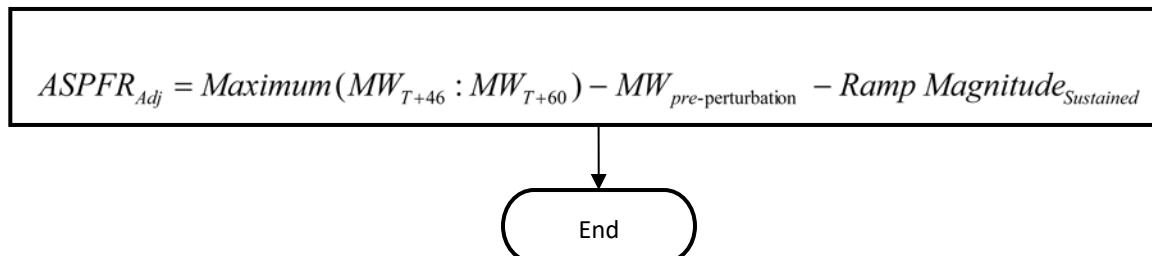


BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region**Ramp Magnitude Calculation - Sustained**

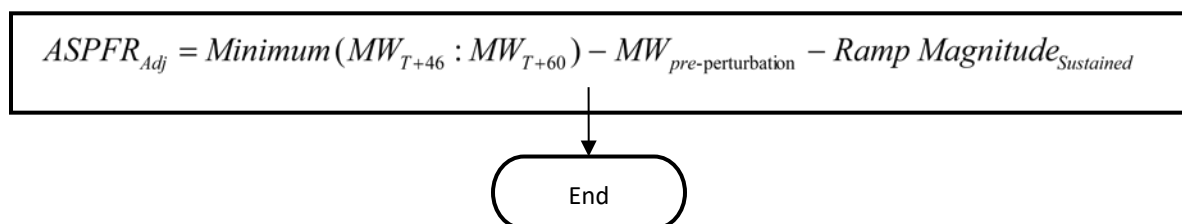
$(MW_{T-4} - MW_{T-60})$ represents the MW ramp of the generator resource/generator facility for a full minute prior to the event. The factor 0.821 adjusts this full minute ramp to represent the ramp the generator would have changed the system had it been allowed to continue on its ramp to T+46 unencumbered.

Actual Sustained Primary Frequency Response (ASPFR_{Adj})

For low frequency events:

