Performance Subcommittee
Control Criteria Task Force

Control Performance Standard and Disturbance Control Standard Frequently Asked Questions

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This document provides the NERC Operating Committee (OC) with a non-technical description of the proposed Control Performance Standard and Disturbance Control Standard developed by the Performance Subcommittee's Control Criteria Task Force. The report is presented in a Question and Answer format. This report, used in conjunction with EPRI's RP 3555-10 and NERC's Performance Standard Survey training document, defines the new Control Performance Standard. The DCS is also fully explained in the NERC Performance Standard Survey training document

The report is divided into two sections: CPS and DCS. The CPS portion contains the following subsections: Background, Application, Test Experience, and Logistics. Each section is introduced by a short discussion. The discussion is followed by a series of questions and answers designed to explain the Control Criteria Task Force's position on each of the questions.

I.A. CPS — Background

Q1. Why do we need to replace A1 and A2?

The primary reason for replacing A1 and A2 is that the A1/A2 criteria do not meet the needs of the current industry environment. In the absence of an industry standard, A1 and A2 are viable measures of control performance. However, in a competitive environment, the A1/A2 criteria have four shortcomings:

1. Although A1 and A2 are based on "mature operating experience and judgment," they lack theoretical justification to directly relate them to any reliability parameter.
2. The existing A1 and A2 do not provide a direct measure of the impact of ACE on the Interconnection. With A1 and A2 all excursions are treated equally regardless of magnitude.
3. A1 and A2 are blind to the fact that ACE can be in a direction to support the Interconnection frequency. A1 and A2 will require control actions to correct ACE even if the ACE assists the frequency. At times, ACE may be moved in a direction that pushes frequency further off schedule.
4. Control areas expend a significant effort to meet A1 and A2. Economically, these efforts are not trivial. It is increasingly more difficult to justify those expenses when A1 and A2 have no solid theoretical justification.

Q2. Is the proposed Control Performance Standard just putting a new face on the old criteria?

While the proposed CPS has two parameters, both of the parameters evolve from a frequency-based theory. One parameter measures ACE impact on frequency over a 12-month horizon. The second parameter limits the magnitude of short-term ACE values.

The CPS must be viewed not from a single sample perspective, but from the context of frequency impact. It is true that the theory underlying the CPS does not penalize large ACE values as long as that ACE is helping to support the frequency. However, for frequency to be bounded and the control area to be compliant, the moment the frequency moves toward zero error, the control area must be so well controlled that it can unload that generation fast enough not to be caught by the frequency change. As the control area(s) with poor control correct their ACEs, the area with large supportive ACE must react or face the consequences of large ACE and large frequency deviation in the non-supportive direction.

The CPS will provide many control areas with the opportunity to relax their control during certain operating conditions and, therefore, the opportunity to save on control-related expenses. However, the frequency-related portion of the CPS is non-linear. As frequency error increases (and a control area's ACE is in the same direction), the impact on the compliance parameter of poor control dramatically increases. This dependence of frequency on compliance provides control areas with a strong incentive to support system frequency. In short, control areas with good control have the opportunity to save money on control, while control areas with poor control may be required to spend more money on control.

Historic frequency experience places a practical bound on the magnitude of ACE, and that practical bound becomes the limit in place of A2. This second parameter can also be viewed as a protection for tie lines that would carry the associated power flow.

Q3. Does the proposed Control Performance Standard preclude adverse unscheduled power flows?

No. Compliance does not preclude net unscheduled power flows. The CCTF suggests that a separate standard be set up to address that issue. A control standard cannot in and of itself accomplish that objective in a theoretically justifiable fashion — using a separate standard could.

For a control standard to preclude all adverse unscheduled power flows, the standard would be so restrictive that it would impose unreasonable economic penalties. The CPS addresses the most significant Interconnection control problems without addressing all problems of the Interconnection.

Q4. Is there theoretical justification for both parts of the standard or only the MW-Hz part of the CPS?

The theory includes both parts of the CPS. The modification of the A2 limit comes directly from theoretical considerations. However, from a theoretical perspective the two parts are complimentary. From a practical implementation perspective they address different concerns — one to provide the working space allowed for a control area to maneuver, and the other to ensure that the control area doesn't take too much advantage and, in doing so, risk adversely impacting the interconnected transmission system.

