NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

BAL-001-~~1~~ 2 – Real Power Balancing Control Performance Standard Background Document

February 2013

RELIABILITY | ACCOUNTABILITY




3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com

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Introduction

This document provides background on the development, testing, and implementation of BAL-001-~~1~~ 2 - Real Power Balancing Control Standard. The intent is to explain the rationale and considerations for the requirements and their associated compliance information.

The original work for this standard was done by the Balancing Authority Controls standard drafting team, which later joined with the Reliability-based Control Standard drafting team. These combined teams were renamed Balance Authority Reliability-based Control standard drafting team (BARC SDT).

The purpose of proposed Standard BAL-001-~~1~~ 2 is to maintain Interconnection frequency within predefined frequency limits. This draft standard defines Balancing Authority ACE Limit (BAAL), and required the Balancing Authority (BA) to balance its resources and demand in Real-time so that its clock-minute average of its Area Control Error (ACE) does not exceed its BAAL for more than 30 consecutive clock-minutes.

As a proof of concept for the proposed BAAL standard, a BAAL field trial was approved by the NERC Standards Committee and the Operating Committee. Currently participating in the field trial are 13 Balancing Authorities in the Eastern Interconnection, 26 Balancing Authorities in the Western Interconnection, the ERCOT Balancing Authority, and Quebec. Reliability Coordinators for all Interconnections continue to monitor the performance of those participating Balancing Authorities and provide information to support monthly analysis of the BAAL field trial. As of the end of September 2011, no reliability issues with the BAAL field trial have been identified by any Reliability Coordinator. The Western Interconnection has experienced changes during the field trial with potential degradation to transmission; however, no explicit linkage has been determined between the field trial and these degradations. For further information on the results of the Western Interconnection, please refer to the WECC Reliability-based Control Field Trial Report.

Historical Significance

A1-A2 Control Performance Policy was implemented in 1973 as:

- A1 required the Balancing Authority's ACE to return to zero within 10 minutes of previous zero.
- A2 required that the Balancing Authority's averaged ACE for each 10-minute period must be within limits.
- A1-A2 had three main short comings:
  - Lack of theoretical justification
  - Large ACE treated the same as a small ACE, regardless of direction
  - Independent of Interconnection frequency

In 1996, a new NERC policy was approved which used CPS1, CPS2, and DCS.

CPS1is a:

- Statistical measure of ACE variability
- Measure of ACE in combination with the Interconnection's frequency error
- Based on an equation derived from frequency-based statistical theory

CPS2 is:

- Designed to limit a Control Area's (now known as a Balancing Authority) unscheduled power flows
- Similar to the old A2 criteria

The proposed BAL-001-~~1~~ 2 retains CPS1, but proposes a new measure BAAL to replace CPS2. Currently CPS2:

- Does not have a frequency component.
- CPS2 many times give the Balancing Authority the indication to move their ACE opposite to what will help frequency.
- Only r~~R~~equires Balancing Authorities to comply 90 percent of the time as a minimum.

Background and Rationale by Requirement

Requirement 1

R1. The Responsible Entity~~Each Balancing Authority~~ shall operate such that the ~~Balancing Authority's~~ Control Performance Standard 1 (CPS1), ~~(as~~ calculated in accordance with Attachment 1, ~~)~~ is greater than or equal to 100 percent for the applicable Interconnection in which it operates for each 12-month period, evaluated monthly~~, to support Interconnection frequency~~.

Background and Rationale

Requirement R1 is not a new requirement. It is a restatement of the current BAL-001-0.1a Requirement R1 with its equation and explanation of its individual components moved to an attachment, Attachment 1 - Equations Supporting Requirement R1 and Measure M1. This requirement is commonly referred to as Control Performance Standard 1 (CPS1). R1 is intended to measure how well a Balancing Authority is able to control its generation and load management programs, as measured by its Area Control Error (ACE), to support its Interconnection's frequency over a rolling one-year period.

CPS1 is a measure of a Balancing Authority's control performance as it relates to its generation, Load management, and Interconnection frequency when measured in one-minute averages over a rolling one-year period. If all Balancing Authorities on an Interconnection are compliant with the CPS1 measure, then the Interconnection will have a root mean square (RMS) frequency error less than the Interconnection's Epsilon 1.