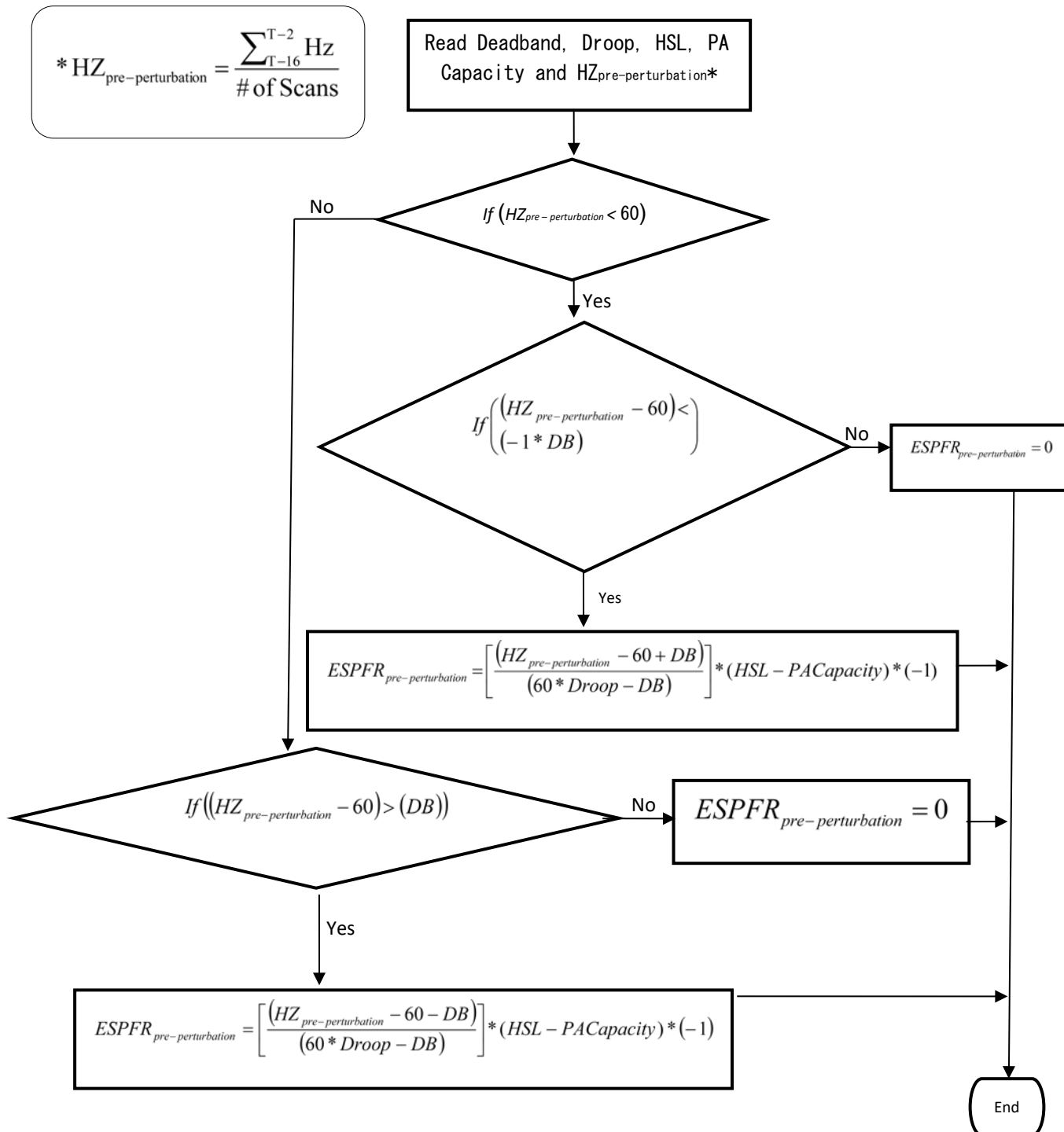


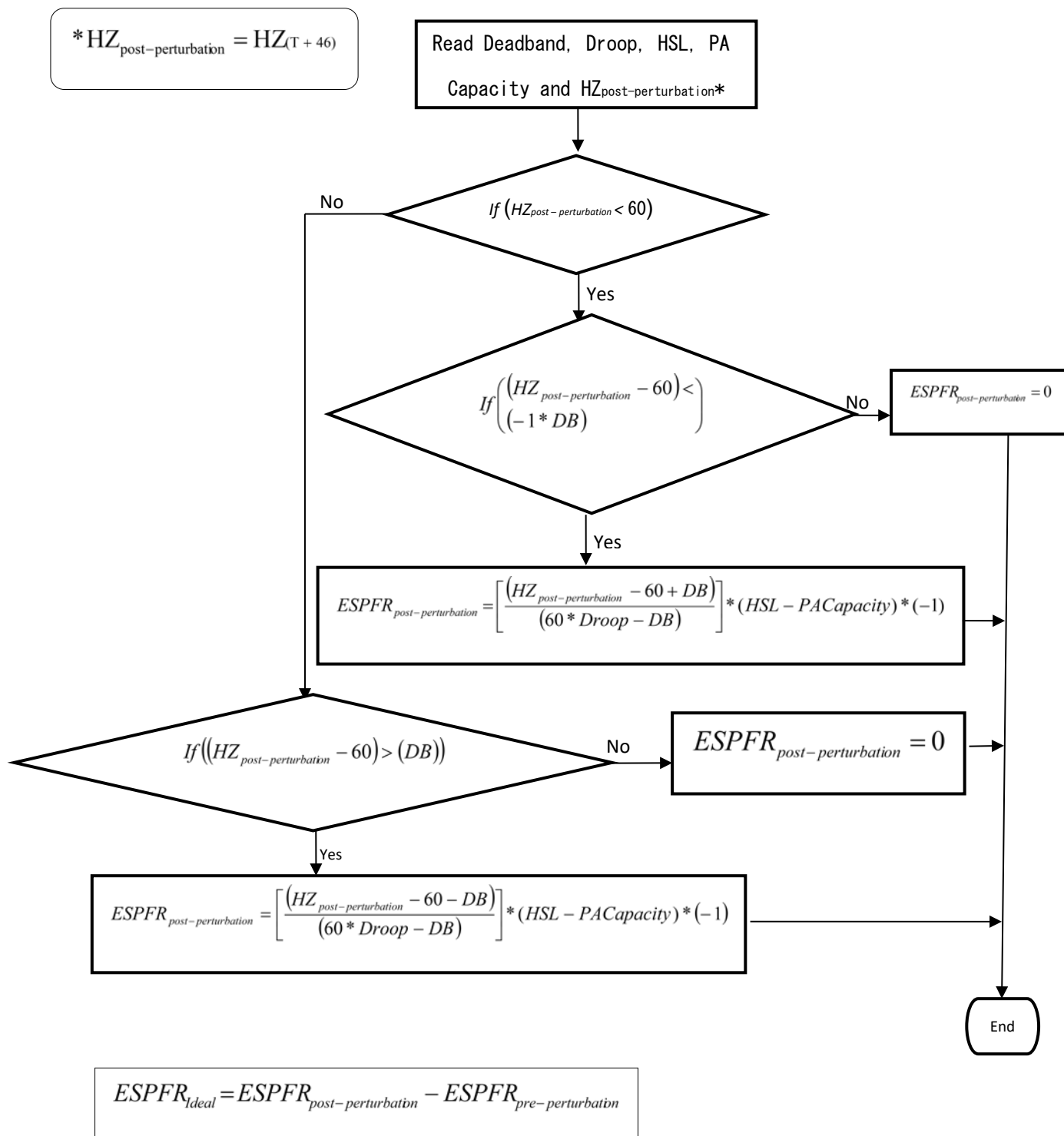
For high frequency events:

**Expected Sustained Primary Frequency Response Calculation**

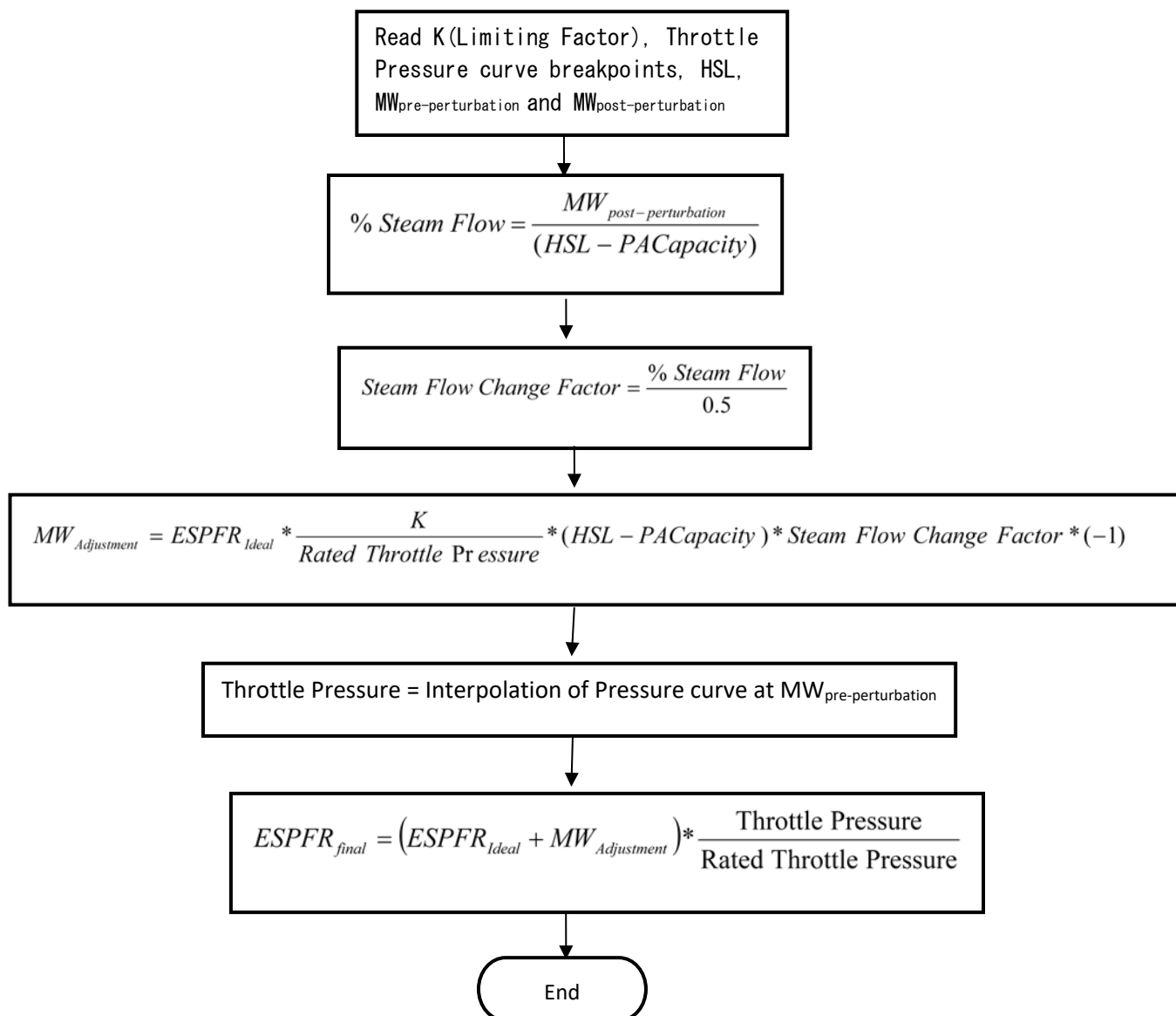
BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

Use the droop and deadband as required by R6. For Combined Cycle Facility evaluation as a single resource (includes MW production of the steam turbine generator), the EPFR will use 5.78% droop in all calculations.



BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

Adjustment for Steam Turbine

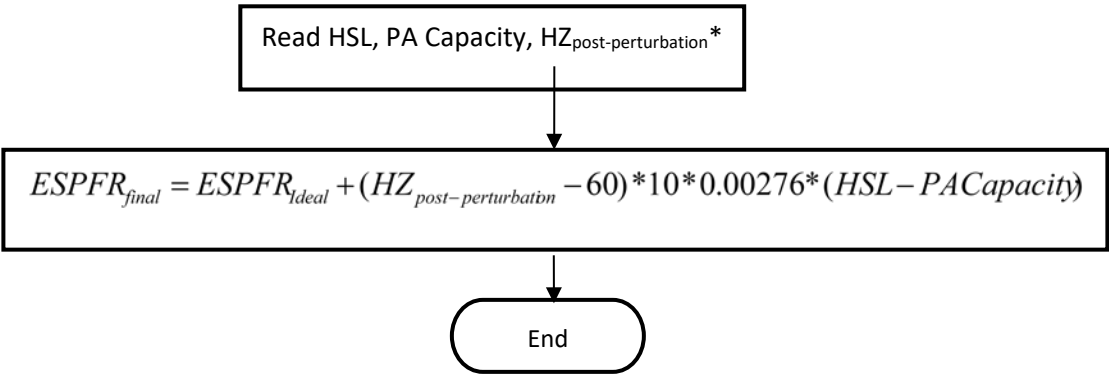


$MW_{post-perturbation}$ = Maximum (MW_{T+46} : MW_{T+60}) for low frequency events.

$MW_{post-perturbation}$ = Minimum (MW_{T+46} : MW_{T+60}) for high frequency events.

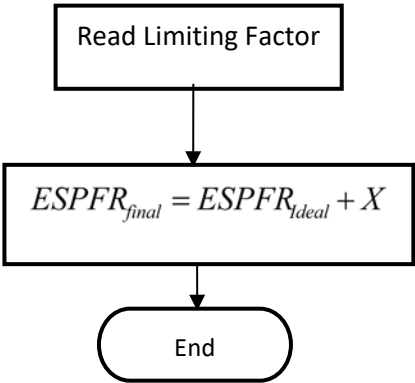
BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

Adjustment for Combustion Turbines and Combined Cycle Facilities



0.00276 is the MW/0.1 Hz change per MW of Capacity and represents the MW change in generator output due to the change in mass flow through the combustion turbine due to the speed change of the turbine during the post-perturbation measurement period. (This factor is based on empirical data from a major 2003 event as measured on multiple combustion turbines in ERCOT.)

