BAL-001-AB-0a Real Power Balancing Control Performance

1. Purpose

The purpose of this *reliability standard* is to maintain *WECC* steady-state frequency within defined limits by balancing real power demand and supply in real-time.

2. Applicability

This *reliability standard* applies to:

- *Independent System Operator* (ISO)

3. Definitions

Italicized terms used in this *reliability standard* have the meanings as set out in the Alberta Reliability Standards Glossary of Terms and Part 1 of the ISO Rules.

4. Requirements

R1 The ISO must operate such that, on a rolling 12-month basis, the average of the clock-minute averages of the *AIES's area control error* (ACE) divided by 10B (B is the clock-minute average of the *AIES*'s *frequency bias*) times the corresponding clock-minute averages of the *Interconnection*'s *frequency error* is less than a specific limit. This limit ε_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.

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

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 scheduled flows on all *tie lines*.
- B is the *frequency bias setting* (MW/0.1 Hz) for the *AIES*. 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 i*nterchange* demand measurement (megawatt hour). This term should normally be very small or zero.

R 1.1 Control Performance Standard (CPS) 1 must be 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:

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

where: ε_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 (raw ACE, unadjusted for the *WECC* Automatic Time Error Control), *frequency error* and *frequency bias settings.*

A clock-minute average is the average of the *AIES*'s valid measured variable (i.e., for *ACE* and for *frequency error*) for each sampling cycle during a given clock-minute.

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

The *AIES*'s clock-minute CF becomes:

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

Normally, sixty (60) clock-minute averages of the *AIES*'s ACE and of the respective *Interconnection*'s *frequency error* will be used to calculate the respective hourly average compliance parameter.

$$CF_{clock-hour} = \frac{\sum CF_{clock-\min ute}}{n_{clock-\min ute\ \ samples\ in\ hour}}$$

The ISO must 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).

$$CF_{clock-hour\ average-month} = \frac{\sum_{days-in-month}\left[\left(CF_{clock-hour}\right)\left(n_{one-minute}\right)\right]}{\sum_{days-in-month}\left[n_{one-minute\ samples\ in\ clock-hour}\right]}$$

$$CF_{month} = \frac{\sum_{days-in-month}\left[\left(CF_{clock-hour\ average-month}\right)\left(n_{one-minute\ \ \ samples\ in\ clock-hour\ averages}\right)\right]}{\sum_{days-in-month}\left[n_{one-minute\ samples\ in\ clock-hour\ averages}\right]}$$

The 12-month CF becomes:

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

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.

R2 The ISO must 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}.

$AVG_{10\ minute}(ACE_i) \le L_{10}$

where:

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

ε_{10} is a constant derived from the 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, ε_{10}, is the same for every *balancing authority area* within the *WECC*, and B_s is the sum of the *frequency bias settings* of the *balancing authority areas* in the *WECC*. For *balancing authority areas* with variable bias, this is equal to the sum of the minimum *frequency bias settings*.

R2.1 CPS2 relates to a bound on the ten-minute average of ACE. A compliance percentage must be calculated as follows:

$$CPS2 = \left[1 - \frac{Violations_{month}}{\left(Total\ Periods_{month} - Unavailable\ Periods_{month}\right)}\right] * 100$$

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

$$\left|\frac{\sum ACE}{n_{samples\ in\ 10-\min utes}}\right| \le L_{10}$$

$$= 1\ if$$

$$\left|\frac{\sum ACE}{n_{samples\ in\ 10-\min utes}}\right| \le L_{10}$$

The ISO must 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.

5. Procedures

No procedures have been defined for this *reliability standard*.

6. Measures

The following measures correspond to the requirements identified in Section 4 of this *reliability standard*. For example, MR1 is the measure for R1.

MR1 CPS1, as defined and calculated per R1 and R1.1, is at least 100%.

MR2 CPS2, as defined and calculated per R2 and R2.1, is at least 90%.

7. Appendices

Appendix 1 CPS1 and CPS2 Data

CPS1 DATA	Description	Retention Requirements
ε_1	A constant derived from the targeted frequency bound. This number is the same for each *balancing authority area* in the *WECC*.	Retain the value of ε1 used in CPS1 calculation.
ACEi	The clock-minute average of ACE (raw ACE, unadjusted for the *WECC* Automatic Time Error Control)	Retain the one-minute average values of *ACE* (525,600 values).
Bi	The f*requency bias* of the *AIES*.	Retain the value(s) of Bi used in the CPS1calculation.
F_A	The actual measured frequency.	Retain the one-minute average frequency values (525,600 values).
F_S	Scheduled frequency for the *WECC*.	Retain the one-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 L10.	Retain the values of V used in CPS2 calculation.
ε_{10}	A constant derived from the frequency bound. It is the same for each *balancing authority area* within the *WECC*.	Retain the value of ε_{10} used in CPS2 calculation.
Bi	The *frequency bias* of the *AIES*.	Retain the value of Bi used in the CPS2 calculation.
Bs	The sum of *frequency bias of the balancing authority areas* in the *WECC*. For systems with variable bias, this is equal to the sum of the minimum *frequency bias setting*.	Retain the value of Bs used in the CPS2 calculation. Retain the one-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.

Revision History

Effective	Description