Western Electricity Coordinating Council

NERC Reliability-Based Control Field Trial Draft Report

For the Western Interconnection

By WECC Performance Work Group
January 13, 2015

Approved by the WECC Operating Committee
March 25, 2015

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Background

The NERC Reliability-based Control (RBC) Field Trial (FT) in the Western Interconnection began on March 1, 2010. During the field trial, NERC waived compliance to BAL-001-01a Requirement R2 - Control Performance Standard 2(CPS2) for participating Balancing Authorities; however the requirement for participants to calculate and report CPS2 performance for informational purposes remains in effect.

The WECC Operating Committee delegated the responsibility for monitoring the field trial and reporting on its impact to the Western Interconnection to the Performance Work Group (PWG). Participating BAs were required to develop a method for calculating and monitoring the BA ACE Limit (BAAL). BAs were encouraged, but not required, to modify their AGC system control algorithms to respond to BAAL.

Appendix A contains a list of Balancing Authorities along with the date that they became involved in the field trial. Initially, 21 BAs joined the field trial. Currently, 27 BAs participate in the field trial and represent approximately 90% of the load in Western Interconnection.

ACE Transmission Limit

Since the Balancing Authority ACE Limit (BAAL) approaches infinity when frequency is at 60 Hz, the WECC field trial participants established an ACE Transmission Limit (ATL) to cap the BAAL at various levels during the field trial to limit its effect on transmission flows. The field trial began with an ATL of two times L_{10} on March 1, 2010. On November 1, 2010, the field trial participants changed the ATL to 4 times L_{10}. Upon recommendation of the Performance Work Group (PWG), the participants effectively removed the ATL limit by changing it to 100 times L_{10} on April 1, 2011. The participants changed the ATL limit back to 4 times L_{10} on March 1, 2013.

Field Trial Evaluation Criteria

The PWG established that the following criteria should be monitored for evaluation of the field trial:

1. Frequency error
2. Manual time error corrections
3. Accumulated inadvertent interchange
4. Transmission issues
5. USF events
6. Control Performance Standard scores

1. Frequency Error

a. Clock-Hour Frequency error

Figures 1.1 through 1.4 below show the Western Interconnection quarterly clock-hour frequency error from 2009 through 2013 and allow for direct comparison of same quarter data for each of the years.

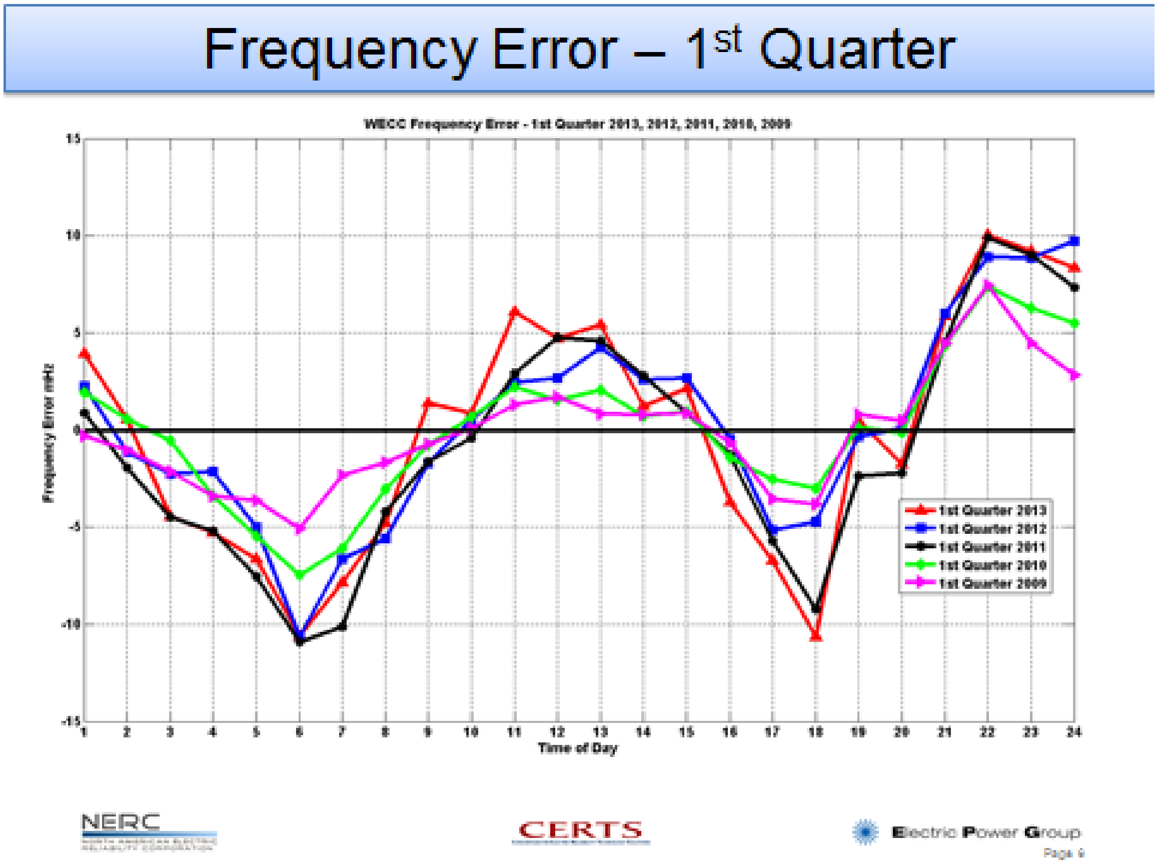
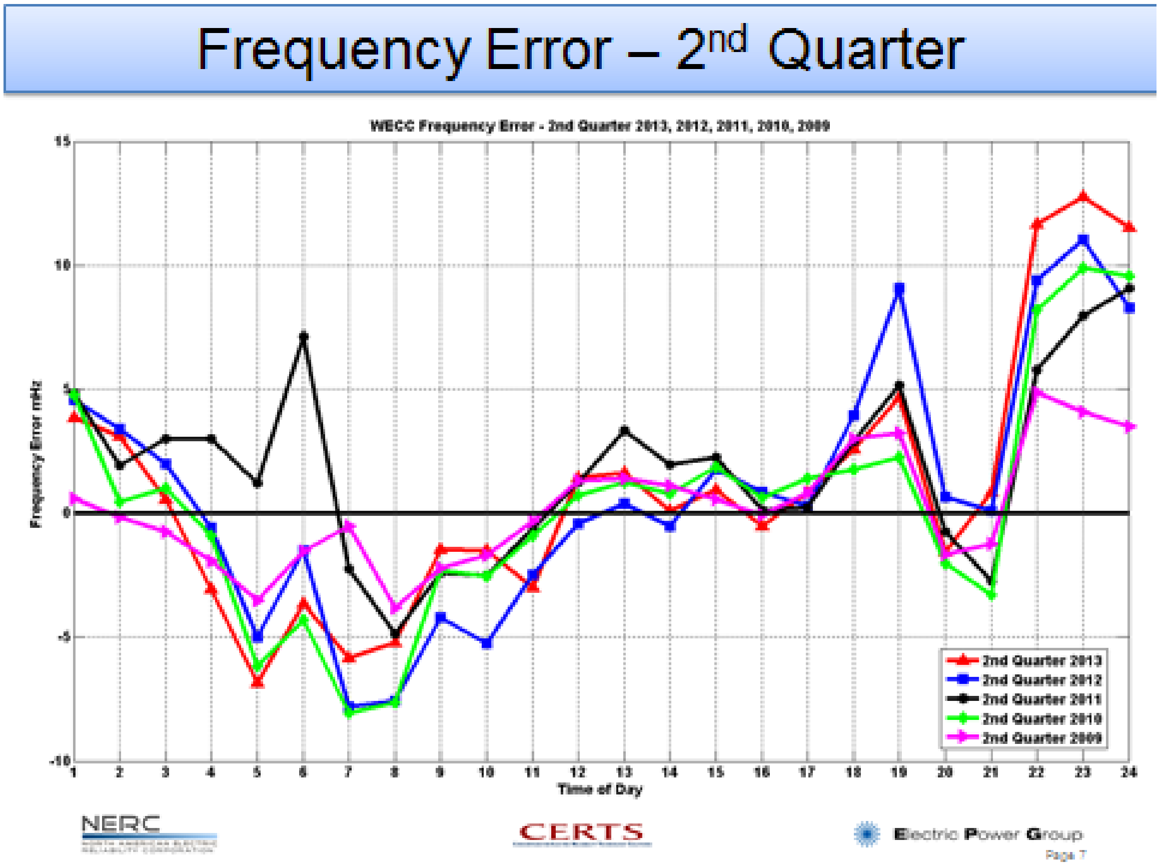