Adjustment for Other Units



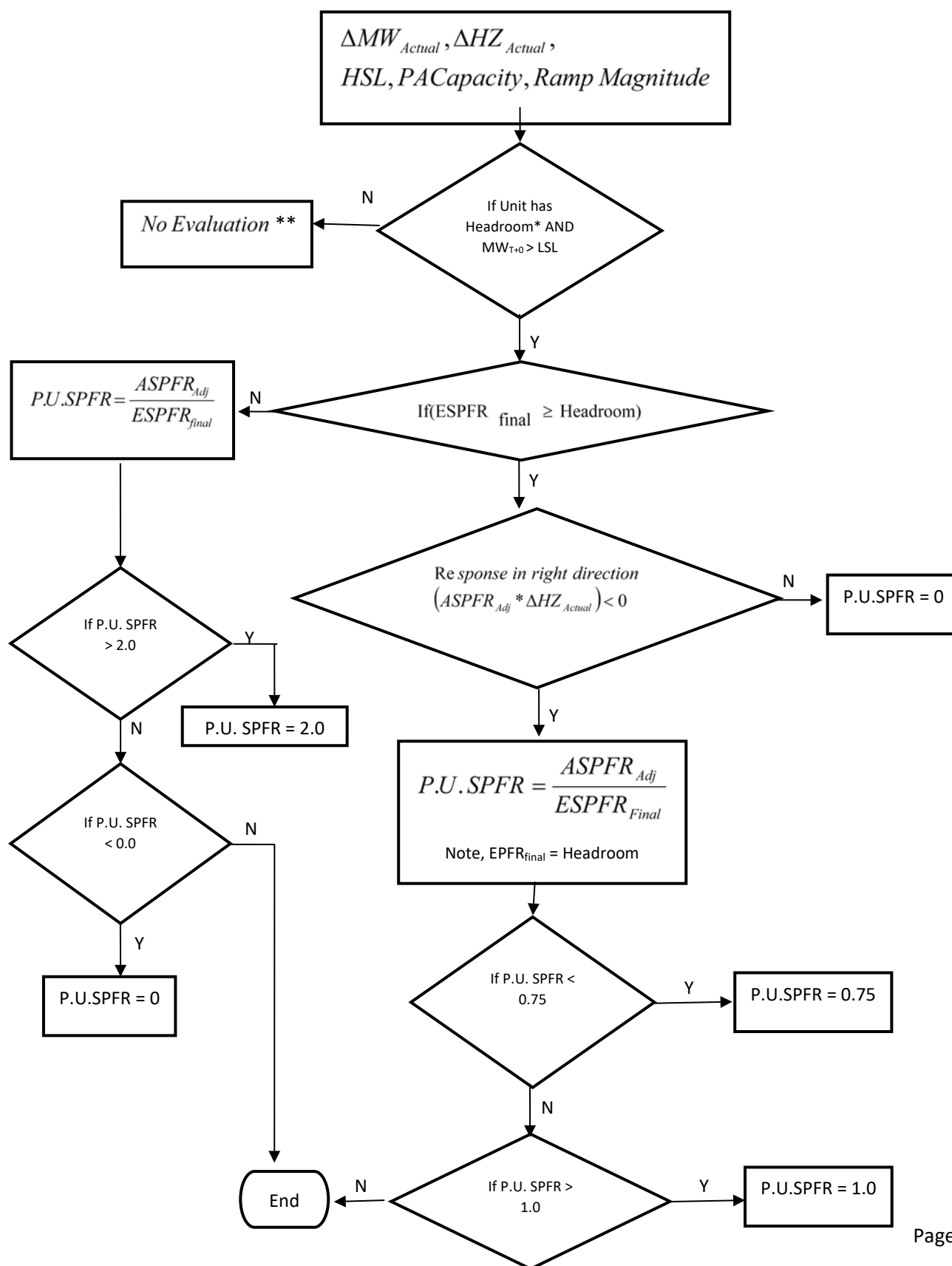
* HZ_{Actual} = HZ_(T + 46)

BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

This adjustment Factor X will be developed to properly model the delivery of PFR due to known and approved technical limitations of the resource. X may be adjusted by the BA and may be variable across the operating range of a resource.

P.U. Sustained Primary Frequency Response Calculation

$$*HZ_{\text{Actual}} = HZ_{(T + 46)}$$

BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

*Check for adequate up headroom, low frequency events. Headroom must be greater than either 5MW or 2% of (HSL less PA Capacity), whichever is larger. If a unit does not have adequate up headroom, the unit is considered operating at full capacity and will not be evaluated for low frequency events.

Check for adequate down headroom, high frequency events. Headroom must be greater than either 5MW or 2% of (HSL less PA Capacity), whichever is larger. If a unit does not have adequate down headroom, the unit is considered operating at low capacity and will not be evaluated for high frequency events.

For low frequency events:

$$Headroom = HSL - PACapacity - MW_{T-2}$$

For high frequency events:

$$Headroom = MW_{T-2} - LSL$$

**No further evaluation is required for Sustained Primary Frequency Response. This event will not be included in the Rolling Average calculation of either Initial or Sustained Primary Frequency Response.