A Balancing Authority reports its CPS1 value to its regional entity each month. This monthly value provides trending data to the Balancing Authority, NERC resources subcommittee, and others as needed to detect changes that may indicate poor control on behalf of the Balancing Authority. Requirement R1 remains unchanged, although the wording of the requirement was modified to provide clarity.

Requirement 2

R2. Each Balancing Authority shall operate such that its clock-minute average of R~~r~~eporting ACE does not exceed its clock-minute Balancing Authority ACE Limit (BAAL) for more than 30 consecutive clock-minutes~~, its clock-minute Balancing Authority ACE Limit (BAAL)~~ ~~(~~as calculated in Attachment 2~~,)~~ for the applicable Interconnection in which the Balancing Authority~~it~~ operates ~~to support Interconnection frequency~~.

Background and Rationale

Requirement R2 is a new requirement intended to replace existing BAL-001-0.1a Requirement R2, commonly referred to as Control Performance Standard 2 (CPS2). The proposed Requirement R2 is intended to enhance the reliability of each Interconnection by maintaining frequency within predefined limits under all conditions.

The Balancing Authority ACE Limits (BAAL) are unique for each Balancing Authority and provide dynamic limits for its Area Control Error (ACE) value limit as a function of its Interconnection frequency. BAAL was derived based on reliability studies and analysis which defined a Frequency Trigger Limit (FTL) bound measured in Hz. The FTL is equal to Scheduled Frequency~~60 Hz~~, plus or minus three times an Interconnection's Epsilon 1 value. Epsilon 1 is the root mean square (RMS) targeted frequency error for each Interconnection, as recommended by the NERC Resources Subcommittee and approved by the NERC Operating Committee. Epsilon 1 values for each Interconnection are unique. When a Balancing Authority exceeds its BAAL, it is providing more than its share of risk that the Interconnection will exceed its FTL. When all Balancing Authorities are within their BAAL (high and low), the Interconnection frequency will be within its FTL limits.

BAAL is defined by two equations; BAAL low and BAAL high. BAAL low is for Interconnection frequency values less than Scheduled Frequency~~60 Hz~~, and BAAL high is for Interconnection frequency values greater than Scheduled Frequency~~60 Hz~~. BAAL values for each Balancing Authority are dynamic and change as Interconnection frequency changes. For example, as Interconnection frequency moves from Scheduled Frequency~~60 Hz~~, the ACE limit for each Balancing Authority becomes more restrictive. The BAAL provides each Balancing Authority a dynamic ACE limit that is a function of Interconnection frequency.

CPS2 was not designed to address Interconnection frequency. Currently, it measures the ability of a Balancing Authority to maintain its average ACE within a fixed limit of plus or minus a MW value called L_{10}. To be compliant, a Balancing Authority must demonstrate its average ACE value during a consecutive 10-minute period was within the L_{10} bound 90 percent of all 10-minute periods over a one-month period. While this standard does require the Balancing Authority to correct its ACE to not exceed specific bounds, it fails to recognize Interconnection frequency. For example, the Balancing Authority may be increasing or decreasing generation to meet its CPS2 bounds, even if this is a direction that reduces reliability by moving Interconnection frequency farther from its scheduled value. CPS2 allows a Balancing Authority to be outside its ACE bounds 10 percent of the time. There are 72 hours per month that a Balancing Authority's ACE can be outside its L_{10} limits and be compliant with CPS2.

In summary, the proposed BAAL requirement will provide dynamic limits that are Balancing Authority and Interconnection specific. These ACE values are based on identified Interconnection frequency limits to ensure the Interconnection returns to a reliable state when an individual Balancing Authority's ACE or Interconnection frequency deviates into a region that contributes too much risk to the Interconnection. This requirement replaces and improves upon CPS2, which is not dynamic, is not based on Interconnection frequency, and allows for~~significant hours when~~ a Balancing Authority's ACE value to be unbounded for a specific amount of time during a calendar month~~s are unbounded~~.

Change From 60Hz to Scheduled Frequency

The base frequency for the determination of BAAL was changed from 60 Hz to Scheduled Frequency, $\mathbf{F_S}$. This change was made to resolve a long-standing problem with the requirement as first presented by the Balancing Resources and Demand Standard Drafting Team. The following presents information about the reason for the initial choice of 60 Hz and the need to change this value to Scheduled Frequency.

