

Standard Development Roadmap

*This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.*

**Development Steps Completed**

SAR submitted April 15, 2008.

RSC Accepted May 27, 2008.

Drafting Team was Nominated and Selected in June 2008.

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Drafting Team Met February 5, 2009.

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Final draft accepted by RSC for public posting March 4, 2009.

**Description of Current Draft**

This drafting team has completed a draft including all requirements, measures, and levels of compliance per the FERC Order associated with this variance and per SAR-003's stated purpose.

**Future Development Plan:**

**Anticipated Actions**

**Anticipated Date**

Post for Comment

March 16, 2009

Technical Workshop during comment period	April 2009
Respond to Comments/Revise	April 2009
Present revised draft to RSC	May 2009
Form ballot pool and vote	May/June 2009
TRE Board Adopt (Tentative)	July 2009
NERC Submit (Tentative)	August 2009
FERC Approval (Tentative)	October 2009
Begin Three Year Implementation Plan	November 2009
Be Auditably Compliant	December 2012

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## Definitions of Terms Used in Standard

*This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these defined terms will be removed from the individual standard and added to the Glossary.*

**Controllable Load Resource:** Load resource capable of providing Regulation Service by controllably reducing or increasing consumption under dispatch control (similar to Automated Generation Control) and that immediately responds proportionally to frequency changes (similar to generator governor action).

**Emergency Interruptible Load Service (EILS):** A special emergency service used during an Electrical Emergency Alert to reduce Load and assist in maintaining or restoring ERCOT System frequency.

**Frequency Responsive Resource:** Facility capable of providing electrical energy or Load capable of reducing or increasing the need for electrical energy or providing Ancillary Services (as defined in the current ERCOT Protocols) to the ERCOT System, excluding Underfrequency Relay Load and Emergency Interruptible Loads but not Controllable Load Resources.

**Generation Resource:** A generator that is capable of providing energy or Ancillary Service to the ERCOT System and is registered with ERCOT as a Generation Resource.

**Interconnection Minimum Frequency Response (IMFR):** The minimum frequency response limit for the Interconnection that is initially set at 420 MW/0.1 Hz.

**Measurable Event (ME):** A sudden change in interconnection frequency that will be evaluated for interconnection frequency response performance and will meet one of the following conditions:

- i) a change in interconnection frequency that has a pre-perturbation average frequency to post-perturbation average frequency absolute deviation greater than 100 mHz (the 100 mHz value may be adjusted by the BA to capture 30 to 40 events per year). See Attachment 1 for detailed criteria for this measurement.

or

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

**Perturbation:** Any disturbance of motion, course, arrangement, or state of equilibrium that causes a sudden change in frequency on the Bulk Electric System.

**Post-perturbation:** The 34-second period of time starting 20 seconds after  $t(0)$ .

**Pre-perturbation:** The 16-second period of time before  $t(0)$ .

**Regulation Service:** A service that is used to control the power output of Resources in response to a change in system frequency so as to maintain the target system frequency within predetermined limits.

**Resource:** Facility capable of providing electrical energy or Load capable of reducing or increasing the need for electrical energy or providing Ancillary Services to the ERCOT System. This includes Generation Resources, Loads acting as Resources and Emergency Interruptible Load Service Resources.

**t(0):** It is the time of the first observable change in Interconnection frequency at the beginning of a perturbation.

**Underfrequency Relay Load:** Load that is taken off-line by an underfrequency relay when the frequency goes below a predetermined frequency value for a predetermined number of cycles.

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## A. Introduction

1. **Title:** Real Power Balancing Control Performance
2. **Number:** BAL-001-TRE-1 (Regional Variance)
3. **Purpose:** To maintain Interconnection steady-state frequency within defined limits by balancing real power demand and supply in real-time. This regional variance replaces the CPS2 Waiver that was approved for ERCOT by NERC on November 21, 2002. Specifically, this variance replaces requirement 2 of BAL-001-0a per FERC Order 693.
4. **Applicability:** Balancing Authorities (BA), Generator Owners (GO), Generator Operators (GOP)
5. **Effective Date:** Within an appropriate time after final regulatory approval and with a three-year implementation plan to allow Generation Resource/Frequency Responsive Resource time to meet the requirements. See outline of implementation plan in Attachment 4.

## B. Requirements

- R1.** The Balancing Authority for the ERCOT Interconnection shall identify Measurable Events (as defined in this regional standard) for primary governing frequency response measurement of Generation Resources, Frequency Responsive Resources, and firm load.
- R2.** Within 30 days of a Measurable Event, the Balancing Authority for the ERCOT Interconnection shall submit to the Compliance Enforcement Authority scan rate data necessary to analyze each Measurable Event identified in R1. This data shall include:
  - (1) Interconnection Frequency;
  - (2) Interconnection scheduled frequency used in the ACE equation;
  - (3) Regulation Service deployed;
  - (4) Responsive Reserve Service deployed;
  - (5) Available Responsive Reserve Service (Nodal only);
  - (6) Generation Resource/Frequency Responsive Resource MW value;
  - (7) Control Error (Schedule CE in Zonal, Generation Resource/Frequency Responsive Resource CE in Nodal);
  - (8) Generation Resource/Frequency Responsive Resource Expected Frequency Response;
  - (9) Resource Regulation Service Allocation (Nodal only);
  - (10) Resource Economic Base Point (Nodal only);
  - (11) Resource High Operating Limit;
  - (12) Resource Low Operating Limit;
  - (13) Load Acting As Resource MW;

- (14) Load Acting As Resource deployed;
  - (15) Resource Responsive Reserve Service Responsibility (Nodal only);
  - (16) ERCOT Load;
  - (17) MW value for loss of individual Generation Resource(s) or Load that triggered the Measurable Event;
  - (18) Emergency Interruptible Load Service deployed;
  - (19) Time (synchronous time stamp to the nearest second for the data above).
- R3.** The BA shall analyze frequency and frequency movements and calculate the Interconnection Minimum Frequency Response (MW/0.1Hz) by January 1 of each year.
- R4.** The BA shall attain a twelve-month rolling average Interconnection Frequency Response, as measured in Attachment 2, greater than or equal to the Interconnection Minimum Frequency Response.
- R5.** For each Measurable Event, the frequency response performance of each interconnected Generation Resource/Frequency Responsive Resource shall be compiled by the BA as measured in Attachment 3.
- R6.** The BA shall calculate the twelve-month rolling average frequency response performance of each Generation Resource/Frequency Responsive Resource and report it to the Compliance Enforcement Authority. Generation Resources less than 10 MW each, who at a single point of interconnection sum to an aggregate greater than 10 MW, shall be treated as a single Generation Resource.
- R7.** The GO shall report to ERCOT the operating range, performance level, and any parameter limiting the frequency response of each Generation Resource/Frequency Responsive Resource. See Attachment 3 for these parameters.
- R8.** The GO shall ensure that combustion turbines in a combined cycle configuration have a governor droop characteristic of 4%, steam turbines have a governor droop characteristic of 5%, and that all other Generation Resources/Frequency Responsive Resources have a governor droop characteristic of 5% or less. See Attachment 3 for these characteristics.
- R9.** Each GO shall limit governor deadbands, intentional and unintentional, of turbine governors to those stated in Attachment 3.
- R10.** Except for protection of equipment or safety, the GO and GOP will sustain its governor response to all frequency deviations that exceed the deadbands stated in Attachment 3.
- R11.** The GO and GOP will meet a minimum twelve-month rolling average frequency response performance on each Generation Resource/Frequency Responsive Resource as stated in Attachment 3. See chart of Figure 4: Expected Resource Performance and associated spreadsheet.

### **C. Measures**

- M1.** The BA shall have a procedure in place for identifying Measurable Events.

