December 30, 2013

VIA ELECTRONIC FILING

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

Re: Informational Filing, Frequency Response Annual Analysis
Docket Nos. RM13-11-000

Dear Ms. Bose:

The North American Electric Reliability Corporation ("NERC") hereby submits its Annual Analysis of Frequency Response for the administration and support of proposed Reliability Standard BAL-003-1 – Frequency Response and Frequency Bias Setting ("Report"). The Report attached hereto provides an update to the statistical analyses and calculations contained in the 2012 Frequency Response Initiative Report included as Exhibit F to the March 29, 2013 NERC petition for approval of proposed Reliability Standard BAL-003-1.

Specifically, the Report analyzes the influence of remedial action schemes that trip more than 2,400 MW of resources on the calculation of the Interconnection Frequency Response Obligation ("IFRO") for the Western Electric Coordinating Council, as proposed in *Frequency Response and Frequency Bias Setting Reliability Standard*, Notice of Proposed Rulemaking, 144 FERC ¶ 61,057 at P 32 (2013) ("NOPR"). The Report also analyzes: (i) the frequency events occurring between January 1, 2010, and June 30, 2013 to determine appropriate adjustment factors for calculating the IFROs; and (ii) the trends in primary Frequency Response sustainability or withdrawal throughout the frequency events.

Dynamic simulations of the Eastern, Western, and ERCOT Interconnections for the recommended IFROs showed those levels of primary Frequency Response to be adequate to avoid tripping of the first stage of the interconnection UFLS systems. Light-load cases were used for the analyses, as proposed in Paragraph 41 of the NOPR. Evaluation of field trial data regarding the use of a linear regression method for calculating the Balancing Authority Frequency Response Measure is not included in the Report, but is currently ongoing.

The Frequency Response performance for all four interconnections from 2010 through 2012 exceeds the recommended IFROs and exhibits stable trends. No changes are proposed to the procedures recommended in the 2012 Frequency Response Initiative Report.

NERC is not requesting any Commission action on the instant filing. NERC respectfully requests that the Commission accept this filing for informational purposes only.

Respectfully submitted,

/s/ Stacey Tyrewala
Stacey Tyrewala

Senior Counsel for North American Electric Reliability Corporation

cc: Official service list in Docket No. RM13-11-000

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Frequency Response Annual Analysis

December 2013

RELIABILITY | ACCOUNTABILITY

3353 Peachtree Road NE
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Preface

The North American Electric Reliability Corporation's (NERC) mission is to ensure the reliability of the North American bulk power system. NERC is the electric reliability organization (ERO) certified by the Federal Energy Regulatory Commission (FERC) to establish and enforce reliability standards for the bulk power system. NERC develops and enforces reliability standards; assesses adequacy annually via a 10-year forecast and summer and winter forecasts; monitors the bulk power system; and educates, trains, and certifies industry personnel. ERO activities in Canada related to the reliability of the bulk power system are recognized and overseen by the appropriate governmental authorities in that country[1].

NERC assesses and reports on the reliability and adequacy of the North American bulk power system, which is divided into eight Regional areas, as shown on the map and table below. The users, owners, and operators of the bulk power system within these areas account for virtually all the electricity supplied in the United States, Canada, and a portion of Baja California Norte, Mexico.

NERC Regional Entities

FRCC	Florida Reliability Coordinating Council
MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RFC	ReliabilityFirst Corporation
SERC	SERC Reliability Corporation
SPP-RE	Southwest Power Pool Regional Entity
TRE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

NERC Regional Entities Map

[1] As of June 18, 2007, FERC granted NERC the legal authority to enforce Reliability Standards with all U.S. users, owners, and operators of the Bulk-Power System and made compliance with those standards mandatory and enforceable. Equivalent relationships have been sought and for the most part realized in Canada and Mexico. Prior to adoption of §215 in the U.S., the provinces of Ontario (in 2002) and New Brunswick (in 2004) adopted all Reliability Standards that were approved by the NERC Board as mandatory and enforceable within their respective jurisdictions through market rules. Reliability legislation is in place or NERC has memoranda of understanding with provincial authorities in Ontario, New Brunswick, Nova Scotia, Québec, Manitoba, Saskatchewan, British Columbia and Alberta, and with the National Energy Board of Canada (NEB). NERC standards are mandatory and enforceable in Ontario and New Brunswick as a matter of provincial law. Manitoba has adopted legislation and standards are mandatory in Manitoba. In addition, NERC has been designated as the "electric reliability organization" under Alberta's Transportation Regulation, and certain Reliability Standards have been approved in that jurisdiction; others are pending. NERC standards are now mandatory in British Columbia and Nova Scotia. NERC and the Northeast Power Coordinating Council (NPCC) have been recognized as standards setting bodies by the Régie de l'énergie of Québec, and Québec has the framework in place for Reliability Standards to become mandatory. NEB has made Reliability Standards mandatory for international power lines. In Mexico, the Comisión Federal de Electricidad (CFE) has signed WECC's reliability management system agreement, which only applies to Baja California Norte.

This Report

This report is the first annual analysis of Frequency Response performance for the administration and support of NERC Reliability Standard BAL-003-1 – Frequency Response and Frequency Bias Setting. It provides an update to the statistical analyses and calculations contained in the 2012 *Frequency Response Initiative Report* approved by the NERC Resources Subcommittee and Operating Committee, and accepted by the NERC Board of Trustees (Board). No changes are proposed to the procedures recommended in that report.

This report contains the analysis and annual recommendations for the calculation of the Interconnection Frequency Response Obligation (IFRO) for each of the four electrical interconnections of North America. This includes:

- Statistical analysis of the frequency behavior for the period January 1, 2010 through December 31, 2012.
- Analysis of the frequency events occurring between January 1, 2010, and June 30, 2013 to determine appropriate adjustment factors for calculating the IFROs.
- Analysis of the trends in primary frequency response sustainability or withdrawal throughout the frequency events.

Special analyses include:

- Analysis of the influence of remedial action schemes (RAS) that trip more than 2,400 MW of resources on the calculation of the WECC IFRO.
- Dynamics analysis of the recommended IFROs.

As a condition of approval by the Resources Subcommittee and the Operating Committee, these analyses are to be redone prior to implementation of BAL-003-1.

This report was approved by the Frequency Working Group on December 16, 2013, via conference call vote.

This report was approved by the Resources Subcommittee on December 18, 2013, via conference call vote.

This report was approved by the Operating Committee Executive Committee on December 20, 2013, via conference call vote.

Executive Summary

Recommendations

The following are the recommended parameters and adjustments to use when calculating the IFROs for the 2014 Frequency Response period (December 2013 through November 2014) during the BAL-003-1 Field Trial. As a condition of approval by the Resources Subcommittee and the Operating Committee, these analyses are to be redone prior to implementation of that standard.

1. No changes are proposed to the procedures recommended in the 2012 *Frequency Response Initiative Report*.

2. The IFROs are calculated as shown in Table A.

Table A: Recommended IFROs					
	Eastern (EI)	Western (WI)	ERCOT (TI)	Québec (QI)	Units
Starting Frequency	59.974	59.971	59.964	59.968	Hz
Max. Allowable Delta Frequency	0.444	0.261	0.449	0.947	Hz
Resource Contingency Protection Criteria	4,500	2,626	2,750	1,700	MW
Credit for LR	–	150	895	–	MW
IFRO[2]	-1,014	-949	-413	-180	MW/0.1Hz
Absolute Value of IFRO	**1,014**	**949**	**413**	**180**	**MW/0.1Hz**
Absolute Value of Current Interconnection Frequency Response Performance[3]	2,314	1,467	586	593	MW/0.1Hz
% of Interconnection Load[4]	0.16%	0.58%	0.60%	0.48%	

3. A Value B to Point C prime adjustment (BC'_{ADJ}) of 21 mHz should be made to the Eastern Interconnection allowable delta frequency to compensate for the predominant

[2] Refer to the IFRO Formulae section of this report for further details on the calculation.

[3] Based on 2012 Interconnection Frequency Response Performance from Appendix B of the 2013 State of Reliability report: EI = -2,314 MW / 0.1Hz, WI = -1,467 MW / 0.1Hz, TI = -586 MW / 0.1Hz, and QI = -593 MW/0.1 Hz.