The initial BAAL equations were developed upon the assumption that the Frequency Trigger Limit (FTL) should be based upon Scheduled Frequency as shown in this draft of the standard. During initial development of values for the FTL the BRD SDT used a deterministic method for the selection of FTL based upon the Under-Frequency Relay Limit (UFRL) of an interconnection. Since the Under-Frequency Relay Limit of the interconnection is fixed the SDT chose to use a fixed value of starting frequency that would maintain a fixed frequency difference between the FTL and the UFRL. Therefore, the BRD SDT chose to base BAAL on a starting frequency of 60 Hz under the assumption that if the UFRL did not change then the FTL and base frequency should not change. The BAAL Field Trial was started using these values.

Shortly after the field trial started, directed research supporting the selection of the FTL for the Eastern Interconnection was completed. Unfortunately, the methods used to support the

selection of an FTL for the Eastern Interconnection could not be repeated successfully for the other interconnections. Included in the final report was a recommendation that a multiple of 3 to 4 times the ε_1 for the interconnection could provide an acceptable alternative choice for determining the FTL.[1] Since the field trial had already started, no change was made to the initial FTL for the Eastern Interconnection, but as additional interconnections joined the field trial the FTL for these new interconnections was based on 3 times ε_1 for the interconnection. This change broke the linkage between FTL and the UFRL and eliminated the justification for using 60 Hz as the only acceptable starting frequency.

As data accumulated from the Eastern Interconnection field trial, it became apparent that Time Error Correction (TEC) causes a detrimental reliability impact. The BAC SDT recognized this problem and initiated actions to provide a case to eliminate TEC based on its effect on reliability. This activity caused the RBC SDT and later the BARC SDT to defer any action on the substitution of Schedule Frequency for 60 Hz in the BAAL Equations until the TEC issue was resolved because the elimination of TEC would eliminate the need for change. When the ERO decided to continue to perform TEC, that decision relieved the BARC SDT of responsibility for the reliability impact of TEC and required the team to instead consider the impact that BAAL could have on the effectiveness of the TEC process and any conflicts that would occur with other standards.

Two conflicts have been identified between BAAL and other standards. The first is a conflict between the BAAL limit and Scheduled Frequency when an interconnection is attempting to perform TEC by adjusting the Scheduled Frequency to either 59.98 of 60.02 Hz. The second is a conflict that results in BAAL providing an ACE limit that is more restrictive that CPS1 when an interconnection is performing TEC. These problems can both be resolved by basing the BAAL Limit on Scheduled Frequency instead of 60 Hz. Eight graphs follow that show the conflict between BAAL as currently defined using 60 Hz and other standards and how the change from 60 Hz to Scheduled Frequency resolves the conflict.

The first four graphs show the conflict that is created while performing TEC. Under TEC the BAAL limit crosses both the CPS1 = 100% line and the Scheduled Frequency Line indicating the conflict between BAAL, CPS1 and TEC when BAAL is based on 60 Hz.

The next four graphs show how this conflict is resolved by using Scheduled Frequency as the base for BAAL. When BAAL is determined in this manner both conflicts are resolved and do not appear with the implementation of TEC.

[1] The initial value for FTL for the Eastern Interconnection was set at 50 mHz. Three time epsilon 1 for the Eastern Interconnection is 54 mHz.

Finally, resolving this conflict reduces the detrimental impact that BAAL has on some smaller BAs on the Western Interconnection during TEC.

