FIELD TRIAL TOOL INFORMATION (4/5/2016)

Below is a description of certain tools developed during the Field Trial of the Balancing Authority ACE Limit ("BAAL") which may be of use to Balancing Authorities in preparation for implementation of NERC BAL-001-2.

EXCEL WORKBOOK INFORMATION

The Excel workbooks provide clock-minute calculations of CPS1 and the BAAL under BAL-001-2. In all cases, files beginning with "E" are applicable to Balancing Authorities in the Eastern Interconnection and all files beginning with "W" are applicable to Balancing Authorities in the Western Interconnection. Please check the NERC website periodically for updated versions of the files and additional tools as they are made available. The Balancing Authority should only use the files designated for its Interconnection. Workbooks should be updated yearly as the Frequency Bias Setting changes.

Note that entry of the Interconnection Frequency Bias Setting is only needed to properly calculate the CPS2 bound. The calculation is included in some of the workbooks as another check for the Balance Authority ("BA") to verify that its Frequency Bias Setting is entered correctly (must be a negative value). The calculated CPS2 should exactly match the bound calculated by the NERC Resources Subcommittee for the applicable time period.

QUICK VIEW OF BOUNDS: The **EB** and **WB** workbooks display the CPS1 and BAAL bounds based upon the BA's Frequency Bias Setting and the total Frequency Bias Setting for that BA's Interconnection. The "Parameters" page allows entry of the BA acronym and Frequency Bias Setting (negative value). Tabs are provided for displaying the bounds for Scheduled Frequency at 59.98Hz, 60 Hz, and 60.02 Hz. Some variables in the workbook contain formulas specific to the Interconnection.

REAL-TIME MONITORING: The **E1W1 and E2W2** workbooks contain cells with formulas updated from an OSI PI DataLink server. To avoid errors in opening any of the workbooks for the first time, the workbooks are initially set up with the manual calculation option in Excel.

The Excel workbooks are protected (no password) to avoid inadvertent modification of protected cells. The "Parameters" tab is the only worksheet with unprotected cells to allow for entry of needed information for the Balancing Authority and Interconnection-specific information. In all cases the Frequency Trigger Limits are set at 3 times the Interconnection Epsilon1.

It is important to use the workbook that matches the method used to determine Scheduled Frequency: some systems store the Scheduled Frequency, other systems store a value representing the offset from 60 Hz during manual Time Error Correction (otherwise zero). If your system doesn't save either variable, modifications to the workbook might be needed to ensure that CPS1 and BAAL are properly calculated.

The workbooks are set up to gather scan-rate data and calculate clock-minute values. Consult with your company's specialist on PI to ensure that data is stored at intervals consistent with the scan rate of the EMS and other parameters are set so that the clock-minute averages of the data are consistent with the clock-minute averages used for NERC CPS1 compliance reporting. To the extent clock-minute data is already saved in PI or eDNA, the "Data" sheet can be modified to use that data rather than calculate clock-minute values with every workbook refresh.

Verification of accuracy: entry of a date and time in cell B1 of the "Parameters" tab, will allow for comparison of clock-minute data in the "Data" worksheet to the clock-minute data used to calculate and report monthly performance under NERC CPS1, in order to determine if the workbook will calculate real-time performance consistent with information that will be gathered and used after-the-fact for reporting performance.

The PC and Server date/time must be verified to ensure that the Excel "now()" function is acquiring real-time information. As mentioned above, to the extent that your PI server data has clock-minute values of ACE, Actual Frequency and Scheduled Frequency, the cells in the "DATA" tab can be revised for prior clock-minutes to use that data, rather than calculate clock-minute averages each time the workbook updates.

The workbooks E1W1 and E2W2 cannot be used by Balancing Authorities using a Variable Frequency Bias Setting – modification will be needed to appropriately reflect performance under CPS1 and BAAL.

AFTER-THE-FACT REVIEW: The **ED** and **WD** workbooks import data using OSI PI DataLink to allow for review of daily performance under BAL-001-2; however in reviewing compliance, it is important to note that any accumulation of consecutive clock-minutes of ACE exceeding the BAAL at midnight must carry into the following day. Note that it takes some time to import scan rate data and calculate clock-minute values for all minutes in a day, however there is value in having a convenient tool to use periodically as a quality check against data used for NERC compliance.