- M2.** The BA shall make available for inspection evidence that the data as specified in R2 was submitted to the Compliance Enforcement Authority for evaluation.
- M3.** The BA shall have available for inspection evidence that the analysis of the IMFR was performed as specified in R3.
- M4.** The BA shall have evidence it calculated the twelve-month rolling average frequency response performance of the Interconnection of all Measurable Events.
- M5.** For each Measurable Event, the BA shall have evidence it reported the performance of each interconnected Generation Resource/Frequency Responsive Resource to the Compliance Enforcement Authority.
- M6.** For each Measurable Event, the BA shall have evidence it reported the twelve-month rolling average performance of each Generation Resource/Frequency Responsive Resource to the Compliance Enforcement Authority.
- M7.** The GOP shall have evidence it reported to the BA, each Generation Resource/Frequency Responsive Resource's governor operating range and expected frequency response performance for the full output range of each Generation Resource/Frequency Responsive Resource.
- M8.** The GO shall have evidence its frequency response Generation Resource/Frequency Responsive Resource's governor droop is set in accordance with the settings in Attachment 3.
- M9.** The GO shall have evidence its frequency response Generation Resource/Frequency Responsive Resource's governor deadband is set in accordance to the limits in Attachment 3.
- M10.** The GO and GOP shall have evidence that premature frequency response withdrawal by the Generation Resource/Frequency Responsive Resource was not visually observed.
- M11.** The GO and GOP shall have evidence that within the Measurable Event report, the twelve-month rolling average per unit frequency response performance of each Generation Resource/Frequency Responsive Resource met the minimum performance as stated in Attachment 3.

## **D. Compliance**

### **1. Compliance Monitoring Process**

#### **1.1. Compliance Enforcement Authority**

Texas Regional Entity

#### **1.2. Compliance Monitoring Period and Reset Time Frame**

- 1.2.1** If a Generation Resource/Frequency Responsive Resource fails any requirement or measure of this standard, the GO and GOP will submit mitigation plans for the failing Generation Resource/Frequency

Responsive Resource with a timeline not to exceed 90 days from the notification of failing performance.

- 1.2.2** Each Generation Resource/Frequency Responsive Resource will have a rolling event average performance as stated in Attachment 3 of this Standard. If a Generation Resource/Frequency Responsive Resource completes a mitigation plan and implements corrective action that corrects past failing performance as measured by this standard, the rolling event average will be reset on the next successful performance during a measurable event and the Generation Resource/Frequency Responsive Resource will begin a new rolling event average performance. If the Generation Resource/Frequency Responsive Resource fails the next measurable event performance, the GO and GOP will submit a follow-up mitigation plan with a timeline not to exceed 30 days from the notification of failing performance.

### **1.3. Data Retention**

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

- Each BA shall retain a list of identified Measurable Events since the last compliance audit for Requirement 1, Measure 1.
- Each BA shall retain all archived data since the last compliance audit for Requirement 2, Measure 2.
- Each BA shall retain all analysis and calculations since its last compliance audit for Requirement 3, Measure 3.
- Each BA shall retain all comparative calculations since its last compliance audit for Requirement 4, Measure 4.
- Each BA shall retain all calculations and compilations since its last compliance audit for Requirement 5, Measure 5.
- Each BA shall retain all calculations since its last compliance audit for Requirement 6, Measure 6.
- Each GOP shall retain evidence since its last compliance audit for Requirement 7, Measure 7.
- Each GO shall retain evidence since its last compliance audit for Requirement 8, Measure 8.
- Each GO shall retain evidence since its last compliance audit for Requirement 9, Measure 9.

- Each GO and GOP shall retain evidence since its last compliance audit for Requirement 10, Measure 10.
- Each GO and GOP shall retain evidence since its last compliance audit for Requirement 11, Measure 11.

