SDT Comments:

Background and Explanation (*Not part of the Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard document*)

The objectives of the additions to the BAL-003 process document are to:

- Provide a supportable process to address the intent of the B-C ratio and the analysis report
- Streamline the administrative support behind BAL-003, possible examples include
  - Reduce time pressure in getting IFROs and Bias values out
  - Only generate a full new analysis report to determine IFRO when triggered by a decline in performance from base year, otherwise a summary report could be developed and reference the last full report.
- Technically defensible replacement for the 4500 MW basis for the East as well as an on-off ramp for new credible contingencies in any Interconnection.
- While encouraging improvement, preserve reliability at the level when the standard was adopted
- Allow learning and minor changes to administrative processes without opening the standard
  - Characteristics of response may change (fewer events under current selection process if performance improves)
  - Forms improvement
- State of Reliability Report indicators to track reliability
  - Rate of Change of Frequency (RoCoF)/GW loss
  - Normalized M-4
    - Regression analyzed to correct for starting frequency and resource loss size
    - Expressed as Beta per GW loss

Below is an example of how the IFROs could be posted along with other balancing parameters.

Measure	East	West	Texas	Quebec	Notes
Epsilon 1	18mHz	22.8mHz	30mHz	21mHz	Parameter that sets CPS1 and BAAL
Balancing Authority ACE Limit	-700%	-700%	-700%	-700%	BAL-001-2 R2
Reportable Balancing Contingency Event	900MW	400MW	800MW	500MW	NERC Glossary
Interconnection Frequency Response Obligation (2019)	-1002	-840	-286	-179	(MW/0.1Hz)
Interconnection Frequency Response Obligation (2020)	-1120	-840	-286	-179	(MW/0.1Hz)

This procedure outlines the Electric Reliability Organization (ERO) process for supporting the Frequency Response Standard (FRS). A Procedure revision request may be submitted to the ERO for consideration. The revision request must provide a technical justification for the suggested modification. The ERO shall post the suggested modification for a 45-day formal comment period and discuss the revision request in a public meeting. The ERO will make a recommendation to the NERC BOT, which may adopt the revision request, reject it, or adopt it with modifications. Any approved revision to this Procedure shall be filed with FERC for informational purposes.

Event Selection Process

Event Selection Objectives

The goals of this procedure are to outline a transparent, repeatable process to annually identify a list of frequency events to be used by Balancing Authorities (BA) to calculate their Frequency Response to determine:

- Whether the BA met its Frequency Response Obligation, and
- An appropriate fixed Bias Setting.

Event Selection Criteria

1. The ERO will use the following criteria to select FRS frequency excursion events for analysis. The events that best fit the criteria will be used to support the FRS. The evaluation period for performing the annual Frequency Bias Setting and the Frequency Response Measure (FRM) calculation is December 1 of the prior year through November 30 of the current year.
2. The ERO will identify 20 to 35 frequency excursion events in each Interconnection for calculating the Frequency Bias Setting and the FRM. If the ERO cannot identify 20 frequency excursion events in a 12 month evaluation period satisfying the criteria below, then similar acceptable events from the subsequent year's evaluation period will be included with the data set by the ERO for determining FRS compliance. This is described later.
3. The ERO will use three criteria to determine if an acceptable frequency excursion event for the FRM has occurred:
    a. The change in frequency as defined by the difference from the A Value to Point C and the arrested frequency Point C exceeds the excursion threshold values specified for the Interconnection in Table 1 below.
        i. The A Value is computed as an average over the period from -16 seconds to 0 seconds before the frequency transient begins to decline.
        ii. Point C is the arrested value of frequency observed within 12 seconds following the start of the excursion.