[4] Interconnection projected Total Internal Demands from the 2013 NERC Long-Term Reliability Assessment (2014 summer demand):
EI = 614,953 MW, WI = 163,691 MW, TI = 69,289 MW, and QI (2014-2015 winter demand) = 37,179 MW.

withdrawal of primary frequency response exhibited in that interconnection. The BC'_{ADJ} was introduced in the Frequency Response Initiative 2012 analysis of the Eastern Interconnection frequency response. Analysis of the frequency events for that interconnection from January 2010 through June 2013 showed a lower nadir (Point C') for the events that typically occur in the T+58 to T+70 second time frame, beyond the measurements of Point C or Value B. Similar analysis of frequency events in the Western and ERCOT Interconnections showed that the nadirs occurred within the time frames of the measurements of Point C or Value B. Therefore, no BC'_{ADJ} is necessary for those interconnections.

Findings

1. The Frequency Response performance for all four interconnections from 2010 through 2012 exceeds the recommended IFROs and exhibits stable trends.

2. For the Western Interconnection IFRO calculation, the Palo Verde unit ratings were adjusted from 2,740 MW to 2,626[5] MW to reflect current unit ratings in the Resource Contingency Protection Criteria (the loss of two Palo Verde units), and the credit for load resources tripped by RAS was modified from 300 MW to 150 MW to reflect the actual load armed to trip by the Palo Verde RAS. Additionally, the maximum allowable delta frequency decreased by 30 mHz. Those changes increased the Western Interconnection IFRO by 109 MW/0.1 Hz.

3. For the ERCOT Interconnection IFRO calculation, credit for load resources was reduced from the contractual 1,400 MW used in the 2012 calculations to a statistically determined 895 MW, representing the amount of load resource that is available 95 percent of the time. That change increased the ERCOT Interconnection IFRO by 127 MW/0.1 Hz.

4. RAS in the Western Interconnection that trip generation resources in excess of 2,400 MW for transmission system contingencies should not be used for the resource contingency protection criteria for the Western Interconnection. Because of the location of the resources tripped and the fact that RAS would not be armed to trip those levels of generation under off peak conditions, the loss of two Palo Verde units is a larger hazard to the interconnection. When the Palo Verde generators trip, it results in an increase in system losses of about 420 MW, while tripping generation by the RAS would tend to decrease system losses due to their distance from the major load centers.

5. Dynamics simulations of the Eastern, Western, and ERCOT Interconnections for the recommended IFROs showed those levels of primary frequency response to be adequate to avoid tripping of the first stage of the interconnection UFLS systems. Light-load cases were used for all three of these analyses.

[5] From the EIA Form 860 Winter Net Capacity ratings for the two largest Palo Verde units.

Frequency Response Performance Analysis

Every year, NERC analyzes the Frequency Response performance of the four interconnections in the *State of Reliability* report. The following charts and statistics are drawn from the 2013 *State of Reliability* report and the Interconnection Frequency Response from the NERC Reliability Indicators dashboard.[6]

The 2012 frequency response values for each interconnection are used to compare the IFROs to current performance.

Eastern Interconnection

Statistical analysis of the annual changes in Eastern Interconnection Frequency Response concluded that there are no statistically significant changes in the expected Frequency Response by year for the Eastern Interconnection.

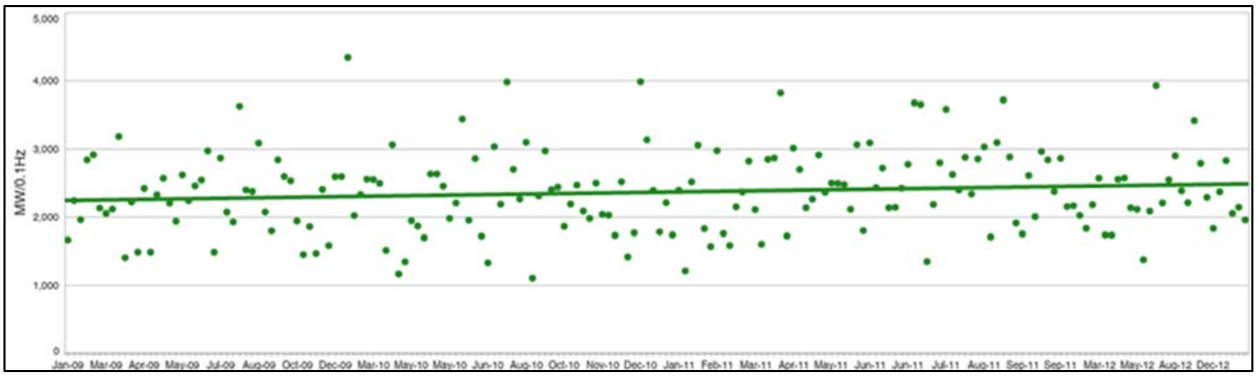

Figure 1: Eastern Interconnection Frequency Response Trend 2009–2012

Table 1: Eastern Interconnection Frequency Response Statistics					
Year	Number of Events	MW/0.1 Hz			
		Mean of Frequency Response	Std. Dev. of Frequency Response	Min.	Max.
2009–2012	186	2,360	599	1,103	4,336
2009	44	2,258	522	1,405	3,625
2010	49	2,336	698	1,103	4,336
2011	65	2,468	594	1,210	3,815
2012	28	2,314	524	1,374	3,921

[6] Located at: http://www.nerc.com/pa/RAPA/ri/Pages/InterconnectionFrequencyResponse.aspx

Western Interconnection

It was not possible to statistically analyze the annual changes in the Western Interconnection Frequency Response due to the small sample sizes for each year.

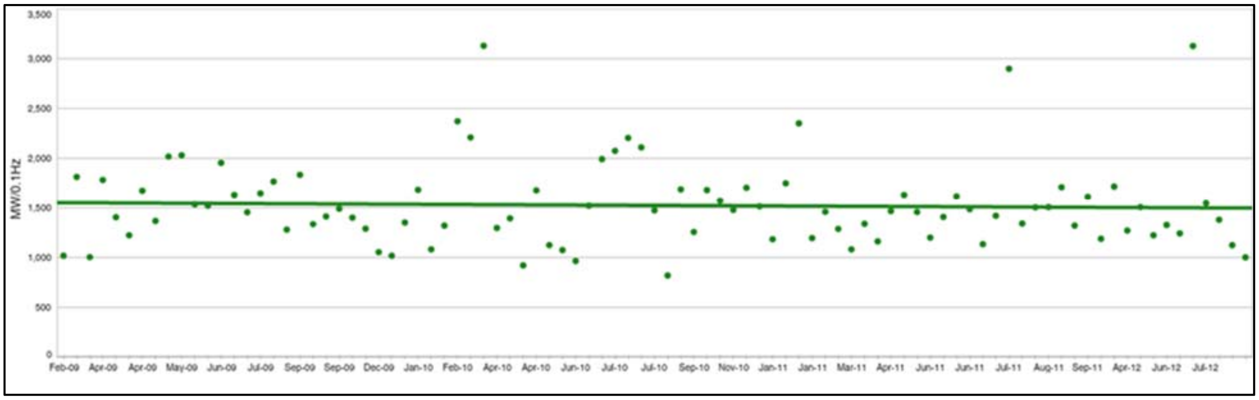

Figure 2: Western Interconnection Frequency Response Trend
February 2009–July 2012

Table 2: Western Interconnection Frequency Response Statistics					
		MW/0.1 Hz			
Year	Number of Events	Mean of Frequency Response	Std. Dev. of Frequency Response	Min.	Max.
2009–2012	91	1,521	430	817	3,125
2009	25	1,514	296	1,000	2,027
2010	29	1,572	512	817	3,125
2011	25	1,497	392	1,079	2,895
2012	12	1,467	557	997	3,123

ERCOT Interconnection

Statistical analysis of the annual changes in ERCOT Interconnection Frequency Response found two statistically significant decreases in the expected Frequency Response (2009–2011 and 2010–2011), and one statistically significant increase (2011–2012). However, the change in the expected Frequency Response from 2009 to 2012 is not statistically significant.