Q5. What does the proposed CPS do that A1 and A2 don't do?

The proposed CPS1 provides a frequency-based objective that focuses on the desired end results (i.e., reliability) and ignores the means used to obtain those results. This outcome-based approach imposes a framework around the mismatch between supply and demand. How a control area lives within that framework is not important. For example, if the loads put short-term demands on the control area that the control area doesn't meet, then that control area must adhere to more restrictive longer-term control if that control area is to live within the framework.

If a control area has a 1 MW ACE and doesn't cross zero, that control area is in compliance (as long as its control objective is larger than 1 MW). And more importantly, if a control area is overgenerating (within prescribed maximum limits) and the frequency is low, that control area is not obligated to reduce generation — a reduction that will further depress the system frequency.

It is noteworthy that the CPS does not require a control area to cross zero within a subjective time period (ten minutes). One control area reported that over 75% of its control actions were required by the A1 criteria to cross zero. And almost one-half of those actions were identified to be in a direction to adversely impact the system frequency.

Q6. If the CPS measures *average* performance, how will it address the matter of a control area performing poorly during one period (e.g., peak load periods) and meeting the long-term performance objectives?

"Poor performance is in the eye of the frequency." The theory will rate a control area based on the health of the Interconnection. To the extent that other control areas overgenerate, the subject control area could undergenerate and be rated a good performer. To the extent that multiple control areas also "drag," the frequency would go down, and the error would penalize the undergenerating control areas. As that error increased, the frequency penalty associated with the CPS increases (as a square of the error) making it very difficult to make up for that poor performance in the future. To make up for the poor performance, the control area must not just offset by an equal amount of MWs but must do more control to compensate for any differences in the frequency error. There are two risks the control area takes with this strategy. One is that past compliance could be out-weighed by the current poor performance. Secondly, if the poor performer significantly contributes to the frequency error, the control area may carry that poor compliance rating for many months before the control area is able to *average out* the poor compliance.

Q7. What would happen if many control areas decide to take the risk (of off-setting poor performance) at the same time — e.g., January 19, 1994.

No performance criteria could prevent this event from occurring, just as the existing A1 and A2 did not prevent the control problems experienced on January 19, 1994. Unlike the current criteria, the proposed CPS severely penalizes control that contributes to the frequency error being experienced. With the CPS, the more a control area's performance hurts the frequency, the more its rating will be impacted. With A1 and A2, the magnitude of poor performance is not reflected — a control area that exceeds its L_d by 1 MW is rated the same as a control area that exceeds its L_d by 100 MW. And worse still, a control area that was supporting the frequency would be shown to be a poor performer if its ACE exceeded its L_d.

Q8. As a primary reliability objective, why is frequency being used as the reliability indicator?

Frequency is one of the measures that displays the health of an entire Interconnection. Frequency does show the composite impact of the supply-demand mismatches over the entire interconnected system. As such, it is a good indicator of the general health of the system. It does not address local problems such as adverse power flows on transmission lines. The NERC Operating Committee mandated that the new criteria not adversely affect frequency performance.

Q9. What happens when a control area changes its frequency bias — does a larger B give a control area a larger control range?

Yes, a larger B gives a control area a larger target — however, it also requires a larger response from the control area. When the frequency error is large, the control area is expected to provide a larger response or risk being in violation of the CPS.

It should be noted that the B that most closely matches a control area's frequency response characteristic will yield a 'natural' generation-frequency match, thus minimizing control actions.

Q10. What does the Performance Subcommittee propose to do to handle adverse power flows?

Pending acceptance of this process and a directive from the Operating Committee, the Performance Subcommittee will initiate a project to develop a power transfer standard. Conceptually, the new standard could address the related issue of inadvertent interchange as well as time error corrections, but that has not been decided.

Q11. How is the new CPS expected to affect inadvertent accumulations?	The CPS itself will not change how inadvertent flows. However, compliance with the new CPS is expected to result in a fairer distribution of inadvertent.

I.B. CPS — Application

The first measure of the CPS Survey provides a measure of the control area's performance. The measure is intended to provide the control area with a frequency-sensitive evaluation of how well it met its demand requirements with its supply resources *in conjunction with* the state of the interconnected system. The measure is not designed to be a visual indicator that an operator would use to control system generation. Nor is the measure designed to address the issue of unscheduled power flows. The second measure is designed to provide a supportable bound on the magnitude of ACE.