The workbooks are protected (no password) to avoid inadvertent modification of protected cells. The "Parameters" tab contains unprotected cells to allow for entry of needed information for the Balancing Authority and Interconnection-specific fields. Once set up, entry of the applicable day is the only entry needed.

The "Data" worksheet contains cells with formulas updated with scan-rate data from an OSI PI DataLink server. To avoid errors in opening any of the workbooks for the first time, the workbooks are initially set up with the manual calculation option in Excel. Along with a tab providing data for the date entered, another tab is provided in the ED and WD workbooks to allow the user to paste sequential days of data for longer-term review of performance. As the data quality codes AQC and FQC are not updated, the user should update the workbook to flag all erroneous clock-minutes - a clock-minute not included in current CPS1 reporting should not be included (unless flagged) in the data evaluated.

Properly formatted, EMS or other data can be used in the **EM** and **WM** workbooks to review CPS1 and BAAL performance under BAL-001-2. As with the daily workbooks, precaution should be taken to ensure that the count of consecutive clock-minutes of ACE exceeding the BAAL are carried over at midnight into the first day of the subsequent month, or any time multiple days are combined.

An example of the file is provided in the group of screenshots below. Some variables in the workbook contain formulas specific to the Interconnection. As an option to writing code to recreate the calculations needed under BAL-001-2, the workbook allows the user to input clock-minute data for the month and then copy formulas (to the right in the worksheet) which calculate the low and high BAAL bounds and increment the clock-minutes whenever ACE is outside the BAAL bounds.

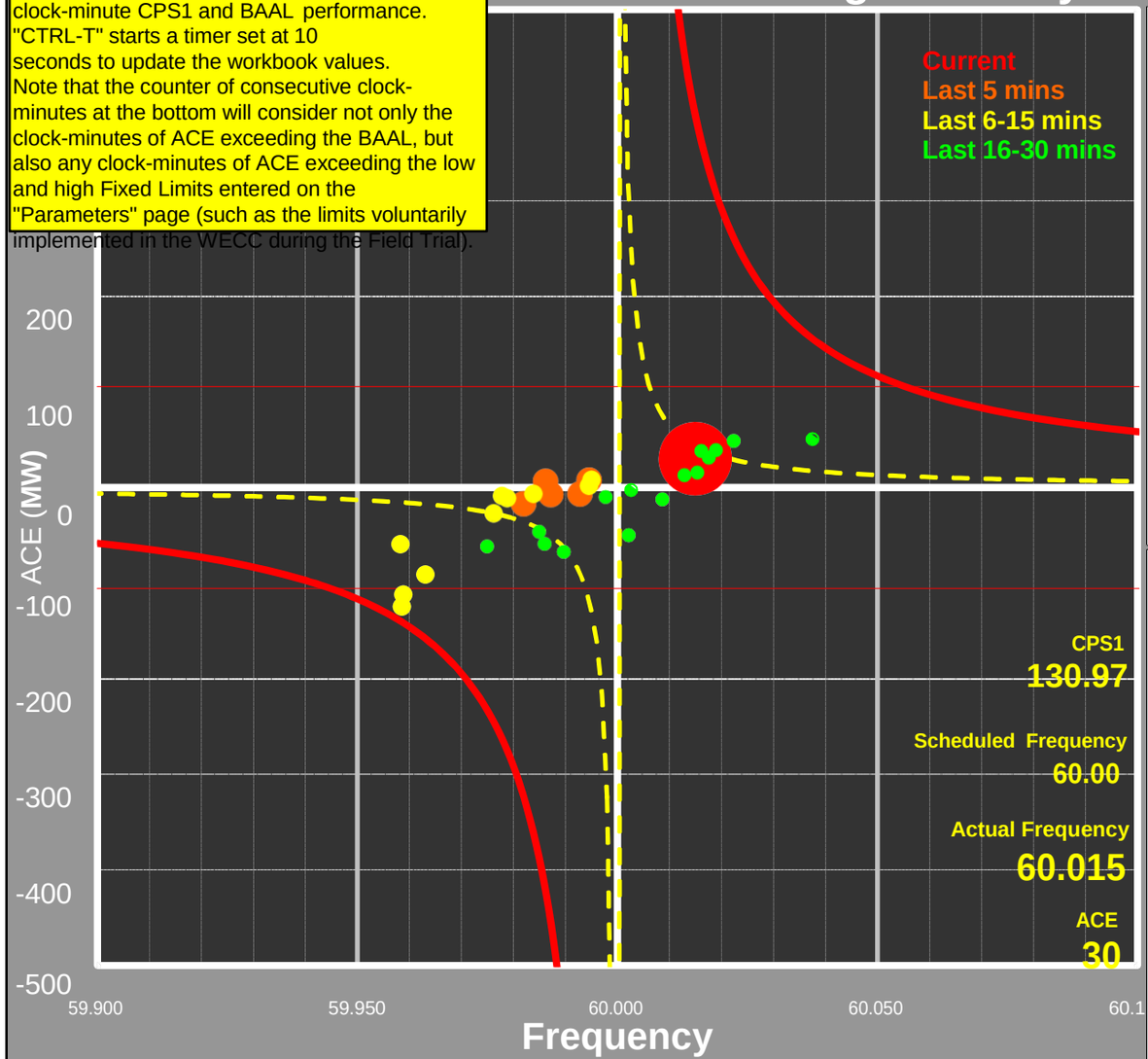
FINAL NOTE: Watch your math. Calculating *A* times *B* at the scan-rate and averaging it over the clock-minute will rarely yield the same result as the clock-minute value of *A* times the clock-minute value of *B*. The calculations of CPS1 and BAAL performance require use of clock-minute variables of actual frequency, scheduled frequency, and the Frequency Bias Setting. CPS1 and BAAL should not be calculated at the scan rate and then averaged over the clock-minute. In at least one case, comparison of the CPS1 calculations in the "ED" daily workbook to the CPS1 data from the BA's EMS revealed that the vendor was calculating CPS1 in real-time and averaging it over the clock-minute. Fortunately, the BA remained compliant to CPS1 after recalculating 12 months of CPS1 performance.