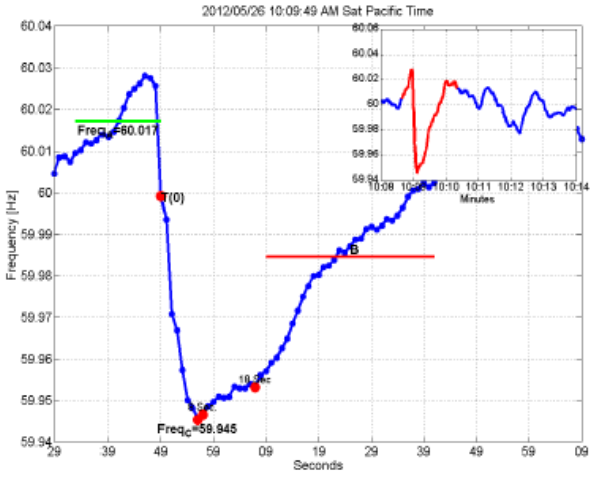
Interconnection	A Value to Pt C	Point C (Low)	Point C (High)
East	0.04Hz	< 59.96	> 60.04
West	0.07Hz	< 59.95	> 60.05
ERCOT	0.15Hz	< 59.90	> 60.10
HQ	0.30Hz	< 59.85	> 60.15

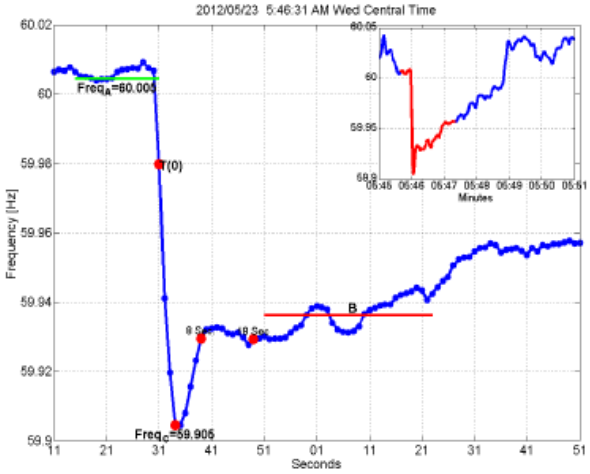
Table 1: Interconnection Frequency Excursion Threshold Values

b. The time from the start of the rapid change in frequency until the point at which Frequency has stabilized within a narrow range should be less than 18 seconds.

c. If any data point in the B Value average recovers to the A Value, the event will not be included.

4. Pre-disturbance frequency should be relatively steady and near 60.000 Hz for the A Value. The A Value is computed as an average over the period from -16 seconds to 0 seconds before the frequency transient begins to decline. For example, given the choice of the two events below, the one on the right is preferred as the pre-disturbance frequency is stable and also closer to 60 Hz.





5. Excursions that include 2 or more events that do not stabilize within 18 seconds will not be considered.

6. Frequency excursion events occurring during periods:

   (i) when large interchange schedule ramping or load change is happening, or

   (ii) within 5 minutes of the top of the hour,

   will be excluded from consideration if other acceptable frequency excursion events from the same quarter are available.

7. The ERO will select the largest (A Value to Point C) 2 or 3 frequency excursion *e*vents occurring each month. If there are not 2 frequency excursion events satisfying the selection criteria in a month, then other frequency excursion events should be picked in the following sequence:
    a. From the same event quarter of the year.
    b. From an adjacent month.
    c. From a similar load season in the year (shoulder vs. summer/winter)
    d. The largest unused event.

As noted earlier, if a total of 20 events are not available in an evaluation year, then similar acceptable events from the next year's evaluation period will be included with the data set by the ERO for determining Frequency Response Obligation (FRO) compliance. The first year's small set of data will be reported and used for Bias Setting purposes, but compliance evaluation on the FRO will be done using a 24 month data set.

To assist Balancing Authority preparation for complying with this standard, the ERO will provide quarterly posting of candidate frequency excursion events for the current year FRM calculation. The ERO will post the final list of frequency excursion events used for standard compliance as specified in Attachment A of BAL-003-1. The following is a general description of the process that the ERO will use to ensure that BAs can evaluate events during the year in order to monitor their performance throughout the year.

Monthly

Candidate events will be initially screened by the "Frequency Event Detection Methodology" shown on the following link located on the NERC Resources Subcommittee area of the NERC website: http://www.nerc.com/docs/oc/rs/Frequency_Event_Detection_Methodology_and_Criteria_Oct_2011.pdf. Each month's list will be posted by the end of the following month on the NERC website, http://www.nerc.com/filez/rs.html and listed under "Candidate Frequency Events".

Quarterly

The monthly event lists will be reviewed quarterly, with the quarters defined as:

- December through February
- March through May
- June through August
- September through November

Based on criteria established in the "*Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard",* events will be selected to populate the FRS Form 1 for each Interconnection.