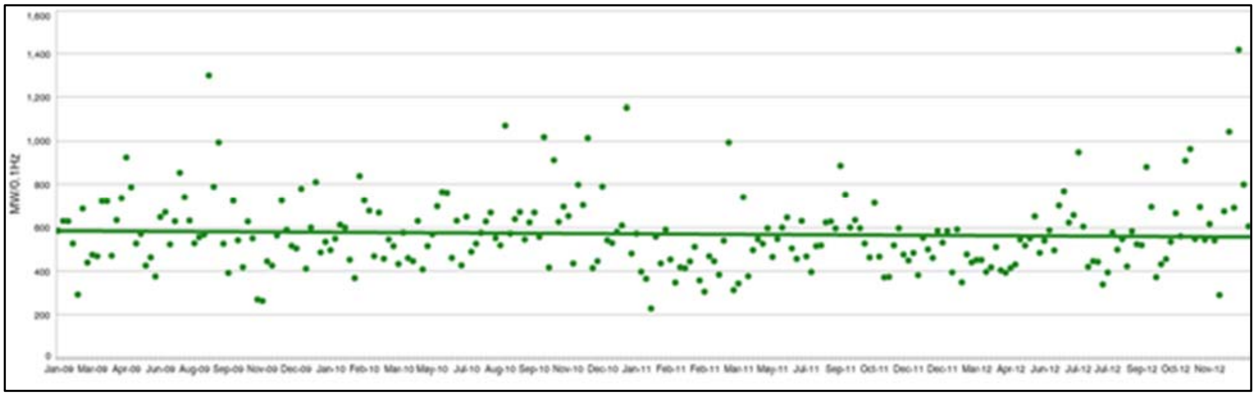

Figure 3: ERCOT Interconnection Frequency Response Analysis for 2009–2012

Table 3: ERCOT Interconnection Frequency Response Statistics					
		MW/0.1 Hz			
Year	Number of Events	Mean of Frequency Response	Std. Dev. of Frequency Response	Min.	Max.
2009–2012	246	570	172	228	1,418
2009	51	595	185	263	1,299
2010	67	610	165	368	1,153
2011	65	510	131	228	993
2012	63	571	192	290	1,418

Québec Interconnection

Statistical analysis of the annual changes in Québec Interconnection Frequency Response found that there are no statistically significant changes in the expected Frequency Response by year for the interconnection.

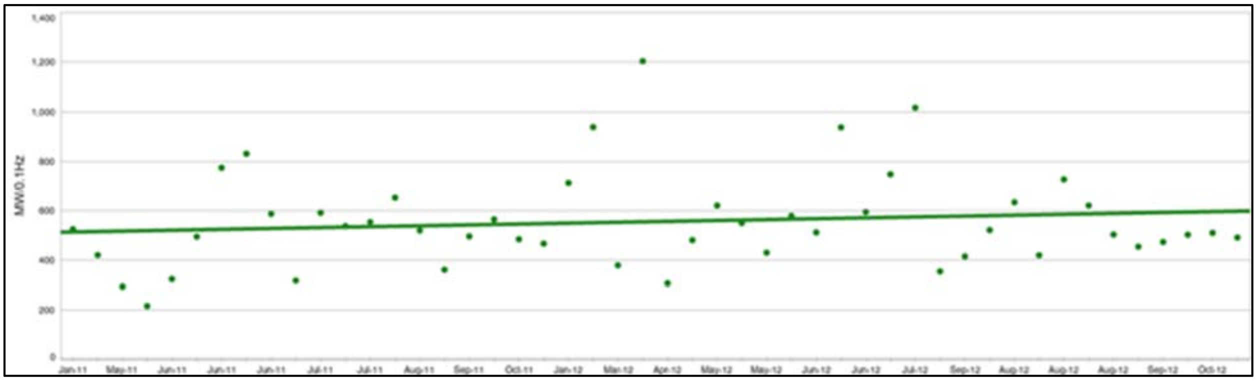

Figure 4: Québec Interconnection Frequency Response Analysis for 2011–2012

Table 4: Québec Interconnection Frequency Response Statistics					
		MW/0.1 Hz			
Year	Number of Events	Mean of Frequency Response	Std. Dev. of Frequency Response	Min.	Max.
2011–2012	48	555	192	215	1,202
2011	20	499	154	215	830
2012	28	593	212	306	1,202

Interconnection Frequency Characteristic Analysis

Frequency Variation Statistical Analysis

NERC staff performed a statistical analysis[7] of the variability of frequency for each of the four interconnections using one-second measured frequency for 2010–2012 (three years).

This variability accounts for items such as time-error correction; variability of load, interchange, and frequency over the course of a normal day; and other uncertainties, including all frequency events.

Table 5: Interconnection Frequency Variation Analysis

Value	Eastern	Western	ERCOT	Québec
Time Frame	2010–2012	2010–2012	2010–2012	2010–2012
Number[8] of Samples	91,595,069	90,386,441	84,388,263	65,408,811
Expected Value (Hz)	60.000	59.996	59.994	59.980
Variance of Frequency (σ^2) (Hz^2)	0.00024576	0.00733550	0.01360250	0.03785004
Standard Deviation (σ) (Hz)	0.01567685	0.08564751	0.11662975	0.19455087
2σ (Hz)	0.03135369	0.17129502	0.23325949	0.38910173
3σ (Hz)	0.04703054	0.25694253	0.34988924	0.58365260
Starting Frequency (F_{Start}) 5% of lower tail samples (Hz)	59.974	59.971	59.964	59.968

Those starting frequencies encompass all variations in frequency, including changes to the target frequency during time-error correction (TEC). That eliminates the need to expressly evaluate TEC as a variable in the IFRO calculation. Therefore, the starting frequency for the calculation of IFROs should remain the frequency calculated at 5% of the lower tail of samples from the statistical analysis, which represents a 95% chance that frequencies will be at or above that value at the start of any frequency event.

[7] Refer to the 2012 *Frequency Response Initiative* report for details on the statistical analyses used.

[8] Numbers of samples vary due to exclusion of data drop-outs and other obvious observation anomalies.

Figures 5–8 show the probability density function of frequency for each interconnection

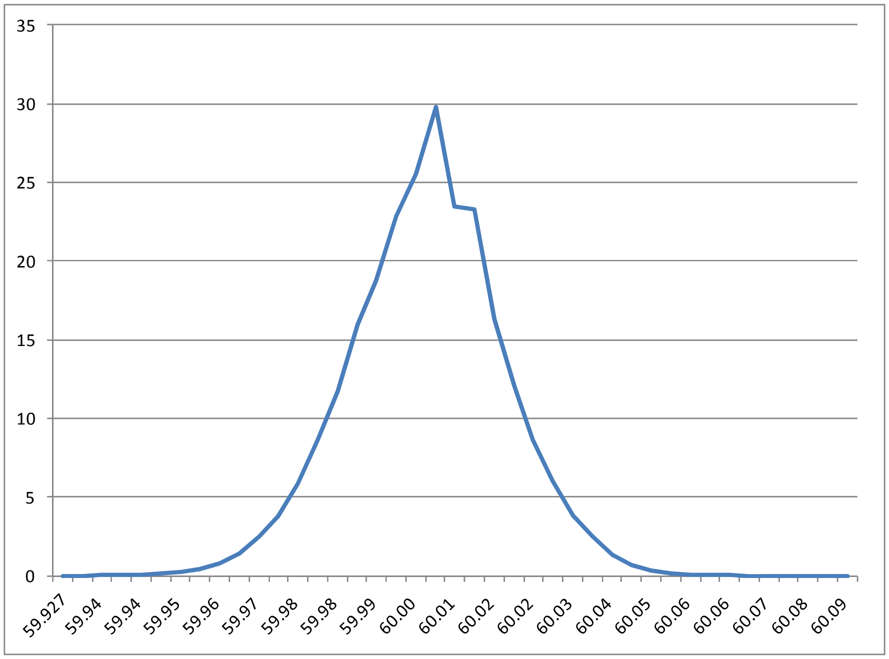

Figure 5: Eastern Interconnection 2010–2012 Probability Density Function of Frequency

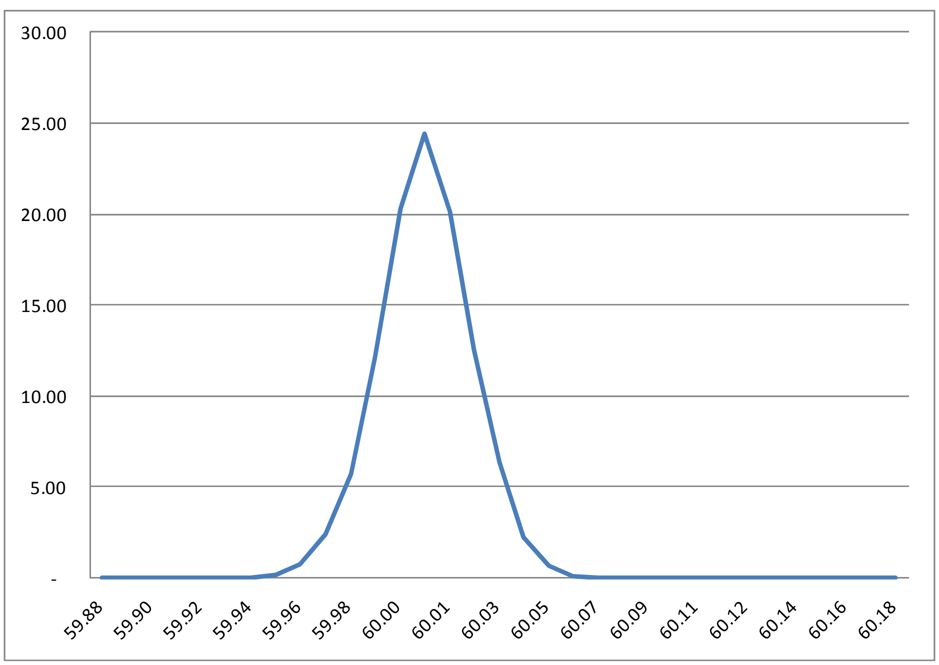

Figure 6: Western Interconnection 2010–2012 Probability Density Function of Frequency