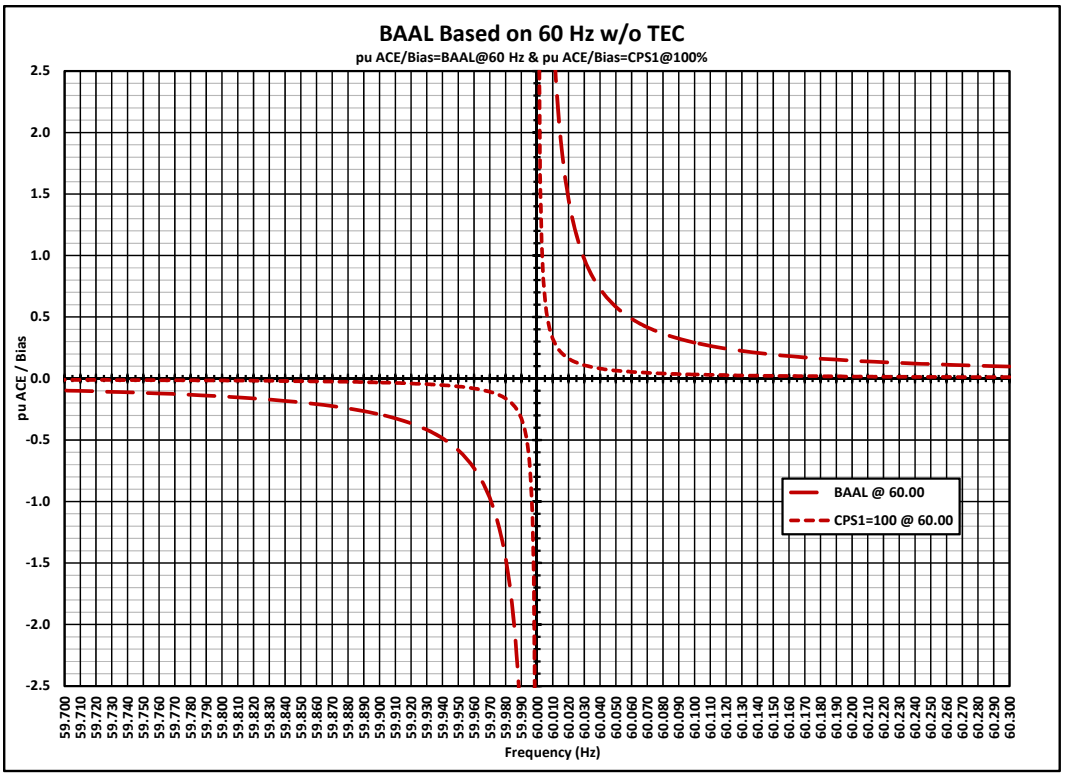

Figure 2. BAAL Based on 60 Hz w/o TEC

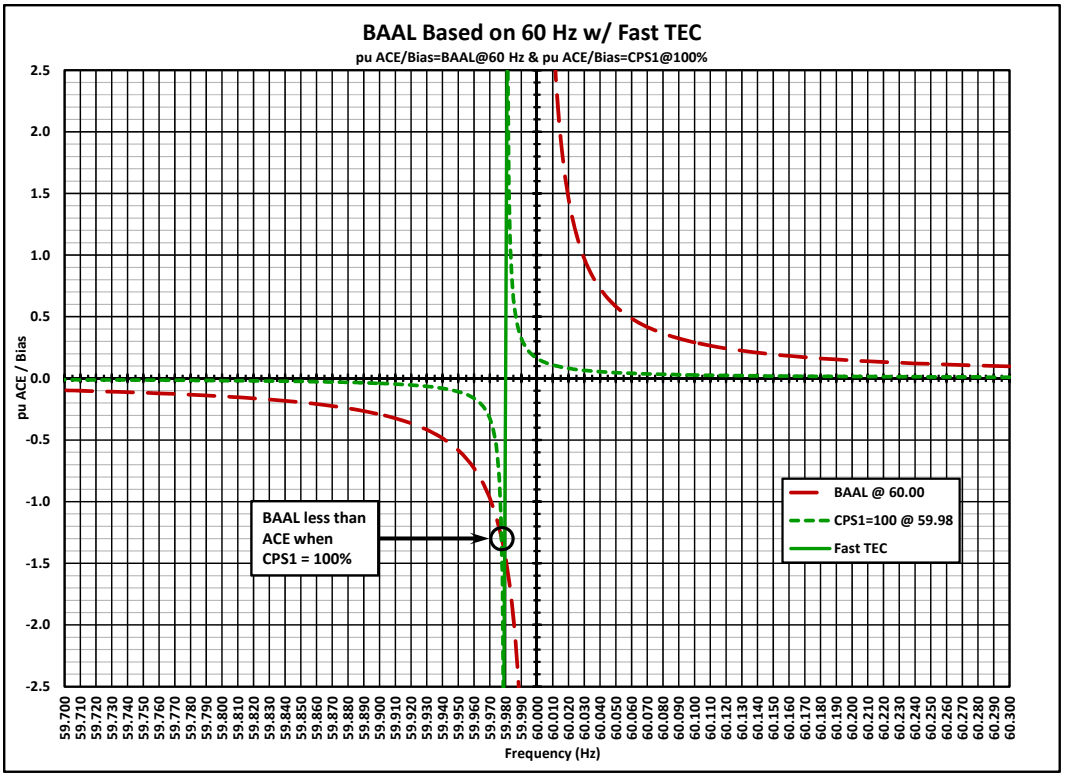