The Form 1's will be posted on the NERC website, in the Resources Subcommittee area under the title "Frequency Response Standard Resources". Updated Form 1's will be posted at the end of each quarter listed above after a review by the NERC RS' Frequency Working Group. While the events on this list are expected to be final, as outlined in the selection criteria, additional events may be considered, if the number of events throughout the year do not create a list of at least 20 events. It is intended that this quarterly posting of updates to the FRS Form 1 would allow BAs to evaluate the events throughout the year, lessening the burden when the yearly posting is made.

Annually

The final FRS Form 1 for each Interconnection, which would contain the events from all four quarters listed above, will be posted as specified in Attachment A. Each Balancing Authority reports its previous year's Frequency Response Measure (FRM), Frequency Bias Setting and Frequency Bias type (fixed or variable) to the ERO as specified in Attachment A using the final FRS Form 1. The ERO will check for errors and use the FRS Form 1 data to calculate CPS limits and FROs for the upcoming year.

Once the data listed above is fully reviewed, the ERO may adjust the implementation specified in Attachment A for changing the Frequency Bias Settings and CPS limits. This allows flexibility in when each BA implements its settings.

Process for Adjusting Interconnection Minimum Frequency Bias Setting

This procedure outlines the process the ERO is to use for modifying minimum Frequency Bias Settings to better meet reliability needs. The ERO will adjust the Frequency Bias Setting minimum in accordance with this procedure.

The ERO will post the minimum Frequency Bias Setting values on the ERO website along with other balancing standard limits.

Under BAL-003-1, the minimum Frequency Bias Settings will be moved toward the natural Frequency Response in each interconnection. In the first year, the minimum Frequency Bias Setting for each interconnection is shown in Table 2 below. Each Interconnection Minimum Frequency Bias Setting is based on the sum of the non-coincident peak loads for each BA from the currently available FERC 714 Report or equivalent. This non-coincident peak load sum is multiplied by the percentage shown in Table 2 to get the Interconnection Minimum Frequency Bias Setting. The Interconnection Minimum Frequency Bias Setting is allocated among the BAs on an interconnection using the same allocation method as is used for the allocation of the Frequency Response Obligation (FRO).

Interconnection	Interconnection Minimum Frequency Bias Setting (in MW/0.1Hz)
Eastern	0.9% of non-coincident peak load
Western	0.9% of non-coincident peak load
ERCOT*	N/A
HQ*	N/A

Table 2. Frequency Bias Setting Minimums

*The minimum Frequency Bias Setting requirement does not apply to a Balancing Authority that is the only Balancing Authority in its Interconnection. These Balancing Authorities are solely responsible for providing reliable frequency control of their Interconnection. These Balancing Authorities are responsible for converting frequency error into a megawatt error to provide reliable frequency control, and the imposition of a minimum bias setting greater than the magnitude the Frequency Response Obligation may have the potential to cause control system hunting, and instability in the extreme.

The ERO, in coordination with the regions of each interconnection, will annually review Frequency Bias Setting data submitted by BAs. If an Interconnection's total minimum Frequency Bias Setting exceeds (in absolute value) the Interconnection's total natural Frequency Response by more (in absolute value) than 0.2 percentage points of peak load (expressed in MW/0.1Hz), the minimum Frequency Bias Setting for BAs within that Interconnection may be reduced (in absolute value) in the subsequent years FRS Form 1 based on the technical evaluation and consultation with the regions affected by 0.1 percentage point of peak load (expressed in MW/0.1Hz) to better match that Frequency Bias Setting and natural Frequency Response.

The ERO, in coordination with the regions of each Interconnection, will monitor the impact of the reduction of minimum frequency bias settings, if any, on frequency performance, control performance, and system reliability. If unexpected and undesirable impacts such as, but not limited to, sluggish post-contingency restoration of frequency to schedule or control performance problems occur, then the prior reduction in the minimum frequency bias settings may be reversed, and/or the prospective reduction based on the criterion stated above may not be implemented.

