

Balancing Authority ACE Limit Proof-of-Concept Field Trial

Update Discussion
May 24, 2010

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Reliability-Based Control Standard Drafting Team

Balancing Authority ACE Limit Proof-of-Concept Field Trial

Eastern Interconnection Field Trial Participation

Participation reflects approximately 67% of the projected 2010 peak load for the Eastern Interconnection

Eastern Interconnection Balancing Authority Participants	2010 Frequency Bias	Region	Reliability Coordinator	Start Date
American Electric Power (CSW)	-103.4	SPP	SPP	September 1, 2005
Associated Electric Cooperative, Inc. (AECI)	-45	SERC	TVA	April 1, 2010
Duke Energy Carolinas (DUK)	-196	SERC	VACS	April 1, 2009
East Kentucky Power Cooperative (EKPC)	-42.73	SERC	TVA	July 6, 2005
Entergy (EES)	-227.1	SERC	ICTE	July 6, 2005
EON-US (LGEE)	-74	SERC	TVA	April 1, 2008
Independent Electricity System Operator (IESO)	-245.8	NPCC	IESO	March 1, 2008
Manitoba Hydro (MHEB)	-43.3	MRO	MISO	July 6, 2005
Midwest Independent Transmission System Operator (MISO)	-1038.6	MRO, RFC, SERC	MISO	January 6, 2009
PJM Interconnection (PJM)	-1358	RFC	PJM	August 1, 2005
Santee Cooper (SC)	-61.52	SERC	VACS	March 1, 2006
Southern Company (SOCO)	-445	SERC	SOCO	October 15, 2005
Tennessee Valley Authority (TVA)	-317.6	SERC	TVA	October 1, 2005

Balancing Authority ACE Limit Proof-of-Concept Field Trial

The Balancing Authority ACE Limit (BAAL) shall not be exceeded for more than 30 consecutive clock-minutes*

	Longest exceedance of the Balancing Authority ACE Limit since starting operation under the Field Trial		April 2010 Performance under BAL-007	
	Max MinCtLow	Max MinCtHigh	Max MinCtLow	Max MinCtHigh
BA01	27	12	27	12
BA02	26	16	7	6
BA03	17	17	9	8
BA04	19	19	7	14
BA05	10	20	9	13
BA06	16	22	9	10
BA07	15	23	5	12
BA08	20	24	12	9
BA09	28	26	14	13
BA10	21	26	10	9
BA11	14	32	5	5
BA12	27	40	13	12
BA13	28	43	7	9

MinCtLow = Count of consecutive clock-minutes BAAL_Low was exceeded

MinCtHigh = Count of consecutive clock-minutes BAAL_High was exceeded

*BAAL being exceeded for more than 30 consecutive clock-minutes would be a violation under the proposed BAL-007 standard.