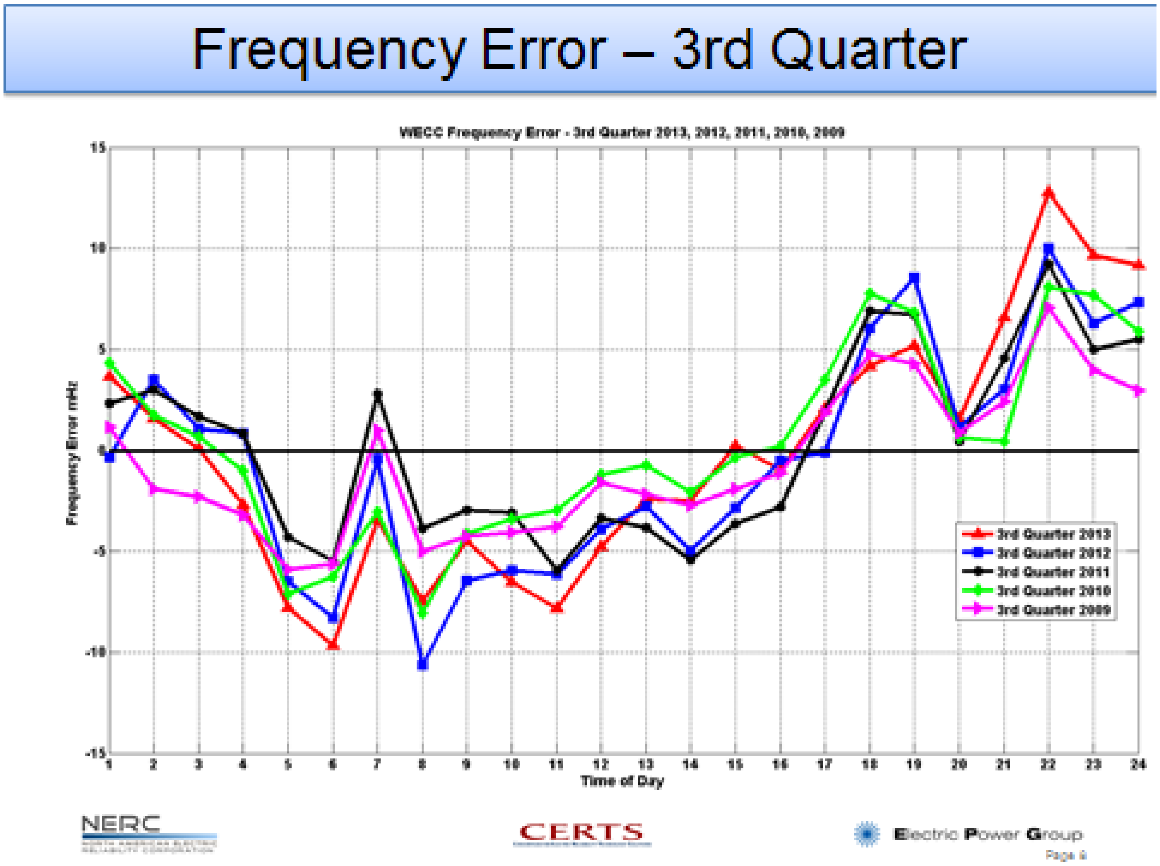
Figure 1.1

Figure 1.1 above shows a general increase in frequency error for most 1st quarter clock hours from 2009 through 2013.



<u>Figure 1.2</u>

Figure 1.2 above shows a general increase in frequency error for most 2nd quarter clock hours from 2009 through 2013.



<u>Figure 1.3</u>

Figure 1.1 above shows a general increase in frequency error for most 3rd quarter clock hours from 2009 through 2013.

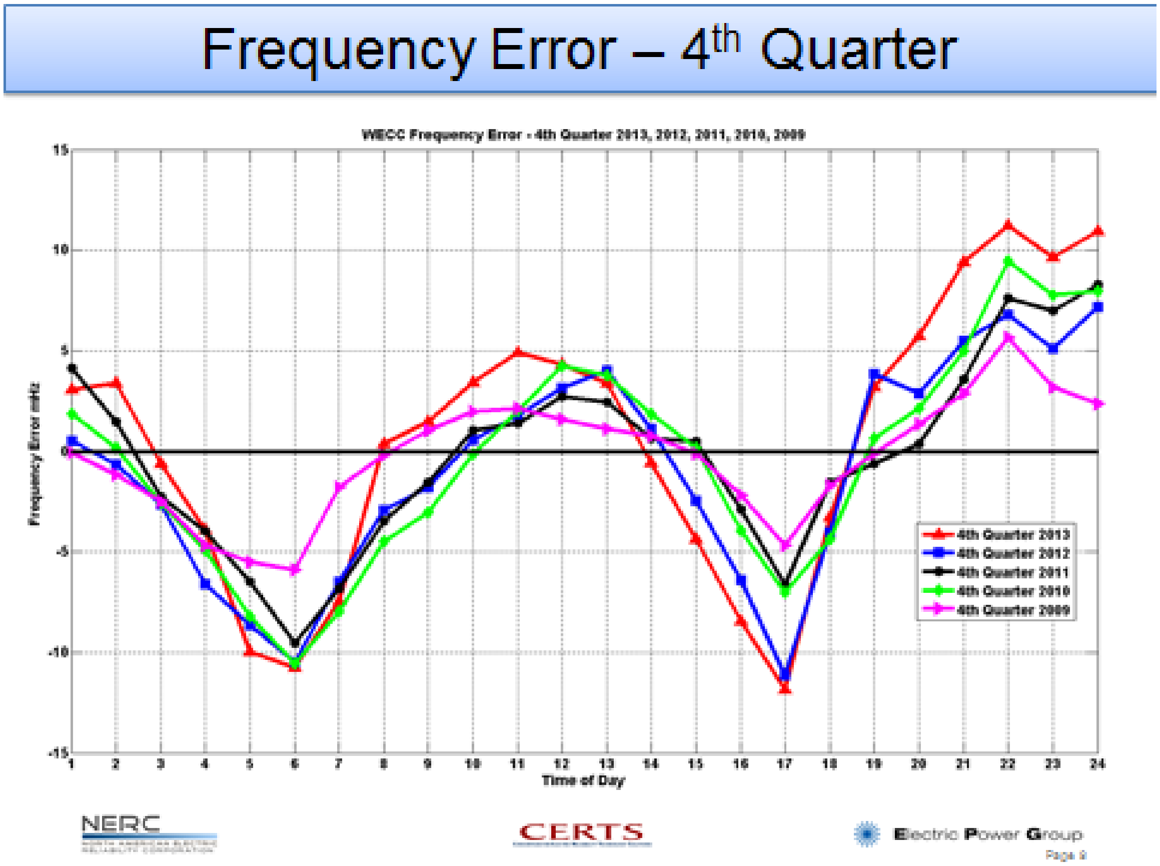


Figure 1.4

Figure 1.4 above shows a general increase in frequency error for most 4th quarter clock hours from 2009 through 2013.

b. 1-min, 10-min and 60-min Frequency Error Averages

Figures 1.5 through 1.9 below show the 1-minute, 10-minute and 60-minute Western Interconnection frequency errors for years 2009 through 2013. The straight horizontal blue, green and red lines in the chart are the Epsilon 1, 10 and 60 target frequency error limits, respectively, and are provided for reference purposes. See section **c.** for a description of Epsilon 1 and Epsilon 10 frequency error targets.

The figures show that frequency error has approximately doubled as follows:

- 1-minute frequency error increased from 10 mHZ to 18 mHZ currently
- 10-minute frequency error increased from 8 mHZ to 15 mHZ currently
- 60-minute frequency error increased from 5 mHz to 11 mHz currently

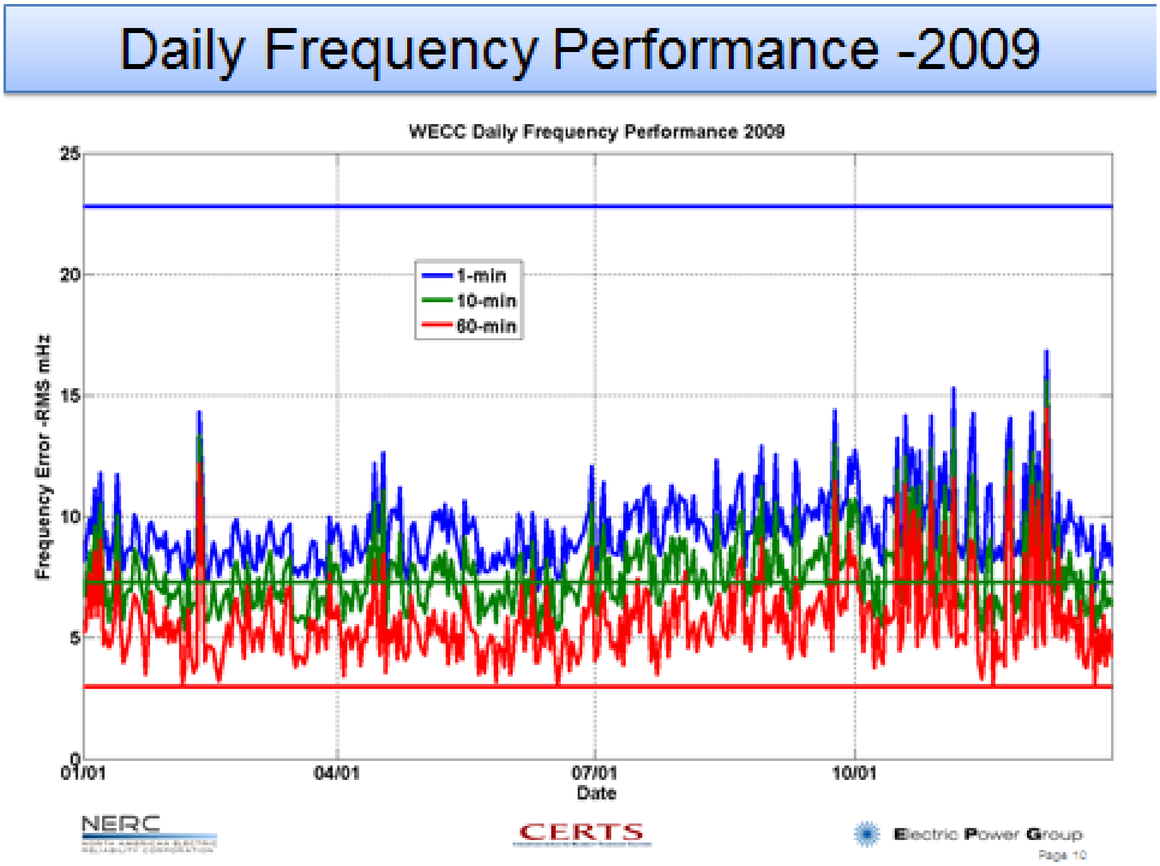


Figure 1.5

Figure 1.5 above shows that the 2009 60-min and 1 min frequency error averages are 5 mHz and 10 mHz, respectively.

