# Performance Standards Reference Document

**Version 3**

*This reference document is intended to provide the reader with a better understanding of the balancing-related standards. While the information can provide clarity on potential ways to demonstrate compliance, the document should not be used by compliance staff as a benchmark to measure compliance or create new obligations not found in the standards. Should any difference or conflict be found between this document and the standards, the standards take precedence.*

## *Subsections*



# A. General

**[Area Interchange Error Training Document – ACE Equation]**

This document provides instructions for calculating the control performance of the balancing authority (BA) and instructions and forms to complete the required surveys. It is intended to serve industry participants as a "how to" guide for application and interpretation of the performance standards.

The BA's Area Control Error (ACE) is the basis for the calculation of control parameters used to evaluate control performance. ACE is used to determine a BA's control performance with respect to the BA's impact on system frequency. The value of ACE to be used throughout the calculation of control parameters is directed by standards to reflect its actual value and exclude short excursions due to transient telemetering problems or other influences such as control algorithm actions. Erroneous readings such as "spikes" due to telemetering error or other false influences should be excluded from the calculations. However, the computations should include ALL of the non-erroneous intervals (i.e., do not exclude intervals that contain disturbance conditions). This ACE is defined as net actual interchange less net scheduled interchange less frequency bias contribution and meter error. It does not include offsets (e.g., unilateral inadvertent payback, WECC's automatic time error correction, etc.).

These measurements of control performance apply to all conditions (i.e., both normal and disturbance conditions). The BA is required to continuously monitor its control performance and report its compliance results at the end of each month.

**Targeted Frequency Bounds.** The targeted frequency bounds, epsilon 1 ($\in_1$) and epsilon 10 ($\in_{10}$), are based on historic measured frequency error. These bounds, typically in millihertz (mHz), embody the targeted frequency characteristics used for developing the Control Performance Standard. Each Interconnection is assigned its own frequency bounds.

The Targeted Frequency Bound for an Interconnection is computed as follows:

1. The NERC Resources Subcommittee (RS) defines a desired frequency profile.
2. The NERC RS collects frequency data from designated providers within each Interconnection. The frequency bounds are the RMS of the one- and ten-clock-minute averages of the frequency error (deviation) from schedule. These values are derived from data samples over a given year. The NERC RS calculates and then sets the targeted

frequency bounds, $\in_1$ and $\in_{10}$, to recognize the desired performance profile of frequency for each Interconnection.

**Compliance for BAs.** A BA that does not comply with CPS is not providing its required regulation services.

1. If a BA does not comply with the CPS, the BA is not permitted to provide regulation or other services related to control performance for any other BA(s) or other entities. Those services are to be determined by the NERC RS.
2. A BA failing to comply is directed by the standard to take immediate corrective action and achieve compliance within three months. If necessary, a BA is directed by the standard to buy sufficient supplemental regulation to achieve compliance.

**Compliance for BAs Providing Regulation.** A BA is not permitted to provide regulation or other services related to control performance (as determined by the NERC Resources Subcommittee) for (an)other BA(s) or other entities external to that BA, if the former BA does not comply with the CPS.

**Compliance for BAs Participating in Supplemental Regulation.** A BA providing or receiving supplemental regulation will continue to be evaluated on the characteristics of its own ACE with the supplemental regulation service included. The compliance calculations for each of the affected BAs will not change.

**Compliance for BAs Participating in Overlap Regulation.**

**BAs Providing Overlap Regulation.** A BA *providing* overlap regulation is to continue to be evaluated on the characteristics of the combined areas' ACE. The provider BA must calculate and use the sum of the frequency bias characteristics of itself and the BA for which it is providing the overlap regulation. Frequency bias minimums apply to each BA individually in these cases.

**BAs Receiving Overlap Regulation.** A BA *receiving* overlap regulation service is not to have its control performance evaluated.

# B. Control Performance Standard 1, CPS1

**[Area Interchange Error Training Document – ACE Equation]**

CPS1 provides the BA with a frequency-sensitive evaluation of how well its demand requirements were met. The measure is not designed to be a visual indicator that an operator would use to control system generation, nor is it designed to address the issue of unscheduled power flows, or control of inadvertent interchange.

**Metrics.**

Over a given period, the average of the clock-minute averages of a BA's [ACE divided by ten times its bias] times the corresponding clock-minute averages of the Interconnection's frequency error is to be less than or equal to a constant (epsilon 1 squared, the constant on the right-hand side of the following inequality):

$$AVG_{Period}\left[\left(\frac{ACE_i}{-10B_i}\right)_1 * \Delta F_1\right] \le \in_1^2 \qquad or \qquad \frac{AVG_{Period}\left[\left(\frac{ACE_i}{-10B_i}\right)_1 * \Delta F_1\right]}{\in_1^2} \le 1$$

where: **$ACE_i$** is the clock-minute average of ACE (as ACE is defined in Section A) and **$B_i$** is the frequency bias of the BA. For those areas with variable bias, an accumulation of $ACE/(-10B_i)$ is made through the AGC cycles of a minute, and the averaged value at the end of the minute should be saved as the clock-minute value of $ACE_i/(-10B_i)$,

**$\in_1$** in Hz, is a constant derived from the targeted frequency bound. It is the targeted RMS of one-minute average frequency error from a schedule based on frequency performance over an averaging period of a year. The bound is the same for every BA within an Interconnection.

**$\Delta F_1$** (delta F sub one) in Hz, is the clock-minute average of frequency error from schedule, $\Delta F = F_a - F_s$, where $F_a$ is the actual (measured) frequency and $F_s$ is scheduled frequency for the Interconnection.

**i** is representative of the individual BA,

**Period** is defined as:

a) one year for BA evaluation
b) one month for reporting and Resources Subcommittee review

**Compliance**.

The fundamental requirement for CPS1 is that performance, as measured by percentage compliance, must be at least 100%.

It is possible for CPS1 percentage compliance to vary from –infinity to +infinity, depending on delta F and ACE magnitudes.

Control Compliance Rating = Pass if CPS1 ≥ 100%

Control Compliance Rating = Fail if CPS1 < 100%

CPS1 begins with a fundamental calculation called the compliance factor (CF). Its basic building block (called CF', or CF prime to distinguish it from CF as used later) is the quantity defined below, which essentially converts ACE to a form of frequency which can be compared with interconnection epsilon(s).

$$CF' = \left[ \left( \frac{ACE}{-10B} \right) * \Delta F \right] \text{ Hz}^2$$

Note that as written above this quantity is an instantaneous value, no averaging involved.