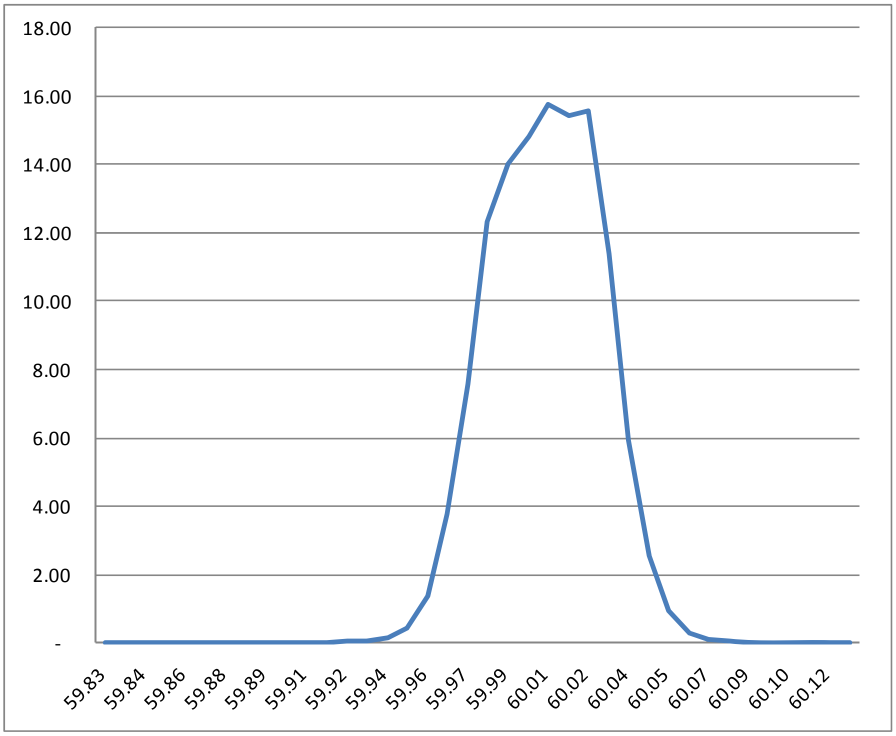

Figure 7: ERCOT Interconnection 2010–2012 Probability Density Function of Frequency

Note that the ERCOT frequency probability density still displays some minor influence of the "flat-top" profile that was common to that interconnection prior to 2008. That phenomenon was caused by a standardized ±36 mHz deadband with a step-function implementation. This is significantly less pronounced than it was in the 2012 analysis as the impacts of migration toward a ±16.7 mHz deadband with a proportional response implementation became more pronounced in the 2011 and 2012 data.

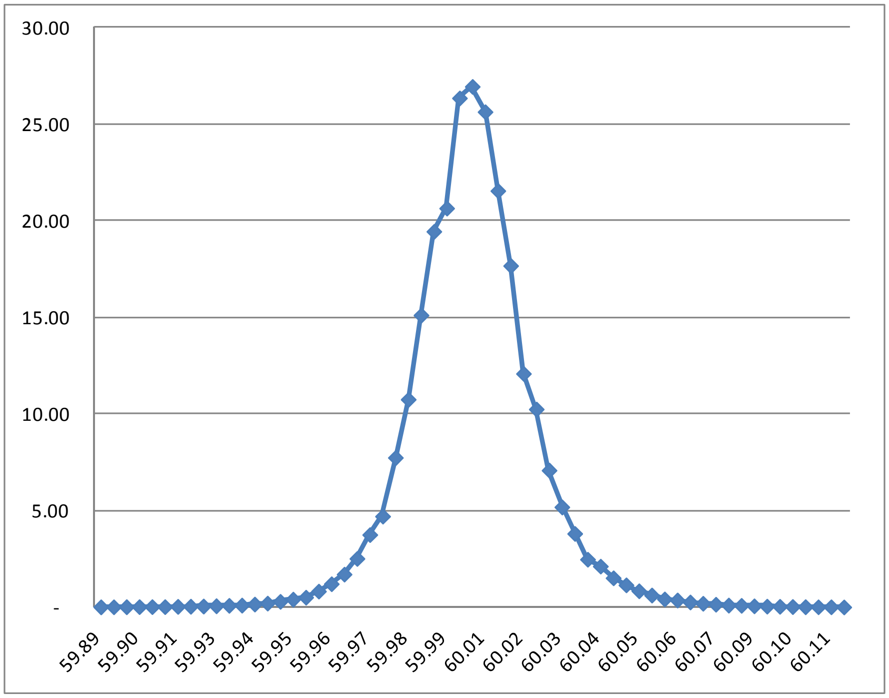

Figure 8: Québec Interconnection 2010–2012 Probability Density Function of Frequency

Changes in Starting Frequency

Comparing the results of the 2013 frequency variability analysis with those conducted in 2012 for the 2009–2011 data (Table 6) shows only slight variations in the starting frequencies.

Table 6: Comparison of Interconnection Frequency Statistics (Hz)				
Expected Frequencies	Eastern	Western	ERCOT	Québec
2012 Analysis	60.0000367	59.9999522	59.9999847	60.0000230
2013 Analysis	60.0000189	59.9957007	59.9936623	59.9802552
Change	-0.0000178	-0.0042515	-0.0063224	-0.0197678
Starting Frequencies	Eastern	Western	ERCOT	Québec
2012 Analysis	59.974	59.976	59.963	59.972
2013 Analysis	59.974	59.971	59.964	59.968
Change	- 0 -	-0.005	0.001	-0.004

Determination of Interconnection Frequency Response Obligations (IFROs)

Tenets of IFRO

The IFRO is the minimum amount of Frequency Response that must be maintained by an interconnection. Each Balancing Authority (BA) in the interconnection should be allocated a portion of the IFRO that represents its minimum responsibility. To be sustainable, BAs that may be susceptible to islanding may need to carry additional frequency-responsive reserves to coordinate with their underfrequency load shedding (UFLS) plans for islanded operation.

A number of methods to assign the Frequency Response targets for each interconnection can be considered. Initially, the following tenets should be applied:

1. A frequency event should not trip the first stage of regionally approved UFLS systems within the interconnection.
2. Local tripping of first-stage UFLS systems for severe frequency excursions, particularly those associated with protracted faults or on systems on the edge of an interconnection, may be unavoidable.
3. Other frequency-sensitive loads or electronically coupled resources may trip during such frequency events (as is the case for photovoltaic inverters in the Western Interconnection).
4. It may be necessary in the future to consider other susceptible frequency sensitivities (e.g., electronically coupled load common-mode sensitivities).

UFLS is intended to be a safety net to prevent system collapse from severe contingencies. Conceptually, that safety net should not be violated for frequency events that happen on a relatively regular basis. As such, the resource loss protection criteria were selected through the Frequency Response Initiative 2012 analysis to avoid violating regionally approved UFLS settings.

IFRO Formulae

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

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

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

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

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

$$ARLPC = RLPC - CLR$$

$$IFRO = \frac{ARLPC}{MDF}$$

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 set point for the interconnection.
- CC_{ADJ} is the adjustment for the differences between one-second and sub-second Point C observations for frequency events. A positive value indicates that the sub-second C data is lower than the one-second data.
- DF_{CC} is the delta frequency adjusted for the differences between one-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 Point C to Value B.
- BC'_{ADJ} is the statistically determined adjustment for the event nadir occurring below the Value B (Eastern Interconnection only) during primary frequency response withdrawal.
- MDF is the maximum allowable delta frequency.
- RLPC is the resource loss protection criteria.
- CLR is the credit for load resources.
- ARLPC is the adjusted resource loss protection criteria adjusted for the credit for load resources.
- IFRO is the interconnection Frequency Response obligation.

Determination of Adjustment Factors

Point C Analysis – One-Second versus Sub-Second Data

The basic statistical analysis of the frequency events was performed for the differences between Point C and Value B, calculated as a ratio of Point C to Value B, using one-second data for events from January 2010 through June 2013. Although the one-second data sample is robust, it does not necessarily ensure the nadir of the event was accurately captured. To do so requires sub-second measurements that can only be provided by phasor measurement units (PMUs) or frequency disturbance recorders (FDRs). Therefore, a "CC" adjustment component (CC_{ADJ}) for the IFRO calculation was designed to account for the differences observed between the one-second Point C and high-speed Point C measurements.