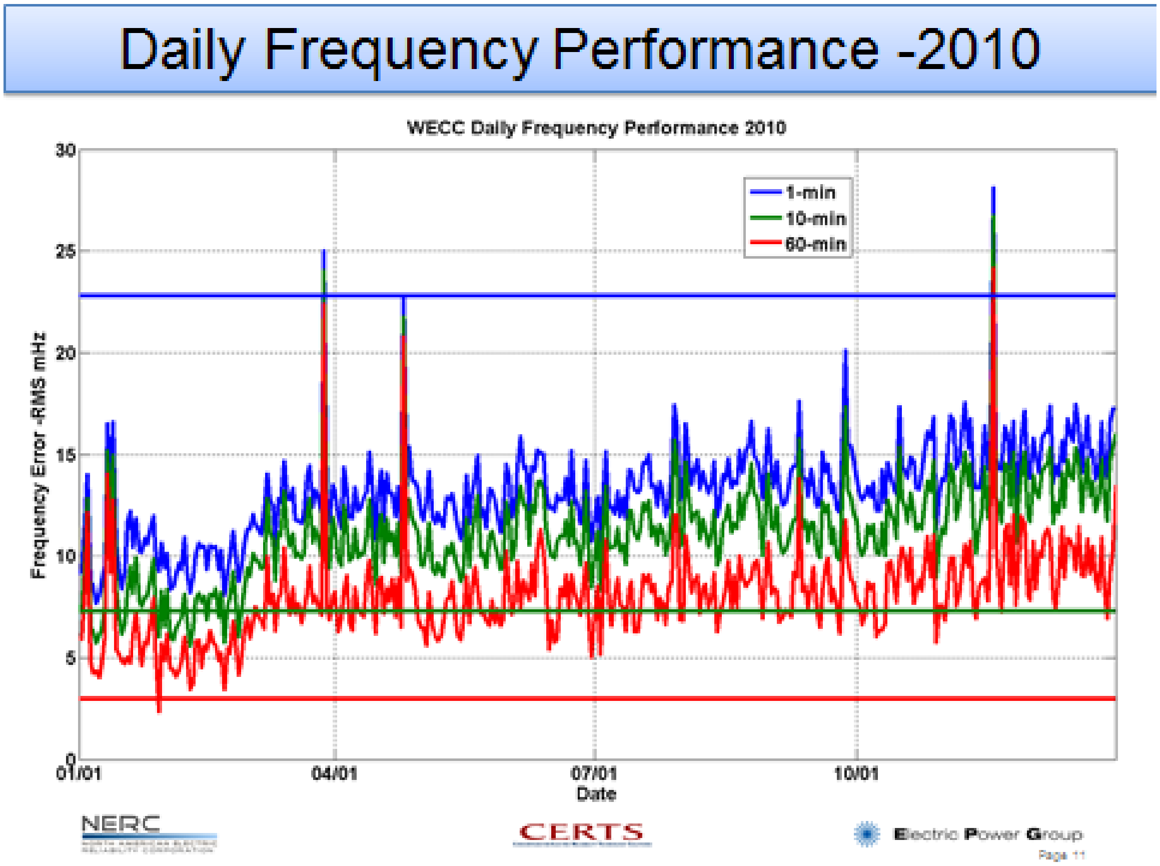


Figure 1.6

Figure 1.6 above shows that the 2010 60-min and 1-min frequency error averages are 8 mHz and 14 mHz, respectively. The figure also shows an increase in frequency error immediately after the March 1st start date of the RBC field trial.

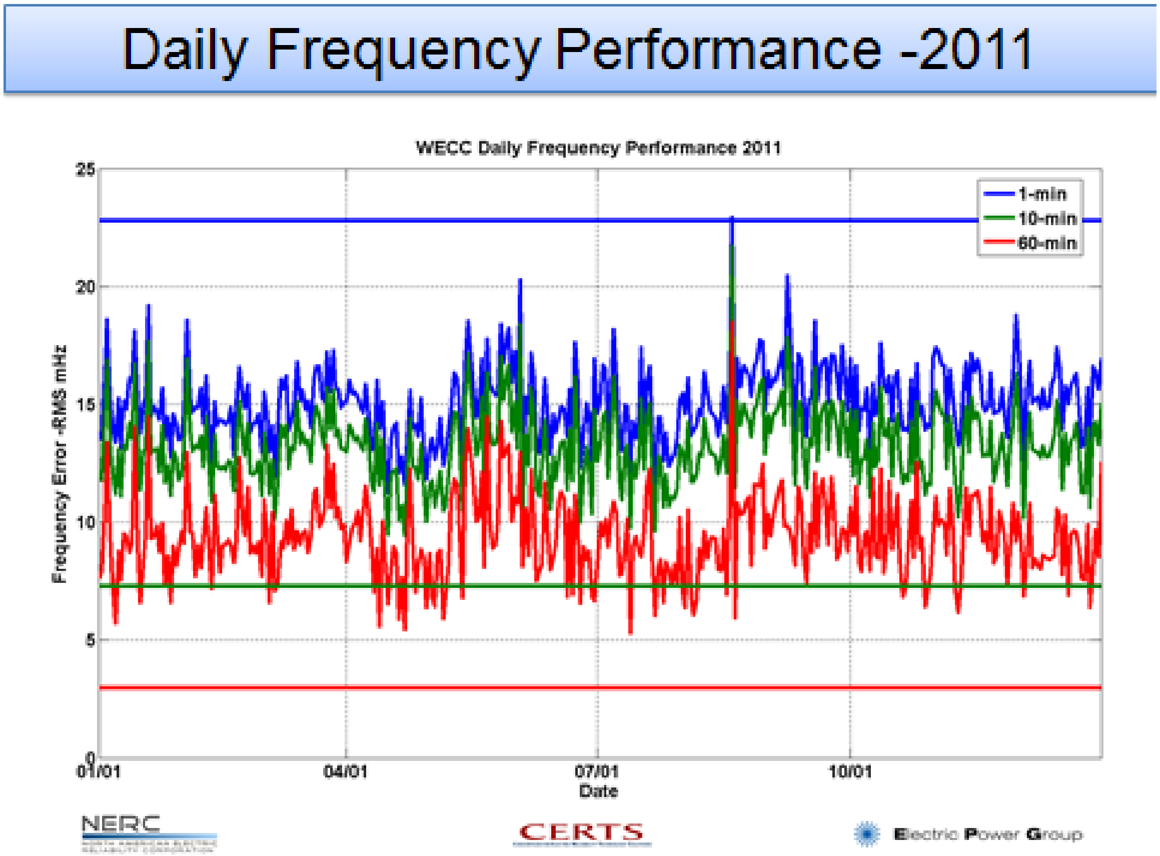


Figure 1.7

Figure 1.7 above shows that the 2011 60-min and 1-min frequency error averages are 10 mHz and 15 mHz, respectively.

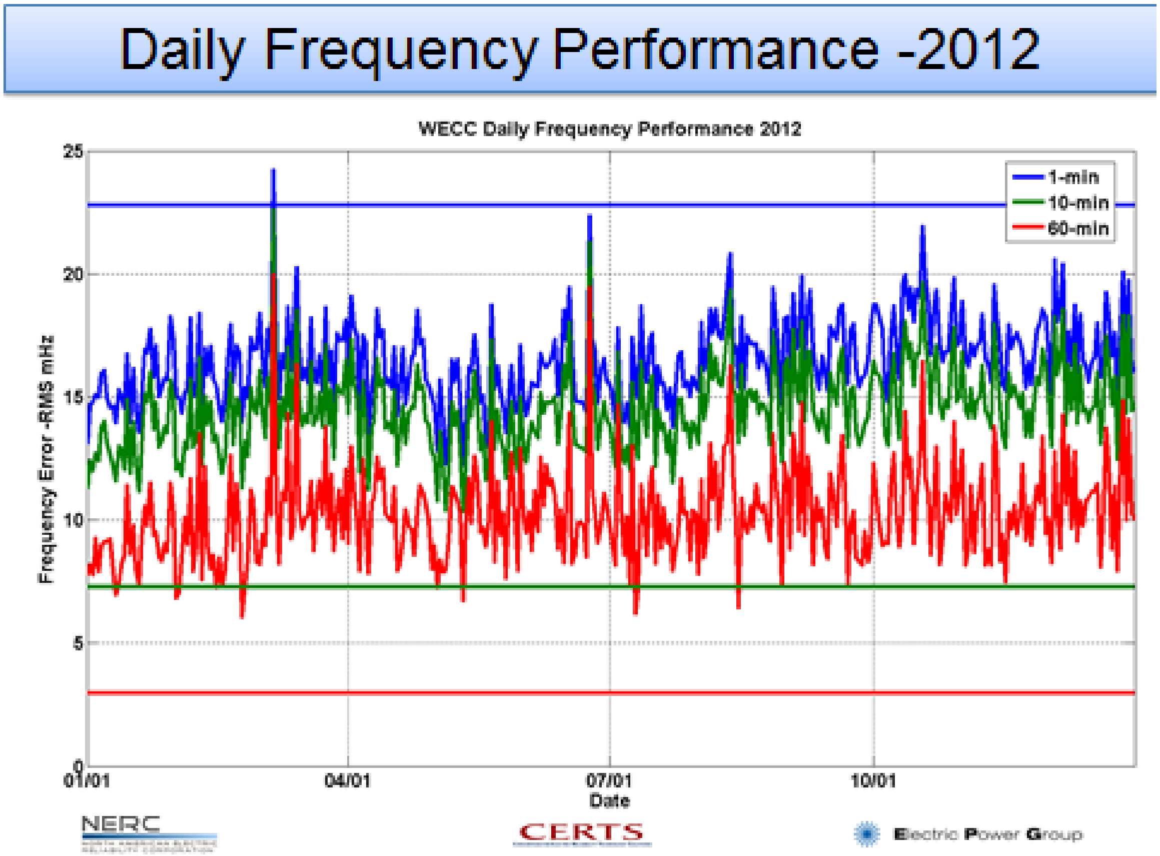


Figure 1.8

Figure 1.8 above shows that the 2012 60-min and 1-min frequency error averages are 10 mHz and 17 mHz, respectively.