Q1. What does MW-Hz mean to an operator?

Intuitively, very little. MW-Hz is the measuring stick that will be used to compute the performance. Good control means having a random ACE that is bounded; but in a competitive environment good control can also be smart control. And control areas should be permitted to take full economic advantage of system conditions as long as the control performance does not fall short of the respective control area's portion of the frequency support.

Q2. What target will the operator control to?

That is a function of the control area. A traditional control area would work to keep its ACE near zero or at least in the direction to help frequency.

A more aggressive control area would want to modify its control system to do as little as possible when it is operating in the direction to help frequency (and is within the designated short-term A2 bound), and to work a little harder when it is operating in the direction to hurt frequency.

Still others may want to optimize their system and compute and display their average ACE in relation to the frequency. And automatically maximize the economic benefits of taking advantage of their share of the frequency control.

Q3. What does a MW limit mean to an operator?

The MW limit would be used the same way A2 is used today. The ten-minute compliance period provides a direct feedback to the operator. The measure limits the NET unscheduled flows between control areas. The limit, however, does not measure or preclude unscheduled parallel flows. But neither do the existing A1 and A2 criteria.

Q4. Why is the basic unit of computation one minute?

Periods shorter than one minute are outside the range of normal control. Control actions are generally effective on a one- to two-minute period.

I.B. CPS — Application

Q5. How are non-constant bias settings handled?

The users of non-constant bias settings must average their bias characteristics over appropriate short intervals associated with the change in bias, and then compute the CPS.

Q6. Does the CPS impact the NERC Policy on ten-minute reserves?

The objective of the CPS is to *rate* a control area's impact on frequency. The objective of the Disturbance Control Standard is to *rate* a control area's ability to respond to a contingency. These two standards are distinct and independent of one another.

Q7. If NERC recognizes 20 mHz offsets for Time Error Corrections then how does it justify rating a control area on the basis of an objective less than 20 mHz?

The long-term frequency constant used to benchmark and rate a control area's performance *is not* the same as the real-time frequency error that can be sustained on an Interconnection. The long-term CPS reliability index defines a control area's performance in terms of how the control area's performance fits in with a given long-term frequency behavior. This behavior includes some large deviations and many smaller deviations. But *on average* a control area would have to perform on the basis of the CPS frequency constant. The new CPS requires that a control area's performance *averaged* over a 12-month period be rated on a frequency objective less than 20 mHz (e.g., about 18 mHz on the Eastern Interconnection).

Q8. Why does each Interconnection have a different frequency-based target (epsilon)?

Due to the Operating Committee mandate to maintain historical frequency performance under the new criteria, the targets are developed from analysis of historical frequency data of each Interconnection (which results in different targets for each of the Interconnections). The differences can be attributed to the dynamics that exist in each Interconnection, such as variations in inertia, frequency response, transmission topology, etc.

Q9. Please explain how an area can have a greater than 100% compliance to CPS1.

Theoretically, CPS1 has no limits on the magnitude of compliance in both the positive and negative direction. The Standard is designed so that if an area has a compliance of 100% then they are supplying **exactly** the amount of frequency support required. Anything above 100 can be considered "helping" interconnection frequency where as anything below 100 can be considered "hurting" interconnection frequency.

I.C. CPS — Test Experience

The NERC OC has approved ad hoc tests of the CPS. The tests were initiated by Bonneville Power Administration, Entergy Services, Inc., and New England Power Exchange. All have distributed documentation of their processes and have issued charts of their results.

Q1. If a control area is a good performer under the current criteria, will it continue to be a good performer under the new CPS?

Probably. Test data is inconclusive at this moment. How a system is controlled determines whether or not its performance will be acceptable. For example, if a control area today was to do nothing for seven minutes then at the seven-minute mark decide whether or not to move generation (so as to cross zero and/or be within the MW limit) then that system may have to modify its control procedures.

A control area that frequently crosses zero and whose ACE is bounded by L_d should have no problem complying with the CPS. This should not be taken to mean that the control area will not have to take any action to comply with the CPS. What it does mean is that if a control area were complying with the current standard, then that control area would not have to take unreasonable actions to comply with the new CPS.