Table 7: Analysis of One-Second and Sub-Second Data for Point C (CC_{ADJ})

Interconnection	Events Analyzed	Mean (Hz)	Standard Deviation (Hz)	CC_{ADJ} (95% Quantile) (Hz)	CC_{ADJ} Adjusted for Confidence (Hz)
Eastern	178	0.008	0.006	0.016	0.009
Western	85	0.007	0.010	0.015	0.008
ERCOT	184	-0.007	0.044	0.017	0.000 (-0.002)[9]
Québec	0	N/A	N/A	N/A	N/A

The CC_{ADJ} should be made to the allowable frequency deviation value before it is adjusted for the ratio of Point C to Value B. Note: No sub-second data was available for the Québec Interconnection.

Adjustment for Differences between Value B and Point C

All of the calculations of the IFRO are based on avoiding instantaneous or time-delayed tripping of the highest set point (step) of UFLS, either for the initial nadir (Point C), or for any lower frequency that might occur during the frequency event. The frequency variance analysis in the previous section of this report is based on one-second data from January 2010 through June 2013.

As a practical matter, the ability to measure the tie line and loads for the BAs is limited to supervisory control and data acquisition (SCADA) scan-rate data of 1–6 seconds. Therefore, the ability to measure Frequency Response of the BAs is still limited by the SCADA scan rates available to calculate Value B.

[9] The CC_{ADJ} value of -0.002 was capped at 0.000 because scan rates, measurement synchronicity, or averaging methods are suspected to have resulted in the ERCOT one-second data being lower than the sub-second value.

Candidate events from the ALR1-12 Interconnection Frequency Response selection process for Frequency Response analysis were used to analyze the relationship between Value B and Point C for the significant frequency disturbances from January 2010 through June 2013. This sample set was selected because data was available for the analysis on a consistent basis. This resulted in the number of events shown in Table 5.

Analysis Method

The IFRO is the minimum performance level that the BAs in an interconnection must meet through their collective Frequency Response to a change in frequency. This response is also related to the function of the Frequency Bias Setting in the area control error (ACE) equation of the BAs for the longer term. The ACE equation looks at the difference between scheduled frequency and actual frequency, times the Frequency Bias Setting to estimate the amount of megawatts that are being provided by load and generation within the BA. If the actual frequency is equal to the scheduled frequency, the Frequency Bias component of ACE must be zero.

When evaluating some physical systems, the nature of the system and the data resulting from measurements derived from that system do not fit the standard linear regression methods that allow for both a slope and an intercept for the regression line. In those cases, it is better to use a linear regression technique that represents the system correctly.

Since the IFRO is ultimately a projection of how the interconnection is expected to respond to changes in frequency related to a change in megawatts (resource loss or load loss), there should be no expectation of Frequency Response without an attendant change in megawatts. It is this relationship that indicates the appropriateness of using regression with a forced fit through zero.

Determination of C-to-B Ratio (CB_R)

The evaluation of data to determine the C-to-B ratio to account for the differences between arrested Frequency Response (to the nadir, Point C) and settled Frequency Response (Value B) is also based on a physical representation of the electrical system. Evaluation of this system requires investigation of the meaning of an intercept. The C-to-B ratio is defined as the difference between the pre-disturbance frequency and the frequency at the maximum deviation in post-disturbance frequency, divided by the difference between the pre-disturbance frequency and the settled post-disturbance frequency.

$$CB_R = \frac{Value\ A - Point\ C}{Value\ A - Value\ B}$$

A stable physical system requires the ratio to be positive; a negative ratio indicates frequency instability or recovery of frequency greater than the initial deviation.

Table 8: Analysis of Value B and Point C (CB_R)					
Interconnection	Events Analyzed	Mean	Standard Deviation	CB_R 95% Confidence	CB_R Adjusted for Confidence
Eastern	181	0.934	0.202	0.025	1.000 (0.959)[10]
Western	86	1.698	0.428	0.077	1.774
ERCOT	187	1.354	1.027	0.124	1.478
Québec[11]	N/A	N/A	N/A	N/A	1.550

This statistical analysis was completed using one-second averaged data that does not accurately capture Point C, which is better measured by high-speed metering (PMUs or FDRs). Therefore, a separate correction must be used to account for the differences between the Point C in the one-second data and the Point C values measured with sub-second measurements from the FNet (Frequency monitoring Network) FDRs.

The CB_R value for the Eastern Interconnection indicates that Value B is generally below the Point C value. Therefore, there no adjustment is necessary for that interconnection, and the CB_R value is set to 1.000.

The Québec Interconnection's resources are predominantly hydraulic and are operated to optimize efficiency, typically at about 85 percent of rated output. Consequently, most generators have about 15 percent headroom to supply primary frequency response. This results in a robust response to most frequency events, exhibited by high rebound rates between Point C and the calculated Value B. For the 83 frequency events in their event sample, Québec's CB_R value would be 2.247, or between 1.3 and 2.25 times the CB_R values of other interconnections. Using the same calculation method for CB_R would effectively penalize Québec for their rapid rebound performance and make their IFRO artificially high. Therefore, the method for calculating the Québec CB_R was modified.

Québec operates with an operating mandate for frequency responsive reserves to protect from tripping their 58.5 Hz (300 millisecond trip time) first step UFLS for their largest hazard at all times, effectively protecting against tripping for Point C frequency excursions. Québec also protects against tripping a UFLS step set at 59.0 Hz that has a 20-second time delay, which protects them from any sustained low frequency Value B and primary frequency response withdrawals. This results in a Point C to Value B ratio of 1.5. To account for the confidence interval, 0.05 is then added, making the CB_R = 1.550.

[10] CB_R value limited to 1.000 because values lower than that indicate the Value B is lower than Point C and does not need to be adjusted. The calculated value is 0.959.

[11] Based on Québec UFLS design between their 58.5 Hz UFLS with 300 millisecond operating time (responsive to Point C) and 59.0 Hz UFLS step with a 20-second delay (responsive to Value B or beyond) with a 0.05 Hz confidence interval. See the adjustment for differences between Value B and Point C section of this report for further details.

Adjustment for Primary Frequency Response Withdrawal

At times, the nadir for a frequency event occurs after Point C—defined in BAL-003-1 as occurring in the T+0 to T+12 second period, during the Value B averaging period (T+20 through T+52 seconds), or later. For purposes of this report, that later-occurring nadir is termed Point C'. This lower nadir is symptomatic of primary frequency response withdrawal, or squelching, by unit or plant-level outer-loop control systems. Withdrawal is most prevalent in the Eastern Interconnection.

Primary frequency response withdrawal can become important depending on the type and characteristics of the generators in the resource dispatch, especially during light-load periods. Therefore, an additional adjustment to the maximum allowable delta frequency for calculating the IFROs was statistically developed. This adjustment should be used whenever withdrawal is a prevalent feature of frequency events.

Table 9 shows the number of events for each interconnection where the C' value was lower than Value B (averaged from T+20 through T+52 seconds) for the period of January 2010 through June 2013. A sample of T+300 one-second data was used for this analysis.

Table 10 shows when Point C' occurred after T+0. For the Western and ERCOT Interconnections, the occurrences of Point C' were before or within the Value B time frame, indicating that a Point C' adjustment to Value B is not needed in those interconnections.

Table 9: Statistical Analysis of the Adjustment for C' Nadir (BC'_{ADJ})

Interconnection	Total Events	Events with Point C' Lower than Value B	Mean	Standard Deviation	BC'_{ADJ} (95% Quantile)
Eastern	181	179	8.2 mHz	6.2 mHz	21.0 mHz
Western	86	86	31.2 mHz	11.6 mHz	50.3 mHz
ERCOT	186	175	19.0 mHz	20.8 mHz	63.5 mHz
Québec	0	N/A	N/A	N/A	N/A

Table 10: Seconds from T+0 to C' Nadir

Interconnection	Total Events	Events W/C' Lower than B	Mean	Point C' Time (Confidence Adjusted)
Eastern	181	179	64 s	58 s to 70 s
Western	86	86	16 s	12 s to 20 s
ERCOT	186	175	30 s	26 s to 35 s
Québec	0	N/A	N/A	N/A

Note that the expected time for the Point C' nadir to occur in the Eastern Interconnection is 58 to 70 seconds after the start of the event, which is beyond the Value B time frame. Therefore, a BC'_{ADJ} of 21 mHz is appropriate for the Eastern Interconnection.

The 95 percent quantile value is used for the Eastern Interconnection BC'_{ADJ} to account for the statistically expected Point C' value of a frequency event.