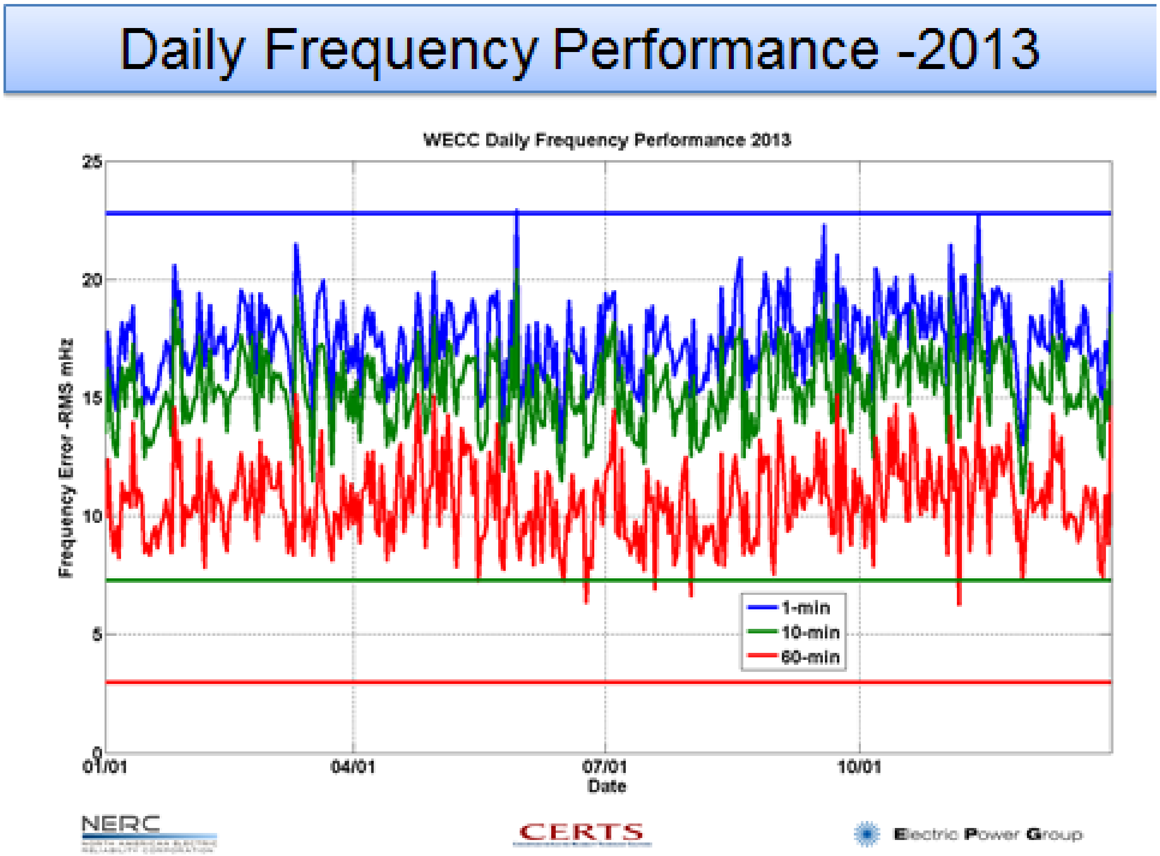


Figure 1.9

Figure 1.9 above shows that the 2013 60-min and 1-min frequency error averages are 11 mHz and 18 mHz, respectively.

c. Frequency Error Profile

Figure 1.10 below compares the Western Interconnection frequency error for all time intervals up to 60-minute with the corresponding epsilon target profile for years 2009 through March 31, 2014. This figure shows that the largest frequency error increase was between 2009 and 2010 when the field trial began. It also shows that frequency error has not increased much from 2012 to present. The WECC Epsilon Target Profile is provided for reference purposes. Two points on the curve represent Epsilon 1 and Epsilon 10, values that were derived from pre-1997 Western Interconnection frequency error performance data to be used for the CPS1 and CPS2 measurements.

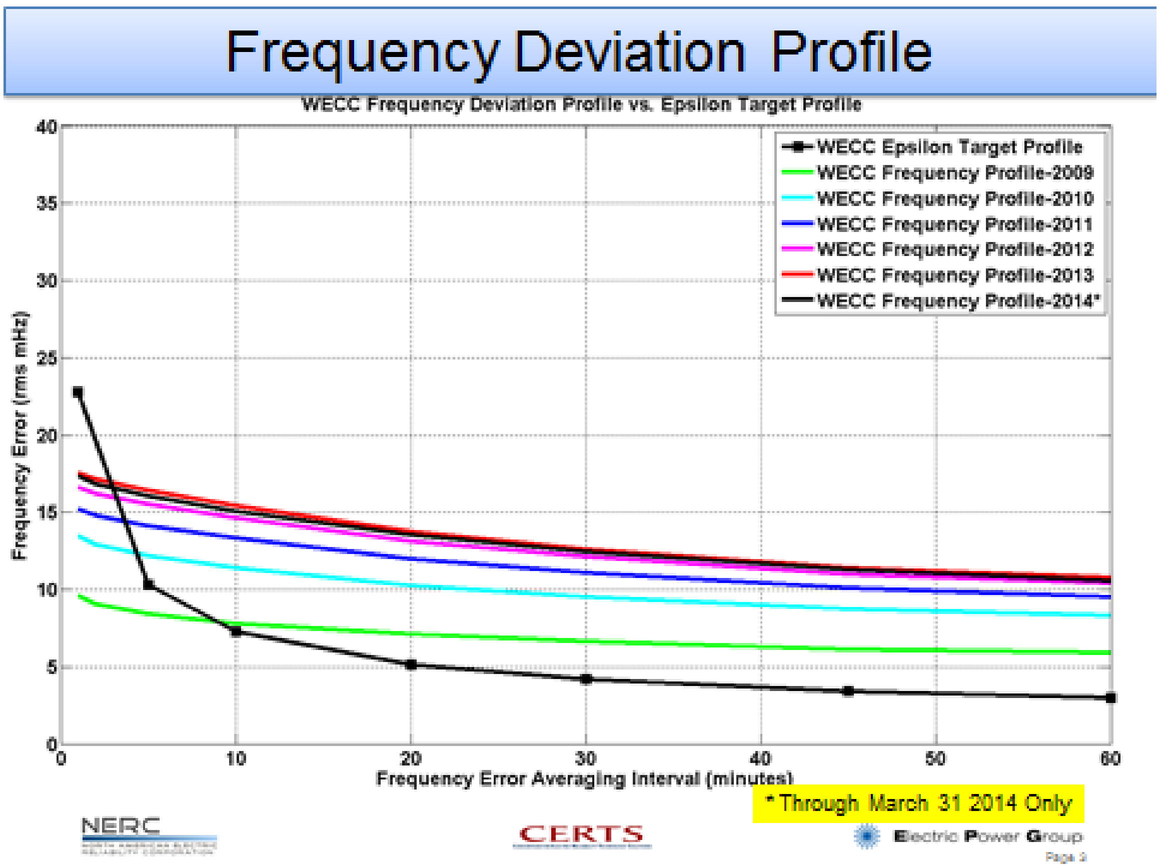


Figure 1.10

d. 1-min and 10-min Frequency Error Averages

Figures 1.11 through 1.12 below show the 1-min and 10-min frequency error for years 2009 through March 31, 2014. Figure 1.11 shows that the 1-min frequency error has approximately doubled since the field trial began. Figure 1.12 shows that the 10-min frequency error has approximately doubled since the field trial began.. The figures also show that frequency error has not increased much from 2012 to present. The general consensus is that the reliability of the interconnection decreases as frequency error increases.

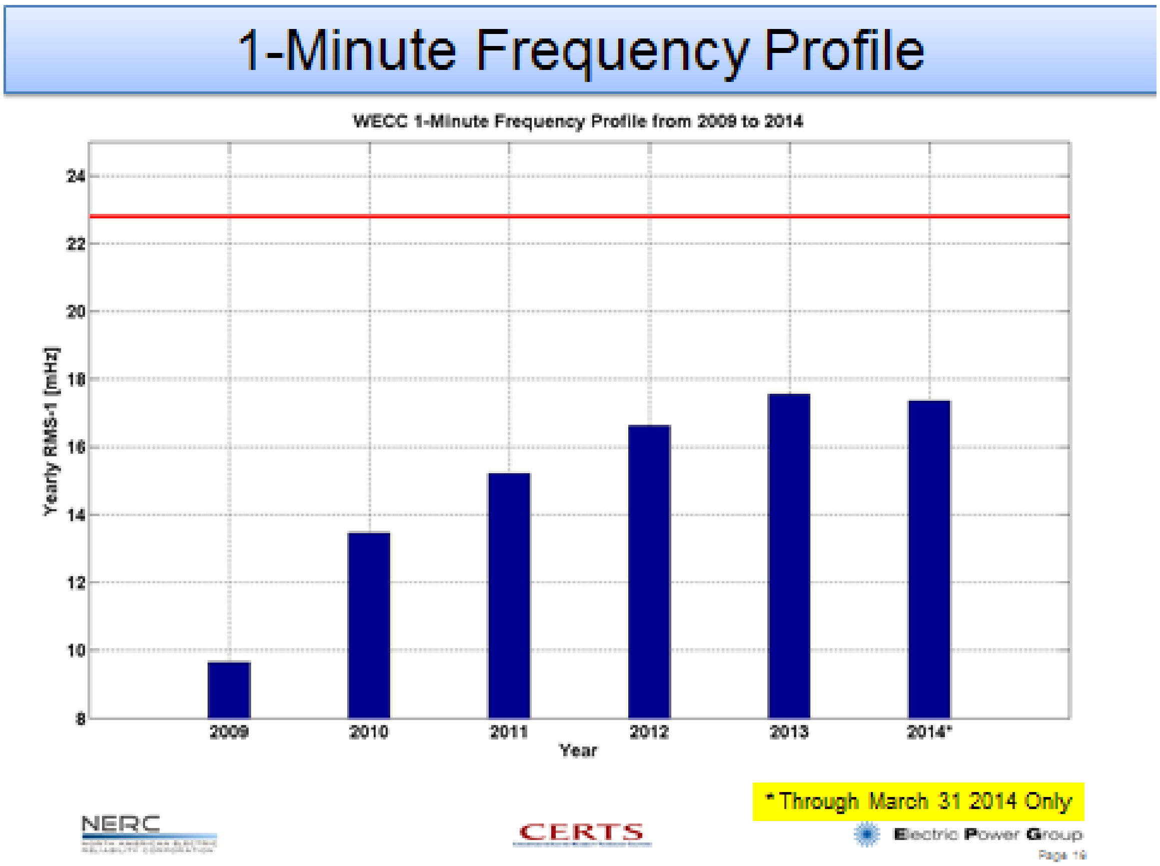


Figure 1.11

Figure 1.11 only includes the frequency error for the first quarter of 2014.