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

**1.4. Compliance Monitoring and Assessment Processes**

Compliance Audits

Self-Certifications

Spot Checking

Compliance Violation Investigations

Self-Reporting

Complaints

Periodic Data Submittals as required

Exception Reporting as necessary per Attachment 2

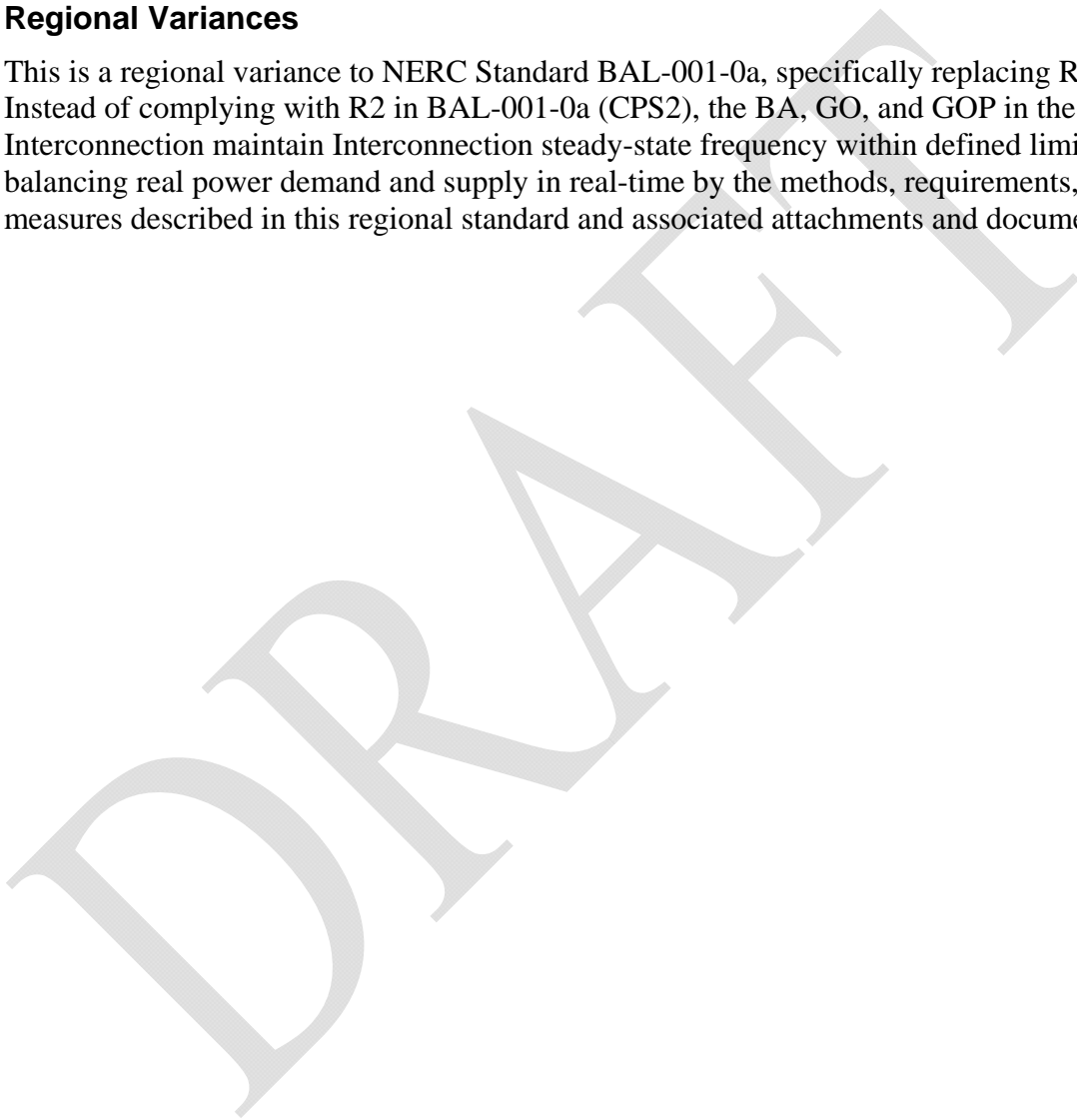
2. Violation Severity Levels

R #	Lower VSL	Moderate VSL	High VSL	Severe VSL
R1				Did not have a procedure in place to identify Measurable Events.
R2	Submitted data to Compliance Enforcement Authority 45 days after the event.	Submitted data to Compliance Enforcement Authority 60 days after the event.	Submitted data 120 days after the event.	No submission was made to Compliance Enforcement Authority on the identified event.
R3			All changes in Generation Resources greater than 10 MW, either individually or as aggregated behind a single meter, were not included in the IMFR analysis.	No analysis was performed to determine IMFR or there was no record of doing so.
R4	The twelve-month rolling average frequency response is less than 100% but greater than or equal to 90% of the IMFR.	The twelve-month rolling average frequency response is less than 90% but greater than or equal to 80% of the IMFR.	The twelve-month rolling average frequency response is less than 80% but greater than or equal to 70% of the IMFR.	The twelve-month rolling average frequency response is less than 70% of the IMFR.
R5				No evidence of reporting to Compliance Enforcement Authority.
R6				No evidence of reporting to Compliance Enforcement Authority.
R7			The GOP does not have evidence that it reported to the BA most of its Generation Resource/Frequency Responsive Resource's expected frequency response for its normal operating range.	The GOP does not have evidence that it reported to the BA any of its Generation Resource/Frequency Responsive Resource's expected frequency response for its normal operating range.
R8	Completed governor droop test form dated longer than two years.	Completed governor droop test form dated longer than three years.	Completed governor droop test form dated longer than four years.	The GOP does not have evidence that the governor droop characteristics were set per Attachment 3.
R9				The GOP does not have evidence that the governor deadband limits were set per Attachment 3.
R10				The GO or GOP applied control action to reduce or withdraw frequency response of a Generation Resource/Frequency Responsive Resource that exceeded the allowable deadbands as stated in Attachment 3.
R11	The twelve month rolling average frequency response performance of a Generation	The twelve-month rolling average frequency response performance of a Generation	The twelve-month rolling average frequency response performance of a Generation	The twelve-month rolling average frequency response performance of a Generation Resource/Frequency Responsive Resource is less than 0.25 P.U. as measured in Attachment 3.

	Resource/Frequency Responsive Resource is greater than or equal to 0.45 P.U. and less than 0.55 P.U. as measured in Attachment 3.	Resource/Frequency Responsive Resource is greater than or equal to 0.35 P.U. and less than 0.45 P.U. as measured in Attachment 3.	Resource/Frequency Responsive Resource is greater than or equal to 0.25 P.U. and less than 0.35 P.U. as measured in Attachment 3.	
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**E. Regional Variances**

This is a regional variance to NERC Standard BAL-001-0a, specifically replacing R2. Instead of complying with R2 in BAL-001-0a (CPS2), the BA, GO, and GOP in the ERCOT Interconnection maintain Interconnection steady-state frequency within defined limits by balancing real power demand and supply in real-time by the methods, requirements, and measures described in this regional standard and associated attachments and documents.



## F. Associated Documents

### Waiver Request – Control Performance Standard 2

#### **Organization**

ERCOT

#### **Operating Policy**

ERCOT requests a waiver from Policy 1, “Generation Control and Performance,” Section E, “Performance Standard” as follows:

#### Standards

- 1.2. **Control Performance Standard (CPS2).** The average ACE for each of the six ten-minute periods during the hour (i.e., for the ten-minute periods ending at 10, 20, 30, 40, 50, and 60 minutes past the hour) must be within specific limits, referred to as  $L_{10}$ . See the “Performance Standard Training Document,” Section B.1.1.2 for the methods for calculating  $L_{10}$ .

#### Requirements

2. **Control Performance Standard (CPS) Compliance.** Each CONTROL AREA shall achieve CPS1 compliance of 100% and achieve CPS2 compliance of 90% (see the “Performance Standard Training Document,” Section C).

#### **Explanation**

ERCOT requests a waiver from the CPS2 Standards and Requirements listed above for the following reasons:

1. On July 31, 2001, the ERCOT Interconnection began operating as a single CONTROL AREA, asynchronously connected via two DC ties to the Eastern Interconnection. At that time, ERCOT changed from the traditional tie-line bias generation control algorithms in which ten CONTROL AREAS participated, to a single 15-minute interval competitive balancing energy market and a frequency control system that regulates around the balancing energy schedule on two-to-four second intervals. ERCOT requests that the Operating Committee reconsider CPS2 to ensure it is feasible under this new type of market-based control.

If the Operating Committee believes that the CPS2 is feasible, then ERCOT would suggest that Policy 1 (or the appropriate Compliance document) provide for a “test period” of six months to allow CONTROL AREAS making such a transition the opportunity to test new control algorithms *provided* they can show that reliability is not degraded during that period. ERCOT also believes that its  $L_{10}$  may not be appropriate as it is less than half of the  $L_{10}$  of another NERC CONTROL AREA of similar load size.

- The ERCOT Interconnection is now a single CONTROL AREA asynchronously connected to the Eastern Interconnection, and cannot create inadvertent power flows or frequency errors in other CONTROL AREAS. Therefore, the ISO questions whether the CPS2 Standard is necessary or even beneficial for such asynchronous operation. ERCOT is currently performing a study that compares its single CONTROL AREA performance against that of the former ten CONTROL AREA operations. Initial results of that study show that while the ten CONTROL AREAS *individually* met CPS2 standards, the *aggregate* CPS2 performance of the ten CONTROL AREAS did not, and was actually below that of the current single CONTROL AREA.

**Current Operating Reliability**

ERCOT does not believe that Frequency control within its new single CONTROL AREA INTERCONNECTION is less reliable as a result of non-compliance with the CPS2 Standard following its conversion. ERCOT Interconnection frequency control has been, and continues to be, very reliable since that conversion.

The table below shows ERCOT’s CPS2 performance for August through December 2000 as an INTERCONNECTION with ten Control Areas. The average CPS2 compliance was 74.82%. CPS2 compliance for ERCOT as a single control area for August 2001 was 83.88%, an improvement of approximately nine percentage points.

	% of Frequency Data Available	Supplier Of Frequency Data	Single Control Area		Average of	Average of
			CPS1 %	CPS2 %	Absolute1 min Averages Freq Deviation	Absolute10 min Averages Freq Deviation
August-00	79	ERCOT	140.99	76.50	0.011978483	0.008299971
September-00	100	ERCOT	134.89	76.02	0.012366	0.009495
September-00	100	REIT HLP	135.91	77.01	0.012221795	0.008443165
October-00	23	ERCOT	199.68	76.90	0.013910426	0.00857111
October-00	100	REIT HLP	114.01	78.58	0.014621429	0.008120248
November-00	65	ERCOT	105.19	67.20	0.015061531	0.010523159
December-00	60	ERCOT	192.59	72.60	0.013428052	0.009330552
Average	(See Note 1)		134.71	74.82	0.013439915	0.009062032
August-01	None (See Note 2)	None (See Note 2)	127.30	83.88		

Note 1: Weighted Average Based on ERCOT for August, September November and December and REIT for October.

Note 2: From ERCOT CPS report. ERCOT is working on providing frequency data for August 2001.

## **FERC ORDER 693**

FROM FERC ORDER 693, March 16, 2007, Paragraphs 309-315

Regional Difference to BAL-001-0: ERCOT Control Performance Standard 2

**309.** NERC approved a regional difference for ERCOT by allowing it to be exempt from Requirement R2 in BAL-001-0, which requires that the average area control error (ACE) for each of the six ten-minute periods during the hour must be within specific limits, and that a balancing authority achieves 90 percent compliance. This Requirement is referred to as Control Performance Standard 2 (CPS2).