CPS1 uses a 1-minute average base calculation, so CF' becomes

$$CF'_{\text{clock-minute}} = \left[ \left( \frac{ACE}{-10B} \right)_{\text{clock-minute}} * \Delta F_{\text{clock-minute}} \right] \text{ Hz}^2$$

Note the units of this calculation are in terms of frequency squared. This is important in the calculations to follow, as comparison is made to epsilon squared to determine compliance.

The compliance factor, CF, is derived from CF' by dividing by epsilon squared:

$$CF = \frac{CF'}{(\in_1)^2}$$

CF is a (dimensionless) ratio that defines whether a BA's contribution to frequency deviation "noise" is greater than or less than the amount allowed. A value of 1 means exactly the amount of allowed frequency deviation-coincident "noise" has been contributed by the BA. Less than 1 means a "quieter" than required ACE characteristic. Negative means the BA is actually anticoincident with frequency deviation; generally a good thing as long as ACE magnitude is kept in check and the BA is not seriously over-controlling.

CPS1 then converts CF to a compliance percentage as follows:

$CPS1\% = ( 2 - CF ) * 100\%$

This calculation is for any time interval. For compliance purposes, CPS1 percentage is calculated over the most recent 12 months (the month of the report plus the most recent 11 consecutive prior months). Epsilon can change, but since CPS1 is reported monthly, and epsilon would normally not be changed except on a month boundary, it is valid to calculate the monthly and the running 12-month CPS1 compliance as follows:

$$\mathbf{CPS1\%_{month} = (2 - CF_{month}) * 100\%}$$

where

$$CF_{\text{month}} = \frac{CF'_{\text{month}}}{(\in_1)^2} \qquad \text{and} \qquad CF'_{\text{month}} = \frac{\sum_{\text{1 min. periods in month}} (CF_{\text{clock-minute}})}{\left[ n_{\text{1 min. periods in month}} \right]}$$

$$\mathbf{CPS1\%_{12\text{-month}} = (2\text{-}CF_{12\text{-month}})}$$

where

$$CF_{12-month} = \frac{\sum_{m=1}^{12}\left[CF_{month} \times n_{1min.\,periods\,in\,month\,m}\right]}{\sum_{m=1}^{12} n_{1min.\,periods\,in\,month\,m}}$$

"$n_{1\ min.\ periods\ in\ month\ m}$" means the number of valid periods in the month (m), as described later herein.

The reason for the 12-month calculation (running 12-month compliance) being different is to allow for possible changes to epsilon 1. It would be undesirable to retroactively change previous months' measured performance by using a different epsilon than was in effect for them orginally. Also note that compliance percentages can be calculated for other time periods (month, day, shift hours, etc.) by replacing $CF_{12\text{-month}}$ in the above formula with the appropriate CF value.

**Clock-minute average calculations.**

A clock-minute average is the average of the reporting BA's valid measured variable (i.e., for ACE and for frequency error, as well as for the BA's frequency bias, as defined above) for each valid sample during a given clock minute.

$$\left(\frac{ACE}{-10B}\right)_{clock\text{-}minute} = \frac{\sum_{samples\,in\,clock\text{-}minute}\left[\frac{ACE}{-10B}\right]}{n_{samples\,in\,clock\text{-}minute}}$$

or, for a BA with constant Bias

$$\left(\frac{ACE}{-10B}\right)_{clock\text{-}minute} = \frac{\left(\frac{\left[\sum_{samples\,in\,clock\text{-}minute} ACE\right]}{n_{samples\,in\,clock\text{-}minute}}\right)}{-10B}$$

and

$$\Delta F_{clock\text{-}minute} = \frac{\sum_{samples\,in\,clock\text{-}minute} \Delta F}{n_{samples\,in\,clock\text{-}minute}}$$

The BA's clock-minute Compliance Factor (CF) becomes:

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

**Accumulated Averages.**

The reporting entity can calculate and store compliance factors for a number of different reporting / analysis intervals. These factors can be used to calculate a CPS1 percentage for any desired time interval for any purpose desired.

for a single hour: $$CF_{clock\text{-}hour} = \frac{\left[\sum_{\text{valid clock-minute averages in hour}} CF_{clock\text{-}minute}\right]}{n_{\text{valid clock-minute averages in hour}}}$$

for a month: $$CF_{month} = \frac{\sum_{\text{hours-in-month}}[(CF_{clock\text{-}hour})(n_{\text{valid clock-minute averages in hour}})]}{\sum_{\text{hours-in month}}[n_{\text{valid clock-minute averages in hour}}]}$$

for (running) 12 months: $$CF_{12\text{-}month} = \frac{\sum_{1}^{12}(CF_{month})(n_{\text{valid clock-minute averages in month}})]}{\sum_{1}^{12}[n_{\text{valid clock-minute averages in month}}]}$$

**Interruptions in Data.**

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 sample pairs during that one-minute interval be present. The data pairs within a one-minute period need not be contiguous, but ACE and frequency data pairs must be simultaneous. Should an interruption in the recording of ACE or Frequency Deviation due to uncontrollable causes result in a one-minute interval not containing at least 50% of sample pairs of both ACE and Frequency Deviation, that one-minute interval is excluded from the calculation of CPS1.

**Examples**

Below is an example of the calculations required for CPS1 monitoring and compliance. The example starts with the first hour of the first day of a month through to the end of the month, and the BA bias, B = –60 MW/0.1 Hz.