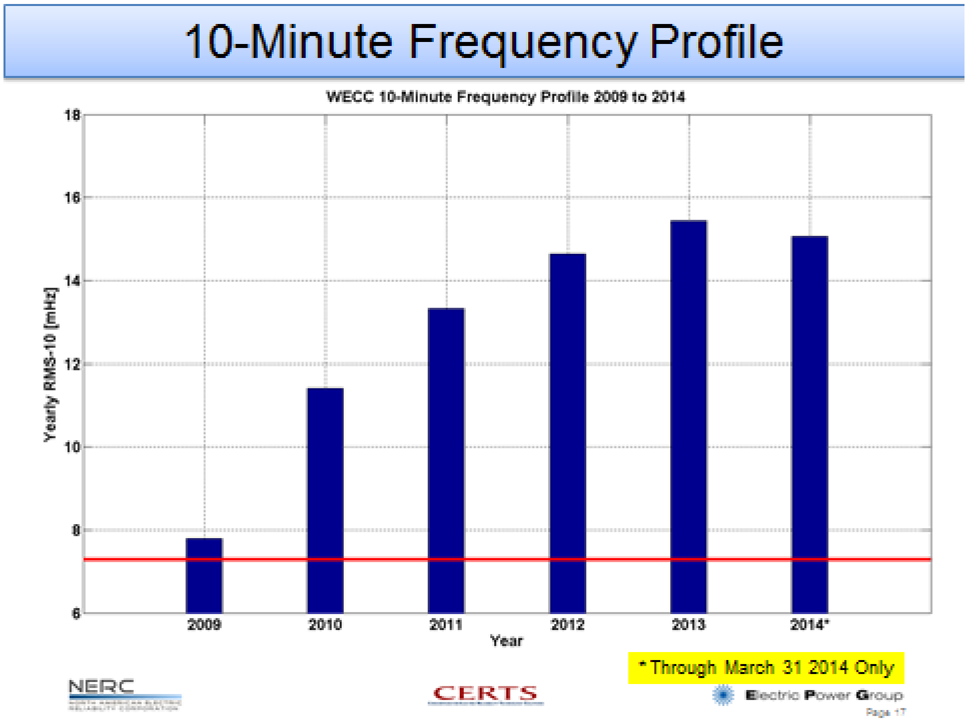


Figure 1.12

Figure 1.12 only includes the frequency error for the first quarter of 2014.

2. Manual Time Error Corrections

For manual time error corrections for each year from 2006 through 2013, Table 2.1 below lists the number, total hours, average duration and total time corrected. All measures of manual time error corrections increased dramatically in the second year of the field trial. Because all measures in 2010 were commensurate with previous years (2009 being somewhat anomalous), the increases in 2011 seems to correlate with the increase in active participation in the field trial. Also, on April 1,2011, the ATL was increased to 100 times L_{10}, then decreased back to 4 times L_{10} on March 1, 2013; this is coincident with the increase in the number of seconds of time corrected during 2011 and 2012. The 2013 data indicates a decrease in the effectiveness of manual time error corrections since a comparable amount of time was spent in corrections but fewer seconds were corrected. This anomaly coincides with the decrease in the ATL from 100 times L_{10} to 4 times L_{10} but its relationship is counter intuitive.

Year	Number of Corrections			Hours of Correction			Average Duration (Hrs)			Time Corrected
	Total	Fast	Slow	Total	Fast	Slow	Total	Fast	Slow	Seconds
2006	100	69	31	582	409	172	5.8	5.9	5.5	560
2007	106	72	34	586	402	184	5.5	5.6	5.4	568
2008	113	62	51	693	360	332	6.1	5.8	6.5	616
2009	74	33	41	424	174	236	5.7	5.3	5.8	407
2010	106	51	55	608	308	300	5.7	6.0	5.5	673
2011	160	88	72	1037	585	451	6.5	6.7	6.3	1011
2012	173	88	85	1108	548	561	6.4	6.2	6.6	1069
2013	178	98	80	1053	612	441	5.9	6.2	5.5	471
2014 Q1	36	12	24	207	64	143	5.7	5.3	6.0	221

Table 2.1

Table 2.2 below compares the average manual time error correction measures for the years 2006 through 2010 to those for the years 2011 through 2013.

Time Error Correction Measure	2006 – 2010	2011 - 2013
Number per Year	100	170

Total Hours	579	1066
Hours per Correction	5.8	6.3
Total Seconds Corrected	441	850

Table 2.2

3. NERC Inadvertent Interchange

Figure 3.1 below shows the absolute value of accumulated NERC Inadvertent Interchange (II) for all BAs in the Western Interconnection and for the field trial participants from the effective date of the ATEC standard (BAL-004-WECC-001 – July 1, 2009) through the end of March 2014. Several known EMS errors and other significant unknown control problems, which have been identified and corrected, make it difficult to relate NERC II accumulations with RBC. Recently, WECC advised some BA's to manage their Primary II accumulation in preparation for the new BAL-004-WECC-02 requirement that limits the end of month Primary II accumulations to 150 percent of peak load or generation. The decrease in the NERC II values can be attributed to the upcoming implementation of the standard.

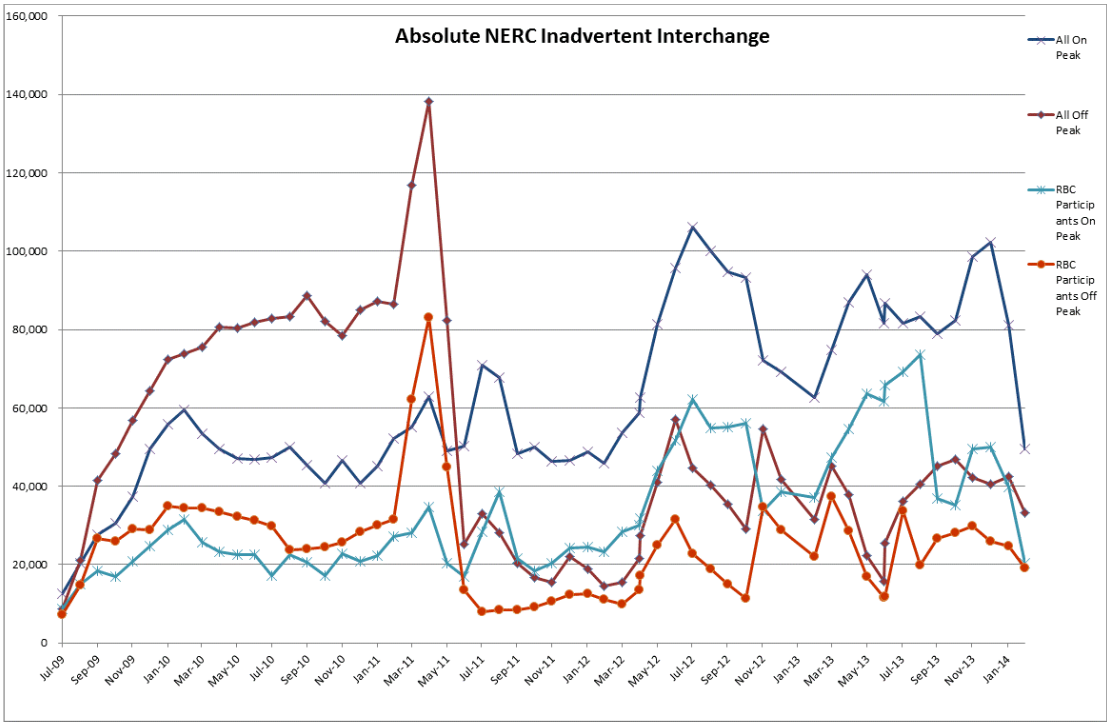


Figure 3.1

4. Transmission Issues

The PWG analyzed 19 SOL exceedance events that occurred between March 2013 and April 2014. Appendix B contains a brief description of the SOL event analysis methodology and its associated analysis criteria. The PWG defined the set of SOL event **Cause** and **Mitigation** categories that are explained in the bullet lists below. Then the PWG assigned one or more causes and mitigations to each event based on the analysis criteria data along with information contained in the Reliability Coordinator's SOL Exceedance report.

Cause Categories:

- **Schedule Increase** – SOL exceedance caused by re-dispatch of generation resources resulting from an increase in scheduled path use. The increase in scheduled use during the SOL exceedance period when added to the actual flow prior to the SOL exceedance period exceeds the path SOL.
- **High ACE** – SOL exceedance caused by BA ACE contribution to unscheduled flow on the path. The ACE contribution to unscheduled flow when added to the scheduled use exceeds the path SOL.
- **High Unscheduled Flow** – SOL exceedance caused by unscheduled flow on the path. The unscheduled flow excluding the ACE contribution component when added to the scheduled use exceeds the path SOL.
- **High Unscheduled Flow & ACE** – SOL exceedance caused by a combination of unscheduled flow and BA ACE contribution to unscheduled flow on the path. The unscheduled flow including the ACE contribution component when added to the scheduled use exceeds the path SOL.
- **Unplanned Path De-rate** – SOL exceedance caused by unplanned de-rate of path SOL. The path SOL suddenly decreased to a value less than the actual flow due to loss of a BES component such as a transmission element or generating unit.
- **Phase Shifter Mis-operation** – SOL exceedance caused by phase shifting transformer tap position changes that increased actual path flow to a value greater than its SOL. The event analysis tool presents graphical evidence of phase shifting transformer tap position changes that increased unscheduled flow.

Mitigation Categories:

- **Schedule Reduction** – SOL exceedance mitigated by re-dispatch of generation resources resulting from a reduction in scheduled path use. The decrease in the scheduled use after the SOL exceedance period is greater than the SOL exceedance amount.
- **ACE Reduction** – SOL exceedance mitigated by re-dispatch of generation that reduced BA ACE. The decrease in the ACE contribution to unscheduled flow after the SOL exceedance period is greater than the SOL exceedance amount.
- **Phase Shifter Operation** – SOL exceedance mitigated by phase shifting transformer tap position changes. The event analysis tool presents graphical evidence of phase shifting transformer tap position changes that reduce unscheduled flow.
- **L_{10} Request–** SOL exceedance mitigated by re-dispatch of generation resources resulting from the RC requesting a BA to reduce its ACE to less than its L_{10}.
- **Path Re-rate** – SOL exceedance mitigated by an increase in the path SOL to a value greater than its actual flow.