Figure 1. BAAL Based on 60 Hz w/ Fast TEC

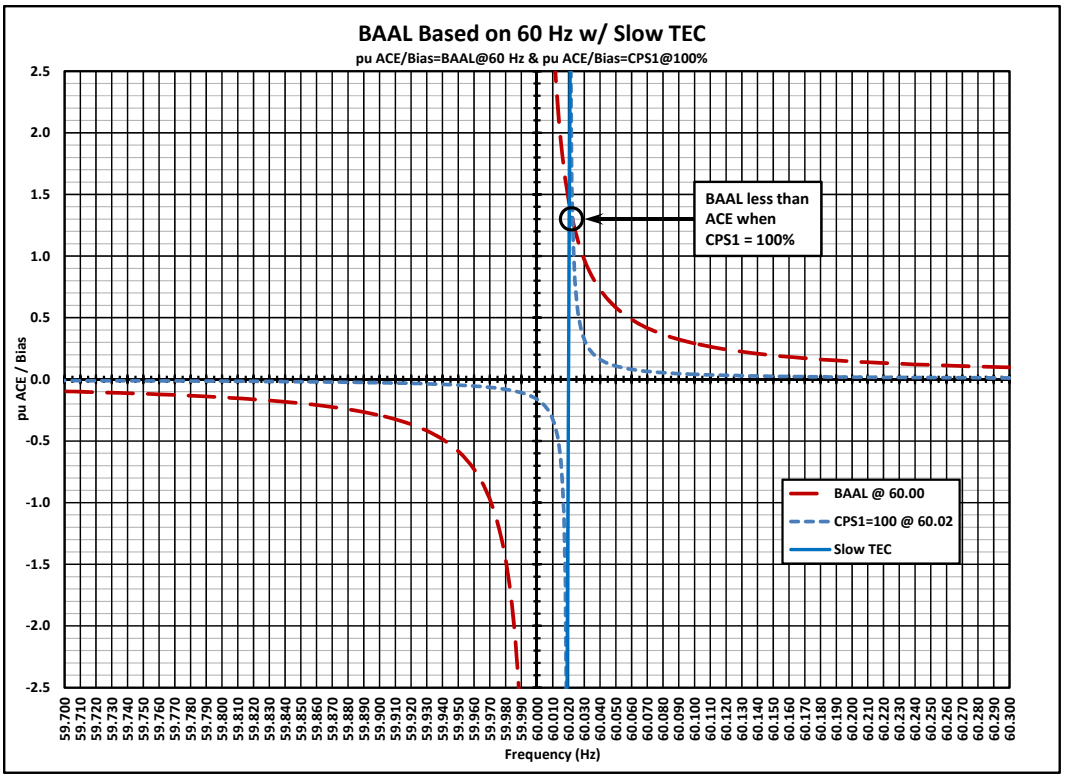

Figure 4. BAAL Based on 60 Hz w/ Slow TEC

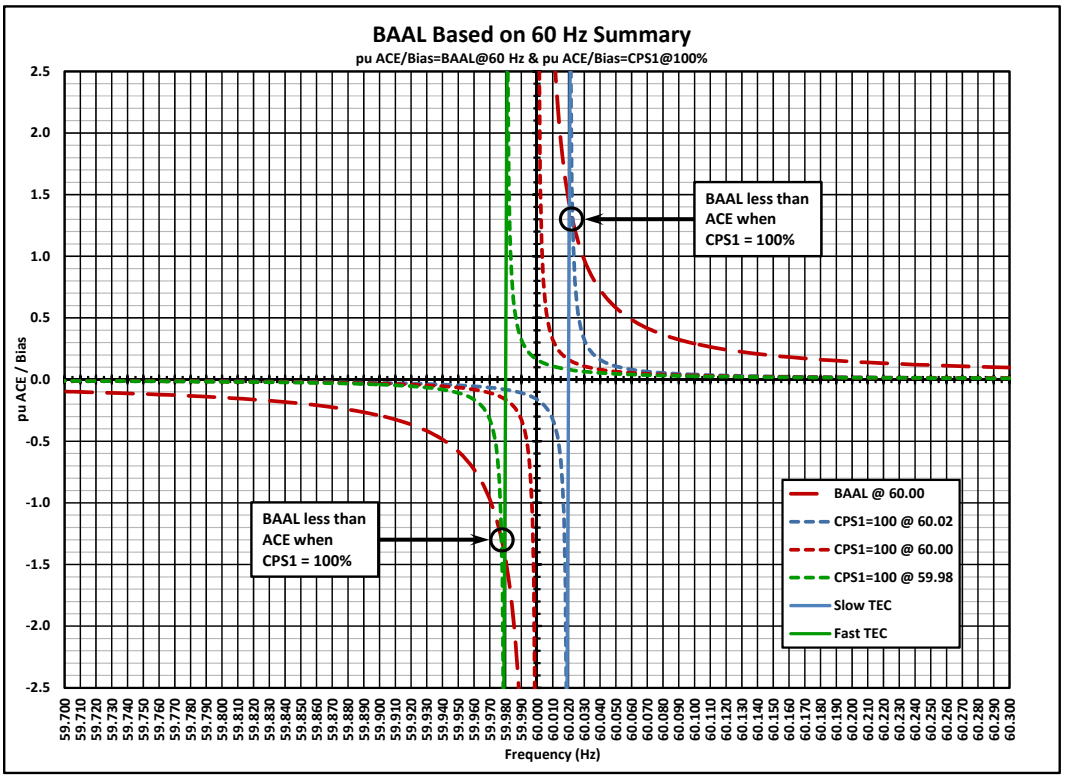