Frequency Statistics

Eastern Interconnection

Year	Month	Total Minutes FTL_Low at 59.98 Hz SF	Total Minutes FTL_Low at 60 Hz SF	Total FTL_Low Minutes	Percentage Low During TEC	FTL_Low Events	FTL_Low Max Duration	Total Minutes FTL_High at 60.02 Hz SF	Total Minutes FTL_High at 60 Hz SF	Total FTL_High Minutes	Percentage High During TEC	FTL_High Events	FTL_High Max Duration	Total FTL_Low and FTL_High Minutes at 60 Hz SF	Total FTL_Low and FTL_High Minutes
2005	7	28	30	58	48.28%	32	5	0	16	16	0.00%	11	3	46	74
2005	8	47	91	138	34.06%	56	10	0	35	35	0.00%	21	5	126	173
2005	9	32	39	71	45.07%	33	8	0	39	39	0.00%	21	7	78	110
2005	10	42	48	90	46.67%	43	11	0	33	33	0.00%	23	5	81	123
2005	11	65	43	108	60.19%	58	6	0	35	35	0.00%	22	7	78	143
2005	12	37	36	73	50.68%	41	7	0	27	27	0.00%	19	3	63	100
2006	1	42	33	75	56.00%	43	6	0	61	61	0.00%	27	5	94	136
2006	2	0	64	64	0.00%	39	6	2	43	45	4.44%	24	4	107	109
2006	3	28	51	79	35.44%	50	4	17	37	54	31.48%	33	8	88	133
2006	4	19	86	105	18.10%	58	5	0	76	76	0.00%	46	8	162	181
2006	5	52	67	119	43.70%	54	8	0	72	72	0.00%	39	5	139	191
2006	6	45	34	79	56.96%	41	5	0	59	59	0.00%	24	10	93	138
2006	7	31	40	71	43.66%	34	9	0	50	50	0.00%	29	4	90	121
2006	8	16	85	101	15.84%	49	5	0	58	58	0.00%	26	8	143	159
2006	9	19	60	79	24.05%	39	6	0	53	53	0.00%	33	4	113	132
2006	10	53	42	95	55.79%	51	6	0	54	54	0.00%	28	8	96	149
2006	11	56	35	91	61.54%	47	5	1	36	37	2.70%	22	3	71	128
2006	12	34	18	52	65.38%	34	4	0	54	54	0.00%	29	6	72	106
2007	1	59	29	88	67.05%	44	7	0	55	55	0.00%	31	7	84	143
2007	2	17	31	48	35.42%	33	3	0	39	39	0.00%	21	4	70	87
2007	3	75	83	158	47.47%	76	15	0	78	78	0.00%	38	8	161	236
2007	4	36	41	77	46.75%	45	5	0	58	58	0.00%	31	4	99	135
2007	5	70	46	116	60.34%	64	5	0	95	95	0.00%	49	7	141	211
2007	6	62	30	92	67.39%	47	6	0	51	51	0.00%	25	7	81	143
2007	7	47	20	67	70.15%	33	6	0	39	39	0.00%	20	4	59	106
2007	8	37	25	62	59.68%	31	6	1	55	56	1.79%	32	5	80	118
2007	9	20	75	95	21.05%	41	8	0	27	27	0.00%	16	5	102	122
2007	10	57	65	122	46.72%	73	5	1	56	57	1.75%	36	5	121	179
2007	11	74	21	95	77.89%	60	4	0	34	34	0.00%	24	5	55	129
2007	12	37	22	59	62.71%	38	6	0	61	61	0.00%	38	4	83	120
2008	1	0	75	75	0.00%	34	8	0	48	48	0.00%	24	4	123	123
2008	2	18	71	89	20.22%	46	8	0	51	51	0.00%	24	8	122	140
2008	3	37	65	102	36.27%	55	6	0	40	40	0.00%	34	2	105	142
2008	4	41	65	106	38.68%	60	5	0	59	59	0.00%	33	6	124	165
2008	5	67	39	106	63.21%	63	4	0	40	40	0.00%	20	5	79	146
2008	6	40	21	61	65.57%	34	5	0	35	35	0.00%	19	5	56	96
2008	7	42	17	59	71.19%	29	7	0	17	17	0.00%	12	3	34	76
2008	8	41	19	60	68.33%	35	5	0	29	29	0.00%	17	6	48	89
2008	9	25	44	69	36.23%	39	4	0	55	55	0.00%	21	11	99	124
2008	10	35	33	68	51.47%	38	5	0	27	27	0.00%	19	3	60	95
2008	11	13	9	22	59.09%	13	5	0	13	13	0.00%	9	4	22	35
2008	12	16	34	50	32.00%	35	4	0	11	11	0.00%	8	3	45	61
2009	1	2	26	28	7.14E-02	16	4	0	19	19	0.00%	9	3	45	47
2009	2	0	34	34	0.00%	18	4	0	18	18	0.00%	11	6	52	52
2009	3	0	41	41	0.00%	23	5	0	25	25	0.00%	11	9	66	66
2009	4	0	59	59	0.00%	37	5	0	27	27	0.00%	20	3	86	86
2009	5	8	35	43	18.60%	31	4	0	27	27	0.00%	15	8	62	70
2009	6	30	28	58	51.72%	28	5	0	25	25	0.00%	16	3	53	83
2009	7	14	22	36	38.89%	22	3	0	28	28	0.00%	16	6	50	64
2009	8	16	10	26	61.54%	20	2	0	13	13	0.00%	10	2	23	39
2009	9	11	22	33	33.33%	21	3	0	20	20	0.00%	14	4	42	53
2009	10	44	45	89	49.44%	44	6	0	18	18	0.00%	10	3	63	107
2009	11	30	19	49	61.22%	33	3	0	34	34	0.00%	21	4	53	83
2009	12	11	23	34	32.35%	20	5	0	22	22	0.00%	15	3	45	56
2010	1	36	26	62	58.06%	35	6	0	16	16	0.00%	9	3	42	78
2010	2	23	16	39	58.97%	24	3	0	26	26	0.00%	16	2	42	65
2010	3	38	71	109	34.86%	65	6	0	40	40	0.00%	22	6	111	149
2010	4	63	38	101	62.38%	65	5	0	54	54	0.00%	34	6	92	155

This chart is a summary of frequency-related statistics gathered since the start of the Field Trial. Of particular interest is the drop in operation outside of the FTL bounds, trending lower in the latter part of 2008 with November 2008 having the least number of clock-minutes of operation outside the FTL bounds, followed by August 2009, over the dataset.