On Day 1, at the beginning of HE 0100, the area must calculate $CF'_{clock\text{-}minute}$ by multiplying the clock-minute average ACE (divided by ten times the area's bias) by the clock-minute average frequency error from schedule. Subsequent products are calculated for the remaining clock-minutes of the hour.

| ***HE 0100:*** | | ***Minute 1*** | ***Minute 2*** | ***...*** | ***Minute 60*** | | |
|---|---|---|---|---|---|---|---|
| ACE | MW | -20 | -10 | | -40 | | |
| ACE/-10B | Hz | -20/-10(-60) = .0333332 | .0166667 | ... | .06666667 | | |
| ΔF | Hz | 0.005 | -0.005 | ... | 0.005 | ***Sum*** | ***$CF'_{clock\text{-}hour} = \Sigma(CF')/n$*** |
| **CF' = (ACE/-10B) x ΔF** | $Hz^2$ | -0.000167 | 0.000083 | ... | -0.000333 | 0.00525 | 0.000088 or 88 $mHz^2$ |
| n = (# of 1-min averages) | | 1 | 1 | | 1 | 60 | |

Note that n (# of 1-minute sample averages) is based on the number of valid samples over the hour. Since CPS1 requires 1-minute averages of ACE and frequency error (and there were no data anomalies in this hour), n = 60. The procedure shown above is repeated for each of the 24 hourly periods of each day. As the days of the month continue, the 24-hour period $CF'_{\text{clock-hour average-month}}$ values are averaged as shown below: At the end of the month, a $CF'_{\text{month}}$ can be calculated.

| ***Hour*** | | ***Day 1*** | ***Day 2*** | ***...*** | ***Day 31*** | ***Sum*** | ***$CF'_{\text{clock-hour average-month}}$ = $[\Sigma(CF' \times n)]/\Sigma(n)$ mHz$^2$*** |
|---|---|---|---|---|---|---|---|
| HE 0100 | $CF'_{\text{clock-hour}}$ | 87.5 | 93.5 | ... | 92.0 | | 90.5 |
| | n (# of averages) | 60 | 59 | | 57 | 1842 | |
| | $CF'_{\text{clock-hour}} \times n$ | 5250 | 5516.5 | | 5244 | 166,742 | |
| HE 0200 | $CF'_{\text{clock-hour}}$ | 90.0 | 85.0 | ... | 89.5 | | 87.5 |
| | n | 58 | 60 | | 60 | 1830 | |
| | $CF'_{\text{clock-hour}} \times n$ | 5220 | 5100 | | 5370 | 160,170 | |
| ... | ... | ... | ... | ... | ... | | ... |
| HE 2400 | $CF'_{\text{clock-hour}}$ | 89.0 | 92.0 | ... | 89.0 | | 89.5 |
| | n | 60 | 59 | | 59 | 1830 | |
| | $CF'_{\text{clock-hour}} \times n$ | 5340 | 5428 | | 5251 | 163,787 | |
| 12-month | | Total n | | | | 44,208 | |
| | | Total $CF'_{\text{clock-hour average-month}} \times n$ | | | | 3,930,888 | |
| | | $CF'_{\text{month}}$ = $\Sigma(CF'_{\text{clock-hour average-month}} \times n)/\Sigma(n)$ | | | | 88.9 mHz$^2$ | |

$CF_{\text{12-month}}$ can be calculated using the $CF_{\text{month}}$ values.

| | ***Month*** | | | | ***Year*** | ***Year*** |
|---|---|---|---|---|---|---|
| Assumin | 1 | 2 | ... | 12 | Sum | $CF'_{\text{12-month}}$ |
| | $CF'_{\text{month}}$ | 88.9 | 93.3 | ... | 91.7 | | $[\Sigma(CF'_{\text{month}} \times n)/\Sigma(n)]$ = |
| | n | 44,208 | 42,072 | ... | 42,875 | 515,030 | **91.3 mHz$^2$** |
| | $CF'_{\text{month}} \times n$ | 3,930,888 | 3,925,345 | | 3,931,655 | 47,022,239 | |

Assuming this interconnection has an $\varepsilon_1$ of 10 mHz, then the CPS1 compliance percentage would be calculated as follows:

**CF** = $CF'_{\text{12-month}} / (\varepsilon_1)^2$ = 91.3 mHz$^2$ / (10)$^2$ mHz$^2$ = 91.3 / 100 = **.913**

**CPS1 %** = ( 2 – CF ) x 100% = (2 - .913 ) x 100% = (1.087) x 100% = **108.7%**

which is a "passing" grade (12-month CPS1 must be at least 100%)

**Surveys.**

Performance Standard surveys are conducted monthly to analyze and demonstrate each BA's level of compliance with the Control Performance Standards. Completed surveys must be provided each month, to the Resources Subcommittee member, or designee representing the Region, by the tenth working day of the month following the month reported. Users should check with regions to determine reporting requirements.

**Instructions for BA Survey.** Using data derived from digital processing of the ACE signal, a representative from each BA will complete and submit CPS1 Form 1, "NERC Control Performance Standard Survey."

Hourly Table - Report the clock-hour average compliance factor (CF) for each of the 24 hourly periods and the total number of clock-minute sample averages in each clock-hour average.

**CPS1 Standard Summary.**

| | | |
|---|---|---|
| CPS1 | CPS1 Month | Report the monthly compliance factor, percent compliance, and number of clock-minute sample averages and enter in this cell. This value is for the month, only and is critical to correct evaluation of 12-month compliance. |
| | CPS1 Rolling 12 Month Value | Report the rolling 12-month compliance factor, percent compliance, and number of samples and enter in this cell. This is your calculation of the rolling compliance. NERC will also make the calculation based on your monthly submittals. |
| | Number of Valid Samples | Enter number of valid clock-minute averages in the profile hour and total. |
| | Unavailable Periods | Enter number of unavailable 1-min periods in the profile hour and column total. |

**Instructions for Regional and NERC Surveys.** From a review of the BAs' surveys, each Regional Survey Coordinator or RS member will ensure completion of CPS1 Form 2, "NERC Control Performance Standard — Regional Summary."

A. Review CPS1 Form 1 data received from each BA in the Region for uniformity, completeness, and compliance with the instructions. Iterate with BA survey coordinators where necessary.

B. Transfer the data from each Form to the appropriate columns on CPS1 Form 2 or its equivalent. Review the comments submitted and, if significant, identify them with the appropriate BAs.

C. Ensure forwarding of a copy each of the completed CPS Forms 1 and 2 or their equivalent to the NERC staff.

NERC staff will combine the Regional reports into a single summary report and post on the NERC Resources Subcommittee web page.