T = Time in Seconds

BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

Revision History

Version	Date	Action	Change Tracking
1	7/25/2011	Approved by SDT and submitted to Texas RE RSC for approval to post for regional ballot	
1.1	12/7/2012	Approved by SDT for submission to Texas RE RSC for approval to post for second regional ballot.	Changed sustained measure from average over event recovery period to point at 46 seconds after FME, and other changes to respond to field trial results, comments, and corrections.
1.1	3/6/2013	Texas RE RSC approves submittal to Texas RE Board	
1.1	4/23/2013	Texas RE Board approves submittal to NERC and FERC	
1.1	9/18/2013	NERC and Texas RE file Petition for approval to FERC	
1.1	1/16/2014	Approved by FERC	
1.2	5/21/2015	Texas RE Board approves revisions to Attachment 2 Primary Frequency Response Reference Document	<p>For clarification and consistency of the equations used in the Attachment, changes performed to:</p> <ul style="list-style-type: none"> - “T” in the equations refers to the start of the Frequency Measurable Event. - “T-2” nomenclature utilized for clarity rather than “t(-2)” (applicable to numerous equations) - Removed floating x in $EPFR_{final}$ for Steam Turbine equation - Corrected sign convention for Expected Sustained Primary Frequency Response to match the calculation for expected primary frequency response. Corrected Adjusted MW for $ESPFR_{final}$ for Steam Turbine by multiplying -1 to calculate proper value. - On Steam Flow Change Factor removed floating x and reinserted PA Capacity. - Clarified Footnote 5 for scenario of high frequency event for setting LSL as operating margin (similar to HSL for low frequency events). - Clarified in flowcharts for both P.U. Initial Primary & Sustained

BAL-001-TRE-24 — Primary Frequency Response in the ERCOT Region

			<p>Frequency Response Calculations:</p> <ul style="list-style-type: none"> ○ Unit needs to have Headroom and be above LSL to be scored. ○ Cap EPFR_{final} at value of Headroom on unit - Per RSC 5/11/2015, all references to “Final” were changed to “final”. - Per RSC 5/11/2015, P.U.PFR and P.U.S.PFR removed italics in flowcharts.
1.3	11/14/2016	RSC approves minor changes to Attachment 2 Primary Frequency Response Reference Document	Replaced Reliability Standards Committee with Members Representative Committee to conform with changes to the Texas RE bylaws and regional standards development process.
1.3	12/07/2016	Texas RE Board approves minor changes to Attachment 2 Primary Frequency Response Reference Document.	Replaced Reliability Standards Committee with Members Representative Committee to conform with changes to the Texas RE bylaws and regional standards development process.
<u>2.0</u>	<u>MM/DD/YYYY</u>		<p><u>Removed the requirement for Governor droop and deadband settings for Steam turbines of combined cycle resources.</u></p> <p><u>Edited Requirements R9.3 and R10.3 to reflect the current process for submitting an exclusion request.</u></p> <p><u>Removed Attachment 1, which is the implementation plan for Regional Standard BAL-001-TRE-1. Changed numbering on Attachment 2 to Attachment 1</u></p>



Summary of Changes

SAR-011 Revisions to Regional Standard BAL-001-TRE-1

Draft Standard

Section	Proposed Change	Rationale
Format	Updated to NERC's most recent Results-based template.	This is at the request of NERC standards staff.
Format	Changed all of the abbreviations of the functions to the written function.	This is at the request of NERC standards staff.
Header	Changed from BAL-001-TRE-1 to BAL-001-TRE-2	The version of the standard is changing.
Standard Version	Changed from BAL-001-TRE-1 to BAL-001-TRE-2	The version of the standard is changing.
Background	Changed "Section 5.9" to Section 8.5".	This information moved to a different section in the Protocols.
Background	Added (FME) after Frequency Measurable Event	This change shows that the rest of the document will use the acronym FME.
Background	Capitalized "regional standard".	The term "Regional Standard" is defined in the Texas RE Standard Development Process document.
Background	Added (PFR) after Primary Frequency Response.	This change shows that the rest of the document will use the acronym PFR.
Effective Date	Changed to "See implementation plan"	This is consistent with the national standards. There is a separate implementation plan document.
Requirement 6.2 Table	Remove Nuclear, Coal and Lignite, from the table	These are fuel types. Plants with these fuel types operate as steam turbines.
Requirement 6.2 Table	Removed Wind Powered Generator from the table	Wind Powered Generator is included in Variable Renewable (Non-Hydro)
Requirement 6.2 Table	Changed "Steam Turbine (Simple Cycle)" to "Steam Turbine"	The original BAL-001-TRE drafting team accounted for the lack of Primary Frequency Response (PFR) from the steam turbines in a combined cycle resource train by requiring an overall 5.78% PFR performance for the entire



Section	Proposed Change	Rationale
		<p>train. This change aligns the standard's requirements with current operational practices. As the Balancing Authority for the ERCOT Region, ERCOT has already used its directive authority under R6 of the standard to explicitly exempt Generator Operators with steam turbines in combined-cycle trains from the droop and deadband settings in R6.1 and R6.2, pending a clarification to the standard. See ERCOT Market Notice W-C050418-01 (May 4, 2018).</p>
Requirement 6.2 Table	Removed "Steam Turbine (Combined Cycle)"	<p>The original BAL-001-TRE drafting team accounted for the lack of Primary Frequency Response (PFR) from the steam turbines in a combined cycle resource train by requiring an overall 5.78% PFR performance for the entire train. This change aligns the standard's requirements with current operational practices. As the Balancing Authority for the ERCOT Region, ERCOT has already used its directive authority under R6 of the standard to explicitly exempt Generator Operators with steam turbines in combined-cycle trains from the droop and deadband settings in R6.1 and R6.2, pending a clarification to the standard. See ERCOT Market Notice W-C050418-01 (May 4, 2018).</p>
Requirement 6.2 Table	Revised "Renewable (Non-Hydro)" to "Variable Renewable (Non-Hydro)"	<p>This change indicates that all non-hydro renewable resources, including wind, are included.</p>
Requirement 6.2 asterisk	Revised the asterisk from "Steam Turbines of combined cycle resources are required to comply with Requirements R6.1, R6.2, and R6.3. Compliance with Requirements R9 and R10 will be determined through	<p>The original BAL-001-TRE drafting team accounted for the lack of Primary Frequency Response (PFR) from the steam turbines in a combined cycle resource train by requiring an overall 5.78% PFR performance for the entire</p>