**310.** NERC explains that ERCOT requested a waiver of CPS2 because: (1) ERCOT, as a single control area asynchronously connected to the Eastern Interconnection, cannot create inadvertent flows or time errors in other control areas and (2) CPS2 may not be feasible under ERCOT's competitive balancing energy market. In support of this argument, ERCOT cites to a study that it performed showing that, under the new market structure, the ten control areas in its region individually were able to meet CPS2 standards while the aggregate performance of the ten control areas was not in compliance. Since requesting the waiver from CPS2, ERCOT has adopted section 5 of the ERCOT protocols which identify the necessary frequency controls needed for reliable operation in ERCOT.

**311.** In the NOPR, the Commission proposed to approve the ERCOT regional difference and have the ERO submit a modification of the ERCOT regional difference to include the requirements concerning frequency response contained in section five of the ERCOT protocols.

**312.** No comments were filed on this regional difference.

**313.** The Commission approves the ERCOT regional difference as mandatory and enforceable. Order No. 672 explains that "uniformity of Reliability Standards should be the goal and the practice, the rule rather than the exception." However, the Commission has stated that, as a general matter, regional differences are permissible if they are either more stringent than the continent-wide Reliability Standard, or if they are necessitated by a physical difference in the Bulk-Power System. Regional differences must still be just, reasonable, not unduly discriminatory or preferential and in the public interest.

**314.** The Commission finds that ERCOT's approach under section 5 of the ERCOT protocols appears to be a more stringent practice than Requirement R2 in BAL-001-0 and therefore approves the regional difference.

**315.** As proposed in the NOPR, the Commission directs the ERO to file a modification of the ERCOT regional difference to include the requirements concerning frequency response contained in section 5 of the ERCOT protocols. As with other new regional differences, the Commission expects that the ERCOT regional difference will include Requirements, Measures and Levels of Non-Compliance sections.

## **ERCOT Protocol 5.9**

### **5.9 Frequency Response Requirements and Monitoring**

#### **5.9.1 Generation Resource and QSE Participation**

##### **5.9.1.1 Governor in Service**

At all times a Generation Resource is on line, its turbine governor shall remain in service and be allowed to respond to all changes in system frequency. Generation Entities shall not reduce governor response on individual Resources during abnormal conditions without ERCOT's consent (conveyed by way of the Generation Entity's QSE) unless equipment damage is imminent.

##### **5.9.1.2 Reporting**

Generation Entities shall conduct applicable generating governor speed regulation tests on Resources as specified in the Operating Guides. Test results and/or other relevant information shall be reported to ERCOT and ERCOT shall forward results to the appropriate TSPs.

Resource governor modeling information required in the ERCOT Planning Criteria shall be determined from actual Resource testing described in the Operating Guides. Within thirty (30) days of ERCOT's request, the results of the latest test performed shall be supplied to ERCOT and the connected TSP.

When the governor of a Generation Resource is blocked while the Resource is operating, the QSE shall promptly inform ERCOT. The QSE shall also supply governor status logs to ERCOT upon request.

Any short-term inability of a Generation Resource to supply governor response shall be immediately reported to ERCOT.

If a Generation Resource trips Off-line due to governor response problems, the Generation Entity shall immediately report the change in the status of the Resource to ERCOT and the QSE.

#### **5.9.2 Primary Frequency Control Measurements**

For the purposes of this section, the A Point is the last stable frequency value prior to a frequency disturbance. For a decreasing frequency event with the last stable frequency value of 60.000 Hz or below, the actual frequency is used. For a decreasing frequency event with the last stable frequency value between 60.000 and 60.036 Hz, 60.000 Hz will be used. For a decreasing frequency event with the last stable frequency value above 60.036 Hz, actual frequency will be used. For an increasing frequency event with the last stable frequency value of 60.000 or above, the actual frequency is used. For an increasing frequency event with the last stable frequency between 59.964 and 60.000 Hz, 60.000 Hz will be used. For an increasing frequency event with the last stable frequency value of 59.964 or below, the actual frequency is used. ERCOT shall determine the A Point frequency for each event.

For the purposes of this section, the C Point is the lowest frequency value during the first five seconds of the event.

For the purposes of this section, the B Point is the “recovery” frequency value after the C Point. The B Point should occur after full governor response of the turbines has occurred, usually between ten (10) and thirty (30) seconds after the A Point, but not greater than sixty (60) seconds after the A Point. ERCOT shall determine the B Point for each event.

**B Point Plus Thirty Seconds:** At thirty seconds following the B Point, an analysis will be performed by ERCOT with the assistance of the appropriate ERCOT subcommittee to determine if primary frequency control response is sustained.

For the purposes of this section, a “Measurable Event” is the sudden change in interconnection frequency that will be evaluated for performance compliance will have i) a frequency B Point between 59.700 Hz and 59.900 Hz or between 60.100 Hz and 60.300 Hz, and ii) a difference between the B Point and the A Point greater than or equal to +/- 0.100 Hz.

### **5.9.2.1 ERCOT Required Primary Frequency Control Response**

The combined response of all Generation Resources interconnected in ERCOT to a Measurable Event shall be at least 420 MW / 0.1 Hz. This value should be reviewed on an annual basis by ERCOT and the appropriate ERCOT subcommittee for system interconnect reliability needs.

ERCOT will evaluate, with the assistance of the appropriate ERCOT subcommittee, primary frequency control response during Measurable Events. The actual Generation Resource response will be compiled to determine if adequate primary frequency control participation was available.

ERCOT and the appropriate ERCOT subcommittee will review each Measurable Event, verifying the reasonableness of data. Data that is in question may be requested from the QSE for comparison and/or individual Resource data may be retrieved from ERCOT’s database.

ERCOT’s performance will be averaged using the most recent six (6) Measurable Events to determine its rolling average contribution.

### **5.9.3 ERCOT Data Collection**

#### **5.9.3.1 Data Collection**

ERCOT will collect all data necessary to analyze each Measurable Event. This will include the following real-time data:

- (1) Interconnection Frequency;
- (2) Regulation Service deployed;
- (3) Responsive Reserve Service deployed;
- (4) QSE available Responsive Reserve Service;
- (5) QSE total Generation;
- (6) QSE SCE;
- (7) QSE Bias;

- (8) QSE LaaR MW;
- (9) LaaR deployed;
- (10) QSE Responsive Reserve Service;
- (11) ERCOT Load and individual Resource(s) that contributed to the frequency deviation; and
- (12) EILS deployed.

**Version History**

<b>Version</b>	<b>Date</b>	<b>Action</b>	<b>Change Tracking</b>

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## Attachment 1

**The goal of these criteria is to capture 30 to 40 events each year. These criteria shall be adjusted by the BA to achieve at least the minimum target number of events.**

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### Part 1: Frequency deviation criteria

In the attached Excel spreadsheet “ERCOT Measurable Event Detection.xls” ERCOT scan rate frequency data is collected and automatically analyzed for frequency deviations. The size of the frequency deviation used in the analysis can be controlled in cell C1 of the first worksheet “2secHz” and is presently set at 0.100 Hz (100 mHz). This value in Hz deviation will control how many “events” will be detected from the data set. The data set will collect eleven days of 2-second data and summarize the total number of events detected in the data column. Not all events detected by the spreadsheet will be valid frequency events for performance measurement. Any event detected that results in the “post-perturbation” average frequency ending within the turbine governor deadbands (~60.020 to ~59.980 Hz) should be eliminated. Also, any event that has a median frequency deviation near 60.000 Hz should be eliminated. This would occur when the Pre-perturbation to Post-perturbation frequency is centered around 60.000 Hz. This measurement of Interconnection frequency response would include deadbands in both directions from 60.000 Hz and turbine governor performance will be reduced due to the deadband impact of the non responsive regions. Valid frequency deviations for performance evaluation shall have the Post-perturbation frequency further from 60.000 Hz than the Pre-perturbation frequency.

