## A. Introduction

**1. Title:** **Real Power Balancing Control Performance**

**2. Number:** BAL-001-MX-0

**3. Purpose:** To maintain Interconnection steady-state frequency within defined limits by balancing real power demand and supply in real-time.

**4. Applicability:**

**4.1** Balancing Authorities

**5. Effective Date**: January 1, 2012.

## B. Requirements

**R1.** The Balancing Authority shall operate such that, on a rolling 12-month basis, the average of the clock-minute averages of the Balancing Authority's Area Control Error (ACE) divided by 10B (B is the clock-minute average of the Balancing Authority Area's Frequency Bias) times the corresponding clock-minute averages of the Interconnection's Frequency Error is less than a specific limit. This limit $\epsilon_1^2$ is a constant derived from a targeted frequency bound (separately calculated for each Interconnection) that is reviewed and set as necessary by the NERC Operating Committee.

$$AVG_{Period}\left[\left(\frac{ACE_i}{-10B_i}\right)_1 * \Delta F_1\right] \le \epsilon_1^2 \quad or \quad \frac{AVG_{Period}\left[\left(\frac{ACE_i}{-10B_i}\right)_1 * \Delta F_1\right]}{\epsilon_1^2} \le 1$$

The equation for ACE is:

$ACE = (NI_A - NI_S) – 10B (F_A - F_S) – I_{ME}$

where:

- $NI_A$ is the algebraic sum of actual flows on all tie lines.
- $NI_S$ is the algebraic sum of schedules flows on all tie lines.
- B is the Frequency Bias Setting (MW/0.1 Hz) for the Balancing Authority. The constant factor 10 converts the frequency setting to MW/Hz.
- $F_A$ is the actual frequency.
- $F_S$ is the scheduled frequency. $F_S$ is normally 60 Hz, but may be offset to effect manual time error corrections.

- $I_{ME}$ is the meter error correction factor typically estimated from the difference between the integrated hourly average of the net tie line flows ($NI_A$) and the hourly net interchange demand measurement (megawatt-hour). This term should normally be very small or zero.

**R2.** Each Balancing Authority shall operate such that its average ACE for at least 90% of clock-ten-minute periods (6 non-overlapping periods per hour) during a calendar month is within a specific limit, referred to as $L_{10}$.

$AVG_{10\text{-minute}}\ (ACE_i) \leq L_{10}$

where:

$$L_{10} = 1.65 \in_{10} \sqrt{(-10B_i)(-10B_s)}$$

$\varepsilon_{10}$ is a constant derived from a targeted frequency bound. It is the targeted root-mean-square (RMS) value of ten-minute average Frequency Error based on frequency performance over a given year. The bound, $\varepsilon_{10}$ is the same for every Balancing Authority Area within an Interconnection and $B_s$ is the sum of the Frequency Bias Settings of the Balancing Authority Areas in the respective Interconnection. For Balancing Authority Area's with variable bias, this is equal to the sum of the minimum Frequency Bias Settings.

**R3.** Each Balancing Authority providing Overlap Regulation Service shall evaluate Requirement R1 (i.e., Control Performance Standard 1 or CPS1) and Requirement R2 (i.e., Control Performance Standard 2 or CPS2) using the characteristics of the combined ACE and combined Frequency Bias Settings.

**R4.** Any Balancing Authority receiving Overlap Regulation Service shall not have its control performance evaluated (i.e., from a control performance perspective, the Balancing Authority has shifted all control requirements to the Balancing Authority providing Overlap Regulation Service).

## C. Measures

**M1**. Each Balancing Authority shall achieve, as a minimum, Requirement 1 (CPS1) compliance of 100%.

CPS1 is calculated by converting a compliance ratio to a compliance percentage as follows:

CPS1 = (2 – CF) * 100%

The frequency-related compliance factor, CF, is a ratio of all one-minute compliance parameters accumulated over 12 months divided by the target frequency bound:

$$CF = \frac{CF_{12-\text{month}}}{(\in_1)^2}$$

where $\varepsilon_1$ is defined in Requirement R1.