Variables in Determination of IFRO

To determine the IFROs, a number of other variables must be taken into consideration.

Low-Frequency Limit

The low-frequency limit to be used for the IFRO calculations should be the highest step in the interconnection for regionally approved UFLS systems.

Table 11: Low-Frequency Limits (Hz)

Interconnection	Highest UFLS Trip Frequency
Eastern	59.5
Western	59.5
ERCOT	59.3
Québec	58.5

Note that the highest UFLS set point in the Eastern Interconnection is 59.7 Hz in FRCC, while the prevalent highest set point in the rest of that interconnection is 59.5 Hz. The FRCC 59.7 Hz first UFLS step is based on internal stability concerns and for preventing the separation of the Florida peninsula from the rest of the interconnection. FRCC concluded that the IFRO starting point of 59.5 Hz for the Eastern Interconnection is acceptable in that it imposes no greater risk of UFLS operation for an interconnection resource loss event than for an internal FRCC event.

Protection against tripping the highest step of UFLS does not ensure that generation that has frequency-sensitive protection or turbine control systems will not trip. Severe system conditions might drive the frequency to levels that may present a combination of conditions to protection and control systems that may cause the generation to trip. Severe rate-of-change in voltage or frequency, which might actuate volts-per-hertz relays could trip the unit. Similarly, some combustion turbines may not be able to sustain operation at frequencies below 59.5 Hz. Southern California Edison's recent laboratory testing of inverters used on residential and commercial scale photovoltaic (PV) systems revealed a propensity to trip at about 59.4 Hz, which is 200 mHz above the expected 59.2 Hz prescribed in IEEE Standard 1547 for distributionconnected PV systems rated at or below 30 kW (57.0 Hz for larger installations). This could become problematic in areas of high penetration of PV resources.

Credit for Load Resources (CLR)

The ERCOT Interconnection depends on contractually interruptible demand that automatically trips at 59.7 Hz to help arrest frequency declines. A load resource credit of up to 1,400 MW (formerly called Load acting as a Resource – LaaR) is included against the resource contingency for the ERCOT Interconnection. The actual amount of CLR available at any given time varies. Therefore, NERC performed a statistical analysis on hourly available CLR for the period of January 1, 2011, through November 30, 2013. That analysis indicated that at least 895 MW of CLR is available 95 percent of the time. A CLR adjustment of 895 MW should be applied in the calculation of the ERCOT IFRO instead of the contractual 1,400 MW used in the 2012 calculation.

Similarly, there is a RAS in WECC that automatically trips load for the loss of two Palo Verde generating units. After more closely reviewing that RAS, this year's analysis modified that load resource adjustment to 150 MW from the 300 MW used in the 2012 IFRO analysis.

For both interconnections, CLR is handled in the calculation of the IFRO as a reduction to the loss of resources.

Determination of Maximum Allowable Delta Frequencies

Because of the measurement limitation of the BA-level Frequency Response performance using Value B, the IFROs must be calculated in "Value B space." Protection from tripping UFLS for the interconnections based on Point C[12], Value B[13], or any nadir occurring after point C, within Value B, or after T+52 seconds, must be reflected in the maximum allowable delta frequency for IFRO calculations expressed as a Value B.

[12] The nadir, defined as occurring between T=0 and T+12 seconds in BAL-003-1.

[13] Defined as occurring from T+20 seconds to T+52 seconds.

Table 12: Determination of Maximum Allowable Delta Frequencies					
	Eastern	Western	ERCOT	Québec	Units
Starting Frequency	59.974	59.971	59.964	59.968	Hz
Minimum Frequency Limit	59.500	59.500	59.300	58.500	Hz
Base Delta Frequency	0.474	0.471	0.664	1.468	Hz
CC_{ADJ}[14]	0.009	0.008	0.000[15]	N/A	Hz
Delta Frequency (DF_{CC})	0.465	0.463	0.664	1.468	Hz
CB_R[16]	1.000[17]	1.774	1.478	1.550[18]	—
Delta Frequency (DF_{CBR})[19]	0.465	0.261	0.449	0.947	Hz
BC'_{ADJ}[20]	0.021	N/A	N/A	N/A	Hz
Max. Allowable Delta Frequency	0.444	0.261	0.449	0.947	Hz

Table 12 shows the calculation of the maximum allowable delta frequencies for each of the interconnections. All adjustments to the maximum allowable change in frequency are made to include:

- Adjustments for the differences between one-second and sub-second Point C observations for frequency events;
- Adjustments for the differences between Point C and Value B; and
- Adjustments for the event nadir being below Value B (Eastern Interconnection only) due to primary frequency response withdrawal.

Comparison of Maximum Allowable Delta Frequencies

The following is a comparison of the 2013 maximum allowable delta frequencies with those presented in the 2012 *Frequency Response Initiative Report*.

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14 Adjustment for the differences between one-second and sub-second Point C observations for frequency events.

15 The ERCOT CC_{ADJ} value of -0.002 was capped at 0.000 because scan rates, measurement synchronicity, or averaging methods are suspected to have resulted in the ERCOT one-second data being lower than the sub-second value.

16 Adjustment for the differences between Point C and Value B.

17 CB_R value for the Eastern Interconnection limited to 1.000 because values lower than that indicate the Value B is lower than Point C and does not need to be adjusted. The calculated value is 0.959.

18 Based on Québec UFLS design between their 58.5 Hz UFLS with 300 millisecond operating time (responsive to Point C) and 59.0 Hz UFLS step with a 20-second delay (responsive to Value B or beyond).

19 DF_{CC}/CB_R

20 Adjustment for the event nadir being below the Value B (Eastern Interconnection only) due to primary frequency response withdrawal.

Table 13a: Maximum Delta Allowable Frequency Comparison				
Eastern	**2012**	**2013**	**Change**	**Units**
Starting Frequency	59.974	59.974	–	Hz
Min. Frequency Limit	59.500	59.500	–	Hz
Base Delta Frequency	0.474	0.474	–	Hz
CC_{ADJ}	0.007	0.009	0.002	Hz
Delta Frequency (DF_{CC})	0.467	0.465	-0.002	Hz
CB_R	1.000	1.000	–	Ratio
Delta Freq. (DF_{CBR})	0.467	0.465	-0.002	Hz
BC'_{ADJ}	0.018	0.021	0.003	Hz
Max. Allowable Delta Frequency	0.449	0.444	-0.005	Hz
Western	**2012**	**2013**	**Change**	**Units**
Starting Frequency	59.976	59.971	-0.005	Hz
Min. Frequency Limit	59.500	59.500	–	Hz
Base Delta Frequency	0.476	0.471	-0.005	Hz
CC_{ADJ}	0.004	0.008	0.004	Hz
Delta Frequency (DF_{CC})	0.472	0.463	-0.009	Hz
CB_R	1.625	1.774	0.149	Ratio
Delta Freq. (DF_{CBR})	0.291	0.261	-0.030	Hz
BC'_{ADJ}	N/A	N/A	–	Hz
Max. Allowable Delta Frequency	0.291	0.261	-0.030	Hz

There is only a minor 5 mHz reduction in the Eastern Interconnection maximum allowable delta frequency resulting from the 0.002 Hz increase in CC_{ADJ} and the 0.003 Hz increase in BC'_{ADJ}.

There is a significant reduction of 30 mHz in the Western Interconnection maximum allowable delta frequency caused by:

- 0.005 Hz decrease in the starting frequency;
- 0.004 Hz increase in the CC_{ADJ}; and
- 0.149 increase in the CB_R.

These changes are caused by the changes in the interconnection's frequency characteristics and changes to the Frequency Response performance in the event sample.

Table 13b: Maximum allowable delta Frequency Comparison				
ERCOT	**2012**	**2013**	**Change**	**Units**
Starting Frequency	59.963	59.964	0.001	Hz
Min. Frequency Limit	59.300	59.300	–	Hz
Base Delta Frequency	0.663	0.664	0.001	Hz
CC_{ADJ}	0.012	0.000	-0.012	Hz
Delta Frequency (DF_{CC})	0.651	0.664	0.013	Hz
CB_R	1.377	1.478	0.101	Ratio
Delta Freq. (DF_{CBR})	0.473	0.449	-0.024	Hz
BC'_{ADJ}	N/A	N/A	–	Hz
Max. Allowable Delta Frequency	0.473	0.449	-0.024	Hz
Québec	**2012**	**2013**	**Change**	**Units**
Starting Frequency	59.972	59.968	-0.004	Hz
Min. Frequency Limit	58.500	58.500	–	Hz
Base Delta Frequency	1.472	1.468	-0.004	Hz
CC_{ADJ}	N/A	N/A	–	Hz
Delta Frequency (DF_{CC})	1.472	1.468	-0.004	Hz
CB_R	1.550	1.550	–	Ratio
Delta Freq. (DF_{CBR})	0.949	0.947	-0.002	Hz
BC'_{ADJ}	N/A	N/A	–	Hz
Max. Allowable Delta Frequency	0.949	0.947	-0.002	Hz

There is a significant reduction of 24 mHz in the ERCOT Interconnection maximum allowable delta frequency caused by:

- 0.001 Hz increase in the starting frequency;
- 0.012 Hz decrease in the CC_{ADJ}; and
- 0.101 increase in the CB_R.