The two tables below show the number of SOL events that are assigned to each cause and mitigation category. A single SOL event may be assigned to more than one cause or mitigation category.

Cause Results

	Schedule Increase	High ACE	High Unscheduled Flow	High Unscheduled Flow & ACE	Unplanned Path De-rate	Phase Shifter Mis-operation
# Events	1	4	8	1	5	1

Mitigation Results

	Schedule Reduction	ACE Reduction	Phase Shifter Operation	L_{10} Request	Path Re-rate
# Events	2	11	9	5	2

5. Unscheduled Flow Events

The Unscheduled Flow Event Analysis Task Force analyzed 28 path 66 (COI) USF events that occurred between March 2012 and April 2013, in addition to 4 path 36 (TOT3) and 8 path 30 (TOT1A) USF events that occurred between January and November of 2013. Appendix C contains a brief description of the USF event analysis methodology and its associated analysis criteria. The PWG defined the set of USF event **Cause** and **Mitigation** categories that are explained in the bullet lists below. Then the PWG assigned one or more causes and mitigations to each USF event based on the analysis criteria data.

Cause Categories:

- **Schedule Increase** – SOL exceedance caused by re-dispatch of generation resources resulting from an increase in scheduled path use. The increase in scheduled use during the SOL exceedance period when added to the actual flow prior to the SOL exceedance period exceeds the path SOL.
- **High ACE** – SOL exceedance caused by BA ACE contribution to unscheduled flow on the path. The ACE contribution to unscheduled flow when added to the scheduled use exceeds the path SOL.
- **High Unscheduled Flow** – SOL exceedance caused by unscheduled flow on the path. The unscheduled flow excluding the ACE contribution component when added to the scheduled use exceeds the path SOL.
- **High Unscheduled Flow & ACE** – SOL exceedance caused by a combination of unscheduled flow and BA ACE contribution to unscheduled flow on the path. The unscheduled flow including the ACE contribution component when added to the scheduled use exceeds the path SOL.
- **Unplanned Path De-rate** – SOL exceedance caused by unplanned de-rate of path SOL. The path SOL suddenly decreased to a value less than the actual flow due to loss of a BES component such as a transmission element or generating unit.

Mitigation Categories:

- **Schedule Reduction** – SOL exceedance mitigated by re-dispatch of generation resources resulting from a reduction in scheduled path use. The decrease in the scheduled use after the SOL exceedance period is greater than the SOL exceedance amount.
- **ACE Reduction** – SOL exceedance mitigated by re-dispatch of generation that reduced BA ACE. The decrease in the ACE contribution to unscheduled flow after the SOL exceedance period is greater than the SOL exceedance amount.
- **Phase Shifter Operation** – SOL exceedance mitigated by phase shifting transformer tap position changes. The event analysis tool presents graphical evidence of phase shifting transformer tap position changes that reduce unscheduled flow.

The two tables below show the number of USF events that are assigned to each cause and mitigation category. A single USF event may be assigned to more than one cause or mitigation category.

Cause Results

# Events	Schedule Increase	High ACE	High Unscheduled Flow	High Unscheduled Flow & ACE	Unplanned Path De-rate
Path 66	3	3	3	19	4
Path 36	1	0	2	0	1
Path 30	0	0	8	0	0

Mitigation Results

# Events	Schedule Reduction	ACE Reduction	Phase Shifter Operation
Path 66	13	22	14
Path 36	3	0	1
Path 30	2	2	5

Figure 5.1 below shows the number of hours that Coordinated Operations of Phase Shifters (COPS) was required to mitigate Qualified Path flows from 2006 through 2013. The dramatic increase of COPS hours during 2011 for path 36 (TOT 3) and 2012 for path 66 (California Oregon Intertie) as compared to the pre field trial period and other field trial years corresponds with the increase of the ATL to 100 times L_{10}. is probably due to changing seasonal patterns, changing resource mix, unusual operating conditions, or other events rather than with the field trial, since it only happened for one year on each path.

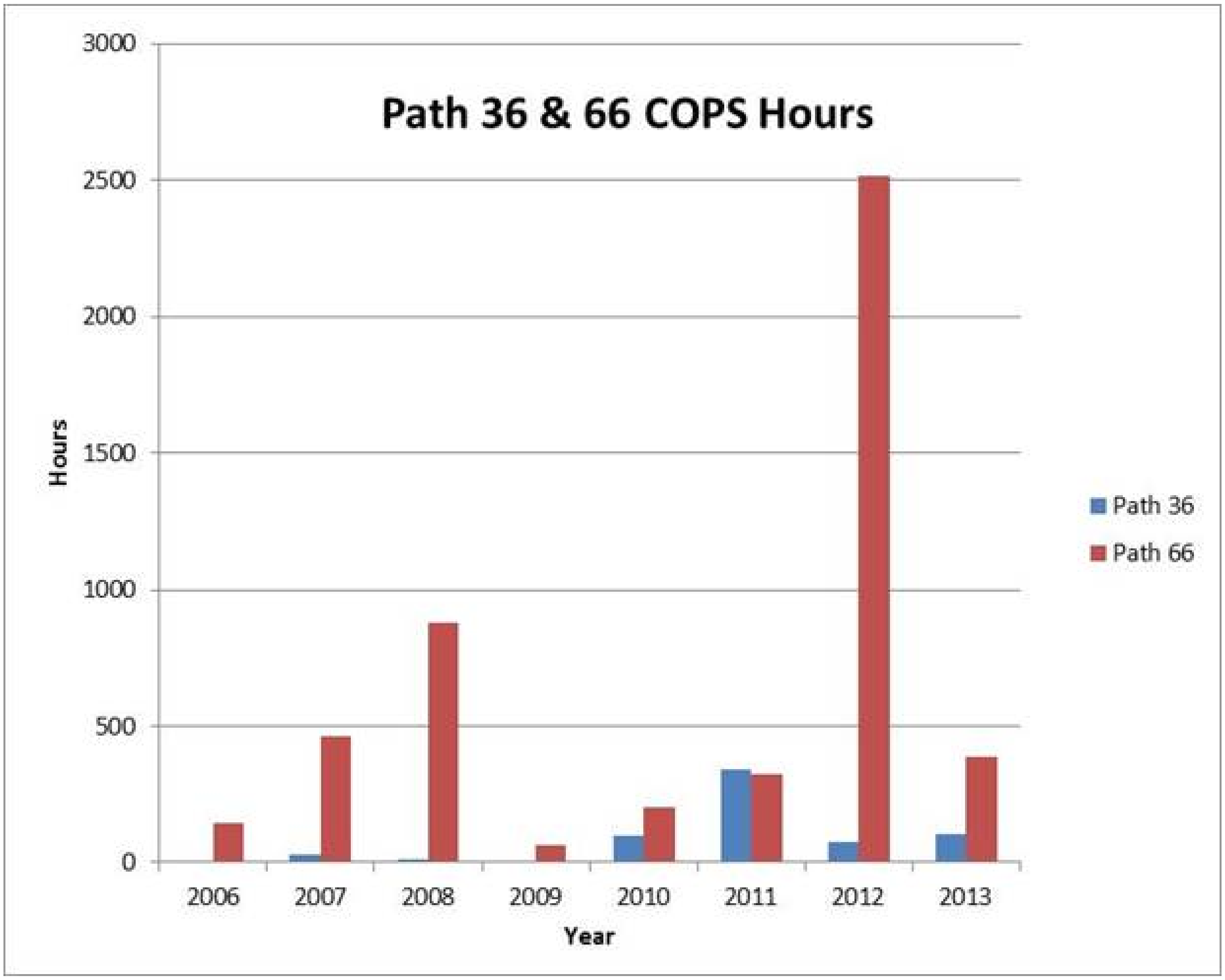

Path 36 & 66 COPS Hours
Hours
3000
2500
2000
1500
1000
500
0
2006
2007
2008
2009
2010
2011
2012
2013
Year
Path 36
Path 66

Figure 5.1

6. Average Interconnection Control Performance Standard (CPS)

Figures 6.1 and 6.2 below show the CPS1 and CPS2 scores for the RBC participants in the Western Interconnection since 2008. The reduction of CPS1 and CPS2 scores can be seen in the Figures below since the March 2010 start of the field trial.