## NERC Control Performance Standard Survey

**CPS1** Form 1

BA -

Region -

Month -

$\varepsilon_1$ –

Year -

Time Zone -

| H.E. | CF | % | # of Valid 1-min Averages | Record the total month's number of valid 1-min sample averages from each of the 24 hourly profile periods | Unavailable Periods | Record the total unavailable periods from each of the month's 24 hourly profile periods |
|---|---|---|---|---|---|---|
| 0100 | | | | | | |
| 0200 | | | | | | |
| 0300 | | | | | | |
| 0400 | | | | | | |
| 0500 | | | | | | |
| 0600 | | | | | | |
| 0700 | | | | | | |
| 0800 | | | | | | |
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| 1000 | | | | | | |
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| 1800 | | | | | | |
| 1900 | | | | | | |
| 2000 | | | | | | |
| 2100 | | | | | | |
| 2200 | | | | | | |
| 2300 | | | | | | |
| 2400 | | | | | | |
| **CPS1 Month -** | | | | | | |
| **CPS1 – Rolling 12 Month Value** | | | | | | |

**Notes:**

| NERC Control Performance Standard Survey – Regional Summary | | | | |
|---|---|---|---|---|
| **CPS1** Form 2 | | | | |
| **Region -** | **Month -** | | | |
| **Date -** | **Year -** | | | |
| **ID #** | **BA Name** | **Monthly CF** | **#Valid 1-min Averages** | **Monthly CPS1 %** |
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**Notes:**

# C. Control Performance Standard 2, CPS2

The second measure of the CPS survey is designed to bound ACE ten-minute averages and in doing so provides a means to limit excessive unscheduled power flows that could result from large ACEs.

**Metrics.**

**Over a given period, the clock ten-minute averages of a BA's ACE is required by the standard to be less than the constant** on the right-hand side of the following inequality during at least a percentage of the period as specified herein:

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

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

$\in_{10}$ in Hz, is a constant derived from the targeted frequency bound. It is the targeted RMS of ten-minute average frequency error from schedule based on a selected historical period of interconnection frequency performance. The bound, $\in_{10}$, is the same for every BA within an Interconnection. In the ideal, it is also equal to epsilon1 divided by the square root of 10.

**1.65** is a constant used to convert the frequency target to 90% probability. It is the number of standard deviations from the mean of a statistical normal distribution (Gaussian distribution) that will result in a probability of noncompliance of 10% (i.e., compliance of 90%).

$\mathbf{B_i}$ in (negative) MW per tenth Hz, is the frequency bias of the BA.

$\mathbf{B_s}$ in (negative) MW per tenth Hz, is the sum of the frequency bias settings of the BAs in the respective Interconnection; for systems with variable bias, this is equal to the sum of the minimum frequency bias settings.

For those systems with variable bias, CPS2 becomes:

$$AVG_{10-\text{minute}}(ACE) \le L_{10}$$

where:

$$L_{10} = 1.65 \in_{10} [-10 AVG_{10-\text{minute}}(B_i)] \sqrt{\frac{B_s}{B_{\text{minimum}}}}$$

$B_{minimum}$ is the area's minimum allowed bias.

**Compliance**.

CPS2 compliance is achieved if the 10-minute ACE averages satisfy the inequality above for 90% (or more) of the intervals in a calendar month. The percentage, described below, is referred to as the CPS2 compliance percentage, or CPS2%.

Control Compliance Rating = Pass CPS2% $\ge$ 90%

Control Compliance Rating = Fail CPS2% < 90%

**The c**ompliance percentage is calculated as follows:

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

The $\text{Violations}_{\text{month}}$ are a count of the number of periods in which the average $\text{ACE}_{\text{clock-ten-minutes}}$ exceeded $L_{10}$. $\text{ACE}_{\text{clock-ten-minutes}}$ is the sum of valid ACE samples within a clock-ten-minute period divided by the number of valid samples (average ACE).

$$\text{Violation}_{\text{clock-ten-minutes}} = 0 \text{ if } \left|\frac{\sum ACE}{n_{\text{samples in 10-minutes}}}\right| \leq L_{10}$$

$$= 1 \text{ if } \left|\frac{\sum ACE}{n_{\text{samples in 10-minutes}}}\right| > L_{10}$$

Each area reports the total number of Violations and Unavailable Periods for the month.

**Determination of $\text{Total Periods}_{\text{month}}$ and $\text{Violations}_{\text{month}}$**

Since the CPS2 Criterion requires that ACE be averaged over a discrete time period, the same factors that limit $\text{Total Periods}_{\text{month}}$ will limit $\text{Violations}_{\text{month}}$. The calculation of $\text{Total Periods}_{\text{month}}$ and $\text{Violations}_{\text{month}}$, therefore, must be discussed jointly.

Each 24-hour period beginning at 0000 and ending at 2400 contains 144 discrete ten-minute periods (six periods more or less on Daylight Saving Time transition days). Each hour (HH) contains six discrete ten-minute periods, where period 1 spans HH:$00^+$ – HH:10, period 2 spans HH:$10^+$ – HH:20, period 3 spans HH:$20^+$ – HH:30, period 4 spans HH:$30^+$ – HH:40, period 5 spans HH:$40^+$ – HH:50, and period 6 spans HH:$50^+$ – (HH+1):00. For a system that samples ACE every four seconds, for example, the average ACE over a ten-minute period would be defined by the algebraic sum of 150 ACE samples (starting at HH:00:04 and ending at HH:10:00) divided by 150.

A CPS2 violation is recorded for any valid ten-minute period where the absolute value of average ACE is greater than $L_{10}$.

**Interruption in the Recording of ACE – Valid Intervals**

A condition may arise which may impact the normal calculation of $\text{Total Periods}_{\text{month}}$ and $\text{Violations}_{\text{month}}$. This condition is a sustained, unavoidable and uncontrollable interruption in the recording of ACE or one of its components.

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. The samples need not be contiguous. Such a period is a valid interval. Should more than half of the ACE data be unavailable due to loss of telemetering or computer unavailability, that ten-minute interval is not valid and is omitted from the calculation of CPS2.

**Data Reporting.**

The BA is responsible for submitting the Control Performance Standard survey each month. In addition (for post-reporting analysis by the Regional Resources Subcommittee representative), the BA is responsible for retaining sufficient pertinent data that will enable reproduction of the performance calculations.

Figure 1 demonstrates various examples of CPS2 compliance determination. Note that Figure 1 is separated into six distinct clock-ten-minute periods. The absolute value of the algebraic mean of the ACE during each period, referred to as $d_a$, is compared to $L_{10}$ (10 MW for this system) to determine if there has been a violation for that period. Note that the fourth interval (0130 – 0140) has recorded a violation because the absolute value of the algebraic mean of 10.1 MW exceeds the $L_{10}$ of 10 MW. Since disturbance conditions are included in the CPS2 calculation, violations are also recorded for the second and third intervals (0110–0120 & 0120–0130).