As the performances of Generation Resource/Frequency Responsive Resources improve as a result of this standard, the Interconnection frequency profile will improve and fewer “false” event detections will be detected by the spreadsheet. It is also likely that with this improved frequency response, the frequency deviation value in cell C1 will have to be decreased to achieve the target number of Measurable Events.

### Part 2: MW change causing or contributing to the perturbation

Accurate accounting of the change in megawatts contributing to the perturbation is necessary for proper evaluation of Interconnection frequency response. Most events will be the result of a single Generation Resource or group of Generation Resources (combined cycle plants). However, the Balancing Authority should consider changes in “non-conforming load” during the measurement period and include sympathetic Generation Resource trips that occur during the measurement period. Generation Operators are required to report such trips to the BA. This standard sets 550 MW within 20 seconds as the trigger level to perform an Event analysis. The BA may adjust this value to achieve the targeted number of Measurable Events each year.

## Attachment 2

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### Part 1: Measuring ERCOT Interconnection Frequency Response

The process for measuring Interconnection Frequency Response requires scan rate data of Interconnection frequency and scan rate data of the Generation Resource(s) or Load(s) causing the perturbation. This data must be aligned to eliminate time skew. The steps in the frequency response calculation are: 1) Determine the scan data for  $t(0)$ , which is the first scan of frequency that frequency deviates from normal. This scan value identifies the beginning of the perturbation; 2) Calculate the average of the Pre and Post perturbation of the Interconnection frequency and megawatt of the Generation Resource(s) or Load(s) causing the perturbation; 3) Take the mathematical differences of each parameter, divide the difference in megawatt change by the difference in frequency change and 4) Divide this quotient by 10 for the standard form in MW per tenth Hz (MW/0.1Hz). An Excel spreadsheet named “Frequency Response data report for Single BA Interconnection 2 second scan.xls” is included in this attachment and performs the frequency response calculation. See Figure 1 below.

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# Draft Standard BAL- 001-TRE-1 — Real Power Balancing Control Performance

Report No.	ERCOT20080825		Date :	08/25/08		Time (HHMMSS):	15:14:32	
Scan Rate	1		Time Standard	CDT		BA BIAS	-660 MW/0.1 Hz	
	2 2 seconds					55,147	Load @ A	
Freq. (before)	Freq. (after)	Freq. Chg.	Sch. Freq.	FR % of Bias	95.0%	54,979	Load @ B	
59.9848	59.8592	-0.12557	60.00	21.3%		-627.22	BA MW/0.1 Hz	
Average Before	Average After			Load FR % of		-133.79	BA Load MW/0.1 Hz	
				Total FR		-660	Interconnection Total Bias	
Comments File:						65340.22	Interconnection Peak Forecast Load	
Interconnection Minimum Freq Response Target.						-420	MW/0.1 Hz	
BA Performance based on Peak Load Ratio						149.34%		
BA Performance based on Bias Ratio						149.34%		
Frequency Response data report for BA:						ERCOT		

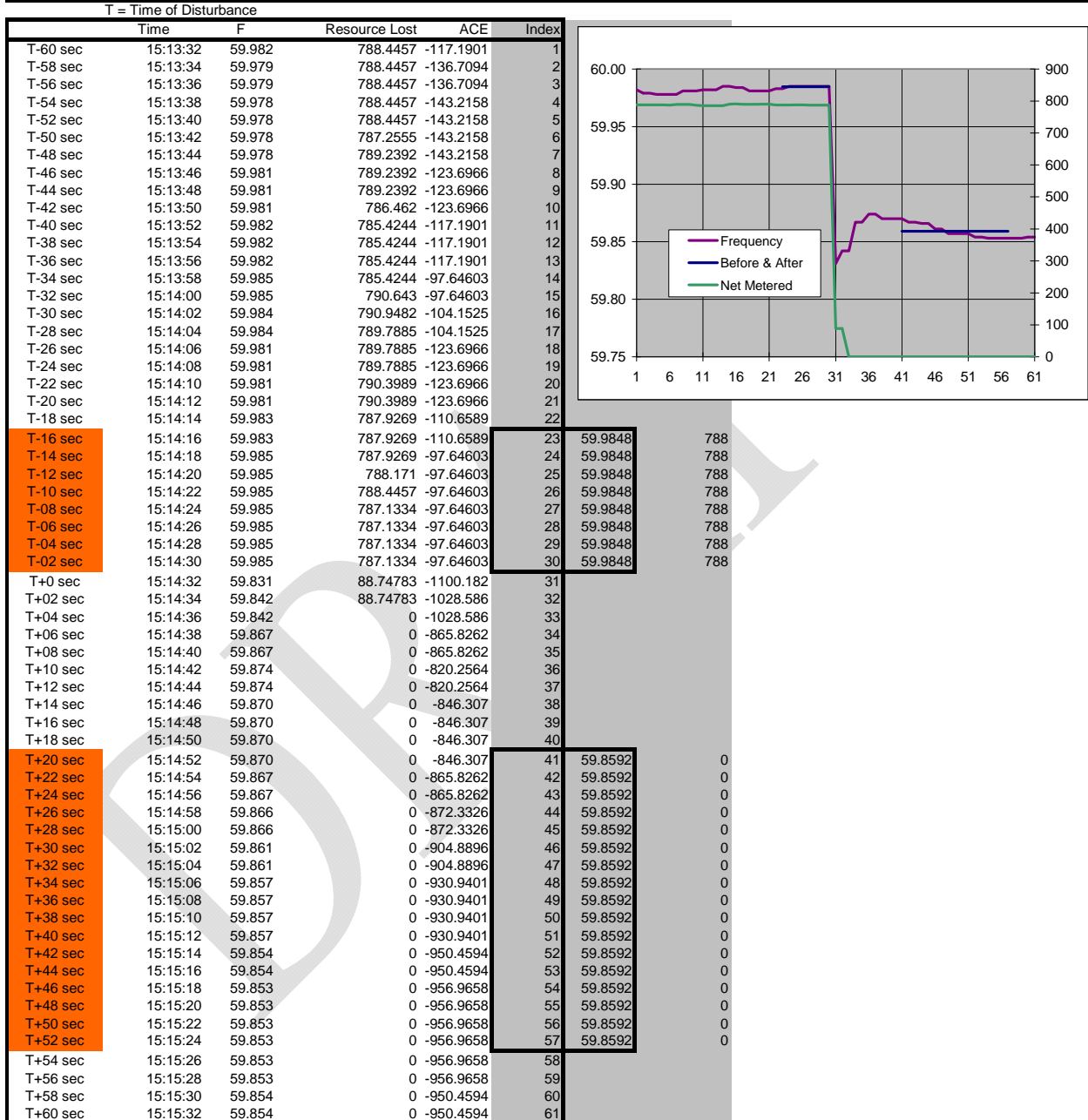


Figure 1: Interconnection frequency response measurement.

## Attachment 3

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### Part 1: Governor deadband and droop settings

#### Governor Deadbands:

Mechanical governors of steam turbine Generation Resources: Due to gear lash and movement of mechanical parts of a mechanical fly-ball governor on a steam turbine, it is common to observe frequency response deadband for small changes in frequency. This deadband, or range of no frequency response, shall be limited to less than  $\pm 0.036$  Hz (36 mHz).

Electronic and digital governors of Generation Resource/Frequency Responsive Resources: Intentional governor deadbands on electronic and digital governors should be avoided. If intentional frequency response deadband of electronic or digital governors is necessary for Generation Resource/Frequency Responsive Resource stability, it shall be limited to a maximum of  $\pm 0.01667$  Hz (16.67 mHz or one rpm on a two pole generator) as measured from 60.000 Hz. Once frequency deviation has exceeded the governor deadband from 60.000 Hz, the frequency response characteristic shall not “step-into” the 5% droop curve or the 4% droop curve. The droop curve shall linearly add frequency response and attain the 5% droop curve characteristic when frequency deviation reaches  $\pm 3.0$  Hz or attain the 4% droop curve characteristic when frequency deviation reaches  $\pm 2.4$  Hz.