These changes are caused by the changes in the interconnection's frequency characteristics and changes to the Frequency Response performance in the event sample.

There is only a minor 2 mHz reduction in the Québec Interconnection maximum allowable delta frequency resulting from the 0.004 Hz decrease in the starting frequency.

Recommended IFROs

Table 14 shows the determination of IFROs based on a resource loss equivalent to the recommended criteria in each interconnection. The maximum allowable delta frequency values have already been modified to include the adjustments for: the differences between Value B and Point C (CB_R); the differences in measurement of Point C using one-second and sub-second data (CC_{ADJ}); and the event nadir being below the Value B (BC'_{ADJ}).

Table 14: Recommended IFROs

	Eastern (EI)	Western (WI)	ERCOT (TI)	Québec (QI)	Units
Starting Frequency	59.974	59.971	59.964	59.968	Hz
Max. Allowable Delta Frequency	0.444	0.261	0.449	0.947	Hz
Resource Contingency Protection Criteria	4,500	2,626	2,750	1,700	MW
Credit for LR	–	150	895	–	MW
IFRO[21]	**-1,014**	**-949**	**-413**	**-180**	**MW/0.1Hz**
Absolute Value of IFRO	**1,014**	**949**	**413**	**180**	**MW/0.1Hz**
Absolute Value of Current Interconnection Frequency Response Performance[22]	2,314	1,467	586	593	MW/0.1Hz
IFRO as a % of Interconnection Load[23]	0.16%	0.58%	0.60%	0.48%	

Comparison to Previous IFRO Values

The IFROs were first calculated and presented in the 2012 *Frequency Response Initiative Report*. Recommendations from that report called for an annual analysis and recalculation of the IFROs. The following is a comparison of the IFROs and their key component values to those used in 2012.

[21] Refer to the IFRO Formulae section of this report for further details on the calculation

[22] Based on 2012 Interconnection Frequency Response Performance from Appendix B of the *2013 State of Reliability* report: EI = -2,314 MW / 0.1Hz, WI = -1,467 MW / 0.1Hz, TI = -586 MW / 0.1Hz, and QI = -593 MW/0.1 Hz.

[23] Interconnection projected Total Internal Demands from the *2013 NERC Long-Term Reliability Assessment* (2014 summer demand):
EI = 614,953 MW, WI = 163,691 MW, TI = 69,289 MW, and QI (2014-2015 winter demand) = 37,179 MW.

Table 15a: Interconnection IFRO Comparison				
Eastern	**2012**	**2013**	**Change**	**Units**
Starting Frequency	59.974	59.974	0	Hz
Max. Allowable Delta Frequency	0.449	0.444	-0.005	Hz
Resource Contingency Protection Criteria	4,500	4,500	0	MW
Credit for LR	–	–	–	MW
Absolute Value of IFRO	1,002	1,014	12	MW/0.1Hz
Western	**2012**	**2013**	**Change**	**Units**
Starting Frequency	59.976	59.971	-0.005	Hz
Max. Allowable Delta Frequency	0.291	0.261	-0.030	Hz
Resource Contingency Protection Criteria	2,740	2,626	-114	MW
Credit for LR	300	150	-150	MW
Absolute Value of IFRO	840	949	109	MW/0.1Hz

There is only a minor 12 MW increase to the Eastern Interconnection IFRO resulting from the 0.005 Hz decrease in the maximum allowable delta frequency.

There is a 109 MW increase in the Western Interconnection IFRO caused by:

- The 30 mHz reduction in the Western Interconnection maximum allowable delta frequency;
- The 114 MW decrease in the Resource Contingency[24]; and the 150 MW decrease in the load resources credit, discussed in the Credit for Load Resources (CLR) section of this report.

[24] Adjusting to use the winter net capacity ratings from EIA Form 806.

Table 15b: Interconnection IFRO Comparison				
ERCOT	**2012**	**2013**	**Change**	**Units**
Starting Frequency	59.963	59.964	0.001	Hz
Max. Allowable Delta Frequency	0.473	0.449	-0.024	Hz
Resource Contingency Protection Criteria	2,750	2,750	0	MW
Credit for LR	1,400	895	–505	MW
Absolute Value of IFRO	286	413	127	MW/0.1Hz
Québec	**2012**	**2013**	**Change**	**Units**
Starting Frequency	59.972	59.968	-0.004	Hz
Max. Allowable Delta Frequency	0.949	0.947	-0.002	Hz
Resource Contingency Protection Criteria	1,700	1,700	0	MW
Credit for LR	–	–	–	MW
Absolute Value of IFRO	179	180	1	MW/0.1Hz

There is a 127 MW increase in the ERCOT Interconnection IFRO caused by:

- The 24 mHz reduction in the ERCOT Interconnection maximum allowable delta frequency; and
- The 505 MW decrease in the load resources credit, as discussed in the Credit for Load Resources (CLR) section of this report.

There is only a minor change to the Québec Interconnection IFRO caused by the 0.004 Hz decrease in starting frequency due to changes in the Québec frequency characteristics.

Dynamics Analysis of Recommended IFROs

Off-peak dynamics analysis was performed for the recommended IFROs for the Eastern, Western, and ERCOT Interconnections to determine if those levels of primary frequency response are adequate to avoid tripping of the first stage of regionally approved UFLS systems in the interconnection. Light-load cases prepared by each of the interconnections were used for the analyses. In each case, the dynamic governor responses were de-tuned until the primary frequency response of the interconnection matched the recommended IFRO value for the prescribed resource loss. In all three simulations, the effects of automatic generation control (AGC), which typically starts to influence Frequency Response in the 30-45 second time frame, were not modeled. This causes the modeled withdrawal of primary frequency response to be exaggerated (see figure 9).

For the Eastern Interconnection, a 2013 light-load "generic" dynamics case was used. That case was created by the Eastern Interconnection Reliability Assessment Group (ERAG) Multiregional Modeling Working Group (MMWG) by replacing the turbine governor models in the case with a generic governor model to ascertain the basic characteristics of the Frequency Response of the interconnection. ERAG is expected to produce a 2014 light-load case for the 2014 analysis that reflects models of the actual governors by August 1, 2014.

In all three interconnections analyzed, the recommended Frequency Response maintained frequency above the highest UFLS set point. Figures 9–11 show the results of the dynamics analyses.