Interconnection Frequency Response Obligation (IFRO)

The default IFRO listed in Table 1 is based on the Resource Loss Protection Criteria (RLPC), which is the largest category C (N-2) event identified except for the Eastern Interconnection, which uses the largest event in the last 10 years. A maximum delta frequency (MDF) is calculated by adjusting a starting frequency for each Interconnection by the following:

- Prevailing UFLS 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
- 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 IFRO for each Interconnection in Table 1 is then calculated by dividing the RLPC MWs by 10 times the MDF. 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 IFRO 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*.

SDT Comments:

Assuming the industry agrees, this language will be moved to the *Procedure Document*, as it will no longer exist in Attachment A of BAL-003-2. The drafting team recommends removing these procedural steps from Attachment A as they are subject to engineering studies and modifications that can be revised outside of the standards development process.

NOTE: Although the language would no longer be included in the standard under the proposed revisions, this calculation process would remain subject to stakeholder comment on any revisions, and it would remain subject to Board approval/adoption and would be filed with FERC for informational purposes.

The process to modify this document is defined in the first paragraph of this document and states, *"This procedure outlines the Electric Reliability Organization (ERO) process for supporting the Frequency Response Standard (FRS). A Procedure revision request may be submitted to the ERO for consideration. The revision request must provide a technical justification for the suggested modification. The ERO shall post the suggested modification for a 45-day formal comment period and discuss the revision request in a public meeting. The ERO will make a recommendation to the NERC BOT, which may adopt the revision request, reject it, or adopt it with modifications. Any approved revision to this Procedure shall be filed with FERC for informational purposes."* The process to modify this document continues in concert with the *Rules of Procedure.*

The information shown here would be modified under the standards drafting team's proposals in the other posted documents in this informal posting. When feedback is received from industry, the standards drafting team will evaluate and modify this section based on comments received.

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 (MDF)	0.449	0.291	0.473	0.949	
Resource Contingency Criteria (RCC)	4,500	2,740	2,750	1,700	MW
Credit for Load Resources (CLR)		300	1,400**		MW
IFRO	-1,002	-840	-286	-179	MW/0.1 Hz

Table 1: Interconnection Frequency Response Obligations

**The Eastern Interconnection UFLS set point listed is a compromise value set midway between the stable frequency minimum established in PRC-006-1 (59.3 Hz) and the local protection UFLS 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 IFRO protection criteria to the ERO by submitting a SAR with supporting technical documentation.

Balancing Authority Frequency Response Obligation (FRO) and Frequency Bias Setting

The ERO will manage the administrative procedure for annually assigning an FRO 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 a multiple Balancing Authority interconnection, the Interconnection Frequency Response Obligation shown in Table 1 is allocated based on the Balancing Authority annual load and annual generation. The FRO allocation will be based on the following method:

$$\text{FRO}_{\text{BA}} = \text{IFRO} \times \frac{\text{Annual Gen}_{\text{BA}} + \text{Annual Load}_{\text{BA}}}{\text{Annual Gen}_{\text{Int}} + \text{Annual Load}_{\text{Int}}}$$

Where:

- Annual Gen_{BA} is the total annual "Output of Generating Plants" within the Balancing Authority Area (BAA), on FERC Form 714, column c of Part II - Schedule 3.
- Annual Load_{BA} is total annual Load within the BAA, 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 NERC in January 2013 would use the Form 714 data filed in 2012, which utilized data from 2011.

Balancing Authorities that are not FERC jurisdictional should use the Form 714 Instructions to assemble and submit equivalent data to the ERO for use in the FRO Allocation process.

Interconnection Frequency Response Obligation Methodology

This procedure outlines the process the ERO is to use for determining the Interconnection Frequency Response Obligation (IFRO).

The following are the formulae that comprise the calculation of the IFROs.

$$DF_{Base} = F_{Start} - UFLS$$

$$DF_{CC} = DF_{Base} - CC_{Adj}$$

$$DF_{CBR} = \frac{DF_{CC}}{CB_R}$$

$$MDF = DF_{CBR} - BC'_{Adj}$$

$$ARCC = RCC - CLR$$

$$IFRO = \frac{ARCC}{10 * MDF}$$

Where:

- DF_{Base} is the base delta frequency.
- F_{Start} is the starting frequency determined by the statistical analysis.
- UFLS is the highest UFLS trip setpoint for the interconnection.
- CC_{Adj} 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.
- DF_{CC} is the delta frequency adjusted for the differences between 1-second and sub-second Point C observations for frequency events.
- CB_R is the statistically determined ratio of the Point C to Value B.
- DF_{CBR} is the delta frequency adjusted for the ratio of the Point C to Value B.
- BC'_{ADJ} is the statistically determined adjustment for the event nadir being below the Value B (Eastern Interconnection only) during primary frequency response withdrawal.
- MDF is the maximum allowable delta frequency.
- RCC is the resource contingency criteria.
- CLR is the credit for load resources.
- ARCC is the adjusted resource contingency criteria adjusted for the credit for load resources.
- IFRO is the interconnection frequency response obligation.

Adjustments to Interconnection Frequency Response Obligations (IFRO)

Similar to the Control Performance Standard, BAL-003 is intended to be tunable, such that if performance degrades or characteristics of an Interconnection change, the IFRO adapts. Information from NERC's annual State of Reliability Report is used to determine if a detailed analysis is needed or if the IFRO needs to be increased. Information for the base year of BAL-003 is outlined in the table below.

Interconnection	Eastern	Western	ERCOT	HQ
Interconnection Median Beta	2,368.6	1,400.0	752.0	543.8
M-4 Point C	59.956	59.918	59.868	59.487
Resource Loss Protection Criteria (RLPC)	4,500	2,740	2,750	1,700
Credit for Load		300	1,400[1]	
IFRO	-1002	-840	-286	-179

Base Year (2016) Data for BAL-003-1

Supporting Annual Frequency Response Analysis

The ERO will review frequency response performance as part of its annual State of Reliability Report analysis. If Operating Year Beta remains above the base year performance, no additional review is necessary. If Operating Year Beta for an Interconnection drops below the BAL-003 base year (currently 2016), a more detailed assessment will be performed to determine if changes are needed to the IFRO. Due to expected variation in sampling and performance, as long as performance remains within 10% of base year performance, no changes in FRO are needed.

If a detailed frequency response analysis is performed, it will be posted on the ERO website.

Changes in Resource Loss Protection Criteria (RLPC)

The default RLPC for an Interconnection will be the sum of the two Most Severe Single Contingencies (MSSC) within the Interconnection. The ERO will annually verify the two largest resources in each Interconnection. If a new RLPC is identified for an Interconnection, there will be a proportional change in IFRO. For example, if a network change in WECC resulted in a 3000 MW RLPC, the new obligation becomes:

[1] The Base Obligation measure for ERCOT, 1400 MW (Load Resources triggered by Under Frequency Relays at 59.70 Hz) was reduced from its Resource Loss Protection 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

-840 x (3000/2740) = -920 MW/0.1Hz

If the change is a reduction in IFRO greater than 10%, the change will be implemented over multiple years. The ERO may pause and reassess a multi-year drop in IFRO if the Interconnection's performance indicators show a statistically significant decline or an event occurs that is larger than the RLPC. The ERO will determine future steps based on analysis.

Credit for Load

Some Interconnections have contractually obligated load that trips at a setpoint above the first step of UFLS. The ERO will annually review changes in the contractual obligation amount and will adjust the credit as appropriate.

As part of its annual analysis, the ERO will confirm whether there has been a material change in the amount of high set interruptible load. Changes in credit for load are not needed if the amount of contributing load has not changed by more than 5%.

Decline in Point C

If the average M-4 Point C in the State of Reliability Report declines below the base year, ERO will as part of its annual analysis determine whether the decline in performance is due to a decline in frequency response or due to other factors (e.g. balancing events not associated generation trips, decline in inertia, increased ramping obligations).

If the review shows the decline in Point C is due to other factors, the issue will be referred to the appropriate stakeholder committee(s).

If the review shows the decline in Point C is likely due to a decline in Frequency Response, the ERO will determine if the IFRO needs adjustment.

Posting and Communicating IFRO Changes

While unofficial, NERC will notify Balancing Authorities if it appears there may be IFRO increases in an Interconnection when it provides Balancing Authorities the final FRS Forms for the year. Once analysis is complete, NERC will post current and any upcoming changes in IFRO on its website and provide official notice to Balancing Authorities at the same time as Bias Setting notifications are transmitted.