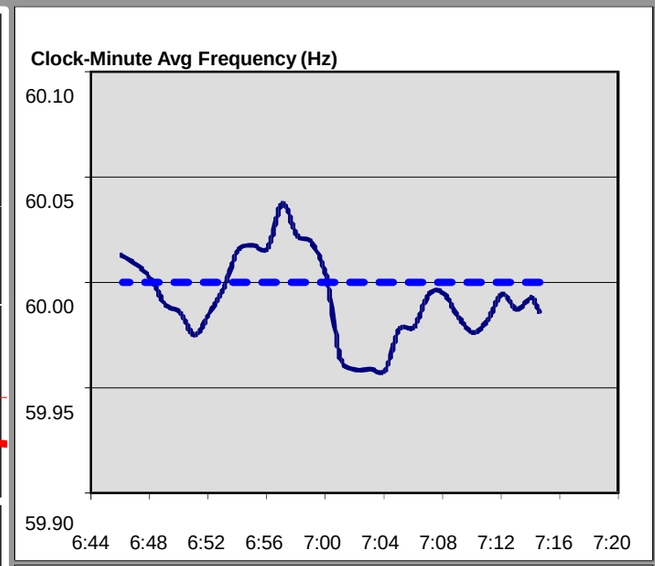
The E1W1 and E2W2 workbooks include a screen for monitoring the past 30 minutes of clock-minute CPS1 and BAAL performance. "CTRL-T" starts a timer set at 10 seconds to update the workbook values. Note that the counter of consecutive clock-minutes at the bottom will consider not only the clock-minutes of ACE exceeding the BAAL, but also any clock-minutes of ACE exceeding the low and high Fixed Limits entered on the "Parameters" page (such as the limits voluntarily implemented in the WECC during the Field Trial).