#### Governor Droop Setting:

##### Steam Turbine:

Droop settings of steam turbines shall be 5% or lower. The 5% droop curve shall linearly add frequency response and attain the 5% droop curve characteristic when frequency deviation reaches  $\pm 3.0$  Hz.

##### Combustion turbines operating in combined cycle mode, single or multiple shafts:

Combustion turbines, operating in a combined cycle mode, governor shall be set at 4% droop or lower. The 4% droop curve shall linearly add frequency response and attain the 4% droop curve characteristic when frequency deviation reaches  $\pm 2.4$  Hz.

##### Combustion turbines operating in a simple cycle mode:

Combustion turbines, not operating in a combined cycle mode, governor shall be set at 5% droop or lower. The 5% droop curve shall linearly add frequency response and attain the 5% droop curve characteristic when frequency deviation reaches  $\pm 3.0$  Hz.

##### Wind turbine:

Wind turbines that have droop capability shall have a droop setting of 5% or lower. The 5% droop curve shall linearly add frequency response and attain the 5% droop curve characteristic when frequency deviation reaches +/-3.0 Hz.

Other Generation Resource/Frequency Responsive Resources:

Other Generation Resource/Frequency Responsive Resources that have droop capability shall have a droop setting of 5% or lower. The 5% droop curve shall linearly add frequency response and attain the 5% droop curve characteristic when frequency deviation reaches +/-3.0 Hz.

Part 2: Minimum performance of turbine governors during actual grid frequency deviations.

The measurement of frequency response can be challenging. There are conditions when the mathematical calculations that perform the measurement of performance do not account for all control functions of a Generation Resource/Frequency Responsive Resource. The following situations are known to cause measurement techniques to improperly measure performance:

- 1) Previous AGC or manual control to change the Generation Resource/Frequency Responsive Resources output. If the Generation Resource/Frequency Responsive Resource is ramping from one output level to another during a measurable frequency deviation, frequency response may be difficult to measure. This is true if the ramp direction is in the same direction as the frequency deviation, that is, the Generation Resource/Frequency Responsive Resource is in a down ramp during a low frequency deviation (see Figure 1 below) or up ramp during a high frequency deviation. This is especially true for Generation Resource/Frequency Responsive Resources that have high ramp rates in comparison to their maximum capability. All Generation Resource/Frequency Responsive Resources shall be responsive to all frequency deviations exceeding the governor deadband while ramping. If frequency response is visually apparent during these ramps and the direction of the ramp causes the measurement of the frequency response to be below the minimum performance level, the Event may be removed from the Generation Resource/Frequency Responsive Resources' 12 month rolling average performance measure.
- 2) Conventional steam driven turbines will have some initial steam pressure drop following large low frequency deviations. This pressure drop should be minimized by the control functions of the steam generator while remaining within the thermal and physical limits of the steam generator. (see Figure 2 below) The same effect is true for high frequency deviations. Steam generator pressure will rise from the frequency response of the turbine thereby reducing the net frequency response of the turbine. The Generator Owner may provide an estimation of this effect in the form of a "parameter" curve to be added to the measurement spreadsheet that accounts for this stored energy limitation.
- 3) Steam turbines of combined cycle Generation Resources. These turbines depend on the waste heat of combustion turbines to provide additional steam supply for their frequency response. The cycle time of the heat recovery boiler is typically longer

- than the performance measure of this standard and performance of these Generation Resources will measure below normal droop characteristic curves.
- 4) Generation Resource/Frequency Responsive Resources located at the same site as the Generation Resource that causes the perturbation may have a shift in site auxiliary load assignment during the measurement period. This may result in a decrease in “Net” output of the Generation Resource/Frequency Responsive Resource and affect the measurement of frequency response. In this scenario Gross megawatt values for Generation Resource/Frequency Responsive Resource output and Gross High Operating Limit may be used for the evaluation of the frequency response measurement of the Generation Resource/Frequency Responsive Resource.
  - 5) Generation Resource/Frequency Responsive Resources may have auxiliary equipment that must be placed in service throughout the load range of the Generation Resource/Frequency Responsive Resource. If the Generation Resource/Frequency Responsive Resource is operating at an output level that requires placing in service auxiliary equipment, frequency response of the Generation Resource/Frequency Responsive Resource may be limited. This may result in below minimum frequency response performance. The Generation Owner shall document this limitation on each occurrence during a Measurable Event. Once the equipment is placed in service, full frequency response is expected.
  - 6) Generation Resource/Frequency Responsive Resources operating near the High Operating Limit (HOL) of the Generation Resource/Frequency Responsive Resource can measure below the minimum frequency response performance level. The expected performance shall be limited to the HOL of the Generation Resource/Frequency Responsive Resource.
  - 7) Generation Resource/Frequency Responsive Resources operating at extremely low output levels may have limited frequency response. This output level may be defined as the Emergency Low Operating Limit, and responding to frequency deviations may place the Generation Resource/Frequency Responsive Resource at risk. The Generator Owner shall identify and document these operating ranges.
  - 8) Generation Resource/Frequency Responsive Resources operating at extremely high output levels may have limited frequency response. This output level may be defined as the Emergency High Operating Limit, and responding to frequency deviations may place the Generation Resource/Frequency Responsive Resource at risk. The Generator Owner shall identify and document these operating ranges. Generation Resource/Frequency Responsive Resources operating in this range shall not be assigned Responsive Reserve Service since frequency response is not available. This may include these operating conditions:
    - a. Over-pressure operation of the steam generator
    - b. Duct burner operation of combined cycle Generation Resources
    - c. Steam augmentation of combustion turbines and the injection of steam into the turbine combustors.