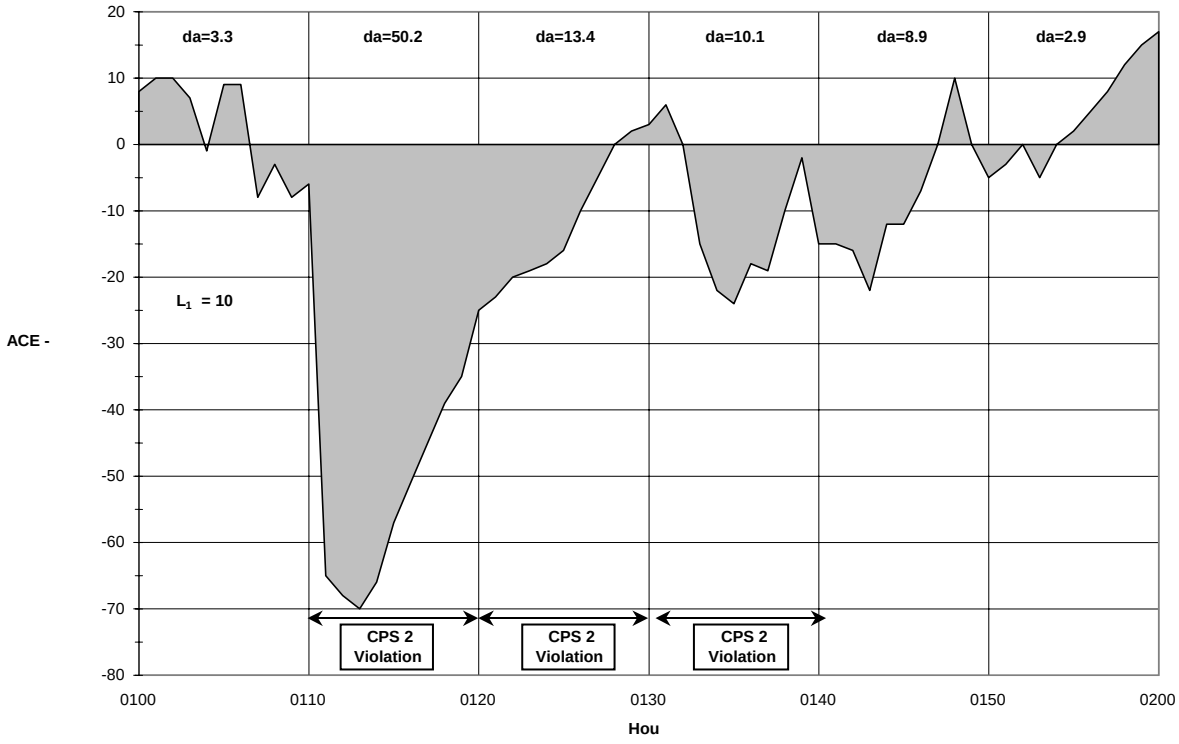


**Figure 1 –- CPS2-$L_{10}$ Compliance Calculation Examples**

Figure 2 demonstrates various examples of $L_{10}$ compliance coupled with an interruption in the recording of ACE. At 1208, ACE recording was interrupted and not returned until 1218. Since the ACE recording for the interval 1210 – 1220 did not include at least five minutes of data, this period is eliminated from CPS compliance analysis. In contrast, the first ten-minute interval of 1200 – 1210 is included in the analysis because ACE recording was interrupted only for the last two minutes of the interval. In fact, the first interval is in violation because the absolute algebraic mean of 12.4 MW exceeds the $L_{10}$ of 10.0 MW.

This algebraic mean of 12.4 MW was calculated for the eight minutes during which ACE was not interrupted. Thus, for this hour, there was one violation out of five valid intervals.

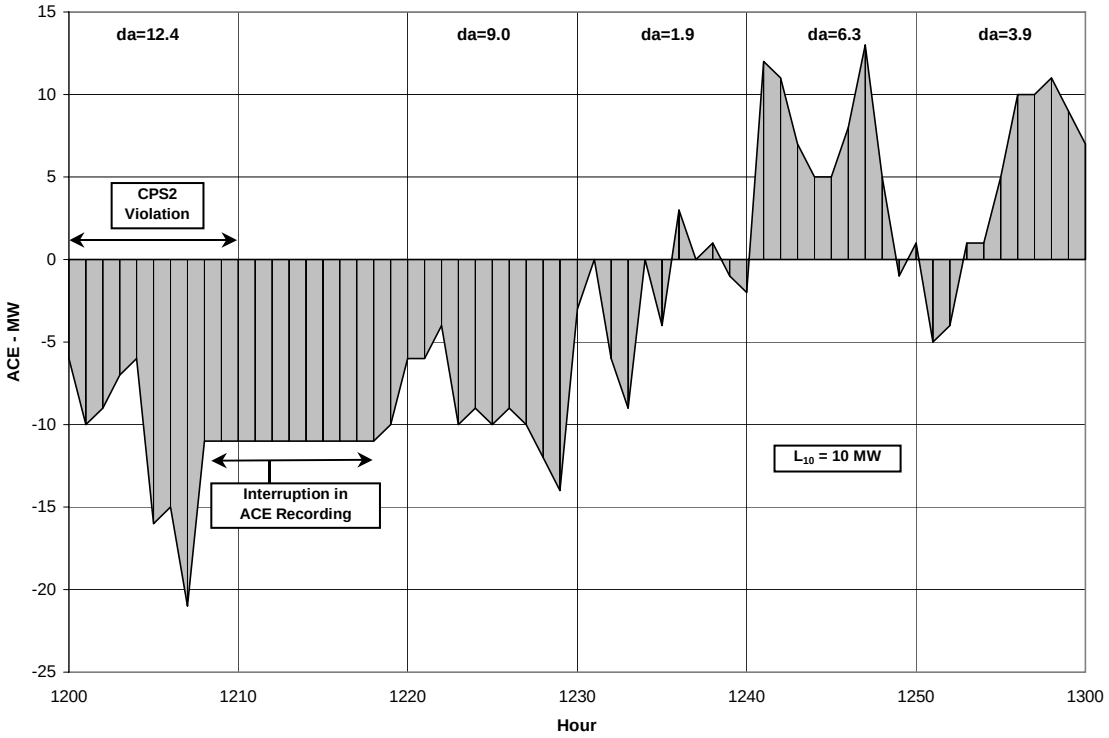


**Figure 2 –- CPS2-$L_{10}$ Compliance & Data Interruption Effects**

**Surveys.**

Performance Standard surveys are submitted monthly to analyze and demonstrate each BA's level of compliance with the Control Performance Standards. Completed surveys must be provided each month to the Resources Subcommittee member (or designee) representing the Region by the tenth working day of the month following the month being reported.