Figure 3. BAAL Based on 60 Hz Summary

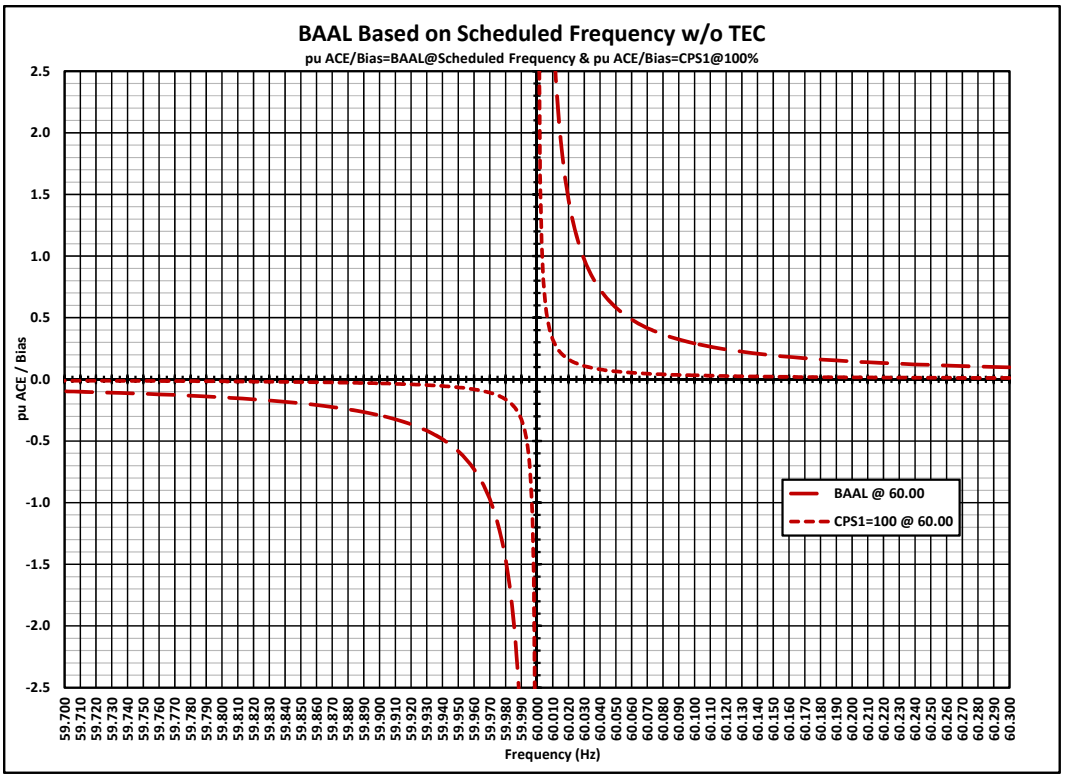

Figure 6. BAAL Based on Scheduled Frequency w/o TEC