Section	Proposed Change	Rationale
	evaluation of the combined cycle facility using an expected performance droop of 5.78%." to "Requirements R6.1, R6.2, and R6.3 are not applicable to steam turbine(s) of a combined cycle resource."	train. This change aligns the standard's requirements with current operational practices. As the Balancing Authority for the ERCOT Region, ERCOT has already used its directive authority under R6 of the standard to explicitly exempt Generator Operators with steam turbines in combined-cycle trains from the droop and deadband settings in R6.1 and R6.2, pending a clarification to the standard. See ERCOT Market Notice W-C050418-01 (May 4, 2018).
Requirement R6.2 asterisk	Removed this from the asterisk: "Compliance with Requirements R9 and R10 will be determined through evaluation of the combined cycle facility using an expected performance droop of 5.78%."	This exists in Section B.R2.1. The intent is to indicate the BA will evaluate performance according to a certain value, which is stated in Section B.R2.1.
M6	Revised "governer" to "governor".	This change corrects the spelling.
Requirement R9.3	Added "by the Balancing Authority"	This change specifies that the BA is the entity responsible for review and approval of exclusion requests for a generating unit/generating facility's initial Primary Frequency Response performance during an FME.
Requirement R9.3	Added "but are not limited to"	There are several legitimate operating conditions that may support exclusion aside from the 2 examples.
Requirement R9.3, second bullet	Changed Compliance Enforcement Authority to Balancing Authority	This change reflects current processes. The BA is the entity that may request raw data from the GO.
M9	Changed "should be excluded" to "was excluded".	This indicates the performance was already excluded from the rolling average calculation.
Requirement R10.3	Added "by the Balancing Authority"	This change specifies that the BA is the entity responsible for review and approval of exclusion requests for a



Section	Proposed Change	Rationale
		generating unit/generating facility's initial Primary Frequency Response performance during an FME.
Requirement R10.3	Added "but are not limited to"	There are several legitimate operating conditions that may support exclusion aside from the 2 examples.
Requirement R10.3, second bullet	Changed Compliance Enforcement Authority to Balancing Authority	This change reflects current processes. The BA is the entity that may request raw data from the GO.
M10	Changed "should be excluded" to "was excluded".	This indicates the performance was already excluded from the rolling average calculation.
C. 1 1.2	Added (s) after corrective action.	There could be more than one corrective action to meet requirements R9 and R10.
C. 1 1.3, First Bullet	Changed Frequency Measurable Event to FME.	It was established during the Background section that FME is the acronym for Frequency Measurable Event.
C. 1 1.3 Fourth Bullet	Changed "The BA shall retain all data and calculations relating to the Interconnection's Frequency Response, and all evidence of actions taken to increase the Interconnection's Frequency Response, since its last compliance audit for Requirements R4 and R5, Measures M4 and M5." To "The BA shall retain all data and calculations relating to the Interconnection's combined Frequency Response performance, and all evidence of actions taken to increase the Interconnection's combined Frequency Response performance, since its last compliance audit for Requirements R4 and R5, Measures M4 and M5."	This indicates the evidence for the performance of Frequency Response.



Section	Proposed Change	Rationale
Standard Attachments	Removed “1. Attachment 1 – Implementation Plan”	This was the implementation plan for BAL-001-TRE-1. It is no longer relevant.
Standard Attachments	Changed “2. Attachment 2 – Primary Frequency Response Reference Document, including Flow Charts A and B” to “1. Attachment 1 – Primary Frequency Response Reference Document, including Flow Charts A and B”	Moved the reference document up to account for the removal of the implementation plan.
Version History	Added 2 with the changes being proposed.	This shows the changes being made at this time.

Primary Frequency Response Reference Document

Attachment 1	Changed from Attachment 2 to Attachment 1.	This change is in accordance with the change to Section E of the standard.
Attachment 1 Title	Changed from BAL-001-TRE-1 to BAL-001-TRE-2	The version of the standard is changing.
Attachment 1 Header	Changed from BAL-001-TRE-1 to BAL-001-TRE-2	The version of the standard is changing.
I. Introduction	Changed “will be” to “is”. Removed the second “will be” and made modifications plural.	This document is currently being used so changed the tense to present.
Requirement R9.3	Added “by the BA”	This reflects the changes made to the standard requirement language.
Requirement R9.3	Added “but are not limited to”	This reflects the changes made to the standard requirement language.
Requirement R9.3	Changed Compliance Enforcement Authority to BA	This reflects the changes made to the standard requirement language.
Initial Frequency Response Performance	Hyphenated 12-month and 8-event	Compound adjectives that precede a noun should be hyphenated.



Calculation Methodology		
Initial Frequency Response performance requirement	Capitalized "Where"	Where should be capitalized because it is at the beginning of the line.
Initial Frequency Response performance requirement	Changed P.U.PFRResource to P.U.PFR _{Resource}	Resource should be a subscript. This is consistent with the formula.
Actual Primary Frequency Response (APFR _{adj})	Capitalized "Where"	Where should be capitalized because it is at the beginning of the line.
EPFR _{final} for Steam Turbine	Capitalized "Where"	Where should be capitalized because it is at the beginning of the line.
EPFR _{final} for Other Generating Units/Generating Facilities	Capitalized "Where"	Where should be capitalized because it is at the beginning of the line.
Requirement R10.3	Added "by the BA"	This reflects the changes made to the standard requirement language.
Requirement R10.3	Added "but are not limited to"	This reflects the changes made to the standard requirement language.
Requirement R10.3	Changed Compliance Enforcement Authority to BA	This reflects the changes made to the standard requirement language.
Sustained Primary Frequency Response Performance Calculation Methodology	Hyphenated 12-month and 8-event	Compound adjectives that precede a noun should be hyphenated.
Actual Sustained Primary Frequency	Capitalized "Where" and "And"	Where and And should be capitalized because they are at the beginning of the line.