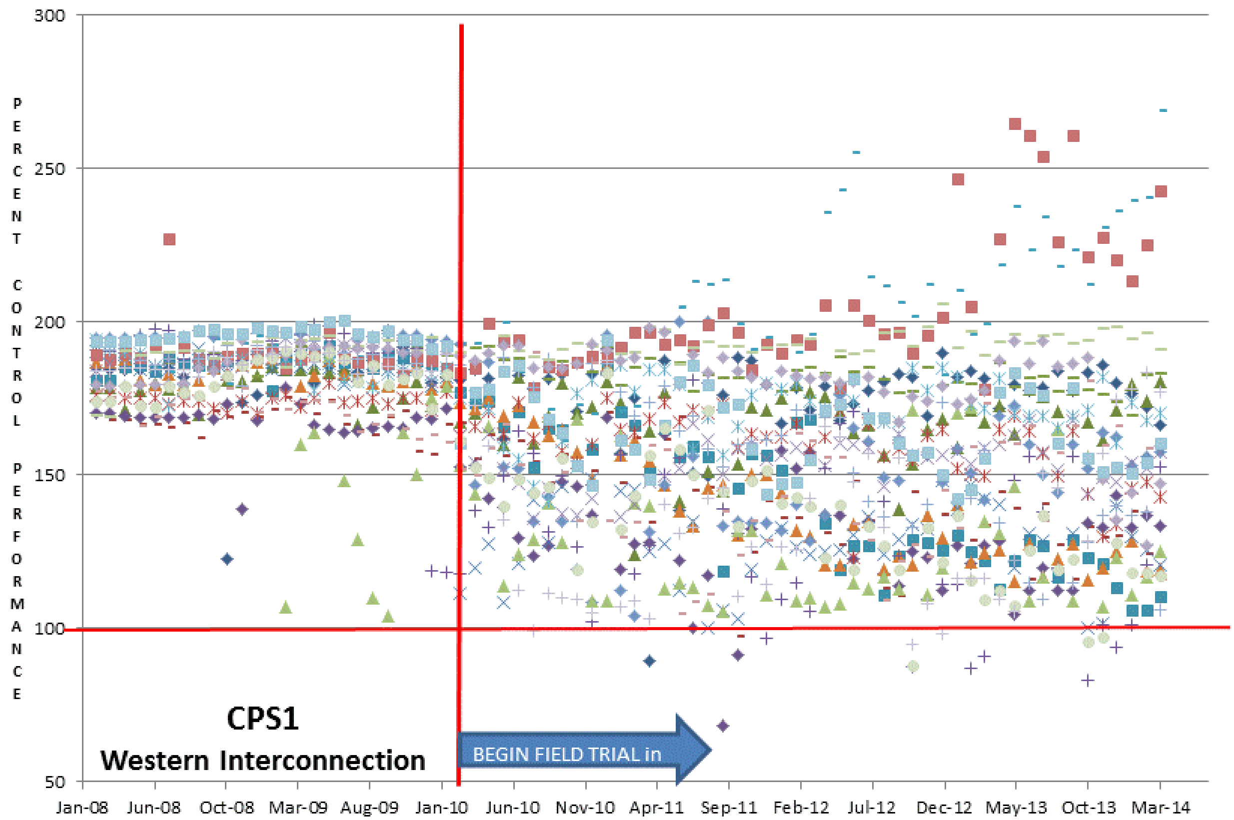


Figure 6.1

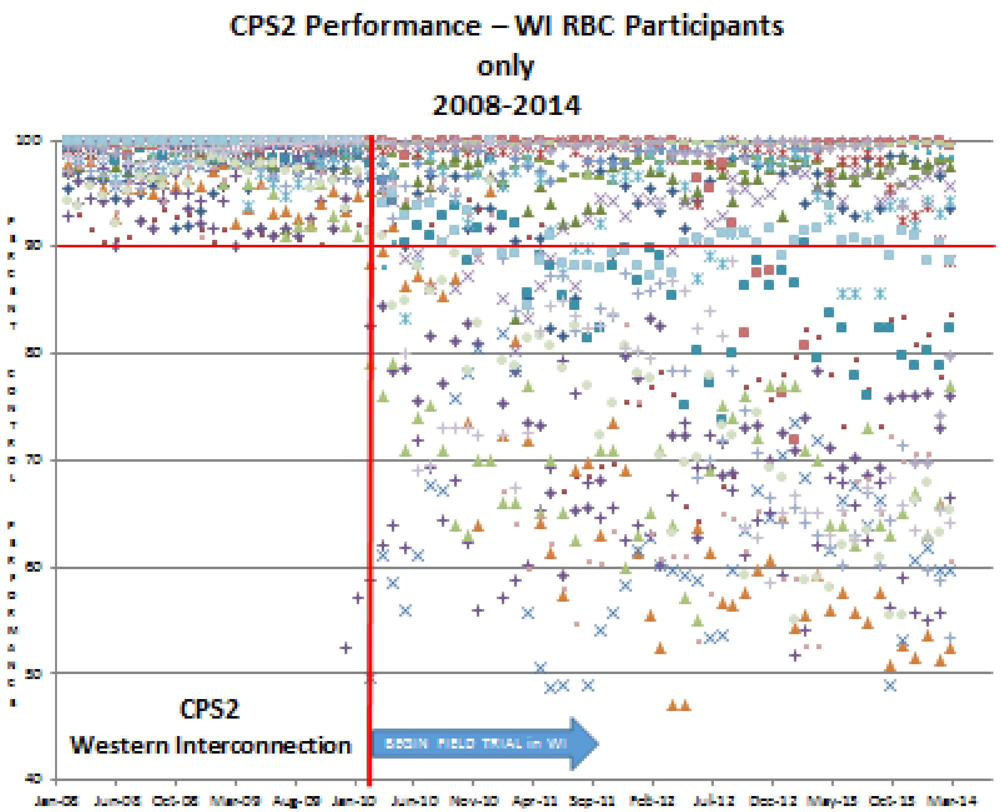


Figure 6.2

Other Issues

BAAL Violations

A violation of the BAAL occurs when a BA's ACE exceeds its BAAL limit for more than 30 consecutive minutes. BAAL violations and reasons for the violation were reported to the NERC Standard Drafting Team on a monthly basis. WECC staff and PWG issued letters to violators asking them to assess their performance and to meet the BAAL standard. A summary of the reasons for BAAL violations is listed below in this section. Change in wind generation, issues during ramp and weather conditions are some of the reasons that resulted in BAAL violations.

In 2011 there were total of 23 BAAL violations and 5 ATL violations in WECC. The ATL violations occurred prior to the removal/increase of the ATL limit in April 2011.

	2011		2012		2013	
	BAAL	ATL	BAAL	ATL	BAAL	ATL
Total	23	5	8	1	7	0
High	17	5	5	1	1	0
Low	6	0	3	0	6	0

Field trial participants gave the following reasons for BAAL high limit violations:

- Several generators tripped due to record low temperatures while BA was in an Energy Emergency Alert (EEA).
- 1000 MW of on-line generation lost due to storm previous hour. As replacement generation was brought on-line, storm rolled through reducing load. Excess generation online during abnormal interconnection high frequency
- Under Voltage Load Shed event caused load shed and load was not restored quick enough to avoid BAAL violation
- When transitioning from Off-Peak to On-Peak periods the area net schedule changes dramatically. In order to prepare for the large schedule change, concurrent with getting ready for a large early morning load ramp up, many generators are held in on-line. Unfortunately, those units must be held at minimum output meaning little down regulation exists. Hence, the BA is over-generating in the hour before transition to On-Peak periods. This, coupled with system frequency being high at the same time makes for a relatively small BAAL limit. Due to the high frequency, BA is pushed into a BAAL violation.
- Sudden wind generation increase
- Large load decrease and abnormally high Interconnection frequency, coal units slow to respond
- Generators slow to ramp down and all other generation at minimum

Field trial participants gave the following reasons for BAAL low limit violations:

- Thermal units slow to ramp up during morning load increase
- Sudden wind generation decrease

- Generators slow to ramp up to meet load

Balancing Authorities with Small Frequency Bias

The range of frequency bias for BAs in the Western Interconnection runs from 2 MW/0.1 Hz to 700 MW/0.1 Hz. The BAAL formula produces an ACE limit that is linearly proportional to a BA's frequency bias. On the other hand, the L_{10} limit used in the CPS2 criteria is proportional to the square root of a BA's frequency bias. For representative BAs with various frequency bias values, Table 8.1 below compares L_{10} to BAAL at two frequency error values (0.001 Hz and 0.02 Hz).

BA Frequency Bias (MW/0.1 Hz)	**L_{10} (MW)**	**BAAL (MW @ 0.001 ∆Hz) 4.62 x bias**	**BAAL (MW @ 0.02 ∆Hz) 0.23 x bias**
-489	+/- 118	+/- 2261	+/- 113
-67	+/- 44	+/- 310	+/- 15
-27	+/- 28	+/- 125	+/- 6
-2	+/- 8	+/- 9	+/- 0.5

Table 8.1

Note that the L_{10} limit for the large BA is about 25% of its bias while the L_{10} limit for the small BA is 400% of its bias. Also note that for the large BA the BAAL is approximately equal to its L_{10} at a 0.02 Hz frequency error while for the small BA the BAAL is approximately equal to its L_{10} at only a 0.001 frequency error. The BAAL formula appears to require tighter control performance from BAs with smaller frequency bias values.

With the increase in frequency error and manual time error corrections in the Western Interconnection during the field trial, the average number of minutes in a month a BA with 2 MW/0.1 Hz frequency bias will have to operate to a BAAL less than the L_{10} limit is approximately 45% of the time. The table below shows the comparison of the average number of minutes in a month a BA's BAAL limit is more restrictive than the CPS2 L_{10} limit. The average was calculated over a 12 month period.

Frequency Bias (MW/0.1 Hz)	0 to -5	-5 to -10	-10 to -20	-20 to -50	-50 to -500	-500 and +
Number of min BAAL< L10 in month (@ 60 Hz)	47%	17%	3%	1%	0%	0%

Frequency Bias (MW/0.1 Hz)	0 to -5	-5 to -10	-10 to -20	-20 to -50	-50 to -500	-500 and +
Number of min BAAL< L10 in month (@ Sch Hz)	45%	17%	3%	1%	0%	0%

AGC systems are typically not capable of calculating and controlling ACE to tolerances less than 1 MW. The fractional BAAL values that a BA with a small frequency bias would experience are impractical.

Conclusions

Data presented in this report leads to the following conclusions.

- 1-min, 10-min and 60-min frequency error averages in the Western Interconnection have increased since the beginning of the field trial. Frequency error has not increased much from 2012 to present.
- The frequency and duration of manual time error corrections increased significantly after the first field trial year. A recently approved increase in the Western Interconnection’s time error threshold to +/- 30 seconds should dramatically reduce the frequency of manual time error corrections in the future.
- Accumulated NERC Inadvertent Interchange reached high levels several times during the field trial among both participants and non-participants, but is currently declining. Because of known BA EMS errors at various times during the field trial, no relationship between the field trial and accumulated inadvertent interchange could be established. The upcoming BAL-004-WECC-02 standard places limits on a BAs accumulation of Primary Inadvertent Interchange.
- Although the number of hours of Coordinated Operations of Phase Shifters increased dramatically in 2011 for path 36 and in 2012 for path 66, a relationship to the field trial could not be established because the anomalies appeared in only one of the four field trial years and are

more likely due to other factors.

- Studies show that the larger ACE values permitted by BAAL were a contributing cause of about 33%, and a major cause of about 17% of SOL exceedance events. In many of these cases the RC, by actively monitoring SOL exceedance, has mitigated the event by requesting the contributing BA(s) to operate within L_{10} limits.