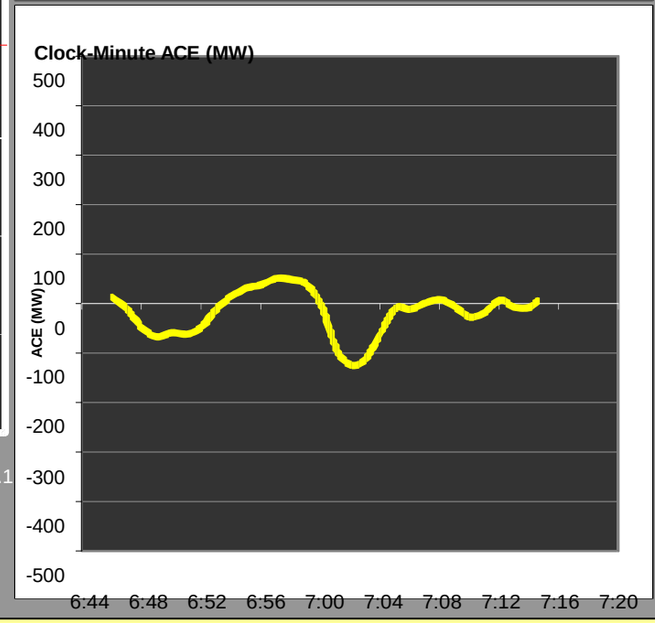
Balancing Authority ACE Limit RADAR

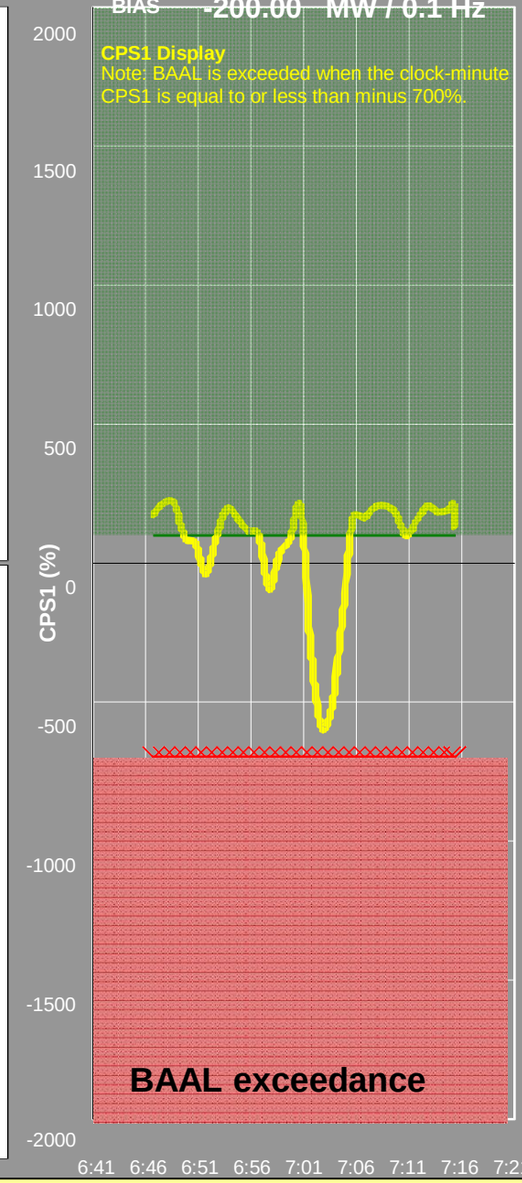
DUK 4/21/15 7:15

BIAS -200.00 MW / 0.1 Hz









NOTE: The bounds displayed above are based upon the current Scheduled Frequency. For any transition of Scheduled Frequency within the prior 30 minutes, the chart may not reflect graphically when the BAAL was exceeded prior to the transition, however the counter below will properly reflect the consecutive clock-minutes beyond BAAL.

Time	6:47	6:48	6:49	6:50	6:51	6:52	6:53	6:54	6:55	6:56	6:57	6:58	6:59	7:00	7:01	7:02	7:03	7:04	7:05	7:06	7:07	7:08	7:09	7:10	7:11	7:12	7:13	7:14	7:15	7:15:30
Consecutive Minutes Exceeding Limit(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CTRL-T to start timer
CTRL-S to stop timer

Balancing Authority ACE Limit RADAR

DUK 4/21/15 7:15

BIAS -200.00 MW / 0.1 Hz

The E1W1 and E2W2 workbooks include a screen for monitoring the past 30 minutes of clock-minute CPS1 and BAAL performance. "CTRL-T" starts a timer set at 10 seconds to update the workbook values.
Note that the counter of consecutive clock-minutes at the bottom will consider not only the clock-minutes of ACE exceeding the BAAL, but also any clock-minutes of ACE exceeding the low and high Fixed Limits entered on the "Parameters" page (such as the limits voluntarily implemented in the WECC during the Field Trial).