Response (ASPFR) Calculations		
EPFR _{final} for Steam Turbine	Capitalized "Where" and "And"	Where and And should be capitalized because they are at the beginning of the line.
EPFR _{final} for Other Generating Units/Generating Facilities	Capitalized "Where"	Where should be capitalized because it is at the beginning of the line.



Implementation Plan

Project SAR-011 Revisions to BAL-001-TRE
BAL-001-TRE-2

Requested Approval

BAL-001-TRE-2 – Primary Frequency Response in the ERCOT Region

Requested Retirement

BAL-001-TRE-1 – Primary Frequency Response in the ERCOT Region

Approvals Required

None.

Prerequisite Approvals

None.

Revisions to Glossary Terms

None.

Applicable Entities

- Balancing Authority (BA)
- Generator Owners (GO)
- Generator Operators (GOP)
- Exemptions:
 - Existing generating facilities regulated by the U.S. Nuclear Regulatory Commission are exempt from Standard BAL-001-TRE-2.
 - Generating units/generating facilities while operating in synchronous condenser mode are exempt from Standard BAL-001-TRE-2.
 - Any generators that are not required by the BA to provide primary frequency response are exempt from this standard.

Effective Date

The standard shall become effective on the first day of the first calendar quarter after the effective date of the applicable governmental authority's order approving the standard, or as otherwise provided for by the applicable governmental authority.

Standard for Retirement

Regional Standard BAL-001-TRE-1 shall be retired immediately prior to the Effective Date of BAL-001-TRE-2.

NERCNORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Unofficial Comment Form

Regional Reliability Standard | BAL-001-TRE-2

DO NOT use this form for submitting comments. Use the [Standards Balloting and Commenting System \(SBS\)](#) to submit comments on the Regional Reliability Standard **BAL-002-TRE-2 – Primary Frequency Response in the ERCOT Region** by **8 p.m. Eastern, Monday, January 6, 2020**.

Documents and information about this project are available on the [Texas RE Standards](#) page. If you have questions, contact Senior Reliability Standards Analyst, [Nasheema Santos](#) (via email) or at (404) 446-2564.

Background Information

Texas Reliability Entity (Texas RE) received a Standard Authorization Request seeking: (i) to remove the governor deadband and droop setting requirements for steam turbines in a combined cycle train and (ii) clarification of the responsible entity for Frequency Measurable Event exclusion requests.

The Texas RE drafting team summarized all of the revisions made to Regional Reliability Standard BAL-001-TRE-2, including template edits, in the [Summary of Changes](#).

NERC Criteria for Developing or Modifying a Regional Reliability Standard

Regional Reliability Standard shall be: (1) a regional reliability standard that is more stringent than the continent-wide reliability standard, including a regional standard that addresses matters that the continent-wide reliability standard does not; or (2) a regional reliability standard that is necessitated by a physical difference in the bulk power system. Regional reliability standards shall provide for as much uniformity as possible with reliability standards across the interconnected bulk power system of the North American continent. Regional reliability standards, when approved by FERC and applicable authorities in Mexico and Canada, shall be made part of the body of NERC reliability standards and shall be enforced upon all applicable bulk power system owners, operators, and users within the applicable area, regardless of membership in the region.

The approval process for a regional reliability standard, or the retirement of an existing standard, requires NERC to publicly notice and request comment on the proposed standard. Comments shall be permitted only on the following criteria (technical aspects of the standard are vetted through the regional standards development process):

Open — Regional reliability standards shall provide that any person or entity that is directly and materially affected by the reliability of the bulk power system within the regional entity shall be able to participate in the development and approval of reliability standards. There shall be no undue financial barriers to participation. Participation shall not be conditional upon membership in the regional entity, a regional entity or any organization, and shall not be unreasonably restricted on the basis of technical qualifications or other such requirements.

Inclusive — Regional reliability standards shall provide that any person with a direct and material interest has a right to participate by expressing an opinion and its basis, having that position considered, and appealing through an established appeals process, if adversely affected.

Balanced — Regional reliability standards shall have a balance of interests and shall not be dominated by any two-interest categories and no single-interest category shall be able to defeat a matter.

Due Process — Regional reliability standards shall provide for reasonable notice and opportunity for public comment. At a minimum, the standard shall include public notice of the intent to develop a standard, a public comment period on the proposed standard, due consideration of those public comments, and a ballot of interested stakeholders.

Transparent — All actions material to the development of regional reliability standards shall be transparent. All standards development meetings shall be open and publicly noticed on the regional entity's website.

Review the revised Regional Reliability Standard and answer the following questions.

