1. Purpose

The purpose of this **reliability standard** is to:

(a) require sufficient **frequency response** from the **ISO** to maintain **Interconnection** frequency within predefined bounds by arresting frequency deviations and supporting frequency until the frequency is restored to its scheduled value; and

(b) provide consistent methods for measuring **frequency response** and determining the **frequency bias setting**.

2. Applicability

This **reliability standard** applies to:

(a) the **ISO**, unless the **interconnected electric system** is not synchronously connected to the **Interconnection**.

3. Requirements

R1 The **ISO** must:

(a) achieve an annual **frequency response** measure (as calculated in accordance with Appendix A) that is equal to or more negative than its **frequency response** obligation; and

(b) report, in accordance with Appendix A, the annual **frequency response** measure calculated pursuant to requirement R1(a),

which obligations the **ISO** may meet through participation in a frequency **reserve sharing group** which the **ISO** has designated as its agent.

R2 The **ISO** must, if it is not receiving overlap regulation service and uses a fixed **frequency bias setting**:

R2.1 implement the **frequency bias setting** determined in accordance with Appendix A, as validated by the Electric Reliability Organization, into its **area control error** calculation during the implementation period specified by the Electric Reliability Organization; and

R2.2 use this **frequency bias setting** until directed to change by the Electric Reliability Organization.

R3 The **ISO** must, if it is not receiving overlap regulation service and is utilizing a variable **frequency bias setting**, maintain a **frequency bias setting** that is:

R3.1 less than zero at all times; and

R3.2 equal to or more negative than its **frequency response** obligation when frequency varies from 60 Hz by more than +/- 0.036 Hz.

R4 The **ISO** must, if it is performing overlap regulation service, modify its **frequency bias setting** in its **area control error** calculation, in order to represent the **frequency bias setting** for the combined **balancing authority area**, to be equivalent to either:

R4.1 the sum of the **frequency bias settings**, as shown on the **NERC** *FRS Form 1* and *FRS Form 2* for the participating **balancing authorities** and as validated by the Electric Reliability Organization, or

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R4.2 the **frequency bias setting** shown on the **NERC** *FRS Form 1* and *FRS Form 2* for the entirety of the participating **balancing authority areas**.

4. Measures

The following measures correspond to the requirements identified in section 3 of this **reliability standard**. For example, MR1 is the measure for requirement R1.

MR1 Evidence of achieving an annual **frequency response** measure as required in requirement R1, and of reporting the annual **frequency response** measure as required in requirement R1 exists. Evidence may include dated data plus documented formula in either hardcopy or electronic format that shows an annual **frequency response** measure was achieved that is equal to or more negative than the **frequency response** obligation, a dated document in hard copy or electronic format showing submission of a completed report, or other equivalent evidence.

MR2 Evidence of implementing the **frequency bias setting** as validated by the Electric Reliability Organization into the **area control error** calculation as required in requirement R2 exists. Evidence may include a dated document in hard copy or electronic format showing the **frequency bias setting** as validated by the Electric Reliability Organization was implemented into the **area control error** calculation within the implementation period specified, or other equivalent evidence.

MR3 Evidence of maintaining a **frequency bias setting** as required in requirement R3 exists. Evidence may include a dated report in hard copy or electronic format showing the average clock-minute average **frequency bias setting** was less than zero and, during periods when the clock-minute average frequency was outside of the range 59.964 Hz to 60.036 Hz, was equal to or more negative than the **frequency response** obligation, or other equivalent evidence.

MR4 Evidence of modifying the **frequency bias setting** in the **area control error** calculation as required in requirement R4 exists. Evidence may include a dated operating log, database or list, in hard copy or electronic format, showing that when overlap regulation service was performed the **frequency bias setting** was modified in the **area control error** calculation, or other equivalent evidence.

5. Appendices

Appendix A - *BAL-003-AB-1.1 Frequency Response & Frequency Bias Setting Standard Supporting Document*

Revision History

Date	Description
2019-07-01	Initial release.

Appendix A

BAL-003-AB-1.1 Frequency Response & Frequency Bias Setting Standard Supporting Document

Interconnection Frequency Response Obligation

The Electric Reliability Organization, in consultation with regional representatives, has established a target contingency protection criterion for each **frequency response** obligation of the **Interconnection**. The default **frequency response** obligation of the **Interconnection** listed in Table 1 is based on the resource contingency criteria, which is the largest category C (N-2) event identified. A maximum delta frequency is calculated by adjusting a starting frequency for each **Interconnection** by the following:

- Prevailing **underfrequency load shedding** first step;

- CC_{Adj} which is the adjustment for the differences between 1-second and sub-second Point C observations for frequency events. A positive value indicates that the sub-second C data is lower than the 1-second data;

- CB_R which is the statistically determined ratio of the Point C to Value B; and

- BC'_{Adj} which is the statistically determined adjustment for the event nadir being below the Value B (Eastern Interconnection only) during primary **frequency response** withdrawal.