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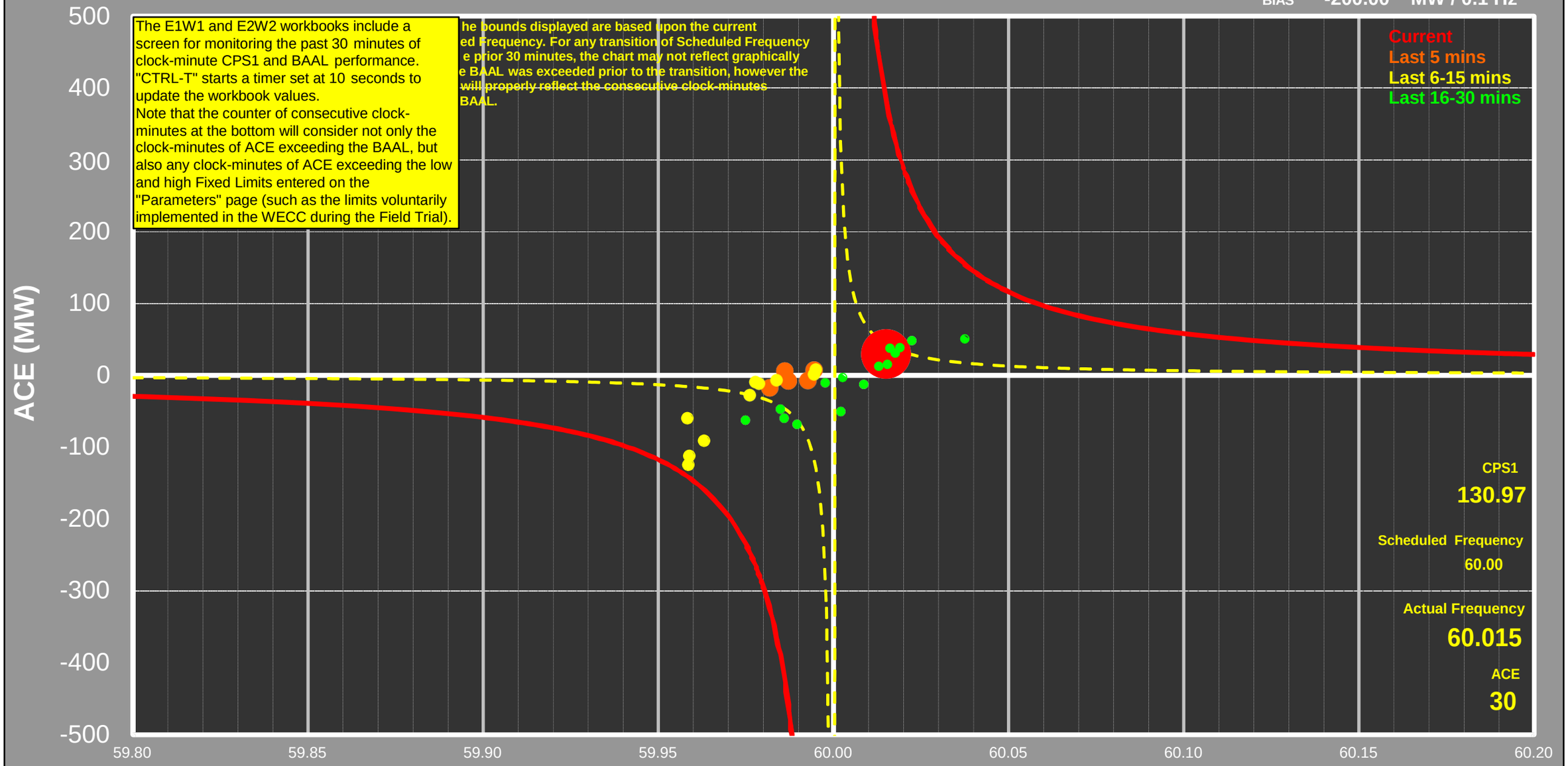