Frequency Statistics

Eastern Interconnection

Year	Month	Total Minutes FTL_Low at 59.98 Hz SF	Total Minutes FTL_Low at 60 Hz SF	Total FTL_Low Minutes	Percentage Low During TEC	FTL_Low Events	FTL_Low Max Duration
2007	5	70	46	116	60.34%	64	5
2007	6	62	30	92	67.39%	47	6
2007	7	47	20	67	70.15%	33	6
2007	8	37	25	62	59.68%	31	6
2007	9	20	75	95	21.05%	41	8
2007	10	57	65	122	46.72%	73	5
2007	11	74	21	95	77.89%	60	4
2007	12	37	22	59	62.71%	38	6
2008	1	0	75	75	0.00%	34	8
2008	2	18	71	89	20.22%	46	8
2008	3	37	65	102	36.27%	55	6
2008	4	41	65	106	38.68%	60	5
2008	5	67	39	106	63.21%	63	4
2008	6	40	21	61	65.57%	34	5
2008	7	42	17	59	71.19%	29	7
2008	8	41	19	60	68.33%	35	5
2008	9	25	44	69	36.23%	39	4
2008	10	35	33	68	51.47%	38	5
2008	11	13	9	22	59.09%	13	5
2008	12	16	34	50	32.00%	35	4
2009	1	2	26	28	7.14E-02	16	4
2009	2	0	34	34	0.00%	18	4
2009	3	0	41	41	0.00%	23	5
2009	4	0	59	59	0.00%	37	5
2009	5	8	35	43	18.60%	31	4
2009	6	30	28	58	51.72%	28	5
2009	7	14	22	36	38.89%	22	3
2009	8	16	10	26	61.54%	20	2
2009	9	11	22	33	33.33%	21	3
2009	10	44	45	89	49.44%	44	6
2009	11	30	19	49	61.22%	33	3
2009	12	11	23	34	32.35%	20	5
2010	1	36	26	62	58.06%	35	6
2010	2	23	16	39	58.97%	24	3
2010	3	38	71	109	34.86%	65	6
2010	4	63	38	101	62.38%	65	5

This chart is a summary of frequency-related statistics gathered since the start of the Field Trial. Of particular interest is the drop in operation outside of the FTL bounds, trending lower in the latter part of 2008 with November 2008 having the least number of clock-minutes of operation outside the FTL bounds, followed by August 2009, over the dataset.