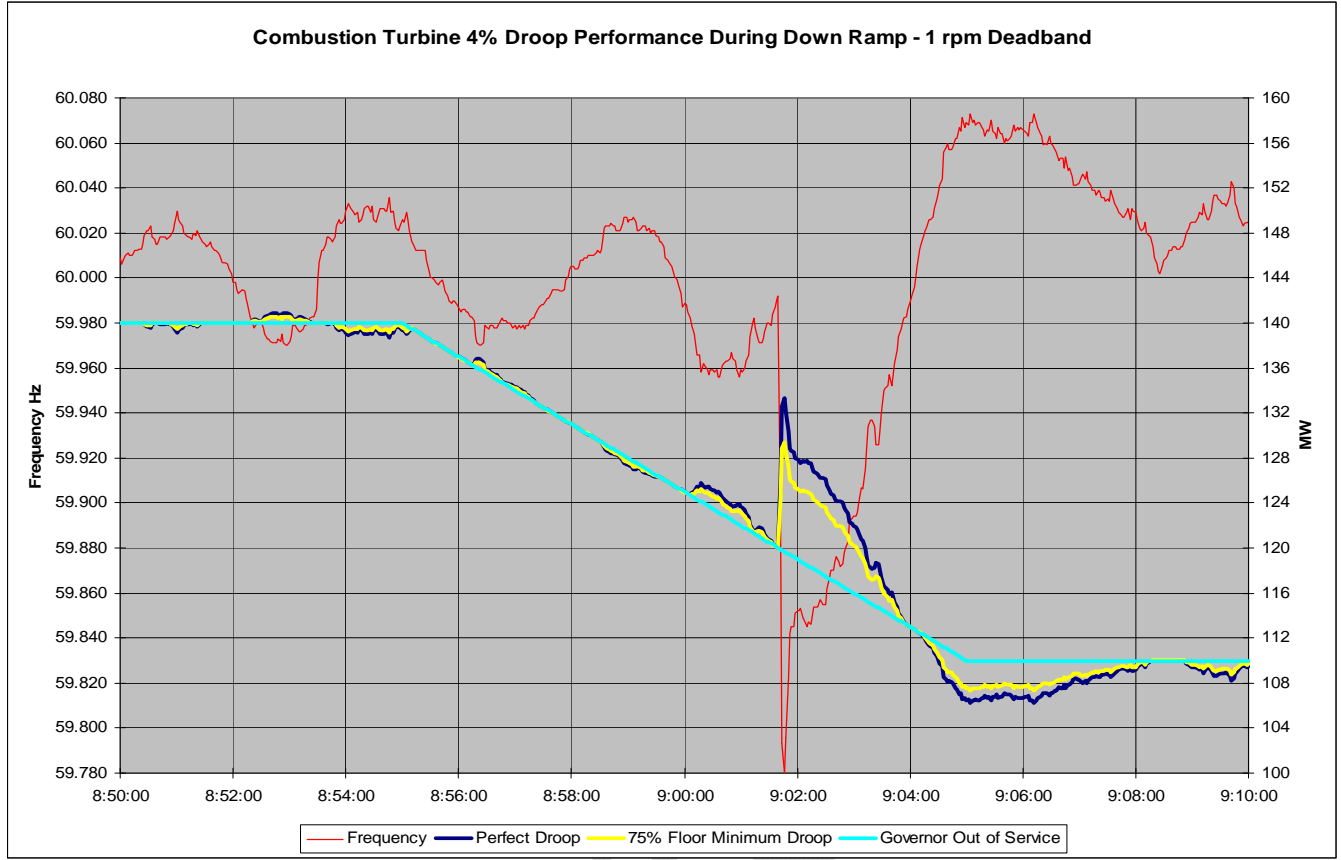


Figure 1: Combustion Turbine – 4% Droop during “Down Ramp”

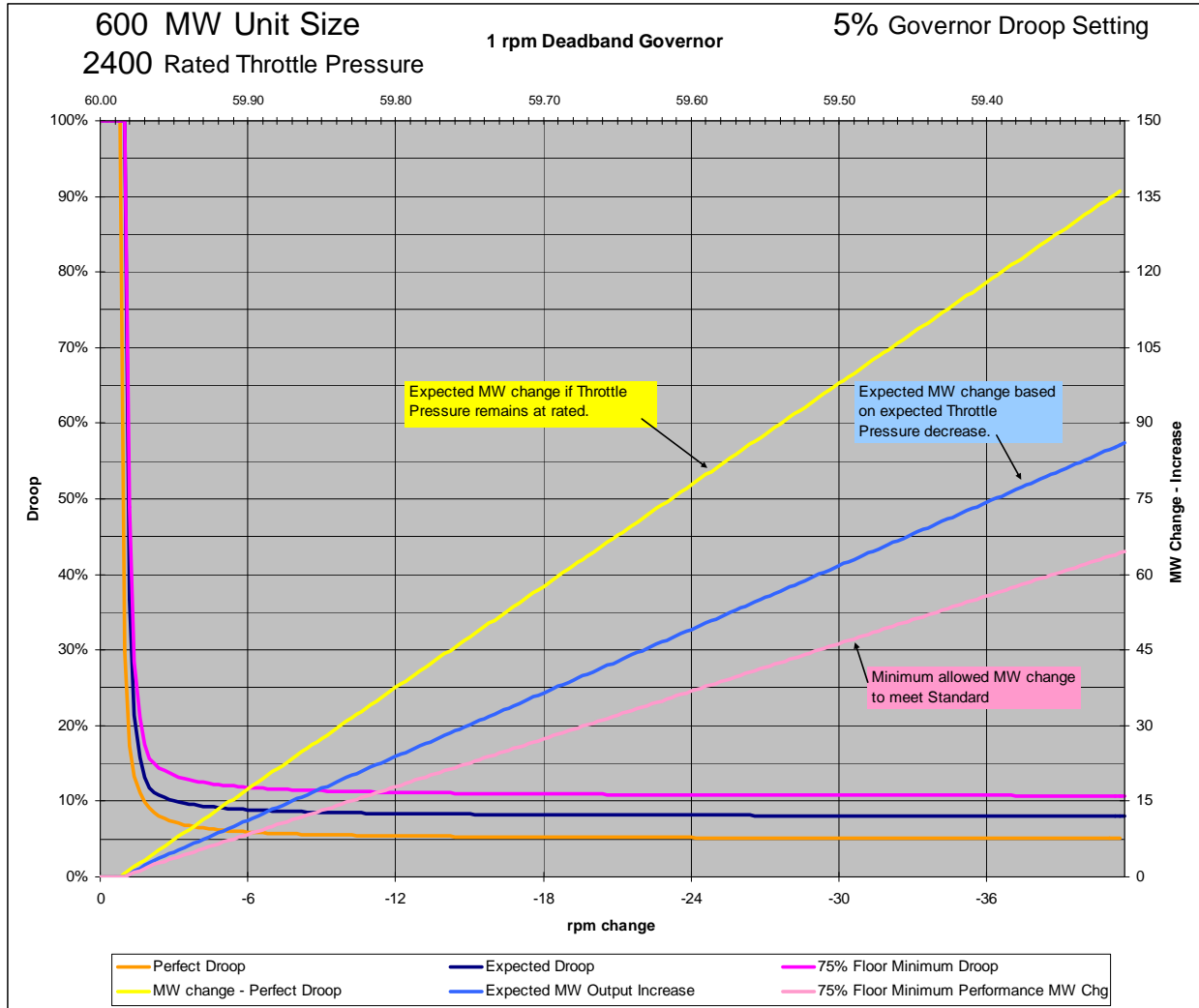


Figure 2: Conventional Steam Turbine @ 5% Droop and Effects of available stored energy.

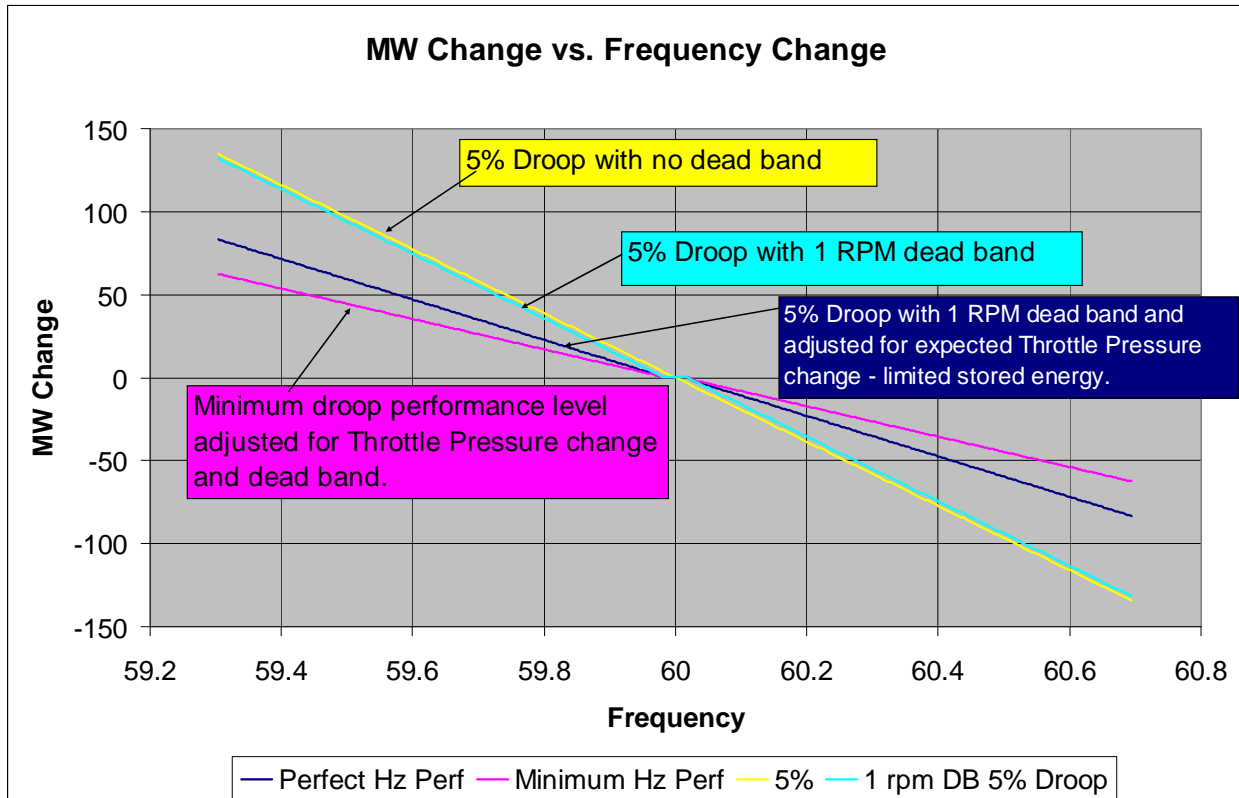


Figure 3. Effects of governor deadband and limited stored energy on frequency response