The rating index $CF_{12\text{-month}}$ is derived from 12 months of data. The basic unit of data comes from one-minute averages of ACE, Frequency Error and Frequency Bias Settings.

A clock-minute average is the average of the reporting Balancing Authority's valid measured variable (i.e., for ACE and for Frequency Error) for each sampling cycle during a given clock-minute.

$$\left(\frac{ACE}{-10B}\right)_{\text{clock-minute}} = \frac{\left(\frac{\sum ACE_{\text{sampling cycles in clock-minute}}}{n_{\text{sampling cycles in clock-minute}}}\right)}{\text{-10B}}$$

$$\Delta F_{\text{clock-minute}} = \frac{\sum \Delta F_{\text{sampling cycles in clock-minute}}}{n_{\text{sampling cycles in clock-minute}}}$$

The Balancing Authority's clock-minute compliance factor (CF) becomes:

$$CF_{\text{clock-minute}} = \left[\left(\frac{ACE}{-10B}\right)_{\text{clock-minute}} * \Delta F_{\text{clock-minute}}\right]$$

Normally, sixty (60) clock-minute averages of the reporting Balancing Authority's ACE and of the respective Interconnection's Frequency Error will be used to compute the respective hourly average compliance parameter.

$$CF_{\text{clock-hour}} = \frac{\sum CF_{\text{clock-minute}}}{n_{\text{clock-minute samples in hour}}}$$

The reporting Balancing Authority shall be able to recalculate and store each of the respective clock-hour averages (CF clock-hour average-month) as well as the respective number of samples for each of the twenty four (24) hours (one for each clock-hour, i.e., hour-ending (HE) 0100, HE 0200, …, HE 2400).

$$\text{CF}_{\text{clock-hour average-month}} = \frac{\sum_{\text{days-in-month}} [(\text{CF}_{\text{clock-hour}})(n_{\text{one-minute samples in clock-hour}})]}{\sum_{\text{days-in month}} [n_{\text{one-minute samples in clock-hour}}]}$$

$$\text{CF}_{\text{month}} = \frac{\sum_{\text{hours-in-day}} [(\text{CF}_{\text{clock-hour average-month}})(n_{\text{one-minute samples in clock-hour averages}})]}{\sum_{\text{hours-in day}} [n_{\text{one-minute samples in clock-hour averages}}]}$$

The 12-month compliance factor becomes:

$$CF_{12\text{-month}} = \frac{\sum_{i=1}^{12} (CF_{\text{month-i}})(n_{(\text{one-minute samples in month})-i})]}{\sum_{i=1}^{12} [n_{(\text{one-minute samples in month})-i}]}$$

In order to ensure that the average ACE and Frequency Deviation calculated for any one-minute interval is representative of that one-minute interval, it is necessary that at least 50% of both ACE and Frequency Deviation samples during that one-minute interval be present.
Should a sustained interruption in the recording of ACE or Frequency Deviation due to loss of telemetering or computer unavailability result in a one-minute interval not containing at least 50% of samples of both ACE and Frequency Deviation, that one-minute interval shall be excluded from the calculation of CPS1.

**M2.** Each Balancing Authority shall achieve, as a minimum, Requirement R2 (CPS2) compliance of 90%. CPS2 relates to a bound on the ten-minute average of ACE. A compliance percentage is calculated as follows:

$$CPS2 = \left[1 - \frac{\text{Violations}_{\text{month}}}{(\text{Total Periods}_{\text{month}} - \text{Unavailable Periods}_{\text{month}})}\right] * 100$$

The violations per month are a count of the number of periods that ACE clock-ten-minutes exceeded $L_{10}$. ACE clock-ten-minutes is the sum of valid ACE samples within a clock-ten-minute period divided by the number of valid samples.