1. Do you agree the development of BAL-001-TRE-2 met the “Open” criteria as outlined above? If “No”, please explain in the comment area below:

☐ Yes
☐ No

Comments:

2. Do you agree the development of BAL-001-TRE-2 met the “Inclusive” criteria as outlined above? If “No”, please explain in the comment area below:

☐ Yes
☐ No

Comments:

3. Do you agree the development of BAL-001-TRE-2 met the “Balanced” criteria as outlined above? If “No”, please explain in the comment area below:

☐ Yes
☐ No

Comments:

4. Do you agree the development of BAL-001-TRE-2 met the “Due Process” criteria as outlined above? If “No”, please explain in the comment area below:

☐ Yes
☐ No

Comments:

5. Do you agree the development of BAL-001-TRE-2 met the “Transparent” criteria as outlined above? If “No”, please explain in the comment area below:

☐ Yes
☐ No

Comments:

Comment Report

Project Name: Regional Reliability Standard (Texas Reliability Entity) | BAL-001-TRE-2
Comment Period Start Date: 11/22/2019
Comment Period End Date: 1/6/2020
Associated Ballots:

There were 4 sets of responses, including comments from approximately 11 different people from approximately 8 companies representing 4 of the Industry Segments as shown in the table on the following pages.

Questions

1. Do you agree the development of BAL-001-TRE-2 met the “Open” criteria as outlined above? If “No”, please explain in the comment area below.
2. Do you agree the development of BAL-001-TRE-2 met the “Inclusive” criteria as outlined above? If “No”, please explain in the comment area below.
3. Do you agree the development of BAL-001-TRE-2 met the “Balanced” criteria as outlined above? If “No”, please explain in the comment area below.
4. Do you agree the development of BAL-001-TRE-2 met the “Due Process” criteria as outlined above? If “No”, please explain in the comment area below.
5. Do you agree the development of BAL-001-TRE-2 met the “Transparent” criteria as outlined above? If “No”, please explain in the comment area below.

Organization Name	Name	Segment(s)	Region	Group Name	Group Member Name	Group Member Organization	Group Member Segment(s)	Group Member Region
Duke Energy	Kim Thomas	1,3,5,6	FRCC,RF,SERC	Duke Energy	Laura Lee	Duke Energy	1	SERC
					Dale Goodwine	Duke Energy	5	SERC
					Greg Cecil	Duke Energy	6	RF
Southern Company - Southern Company Services, Inc.	Marsha Morgan	1,3,5,6	SERC	Southern Company	Katherine Prewitt	Southern Company Services, Inc	1	SERC
					Jennifer Sykes	Southern Company Generation and Energy Marketing	6	SERC
					R Scott Moore	Alabama Power Company	3	SERC
					William Shultz	Southern Company Generation	5	SERC

1. Do you agree the development of BAL-001-TRE-2 met the “Open” criteria as outlined above? If “No”, please explain in the comment area below.

Marsha Morgan - Southern Company - Southern Company Services, Inc. - 1,3,5,6 - SERC, Group Name Southern Company

Answer No

Document Name

Comment

Comments on the technical aspects of the content of the requirements included should be sought and considered. There needs to be a question on the merit, technical content, and material changes affecting those parties included in the requirements. The changes to the combined cycle type of generating facility could go further to more accurately define the effective droop % expectations which include the relative sizes (MW ratings) of the generating resources and the composition the facility (ratio of # of combustion turbine generators to steam turbine generators, e.g. 1 on 1, 2 on 1, 3 on 1, etc.). Both of these factors directly affect the effective % droop to be expected from the total facility where only the combustion turbines will respond to frequency disturbances. The 5.78% effective droop included in the draft regional standard is not accurate for all facilities.

Likes 0

Dislikes 0

Response

Lee Maurer - Oncor Electric Delivery - 1

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Kim Thomas - Duke Energy - 1,3,5,6 - SERC,RF, Group Name Duke Energy

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response	
Teresa Cantwell - Lower Colorado River Authority - 1,5	
Answer	Yes
Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	

2. Do you agree the development of BAL-001-TRE-2 met the “Inclusive” criteria as outlined above? If “No”, please explain in the comment area below.

Teresa Cantwell - Lower Colorado River Authority - 1,5

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Marsha Morgan - Southern Company - Southern Company Services, Inc. - 1,3,5,6 - SERC, Group Name Southern Company

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Kim Thomas - Duke Energy - 1,3,5,6 - SERC,RF, Group Name Duke Energy

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Lee Maurer - Oncor Electric Delivery - 1

Answer Yes

Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	

3. Do you agree the development of BAL-001-TRE-2 met the “Balanced” criteria as outlined above? If “No”, please explain in the comment area below.

Lee Maurer - Oncor Electric Delivery - 1

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Kim Thomas - Duke Energy - 1,3,5,6 - SERC,RF, Group Name Duke Energy

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Marsha Morgan - Southern Company - Southern Company Services, Inc. - 1,3,5,6 - SERC, Group Name Southern Company

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Teresa Cantwell - Lower Colorado River Authority - 1,5

Answer Yes

Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	

4. Do you agree the development of BAL-001-TRE-2 met the “Due Process” criteria as outlined above? If “No”, please explain in the comment area below.

Teresa Cantwell - Lower Colorado River Authority - 1,5

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Marsha Morgan - Southern Company - Southern Company Services, Inc. - 1,3,5,6 - SERC, Group Name Southern Company

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Kim Thomas - Duke Energy - 1,3,5,6 - SERC,RF, Group Name Duke Energy

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Lee Maurer - Oncor Electric Delivery - 1

Answer Yes

Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	

5. Do you agree the development of BAL-001-TRE-2 met the “Transparent” criteria as outlined above? If “No”, please explain in the comment area below.

Lee Maurer - Oncor Electric Delivery - 1

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Kim Thomas - Duke Energy - 1,3,5,6 - SERC,RF, Group Name Duke Energy

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Marsha Morgan - Southern Company - Southern Company Services, Inc. - 1,3,5,6 - SERC, Group Name Southern Company

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Teresa Cantwell - Lower Colorado River Authority - 1,5

Answer Yes

Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	

Document Content(s)

Supplement.DOCX.....1-1

Exhibit D1 - NERC Posting Record.PDF.....2-129