**Instructions for BA Survey.** Each BA will complete and submit CPS2 Form 1, "NERC Control Performance Standard Survey."

For each of the 24 hourly periods of a day, report the monthly total number of CPS2 violations and the number of unavailable ten-minute periods. For example, if there was one violation for hour ending 0100 every day of a 31-day month, a 31 would be entered for the 0100 hourly period.

**CPS2 Standard Summary.**

| | | |
|---|---|---|
| CPS2 | TOTAL | Sum the number of sample averages, the number of violations, and unavailable ten-minute intervals recorded on the hourly tables and enter the sums in this row for each column. |
| | CPS2 (%) | Calculate the CPS2 percentage compliance and enter in |

this row using the formulas and procedures described in Section C.

**Instructions for Regional and NERC Surveys.** From a review of the BAs' surveys, each Regional Survey Coordinator or RS member will ensure completion of CPS2 Form 2, "NERC Control Performance Standard — Regional Summary."

A. Review CPS2 Form 1 data received from each BA in the Region for uniformity, completeness, and compliance with the instructions. Iterate with BA survey coordinators where necessary.

B. Transfer the data from each Form to the appropriate columns on CPS Form 2. Review the comments submitted and, if significant, identify them with the appropriate BAs.

C. Forward a copy each of the completed CPS2 Forms 1 and 2 to the NERC staff..

D. NERC staff will combine the Regional reports into a single summary report and post on the NERC Resources Subcommittee web page.

## NERC Control Performance Standard Survey

**CPS2** Form 1

BA -

Region -

Month -

$L_{10}$ –

Year -

| H.E. CPT | Violations | | Unavailable Periods | |
|---|---|---|---|---|
| 0100 | | Record total violations for each of the 24 hourly profile periods | | Record total unavailable periods for each of the 24 hourly profile periods |
| 0200 | | | | |
| 0300 | | | | |
| 0400 | | | | |
| 0500 | | | | |
| 0600 | | | | |
| 0700 | | | | |
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| 1900 | | | | |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| CPS2 Month - | | | | |

notes: Must be completed monthly and submitted to NERC Resources Subcommittee regional representative or designee by the 10th working day of the month following the month reported.

| NERC Control Performance Standard Survey – Regional Summary | | | | |
|---|---|---|---|---|
| **CPS2** Form 2 | | | | |
| **Region -** | **Month -** | | | |
| **Date -** | **Year -** | | | |
| **ID #** | **BA Name** | **Violations** | **Unavailable Periods** | **Monthly CPS2 %** |
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notes:

# D. Disturbance Control Standard, DCS

During a disturbance, controls cannot usually maintain ACE within the criteria for normal load variation. Balancing areas, alone or collectively through reserve-sharing groups, are expected to activate contingency reserve to cause recovery of ACE magnitude within fifteen minutes following the start of a disturbance. This requires that a disturbance be defined. A disturbance is a sudden, unanticipated change (contingency) in resource(s) or demand. A sudden change is one that takes place over a minute or less. The DCS focuses on reportable disturbances.

Fifteen minutes is the existing recovery period duration which has evolved from debate over the appropriate way to measure the deployment of what has been measured as 10-minute reserves. It was argued that all balancing authorities need time to assess the validity of what appears to be a disturbance, and reserve-sharing groups need time to propagate calls for contingency reserves. Analyses were undertaken to determine probabilistically how lengthening the recovery period from 10 to 15 minutes would increase exposure to a second contingency. It was determined that the effect was very small, and recoverability from the next contingency is largely driven by reserve restoration timing, anyway. The 15 minute recovery standard was passed for recommendation by the NERC Resources Subcommittee in October, 1999.

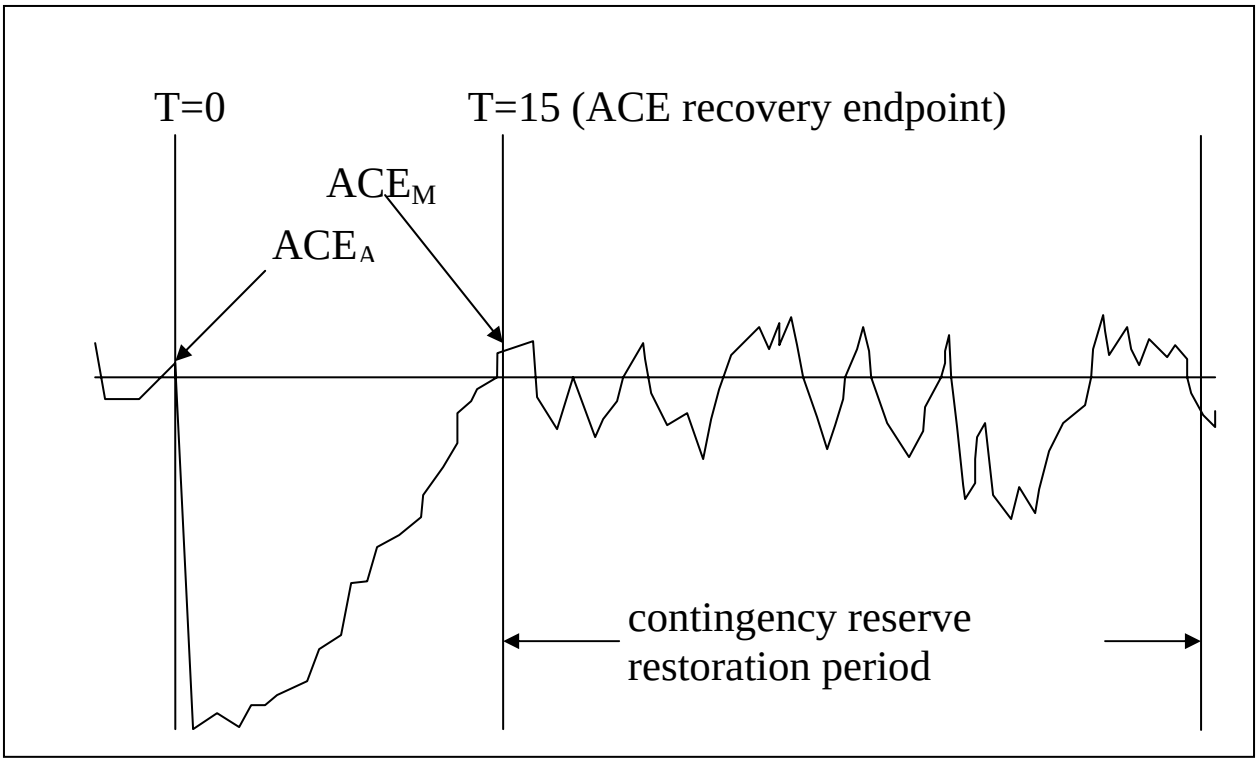
For purposes of disturbance control compliance, reportable disturbances are contingencies that are greater than or equal to 80% of the most severe single contingency loss. The start of a disturbance is the time of the event as best defined by resource output decline, breaker opening, or other such indication – in the absence of such indication, the moment of first ACE deflection may be used. The start of the recovery period is the same moment as the start of the disturbance. Note that the start of a disturbance and its magnitude are determined by the resource or demand change, while recovery and compliance are determined by ACE.