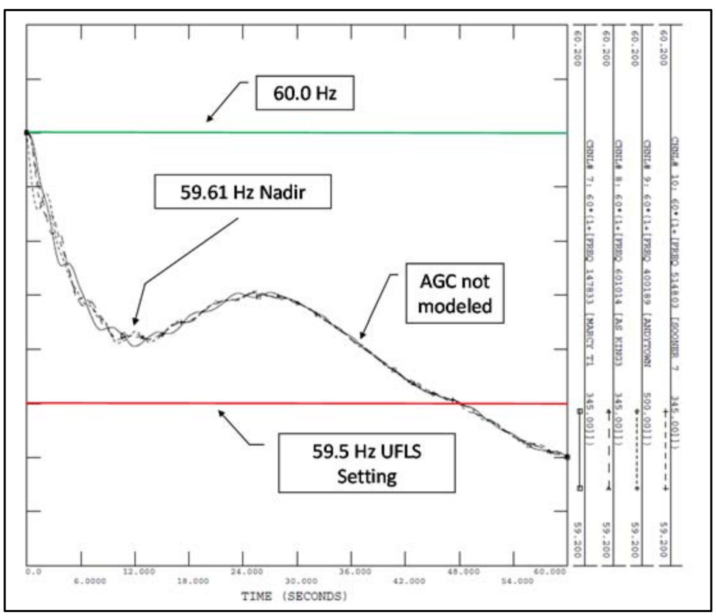

Figure 9: Eastern Interconnection Frequency Response Simulation

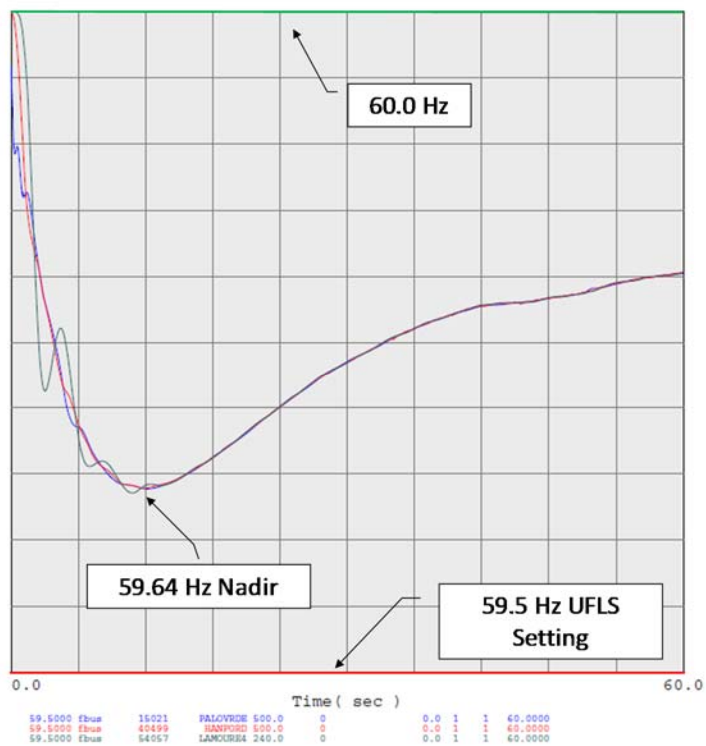

Figure 10: Western Interconnection Frequency Response Simulation

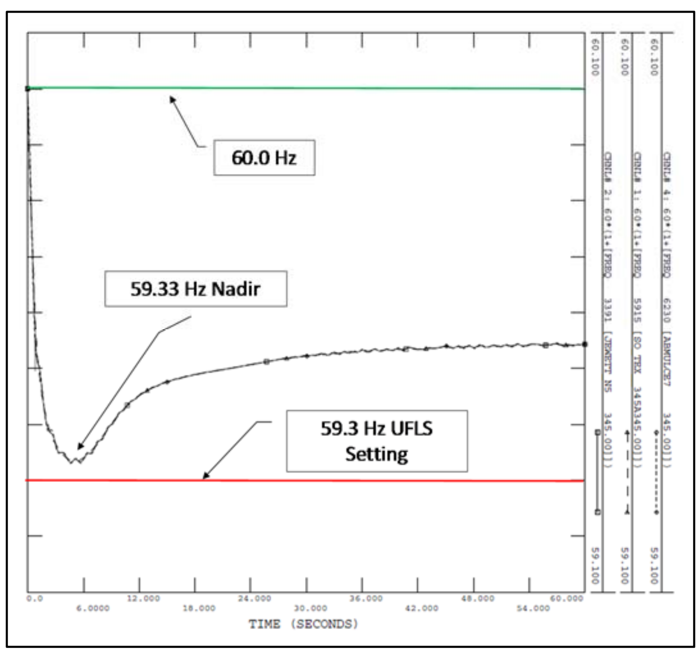

Figure 11: ERCOT Interconnection Frequency Response Simulation

Analysis of WECC Remedial Action Schemes (RAS) for Calculation of Western Interconnection IFRO

NERC performed special analysis of the WECC RAS that intentionally trip generation for the loss of key transmission system elements was performed. One example is the Pacific Northwest RAS for loss of the Pacific DC Intertie (PDCI), which trips up to 2,850 MW of generation in the Pacific Northwest when the PDCI trips.

FERC requested this analysis in the Notice of Proposed Rulemaking in Docket No. RM13-11-000 – Frequency Response and Frequency Bias Setting Reliability Standard, issued July 18, 2013.

The WECC Remedial Action Scheme Reliability Subcommittee supplied the details of six RAS that potentially trip over 2,400 MW of generation. Those RAS are intended to avoid system instability and prevent overloads of the transmission system. The amount of generation tripped by those RAS depends on intricate operating procedures that dictate how much generation to "arm" for tripping, depending on the loading of key system elements. Also, a number of the RAS also block AGC action to prevent the secondary frequency response by a number of generators and BAs to avoid overloading the Pacific AC ties (such as the California-Oregon Interface (COI)).

Because the design event of a loss of two Palo Verde units and the six RAS generation trips are located in significantly different parts of the interconnection, simulations were performed to analyze the overall impact to the system. This is important because:

- Palo Verde is closer to the load centers of Phoenix and southern California. Replacing that resource after a trip from more distant resources would increase losses in the interconnection.
- The Pacific Northwest generation tripped by the RAS is located far from the major load centers. Transferring power from those resources results in significant losses on the system. Therefore, tripping those generators would reduce losses.
- The RAS arming is dependent on heavy loadings on specific system elements caused by heavy north-to-south transfers. Those transfers would not be as high during off-peak hours, which is the time of greatest concern for primary frequency response.

Analysis of the operating procedures for the six RAS indicates that specific amounts of generation must be armed to trip for specific transmission system contingencies. Table 16 shows the net megawatt loss impact to the Western Interconnection following each of the resource contingencies.

Table 16: Western Interconnection IFRO Comparison for RAS						
	On-Peak			Off Peak[25]		
Contingency	Net Resource Tripped	Change in Losses	Net Impact	Net Resource Tripped	Change in Losses	Net Impact
Two Palo Verde Units	2,680[26]	420	3,100	2,680	-420	2,260
RAS 1	2,850	-270	2,580	N/A	N/A	N/A
RAS 2	2,700	-270	2,430	N/A	N/A	N/A
RAS 3	2,700	-270	2,430	N/A	N/A	N/A
RAS 4	2,500	-270	2,230	N/A	N/A	N/A
RAS 5	2,500	-270	2,230	N/A	N/A	N/A
RAS 6	2,230	-270	1,960	N/A	N/A	N/A

[25] The six RAS schemes would not be armed to trip any generation during off-peak operation.

[26] As modeled using 2,800 MW gross generation loss. IFRO calculated using 2,476 MW net loss (net 2,626 MW generation trip and 150 MW of load tripped by RAS).

Interconnection Frequency Response Performance Measurement

Interconnection Process

The process for detecting candidate interconnection frequency events for use in Frequency Response metrics is described in the ALR1-12 Metric Event Selection Process.

Frequency Event Detection, Analysis, and Trending (for Metrics and Analysis)

Interconnection frequency events are detected through a number of systems, including:

- FNet (Frequency monitoring Network) – FNet is a wide-area power system frequency measurement system that uses a type of PMU known as an FDR. FNet is able to measure the power system frequency, voltage, and angle very accurately at a rate of 10 samples per second. The FNet system is currently operated by the Power Information Technology Laboratory at Virginia Tech and the University of Tennessee, Knoxville. FNet alarms are received by the NERC Situational Awareness staff and contain an estimate of the size of the resource or load loss and general location description based on triangulation between FDRs.
- CERTS–EPG Resource Adequacy Tool Intelligent Alarms – The Electric Power Group (EPG) operates the Resource Adequacy (RA) tool developed under the auspices of the Consortium for Electric Reliability Technology Solutions (CERTS). The RA tool uses one-minute frequency and area control error (ACE) SCADA data transmitted to a NERC central database. The RA tool constantly monitors frequency and produces many Smart Alarms for a number of frequency change conditions, but most useful for frequency event detection is the short-term frequency deviation alarm, which indicates when there has been a significant change in frequency over the last few minutes, typically indicating a resource loss.
- CERTS–EPG Frequency Monitoring and Analysis (FMA) Tool – EPG also developed and operates the FMA tool that allows rapid analysis of frequency events, calculating the A, B, and C values for a frequency event in accordance with parameters set by the Frequency Working Group.

NERC staff uses those three systems in combination to detect and collect data about frequency excursions in the four North American interconnections. The size of resource losses is verified with the Regional Entities for events where FNet estimates of resource loss meet the following criteria:

Table 17: Frequency Event Triggers			
Interconnection	**ΔFrequency (mHz)**	**MW Loss Threshold**	**Rolling Windows (seconds)**
Eastern	40	800	15
Western	70	700	15
ERCOT	90	450	15
Québec	300	450	15

NERC uses "candidate events" (events that are detected and meet the ALR1-12 metric criteria) to calculate interconnection Frequency Response metrics and trends. Those candidate events are also presented to the Frequency Working Group for consideration to be used as events for calculation of BA Frequency Response and bias setting calculations in accordance with NERC Standard BAL-003-1.

Ongoing Evaluation

In an effort to improve the process, NERC staff and the Frequency Working Group will review the process for detecting frequency events, calculating Values A and B, determining Point C and the associated interconnection level metrics on an annual basis.