A good A1/A2 compliance should result in good CPS compliance but not necessarily if the control area were using an A1/A2-based control algorithm. This fact is a result of A1/A2 being blind to frequency deviation (aside from the frequency bias term in the ACE equation). The CPS will provide an opportunity to either relax control actions or to adjust generation to reduce the frequency deviation. A1/A2 may force frequency-aggravating behavior for brief periods of time. The best test will be to both control and measure performance using the CPS principles.

Q2. What is a good way to initially control under the CPS?

Generically speaking, the best way to control is to continue to use common sense. In the absence of support tools a control area strategy would be first, minimize ACE. Keep ACE as close to zero as possible. Second, effect corrective control actions when the ACE is in a direction that hurts the frequency.

I.D. CPS — Logistics

The implementation process will consist of a two year phase-in period. This period should provide sufficient time for those control areas without adequate databases in place to get the data collection process in place.

Q1. What is the timetable to get this standard in place?

July 1996 Make a presentation to the NERC OC. Pending OC approval, the Performance Subcommittee will submit three reports to the NERC Regions for comments:

1. EPRI report (describing the theoretical basis)
2. NERC Procedures (describing how users would do calculations, and submit data)
3. Frequently Asked Questions (explaining, in non-mathematical terminology, the PS's positions on various aspects of the CPS.

Oct. 1996 Performance Subcommittee would discuss Regional comments on the CPS and address those comments as appropriate.

Dec. 1996 Submit the CPS to the OC to send out to the Regions for vote. Pending approval, the Regions would have one year to implement the required data support system.

Jan. 1997+ Period of dual evaluation. Areas will not be held accountable for A1/A2 if controlling to CPS.

Jan. 1998+ All control areas being evaluated for compliance to the new standard. As control areas comply with the CPS the frequency characteristics would improve. This will allow the CPS to be adjusted to permit wider control latitude. However, existing control areas with poor performance would be required to bring themselves into compliance before existing control areas with good performance would be permitted to further relax their control.

Q2. How does the PS expect to see operator action to change when the new CPS is introduced.

Many control areas will move quickly to stop crossing zero every ten minutes. This is a simple change in operation and represents significant savings in regulating costs to these areas.

Over time, control areas will start to tune their AGC algorithms to optimize their regulation with CPS1 and CPS2. The PS also expects that a number of control areas shall initially continue operating to A1 and A2. These areas can be comfortable with the fact that A1 and A2 compliant operation will probably lead to CPS1 and CPS2 compliance.

Q3. What happens if a control area does not comply?

If an area is not compliant with the CPS, it shall obtain sufficient regulation assistance to be compliant to the CPS.

Q4. How will the 12-month part of the CPS be useful for evaluating control performance for a given month?

The purpose of the 12-month part of the CPS is to allow for some short-term violations and not over-focus on a short-term indiscretion. The new CPS recognizes long-term good performance and credits a control area for such. On the other hand short-term compliance does not totally erase long term adverse impacts to the Interconnection.

Q5. But good performance is still good performance whether it's short term or long term. How will short-term performance be evaluated?

The Performance Subcommittee will be responsible to oversee both the long- and short-term compliance of all control areas. The Performance Subcommittee representative will collect that representative's Regional data. Short-term trends will be highlighted and discussed at the NERC Performance Subcommittee meetings.

II. DCS

Q1. Why must a control area recover from a disturbance if the offset is helping frequency?	• A disturbance constitutes unscheduled tie flows which may utilize transmission that others may need. • The DCS measures operating reserve adequacy and as such should address every reportable event.
Q2. Why ten minutes?	Policy 1E measures the operating reserves requirements defined in Policy 1A. Policy 1A defines operating reserves over ten minutes so the DCS should be similarly based. If, in the future, the definition of operating reserve is different than ten minutes then Policy 1E should change as well.
Q3. Why should a pre-contingency ACE be considered an advantage to recovery?	If the pre-contingency ACE is in a direction which aids recovery, then that ACE can be thought of as a source of "reserve". It is not considered prudent to deliberately cause a non-zero ACE as part of disturbance recovery.
Q4. If ACE is negative, does a control area need to recover their ACE to zero in addition to recovering from the disturbance?	No. DCS measures if a control area is meeting its reserve requirements. These reserves include contingency reserve and regulating reserve. The control area must: 1) recover from the contingency and 2) regulate to load changes over the ten minutes, but the control area need not correct control error that existped before the contingency.