Regions may optionally reduce the 80% reporting threshold, provided that normal operating characteristics are not being considered or misrepresented as contingencies. Normal load and generation excursions (e.g., pumped storage hydro, arc furnace, rolling steel mill, etc.) that influence ACE are not reportable disturbance conditions. Normal operating characteristics are excluded because DCS strives to measure the recovery from sudden, unanticipated changes in demand or supply-side resources.

**Metrics**

**Balancing Area.** A BA is to return its ACE either to zero or to its pre-disturbance ACE level within a recovery time of fifteen minutes following the start of a disturbance. A BA may, at its discretion, **measure** its compliance based on the ACE measured fifteen minutes after the start of the disturbance, or on the maximum ACE recovery measured within the fifteen minutes following the start of the disturbance.

**Reserve Sharing Group (RSG).** The disturbance control compliance for a BA within an RSG is based on the compliance of the RSG (according to the compliance method chosen). An RSG may, at its discretion, measure this recovery based on the combined ACE measured fifteen minutes after the start of the disturbance, or on the maximum combined coincidental ACE recovery measured within the fifteen minutes following the start of the disturbance event (not the time at which reserve activation was requested).




Relationships among ACE, the 15-minute recovery period, and the reserve restoration period

**Compliance**

A BA or RSG must calculate and report compliance with the Disturbance Control Standard for all disturbances greater than or equal to 80% of the magnitude of the BA's or the RSG's most severe single contingency loss. Regional Reliability Councils may, at their discretion, require a lower reporting threshold. Disturbance Control Standard compliance is measured as the percentage recovery, $R_i$. $R_i$ >= 100% represents full compliance.

For loss of generation:

if $ACE_A < 0$

then

$$R_i = \frac{MW_{Loss} - \max(0, ACE_A - ACE_M)}{MW_{Loss}} * 100\%$$

if $ACE_A \geq 0$

then $$R_i = \frac{MW_{Loss} - \max(0, -ACE_M)}{MW_{Loss}} * 100\%$$

where:

**$MW_{LOSS}$** is the MW size of the disturbance as measured at the beginning of the event. It is the size of the resource or demand loss, not the ACE deflection,

**$ACE_A$** is the pre-disturbance ACE,

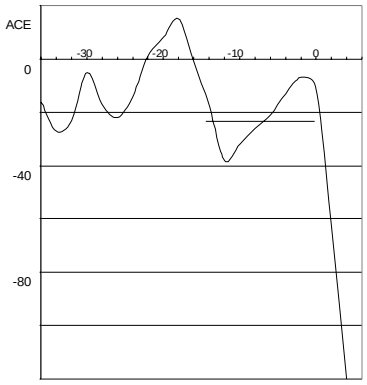
**$ACE_M$** is the value of ACE representing the point of greatest recovery from the disturbance measured within the fifteen minutes following the start of the disturbance event. A BA or RSG may, at their discretion, set $ACE_M = ACE_{15\ min}$.

**a. Determination of $MW_{LOSS}$.**

Record the $MW_{LOSS}$ value as measured at the site of the loss to the extent possible. The value should not be measured as a change in ACE since governor response and AGC response may introduce error.

b. **Determination of $ACE_A$.**

Base the value for $ACE_A$ on the average ACE over the period just prior to the start of the disturbance. Average over a period between 10 and 60 seconds prior and include at least 4 scans of ACE. In the illustration to the right, the horizontal line represents an averaging of ACE for 15 seconds prior to the start of the disturbance with a result of $ACE_A$= - 25 MW.




c. **Determination of $ACE_M$.**

$ACE_M$ is the value of ACE representing the point of greatest recovery from the disturbance measured within fifteen minutes following the start of the disturbance. It is negative for typical generation loss disturbances where zero is not reached within the recovery interval. At the discretion of the BA or of the RSG, compliance may be based on the ACE measured fifteen minutes following the start of the disturbance, i.e., $ACE_M = ACE_{15\ min}$.

Figure 1 demonstrates compliance evaluation during a disturbance condition (Disturbance Control Standard). Note the pattern of the disturbance condition, which began at 0110, the time at which ACE deflection exceeds this entity's disturbance reporting threshold of 50 MW. During this disturbance, the Disturbance Control Standard was violated because ACE was not restored to its pre-contingency level until 0127 (a 17-minute interval which violates the Disturbance Control Standard).