The **frequency response** obligation for each **Interconnection** in Table 1 is then calculated by dividing the resource **contingency** criteria MWs by 10 times the maximum delta frequency. In the Eastern Interconnection there is an additional adjustment (BC'_{Adj}) for the event nadir being below the Value B due to primary **frequency response** withdrawal. This **frequency response** obligation for the **Interconnection** includes uncertainty adjustments at a 95% confidence level. Detailed descriptions of the calculations used in Table 1 below are defined in the *Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard*.

Table 1

Interconnection	**Eastern**	**Western**	**ERCOT**	**HQ**	Units
Starting Frequency (F_{start})	**59.974**	**59.976**	**59.963**	**59.972**	Hz
Prevailing UFLS First Step	**59.5***	**59.5**	**59.3**	**58.5**	Hz
Base Delta Frequency (DF_{Base})	**0.474**	**0.476**	**0.663**	**1.472**	Hz
CC_{ADJ}	**0.007**	**0.004**	**0.012**	**N/A**	Hz
Delta Frequency (DF_{CC})	**0.467**	**0.472**	**0.651**	**1.472**	Hz
CB_R	**1.000**	**1.625**	**1.377**	**1.550**	
Delta Frequency (DF_{CBR})	**0.467**	**0.291**	**0.473**	**0.949**	Hz
BC'_{ADJ}	**0.018**	**N/A**	**N/A**	**N/A**	Hz
Max. Delta Frequency	**0.449**	**0.291**	**0.473**	**0.949**	
Resource Contingency Criteria	**4,500**	**2740**	**2,750**	**1700**	MW

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Interconnection	Eastern	Western	ERCOT	HQ	Units
Credit for Load Resources (CLR)		300	1400**		MW
IFRO	-1002	-840	-286	-179	MW/0.1 Hz

*The Eastern Interconnection **underfrequency load setting** set point listed is a compromise value set midway between the stable frequency minimum established in the **NERC** standard PRC-006-1, *Automatic Underfrequency Load Shedding* (59.3 Hz) and the local protection **underfrequency load setting** setting of 59.7 Hz used in Florida and Manitoba.

In the base obligation measure for ERCOT, 1400 MW (load resources triggered by under frequency relays at 59.70 Hz) was reduced from its resource **contingency criteria level of 2750 MW to get 239 MW/0.1 Hz. This was reduced to accurately account for designed response from load resources within 30 cycles.

An **Interconnection** may propose alternate **frequency response** obligation protection criteria for that **Interconnection** to the Electric Reliability Organization by submitting a *Standard Authorization Request* with supporting technical documentation.

Balancing Authority Frequency Response Obligation and Frequency Bias Setting

The Electric Reliability Organization will manage the administrative procedure for annually assigning a **frequency response** obligation and implementation of the **frequency bias setting** for each **balancing authority**. The annual timeline for all activities described in this section are shown below.

For an **Interconnection** with multiple **balancing authorities**, the **frequency response** obligation shown in Table 1 is allocated based on the **balancing authority** annual load and annual generation. The **frequency response** obligation allocation will be based on the following method:

$$FRO_{BA} = IFRO \times \frac{Annual\ Gen_{BA} + Annual\ Load_{BA}}{Annual\ Gen_{Int} + Annual\ Load_{Int}}$$

Where:

- Annual Gen_{BA} is the total annual "Output of Generating Plants" within the **balancing authority area**, on FERC *Form 714*, column c of Part II - Schedule 3.

- Annual $Load_{BA}$ is total annual load within the **balancing authority area**, on FERC *Form 714*, column e of Part II - Schedule 3.

- Annual Gen_{Int} is the sum of all annual gen_{BA} values reported in that **Interconnection**.

- Annual $Load_{Int}$ is the sum of all annual $load_{BA}$ values reported in that **Interconnection**.

The data used for this calculation is from the most recently filed *Form 714*. As an example, a report to the **NERC** in January 2013 would use the *Form 714* data filed in 2012, which utilized data from 2011.

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Balancing authorities that are not FERC-jurisdictional should use the *Form 714 Instructions* to assemble and submit equivalent data to the Electric Reliability Organization for use in the **frequency response** obligation allocation process.

Balancing authorities that elect to form a **frequency response** sharing group will calculate a **frequency response** sharing group **frequency response** obligation by adding together the individual **frequency response** obligations of the **balancing authority**.

Balancing authorities that elect to form a **frequency response** sharing group as a means to jointly meet the **frequency response** obligation will calculate their **frequency response** measure performance in one of two ways:

- Calculate a group **net actual interchange** and measure the group response to all events in the reporting year on a single *FRS Form 1*, or

- Jointly submit the individual **balancing authorities**' *FRS Form 1*s, with a summary spreadsheet that contains the sum of each participant's individual event performance.

Balancing authorities that merge or that transfer load or generation are encouraged to notify the Electric Reliability Organization of the change in footprint and corresponding changes in allocation such that the net obligation to the **Interconnection** remains the same and so that **control performance standard** limits can be adjusted.

Each **balancing authority** reports its previous year's **frequency response** measure, **frequency bias setting** and **frequency bias** type (fixed or variable) to the Electric Reliability Organization each year to allow the Electric Reliability Organization to validate the revised **frequency bias settings** on *FRS Form 1*. If the Electric Reliability Organization posts the official list of events after the date specified in the timeline below, **balancing authorities** will be given 30 **days** from the date the Electric Reliability Organization posts the official list of events to submit their *FRS Form 1*.