Violation clock-ten-minutes

= 0 if

$$\left|\frac{\sum ACE}{n_{\text{samples in 10-minutes}}}\right| \leq L_{10}$$

= 1 if

$$\left|\frac{\sum ACE}{n_{\text{samples in 10-minutes}}}\right| > L_{10}$$

Each Balancing Authority shall report the total number of violations and unavailable periods for the month. $L_{10}$ is defined in Requirement R2.

Since CPS2 requires that ACE be averaged over a discrete time period, the same factors that limit total periods per month will limit violations per month. The calculation of total periods per month and violations per month, therefore, must be discussed jointly.

A condition may arise which may impact the normal calculation of total periods per month and violations per month. This condition is a sustained interruption in the recording of ACE.

In order to ensure that the average ACE calculated for any ten-minute interval is representative of that ten-minute interval, it is necessary that at least half the ACE data samples are present for that interval. Should half or more of the ACE data be unavailable due to loss of telemetering or computer unavailability, that ten-minute interval shall be omitted from the calculation of CPS2.

## D. Compliance

### 1. Compliance Monitoring Process

#### 1.1 Compliance Monitoring Responsibility

Regional Reliability Organization.

#### 1.2 Compliance Monitoring Period and Reset Timeframe

One calendar month.

#### 1.3 Data Retention

The data that supports the calculation of CPS1 and CPS2 (Appendix BAL-001-MX-0) are to be retained in electronic form for at least a one-year period. If the CPS1 and CPS2 data for a Balancing Authority Area are undergoing a review to address a question that has been raised regarding the data, the data are to be saved beyond the normal retention period until the question is formally resolved. Each Balancing Authority shall retain for a rolling 12-month period the values of: one-minute average ACE ($ACE_i$), one-minute average Frequency Error, and, if using variable bias, one-minute average Frequency Bias.

#### 1.4 Additional Compliance Information

None.

## E. Associated Documents

1. Appendix CPS1 and CPS2 Data

## Version History

| Version | Date | Action | Change Tracking |
|---|---|---|---|
| | | | |

**Appendix BAL-001-MX-0**
**CPS1 and CPS2 Data**

| CPS1 DATA | Description | Retention Requirements |
|---|---|---|
| $\varepsilon_1$ | A constant derived from a targeted frequency bound. This number is the same for each Balancing Authority Area in the Interconnection. | Retain the value of $\varepsilon_1$ used in CPS1calculation. |
| $ACE_i$ | The clock-minute average of ACE. | Retain the 1-minute average values of ACE (525,600 values). |
| $B_i$ | The Frequency Bias of the Balancing Authority Area. | Retain the value(s) of $B_i$ used in the CPS1calculation. |
| $F_A$ | The actual measured frequency. | Retain the 1-minute average frequency values (525,600 values) |
| $F_S$ | Scheduled frequency for the Interconnection. | Retain the 1-minute average frequency values (525,600 values) |

| CPS2 DATA | DESCRIPTION | RETENTION REQUIREMENTS |
|---|---|---|
| V | Number of incidents per hour in which the absolute value of ACE clock-ten-minutes is greater than $L_{10.}$ | Retain the values of V used in CPS2 calculation. |
| $\varepsilon_{10}$ | A constant derived from the frequency bound. It is the same for each Balancing Authority Area within Interconnection. | Retain the value of $\varepsilon_{10}$ used in CPS2 calculation. |
| $B_i$ | The Frequency Bias of the Balancing Authority Area. | Retain the value of $B_i$ used in CPS2 calculation. |
| $B_s$ | The sum of Frequency Bias of the Balancing Authority Areas in the respective Interconnection. For systems with variable bias, this is equal to the sum of the minimum Frequency Bias Setting. | Retain the value of $B_s$ used in the CPS2 calculation. Retain the 1-minute minimum bias value (525,600 values). |
| U | Number of unavailable ten-minute periods per hour used in calculating CPS2. | Retain the number of 10- minute unavailable periods used in calculating CPS2 for the reporting period. |