### Measurement of Generation Resource/Frequency Responsive Resource Frequency Response

The method used to calculate Generation Resource/Frequency Responsive Resource frequency response is similar to the method used in calculating the Interconnection frequency response. The same averaging periods of Pre and Post perturbation are used. The output, in megawatts, of the Generation Resource/Frequency Responsive Resource is used in place of the “Resource Lost” data. Additional Generation Resource/Frequency Responsive Resource information is required for the evaluation. These data are HOL, governor droop setting, governor deadband setting and any parameter that reduces Generation Resource/Frequency Responsive Resource performance as in “limited stored energy” or “reduced mass flow” at lower speeds (frequency). An Excel spreadsheet is attached that provides measurement processes of droop performance of steam turbines and combustion turbines. This spreadsheet can be used by combustion turbines operating in combined cycle mode or simple cycle mode. The spreadsheet name is:

Frequency Response and Droop Calculator for Resources.xls

The spreadsheet calculates the “expected MW change” of the Generation Resource/Frequency Responsive Resource and the “minimum expected MW change” for the Generation Resource/Frequency Responsive Resource. (see Figure 4 below) The “expected MW change” is derived from the governor deadband, droop setting and adjusted for “available stored energy” or

“reduced mass flow at lower speeds” parameter for the particular Generation Resource/Frequency Responsive Resource. The Generator Owner must develop the “limiting parameter” curve for each Generation Resource/Frequency Responsive Resource. This limiting parameter curve must be technically justifiable. The “actual MW change” of the Generation Resource/Frequency Responsive Resource is compared to the “minimum expected MW change” for this Generation Resource/Frequency Responsive Resource on this event. The value is derived from 75% of the “expected MW change”. The performance of the Generation Resource/Frequency Responsive Resource will then be calculated on a per unit (p.u.) measure by dividing the “actual MW change” by the “expected MW change”. This value (p.u.) will be used to develop the twelve month rolling average performance of the Generation Resource/Frequency Responsive Resource. The “expected MW change” shall be limited by the HOL and LOL of the Generation Resource/Frequency Responsive Resource.

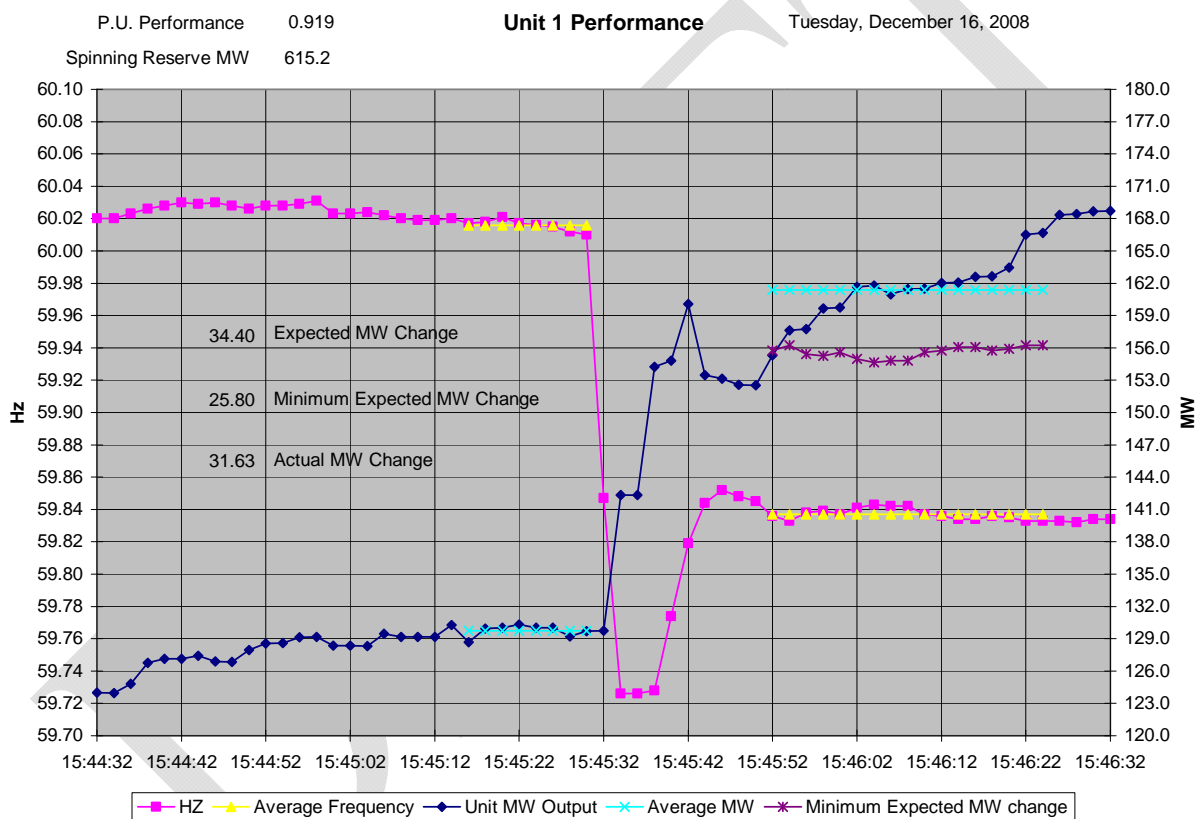


Figure 4: Expected Resource Performance

## Attachment 4

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### Implementation Plan:

### Pre-Implementation process:

Post for Comment	March 2009
Technical Workshop during comment period	April 2009
Respond to comments/revise	April 2009
Present revised draft to RSC	May 2009
Form ballot pool and vote	May/June 2009
TRE Board Adoption (Tentative)	July 2009
Submittal to NERC (Tentative)	August 2009
Receive FERC approval (Tentative)	October 2009

### Implementation Schedule

Initiation of Three-year Implementation	November 2009
Auditably Compliant	December 1, 2012

The table in the attached Compliance Implementation Schedule spreadsheet identifies when Responsible Entities must Begin Work (BW) to become compliant with a requirement, Substantially Compliant (SC) with a requirement, Compliant (C) with a requirement, and Auditably Compliant (AC) with a requirement.

Begin Work means a Responsible Entity has developed and approved a plan to address the requirements of a standard, has begun to identify and plan for necessary resources, and has begun implementing the requirements.

Substantially Compliant means an entity is well along in its implementation to becoming compliant with a requirement, but is not yet fully compliant.

Compliant means the entity meets the full intent of the requirements and is beginning to maintain required “data,” “documents,” “documentation,” “logs,” and “records.”

Auditably Compliant means the entity meets the full intent of the requirement and can demonstrate compliance to an auditor, including 12-calendar-months of auditable “data,” “documents,” “documentation,” “logs,” and “records.”

Per the standards, each subsequent compliance-monitoring period will require the previous full calendar year of such material.