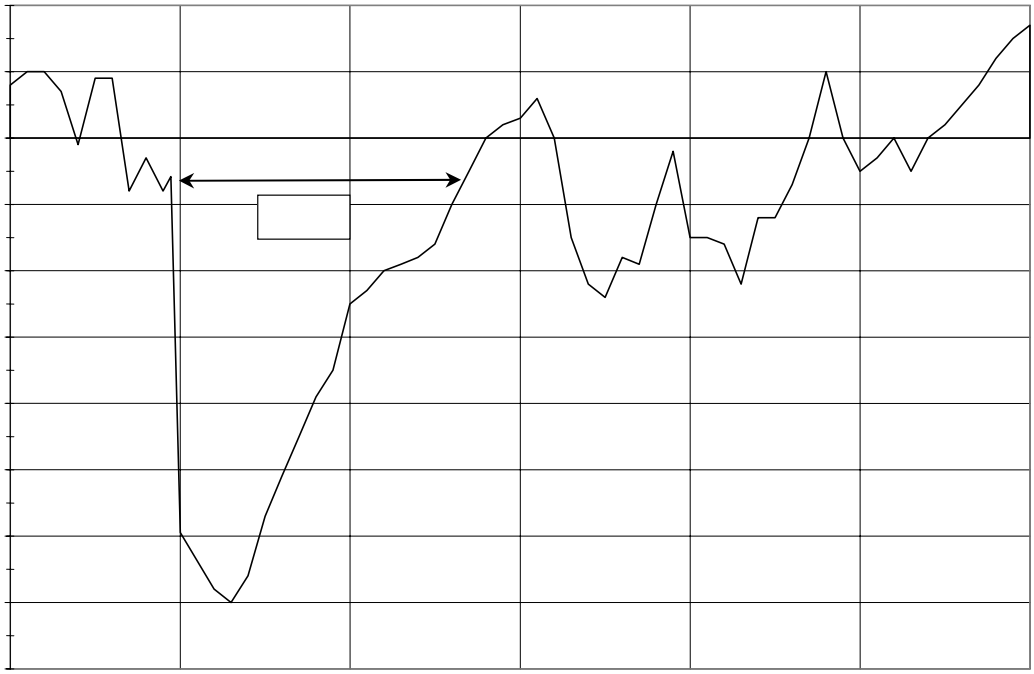


**Figure 1 –- CPS2-$L_{10}$ Compliance & Disturbance Control Standard, 2 Disturbance Examples**

**Reporting**

Each BA or RSG is to report its Disturbance Control Standard compliance quarterly. The completed Disturbance Control Standard survey is to be supplied to NERC by the 20th day following the end of the respective quarter. Where RSGs exist, the Regional Reliability Council is to decide either to report these on a BA basis or on an RSG basis. If an RSG has dynamic membership or allocates reserves dynamically, then it will be required that the Region convert the disturbance reporting for the RSG to a BA basis before reporting to NERC. If a BA basis is selected, each BA reports the RSG's performance only for disturbances occurring in their area.

a. **Reportable Disturbance.** The definition of reportable disturbance magnitude is to be provided to NERC by the respective Regional Reliability Councils. The definition is to include events that are greater than or equal to 80% of a BA's or RSG's most severe single contingency. The definition of a reportable disturbance must be specified in the operating Policy adopted by each Regional Reliability Council. This definition may not be retroactively adjusted in response to observed performance.

1. **Most Severe Single Contingency.** A BA's most severe single contingency is defined as the magnitude of the largest single credible event that would cause the greatest change in the BA's ACE, or as defined by the respective Regional Council. It is not necessarily a single loss; it could be an entire generating station, or a loss from transmission facility or facilities contingency.

2. **Excludable Disturbances and Average Percent Recovery.** The BA or RSG is to report both the number of reportable disturbances that occur in the given quarter, and the average percent recovery for that quarter. The report must also indicate excludable disturbances that occurred in the quarter and the average percent recovery for those excluded events.

3. **Excludable Disturbance.** An excludable disturbance is a disturbance whose magnitude was greater than the magnitude of the most severe single contingency.

4. **Average Percent Recovery.** The average percent recovery is the arithmetic average of all the calculated $R_i$s from reportable disturbances during the given quarter. Average percent recovery is similarly calculated for excludable disturbances. (See calculation of $R_i$ below).

**5.** **Contingency Reserve Adjustment Factor (CRAF)**. The quarterly Contingency Reserve Adjustment factor is to include only those reportable disturbances with magnitudes less than or equal to the magnitude of the respective BA's most severe single contingency.

CRAF is defined as follows:

when $n_{Quarter} \geq 0$, then

$$CRAF_{Quarter} = 200 - \left[ \frac{\sum R_i}{n_{Quarter}} \right]$$

when $n_{Quarter} = 0$, then $CRA_{Quarter} = 100$

where $n_{Quarter}$ is the number of reportable disturbances experienced during the reporting quarter.

$i$ = reportable disturbances.

$R_i$ is defined in section C.2.

**Calculation Precision.** The Adjustment Factor is to be rounded off to two decimal places.

6. **Exemptions**. Requests for exemptions for single events that cause multiple reportable disturbances (e.g. hurricanes, earthquakes, islanding, etc.) is to be submitted to the NERC Director of Compliance. Until the exemption is approved or denied, the BA or RSG is to consider the request denied.

7. **Contingency Reserve Adjustment Period.** BAs are to revise their respective Contingency Reserve Requirement by their computed Contingency Reserve Adjustment factor. The adjustments will be effective starting one month following the end of the reported quarter and remain in effect for three months.

8. **Report Filing.** Each BA or RSG is to report its Disturbance Control Standard compliance quarterly, by the 10th working day following the end of the quarter, on Form DCS "NERC Disturbance Control Standard Survey."

    a. Mail a copy of the completed Form DCS to the NERC staff.

    b. NERC staff will combine the Regional reports into a single summary report and make copies available to each Resources Subcommittee member and others with a legitimate need to know.

# NERC Disturbance Control Standard Report

| Quarter: | | Disturbances Not Greater than the Most Severe Single Contingency Loss | | Disturbances Greater than the Most Severe Single Contingency Loss[3] | | This Quarter's CRAF[4] | Criteria for Determining Reportable Disturbances This Report | Criteria for Determining Reportable Disturbances Next Report |
|---|---|---|---|---|---|---|---|---|
| Year: | | | | | | | | |
| Region: | | | | | | | | |
| Control Area/RSG[1]: | | Number | APR[2] (a) | Number | APR | | | |
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[1] When reporting as a Reserve Sharing Group (RSG), submit data for the entire group only and list the Control Areas comprising the RSG.

[2] APR indicates the Average Percent Recovery.

[3] Not a performance measure. For informational purposes only.

[4] [200-(a)], please round to the nearest whole percentage.

NOTES/COMMENTS:

*A Control Area or Reserve Sharing Group must increase their Contingency Reserve Requirement by the CRAF. CRR changes are implemented one month after the end of a reporting quarter and remain in effect for three months.*