Frequency Statistics

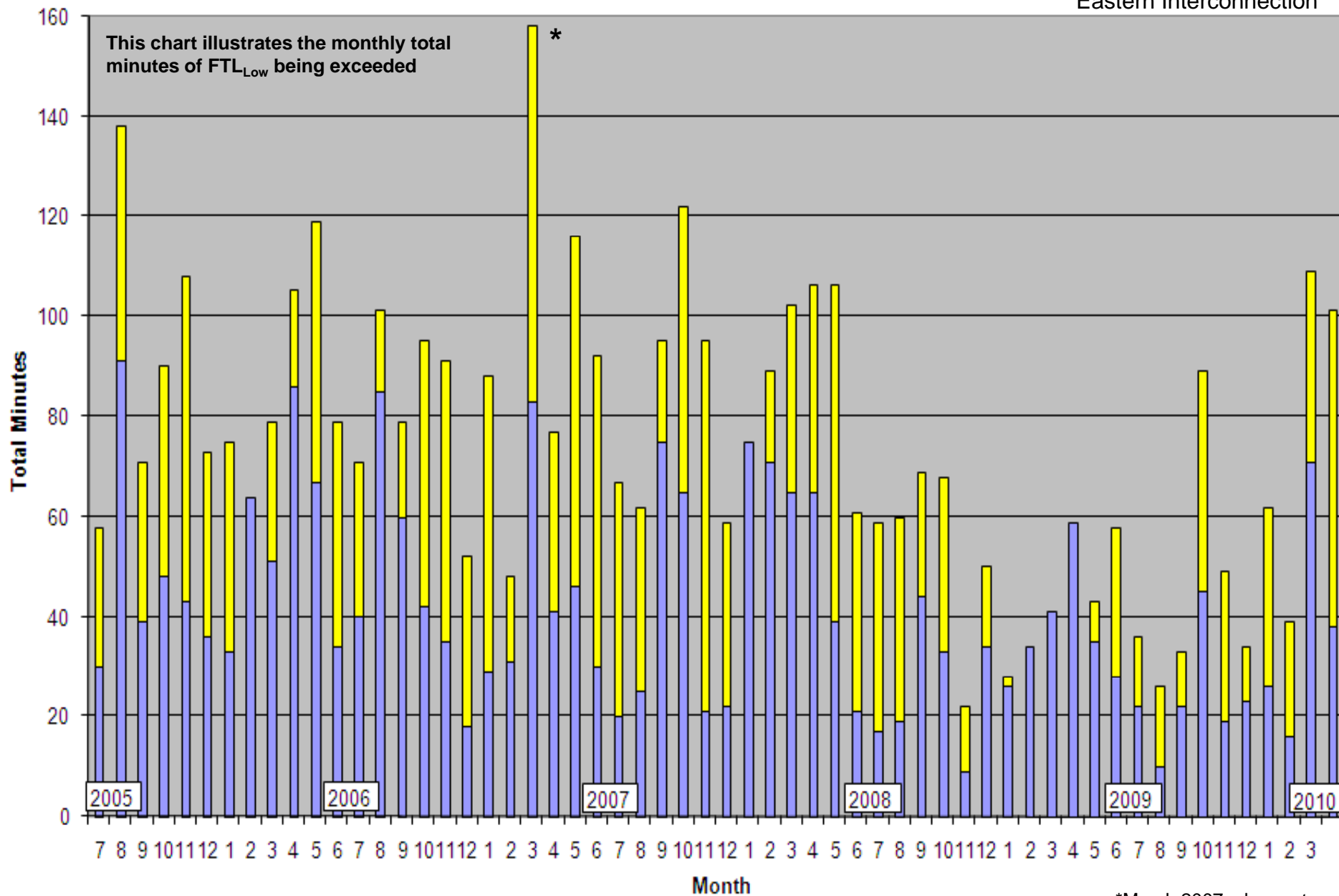
Eastern Interconnection

Year	Month	Total Minutes FTL_High at 60.02 Hz SF	Total Minutes FTL_High at 60 Hz SF	Total FTL_High Minutes	Percentage High During TEC	FTL_High Events	FTL_High Max Duration	Total FTL_Low and FTL_High Minutes at 60 Hz SF	Total FTL_Low and FTL_High Minutes
2007	5	0	95	95	0.00%	49	7	141	211
2007	6	0	51	51	0.00%	25	7	81	143
2007	7	0	39	39	0.00%	20	4	59	106
2007	8	1	55	56	1.79%	32	5	80	118
2007	9	0	27	27	0.00%	16	5	102	122
2007	10	1	56	57	1.75%	36	5	121	179
2007	11	0	34	34	0.00%	24	5	55	129
2007	12	0	61	61	0.00%	38	4	83	120
2008	1	0	48	48	0.00%	24	4	123	123
2008	2	0	51	51	0.00%	24	8	122	140
2008	3	0	40	40	0.00%	34	2	105	142
2008	4	0	59	59	0.00%	33	6	124	165
2008	5	0	40	40	0.00%	20	5	79	146
2008	6	0	35	35	0.00%	19	5	56	96
2008	7	0	17	17	0.00%	12	3	34	76
2008	8	0	29	29	0.00%	17	6	48	89
2008	9	0	55	55	0.00%	21	11	99	124
2008	10	0	27	27	0.00%	19	3	60	95
2008	11	0	13	13	0.00%	9	4	22	35
2008	12	0	11	11	0.00%	8	3	45	61
2009	1	0	19	19	0.00%	9	3	45	47
2009	2	0	18	18	0.00%	11	6	52	52
2009	3	0	25	25	0.00%	11	9	66	66
2009	4	0	27	27	0.00%	20	3	86	86
2009	5	0	27	27	0.00%	15	8	62	70
2009	6	0	25	25	0.00%	16	3	53	83
2009	7	0	28	28	0.00%	16	6	50	64
2009	8	0	13	13	0.00%	10	2	23	39
2009	9	0	20	20	0.00%	14	4	42	53
2009	10	0	18	18	0.00%	10	3	63	107
2009	11	0	34	34	0.00%	21	4	53	83
2009	12	0	22	22	0.00%	15	3	45	56
2010	1	0	16	16	0.00%	9	3	42	78
2010	2	0	26	26	0.00%	16	2	42	65
2010	3	0	40	40	0.00%	22	6	111	149
2010	4	0	54	54	0.00%	34	6	92	155

This chart is a summary of frequency-related statistics gathered since the start of the Field Trial. Of particular interest is the drop in operation outside of the FTL bounds, trending lower in the latter part of 2008 with November 2008 having the least number of clock-minutes of operation outside the FTL bounds, followed by August 2009, over the dataset.