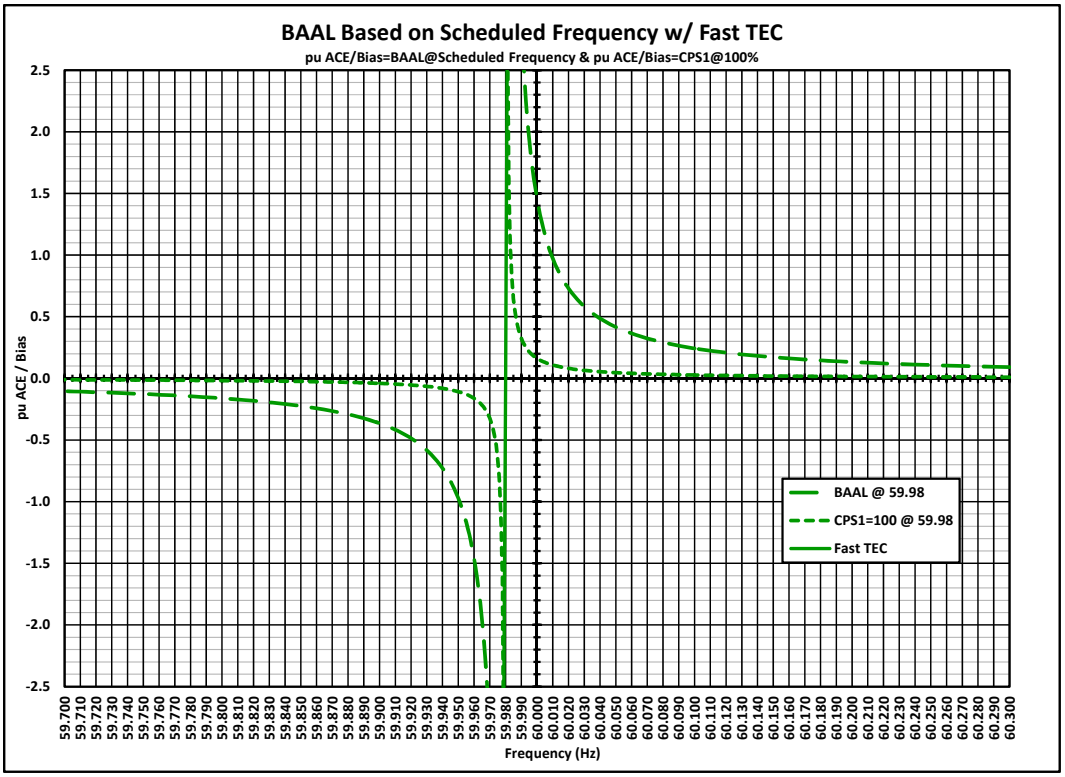

Figure 5. BAAL Based o Scheduled Frequency w/ Fast TEC

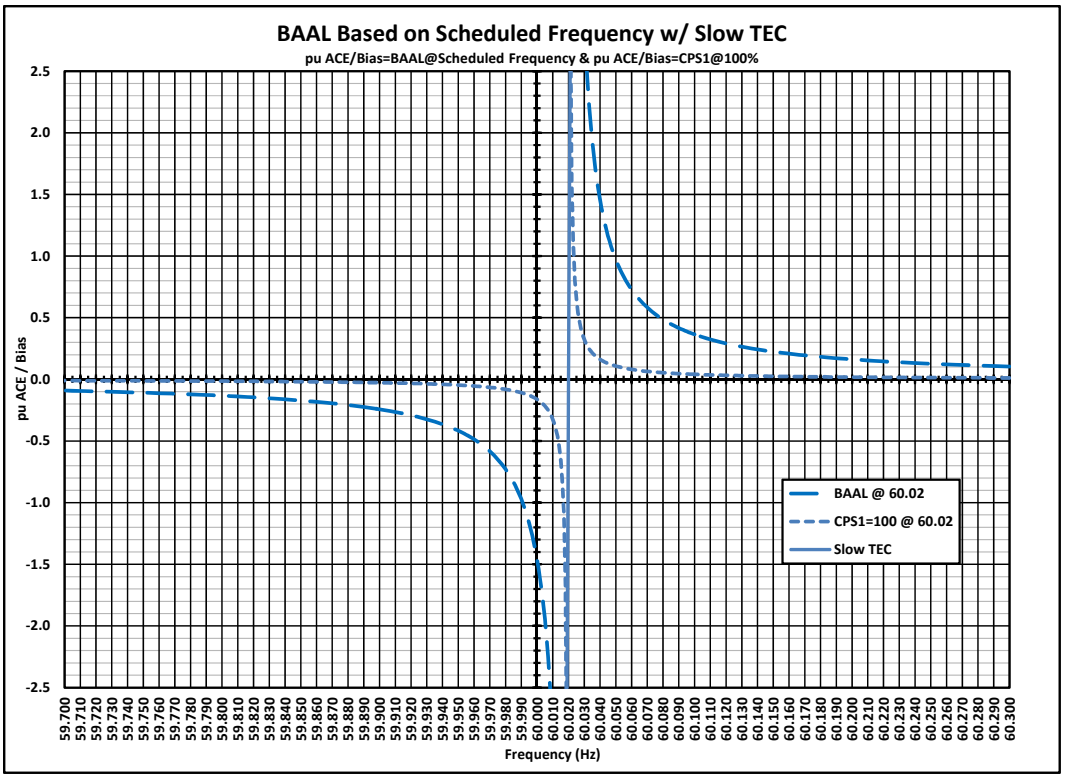