CTRL-T to start timer
CTRL-S to stop timer

Time	7:07	7:08	7:09	7:10	7:11	7:12	7:13	7:14	7:15	7:15:30
Consecutive Minutes Exceeding Limit(s)	0	0	0	0	0	0	0	0	0	0

6:47	6:48	6:49	6:50	6:51	6:52	6:53	6:54	6:55	6:56	6:57	6:58	6:59	7:00	7:01	7:02	7:03	7:04	7:05	7:06
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BA	DATE	TIME	TIMEZONE	ACE	FREQERR	FREQBIAS	ACTFREQ	SCHEDFREQ	AQC	FQC	BAALlow	MinCtLow	BAALhigh	MinCtHigh	CPS1
BA-05	7/1/2004	23:55	EST	-90.6876	-0.1	-311	59.9	60	0	0	**-90.69**	**0**		**0**	-700.0000
BA-05	7/1/2004	23:56	EST	-93.0129	-0.0975	-311	59.9025	60	0	0	**-93.01**	**0**		**0**	-700.0000
BA-05	7/1/2004	23:57	EST	-95.4606	-0.095	-311	59.905	60	0	0	**-95.46**	**0**		**0**	-700.0000
BA-05	7/1/2004	23:58	EST	-98.0406	-0.0925	-311	59.9075	60	0	0	**-98.04**	**0**		**0**	-700.0000
BA-05	7/1/2004	23:59	EST	-100.764	-0.09	-311	59.91	60	0	0	**-100.76**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:00	EST	-134.352	-0.0675	-311	59.9125	59.98	0	0	**-134.35**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:01	EST	-139.519	-0.065	-311	59.915	59.98	0	0	**-139.52**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:02	EST	302.292	0.03	-311	60.01	59.98	0	0		**0**	**302.3**	**0**	-700.0000
BA-05	7/2/2004	0:03	EST	362.75	0.025	-311	60.005	59.98	0	0		**0**	**362.8**	**0**	-700.0000
BA-05	7/2/2004	0:04	EST	-157.718	-0.0575	-311	59.9225	59.98	0	0	**-157.72**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:05	EST	-164.887	-0.055	-311	59.925	59.98	0	0	**-164.89**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:06	EST	-172.738	-0.0525	-311	59.9275	59.98	0	0	**-172.74**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:07	EST	-181.375	-0.05	-311	59.93	59.98	0	0	**-181.38**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:08	EST	-190.921	-0.0475	-311	59.9325	59.98	0	0	**-190.92**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:09	EST	-201.528	-0.045	-311	59.935	59.98	0	0	**-201.53**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:10	EST	-213.383	-0.0425	-311	59.9375	59.98	0	0	**-213.38**	**0**		**0**	-700.0000
BA-05	7/2/2004	0:11	EST	-226.719	-0.04	-311	59.94	59.98	0	0	**-226.72**	**0**		**0**	-700.0000

INSERT DATA FOR THESE FIELDS FOR ALL CLOCK-MINUTES FOR THE MONTH

COPY THESE CELLS DOWN FOR ALL CLOCK-MINUTES

As an option to writing code to recreate the calculations required under BAL-001-2, the user may be able to use one of the following:
The EM and WM workbooks allow the user to input clock-minute data for the month and then copy formulas (to the right in the worksheet) which calculate the low and high Balancing Authority ACE Limit (BAAL) bounds and increment the clock-minutes whenever ACE is outside the BAAL bounds.

Note that in assessing any compliance period, that any carryover of consecutive clock-minutes of BAAL being exceeded (such as at midnight into the following day) must be included in the evaluation.

Note that in the example above, the ACE is set exactly at the calculated bound for the Balancing Authority ACE Limit (BAAL) to demonstrate that the BAAL bound corresponds to a clock-minute CPS1 of minus 700% for the Eastern and Western Interconnections based upon the FTLs chosen.