Appendix A – List of Balancing Authority Participants

Western Interconnection Balancing Authority Areas Participants	**WECC Region**	**Start Date**
Alberta Electric System Operator (AESO)	NWPP	03/01/2010
Arizona Public Service Company (AZPS)	AZNMSNV	03/01/2010
Avista Corporation (AVA)	NWPP	10/01/2013
Balancing Authority of Northern California (BANC)	NWPP	03/01/2010
Bonneville Power Administration (BPAT)	NWPP	03/01/2010
British Columbia Hydro and Power Authority (BCHA)	NWPP	04/01/2010
California Independent System Operator (CISO)	CAMX	03/01/2010
El Paso Electric Company (EPE)	AZNMSNV	03/01/2010
NaturEner Power Watch, LLC (GWA)	NWPP	03/01/2010
Idaho Power Company (IPCO)	NWPP	03/01/2010
Los Angeles Department of Water and Power (LDWP)	CAMX	03/01/2010
Nevada Power Company (NEVP)	AZNMSNV	03/01/2010
PacifiCorp-East (PACE)	NWPP	03/01/2010
PacifiCorp-West (PACW)	NWPP	03/01/2010
Portland General Electric Company (PGE)	NWPP	04/01/2010
Public Service Company of Colorado (PSCO)	RMPA	03/01/2010
Public Service Company of New Mexico (PNM)	AZNMSNV	06/01/2011
PUD No. 1 of Chelan County (CHPD)	NWPP	03/01/2010
PUD No. 1 of Douglas County (DOPD)	NWPP	04/01/2010
PUD No. 2 of Grant County (GCPD)	NWPP	03/01/2010
Puget Sound Energy (PSEI)	NWPP	10/01/2013
Salt River Project (SRP)	AZNMSNV	05/01/2010

Seattle Department of Lighting (SCL)	NWPP	03/01/2010
Tucson Electric Power Company (TEPC)	AZNMSNV	03/01/2010
Turlock Irrigation District (TID)	NWPP	03/01/2010
Western Area Power Administration, Colorado- Missouri Region (WACM)	RMPA	03/01/2010
Western Area Power Administration, Lower Colorado Region (WALC)	AZNMSNV	03/01/2010

Appendix B - SOL Event Analysis Summary

Background

The PWG evaluates the impact of Reliability Based Control on the BES relative to three types of events: SOL exceedance, L_{10} directive events and frequency deviation events. The PWG selects SOL exceedance events that last at least 5 minutes on a variety of paths for analysis. L_{10} directive events – an RC directive for a BA to reduce its ACE to less than its L_{10} – are always found in conjunction with an SOL exceedance event. The expected impact of RBC on interconnection frequency is a long duration deviation from scheduled frequency. Only one such event has occurred and the PWG has not yet studied it.

Methodology Summary

SOL mitigation for events analyzed by the workgroup may involve coordinated operation of phase shifting transformer taps and/or curtailment of schedules (e-Tags) that flow on the overloaded path. For its analysis, the workgroup uses a tool that graphically displays path SOL, actual path flow, scheduled path use and phase shifting transformer tap positions. For qualified paths, the tool also graphically displays the calculated contribution of each Western Interconnection Balancing Authority's ACE on the path flow. The calculated contribution is the sum of each Balancing Authority's Inadvertent Interchange multiplied by an inadvertent interchange distribution factor (IIDF) that is derived from the USF Transmission Distribution Factor Matrices used by webSAS. The IIDF is dependent on the path being analyzed and each BA's default transmission grid interconnection point.

Refer to the PWG Event Analysis Methodology document for a detailed description of the methodology and the calculation of each metric.

Analysis Criteria

The PWG has developed an event analysis methodology that calculates the following metrics for selected SOL exceedance events. The bullet list gives a brief description of each metric.

- **Date/time** – the date and time that the actual path flow exceeded the path SOL.
- **Duration** – the length in minutes that actual path flow exceeded the path SOL.
- **Cause** – the cause of the SOL exceedance as perceived from the event analysis data. Causes are calculated based on the event criteria data. The **Cause legend** that follows the event summary table explains how the event analysis criteria are used to select causes of an event.
- **Mitigation** – the mitigating action for the SOL exceedance as perceived from the event analysis data. Mitigating actions are calculated based on the event criteria data. The **Mitigation legend** that follows the event summary table explains how the event analysis criteria are used to select mitigating actions for an event.

- **Planned SOL** – the average path rating for the time period prior to the SOL exceedance, within the event analysis period. Path operators calculate path ratings based on engineering studies and real-time conditions in the BES. The scheduling process accounts for this path rating.
- **Unplanned De-rate %** – a path SOL reduction due to sudden loss of a BES component during the event analysis period, expressed as a percentage of the **Planned SOL**. The scheduling process does not account for lower unplanned path ratings.
- **Actual Flow %** – the average actual path flow, expressed as a percentage of the **Planned SOL**. This criterion is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance. Path operators calculate actual path flow based on real-time conditions in the BES such as metered flows on physical transmission lines.
- **Scheduled Use %** – the average scheduled path use, expressed as a percentage of the **Planned SOL**. This criterion is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance. Path operators derive scheduled path use based on tagged energy flows on scheduling paths.
- **Unscheduled Flow %** – the average actual path flow minus the average scheduled path use, expressed as a percentage of the average scheduled path use. This metric is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance.
- **ACE Contribution %** – the amount of unscheduled flow caused by the inadvertent interchange component of BA ACE values, expressed as a percentage of the scheduled path use. This metric is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance.
- **ACE Contribution to USF %** - the **ACE Contribution** expressed as a percentage of the **Unscheduled Flow**. This metric is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance.

The **ACE Contribution to USF %** metric best reflects RBC's contribution to SOL exceedance events. The ACE contribution is significant when it is a large portion of the unscheduled flow on a path. The ACE contribution to path unscheduled flow may still be significant even when BA's operate under the CPS2 criteria because it does not limit a BA's ACE to L_{10} at all times.

Appendix C – USF Event Analysis Task Force: USF Event Analysis Summary

Background

In early 2013 the WECC Operating Committee authorized formation of the USF Event Analysis Task Force. Taskforce members represent a variety of industry interests and include members of the USF Accounting Subcommittee, Performance Work Group, the Reliability Coordinator and WECC staff. This document contains the results of the taskforce's analysis of USF events in the Western Interconnection in relation to the Reliability Based Control Field Trial (reference NERC Standard BAL-001-2). The scope of the taskforce is to:

- Create a USF event analysis methodology
- Apply the methodology to confirm the USF Administrative Subcommittee's analysis of 2012 USF events
- Use the methodology to analyze 2013 USF events
- Identify possible improvements to the USF Mitigation Procedure

Methodology Summary

The USF mitigation procedure for events analyzed by the taskforce involves coordinated operation of phase shifting transformer taps and/or curtailment of schedules (e-Tags) that flow on the overloaded path. For its analysis, the taskforce uses a tool that graphically displays path SOL, actual path flow, scheduled path use and phase shifting transformer tap positions. The tool also graphically displays the calculated contribution of each Western Interconnection Balancing Authority's ACE on the path flow. This ACE contribution is the sum of each Balancing Authority's Inadvertent Interchange multiplied by an inadvertent interchange distribution factor (IIDF) that is derived from the USF Transmission Distribution Factor Matrices used by webSAS. The IIDF is dependent on the path being analyzed and each BA's default transmission grid interconnection point.

Refer to the USFEATF Event Analysis Methodology document for a detailed description of the methodology.

Event Selection

The USFEATF evaluates the impact of Reliability Based Control on the BES relative to unscheduled flow events. In conjunction with the PWG, the USF Administrative Subcommittee requested that WECC staff select thirty Path 66 events that encompassed a wide variety of conditions: all USF mitigation steps, single hour events, multi-hour events. Five events for each of the months March through August 2012 were selected. The USFEATF selected the 2013 USF events, desiring two per month from all Qualified Paths that required mitigation beyond step 3. There were less than two events per month in the later part of 2013.

Analysis Criteria

The USFEATF has developed an event analysis methodology that calculates the following criteria for selected USF events. The bullet list gives a brief description of each criterion. Refer to the USFEATF Event Analysis Methodology document for a detailed description of the methodology and the calculation of each criterion.

- **Date/time** – the date and time that the actual path flow exceeded 95% of the path SOL.
- **Duration>95%** – the length in minutes that actual path flow exceeded 95% of the path SOL.
- **Duration>100%** – the length in minutes that actual path flow exceeded 100% of the path SOL.
- **Cause** – the cause of the SOL exceedance as perceived from the event analysis data. Causes are calculated based on the event criteria data. The **Cause legend** that follows the event summary table explains how the event analysis criteria are used to select causes of an event.
- **Mitigation** – the mitigating action for the SOL exceedance as perceived from the event analysis data. Mitigating actions are calculated based on the event criteria data. The **Mitigation legend** that follows the event summary table explains how the event analysis criteria are used to select mitigating actions for an event.
- **Planned SOL** – the average path rating for the time period prior to the SOL exceedance, within the event analysis period. Path operators calculate path ratings based on engineering studies and real-time conditions in the BES. The scheduling process accounts for this path rating.
- **Unplanned De-rate %** – a path SOL reduction due to sudden loss of a BES component during the event analysis period, expressed as a percentage of the **Planned SOL**. The scheduling process does not account for lower unplanned path ratings.
- **Actual Flow %** – the average actual path flow, expressed as a percentage of the **Planned SOL**. This criterion is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance. Path operators calculate actual path flow based on real-time conditions in the BES such as metered flows on physical transmission lines.
- **Scheduled Use %** – the average scheduled path use, expressed as a percentage of the **Planned SOL**. This criterion is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance. Path operators derive scheduled path use based on tagged energy flows on scheduling paths.
- **Unscheduled Flow %** – the average actual path flow minus the average scheduled path use, expressed as a percentage of the average scheduled path use. This metric is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance.
- **ACE Contribution %** – the amount of unscheduled flow caused by the inadvertent interchange component of BA ACE values, expressed as a percentage of the scheduled path use. This metric is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance.

- **ACE Contribution to USF %** - the **ACE Contribution** expressed as a percentage of the **Unscheduled Flow**. This metric is calculated for three time periods within the event analysis period: before, during and after an SOL exceedance.

The **ACE Contribution to USF** metric best reflects RBC's contribution to USF events. The ACE contribution is significant when it is a large portion of the unscheduled flow on a path. The ACE contribution to path unscheduled flow may still be significant even when BA's operate under the CPS2 criteria because it does not limit a BA's ACE to L_{10} at all times.