Once the Electric Reliability Organization reviews the data submitted in *FRS Form 1* and *FRS Form 2* for all **balancing authorities**, the Electric Reliability Organization will use *FRS Form 1* data to post the following information for each **balancing authority** for the upcoming year:

- **frequency bias setting**; and

- **frequency response** obligation.

Once the data listed above is fully posted, the Electric Reliability Organization will announce the three-day implementation period for changing the **frequency bias setting** if it differs from that shown in the timeline below.

A **balancing authority** using a fixed **frequency bias setting** sets its **frequency bias setting** to the greater of (in absolute value):

- Any number the **balancing authority** chooses between 100% and 125% of its **frequency response** measure as calculated on *FRS Form 1*; or

- The **Interconnection** minimum as determined by the Electric Reliability Organization.

For purposes of calculating the minimum **frequency bias setting**, a **balancing authority** participating in a **frequency response** sharing group will need to calculate its stand-alone **frequency response** measure using *FRS Form 1* and *FRS Form 2* to determine its minimum **frequency bias setting**.

A **balancing authority** providing overlap regulation will report the historic peak demand and generation of its combined **balancing authority areas** on *FRS Form 1* as described in requirement R4.

There are occasions when changes are needed to **frequency bias settings** outside of the normal schedule. Examples are footprint changes between **balancing authorities** and major changes in load or generation or the formation of new **balancing authorities**. In such cases, the changing **balancing authorities** will work with their regions, the **NERC**, and the Resources Subcommittee to confirm appropriate changes to **frequency bias settings**, **frequency response** obligation, **control performance standard** limits and **inadvertent interchange** balances.

If there is no net change to the **Interconnection** total **frequency bias**, the **balancing authorities** involved will agree on a date to implement their respective change in **frequency bias settings**. The **balancing authorities** and Electric Reliability Organization will also agree to the allocation of **frequency response** obligation such that the sum remains the same.

If there is a net change to the **Interconnection** total **frequency bias**, this will cause a change in CPS2 limits and **frequency response** obligation for other **balancing authorities** in the **Interconnection**. In this case, the Electric Reliability Organization will notify the impacted **balancing authorities** of their respective changes and provide an implementation window for making the **frequency bias setting** changes.

Frequency Response Measure

The **balancing authority** will calculate its **frequency response** measure from single event **frequency response** data, defined as: "the data from an individual event from a **balancing authority** that is used to calculate its **frequency response**, expressed in MW/0.1Hz" as calculated on *FRS Form 2* for each event shown on *FRS Form 1*. The events in *FRS Form 1* are selected by the Electric Reliability Organization using the *Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard*. The **frequency response** measure for a typical **balancing authority** in an **Interconnection** with more than one **balancing authority** is basically the change in its **net actual interchange** on its **intertie** with its **adjacent balancing authorities** divided by the change in **Interconnection** frequency. (Some **balancing authorities** may choose to apply corrections to their **net actual interchange** values to account for factors such as nonconforming loads.) *FRS Form 1* and *FRS Form 2* show the types of adjustments that are allowed. Note that with the exception of the contingent **balancing authority** column, any adjustments made must be made for all events in an evaluation year. As an example, if an entity has non-conforming loads and makes an adjustment for one event, all events must show the nonconforming load, even if the non-conforming load does not impact the calculation. This ensures that the reports are not utilizing the adjustments only when they are favorable to the **balancing authority**. The Electric Reliability Organization will use a standardized sampling interval of approximately 16 seconds before the event up to the time of the event for the pre-event **net actual interchange**, and frequency (A values) and approximately 20 to 52 seconds after the event for the post-event **net actual interchange** (B values) in the computation of **frequency response** measure values, dependent on the data scan rate of the **balancing authority**'s Energy Management System.

All events listed on *FRS Form 1* need to be included in the annual submission of *FRS Form 1* and *FRS Form 2*. The only time a **balancing authority** should exclude an event is if its **intertie** data or its frequency data is corrupt or its Energy Management System was unavailable. *FRS Form 2* has instructions on how to correct the **balancing authority**'s data if the given event is internal to the **balancing authority** or if other authorized adjustments are used.

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Assuming data entry is correct, *FRS Form 1* will automatically calculate the **frequency response** measure of the **balancing authority** for the past 12 **months** as the median of the **frequency response** measure values. A **balancing authority** electing to report as an **frequency response** sharing group or a provider of overlap regulation service will provide an *FRS Form 1* for the aggregate of its participants.

To allow a **balancing authority** to plan its operations, events with a "Point C" that cause the **Interconnection** frequency to be lower than that shown in Table 1 above or higher than an equal change in frequency going above 60 Hz may be included in the list of events for that **Interconnection**. However, the calculation of the **balancing authority** response to such an event will be adjusted to show a frequency change only to the target minimum frequency shown in Table 1 above or a high frequency amount of an equal quantity. Should such an event happen, the Electric Reliability Organization will provide additional guidance.