Figure 7. BAAL Based on Scheduled Frequency w/ Slow TEC

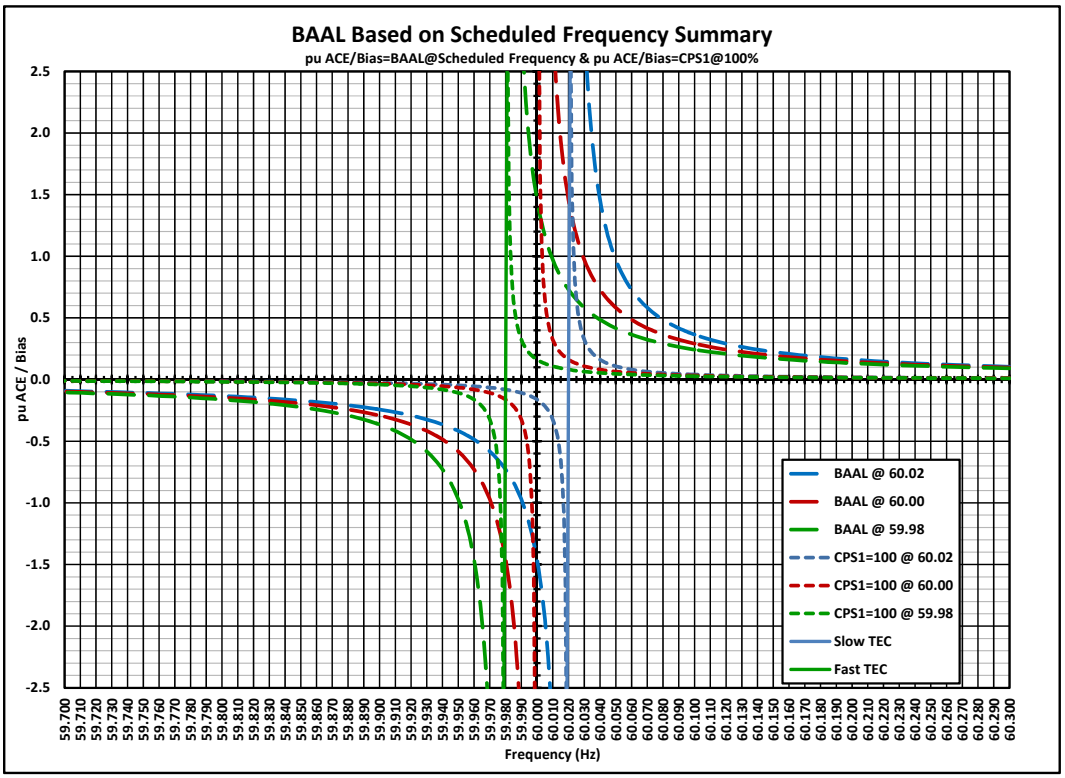

Figure 8. BAAL Based on Scheduled Frequency Summary