Total Minutes Exceeding Low FTL

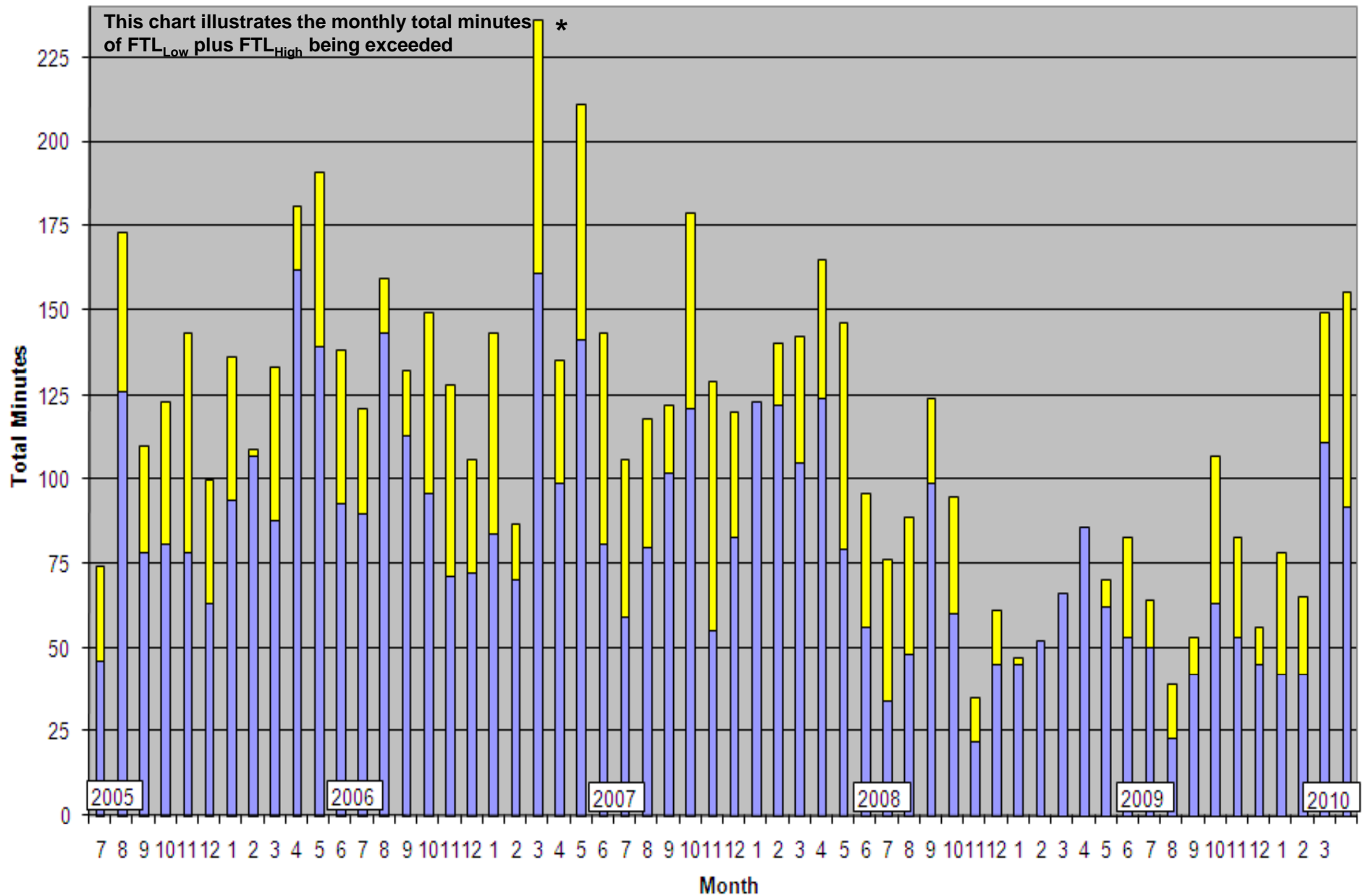
Eastern Interconnection



■ Total Minutes at 60 Hz
 ■ Addition Minutes During Time-Error Corrections

*March 2007- change to the new Daylight Saving Time.

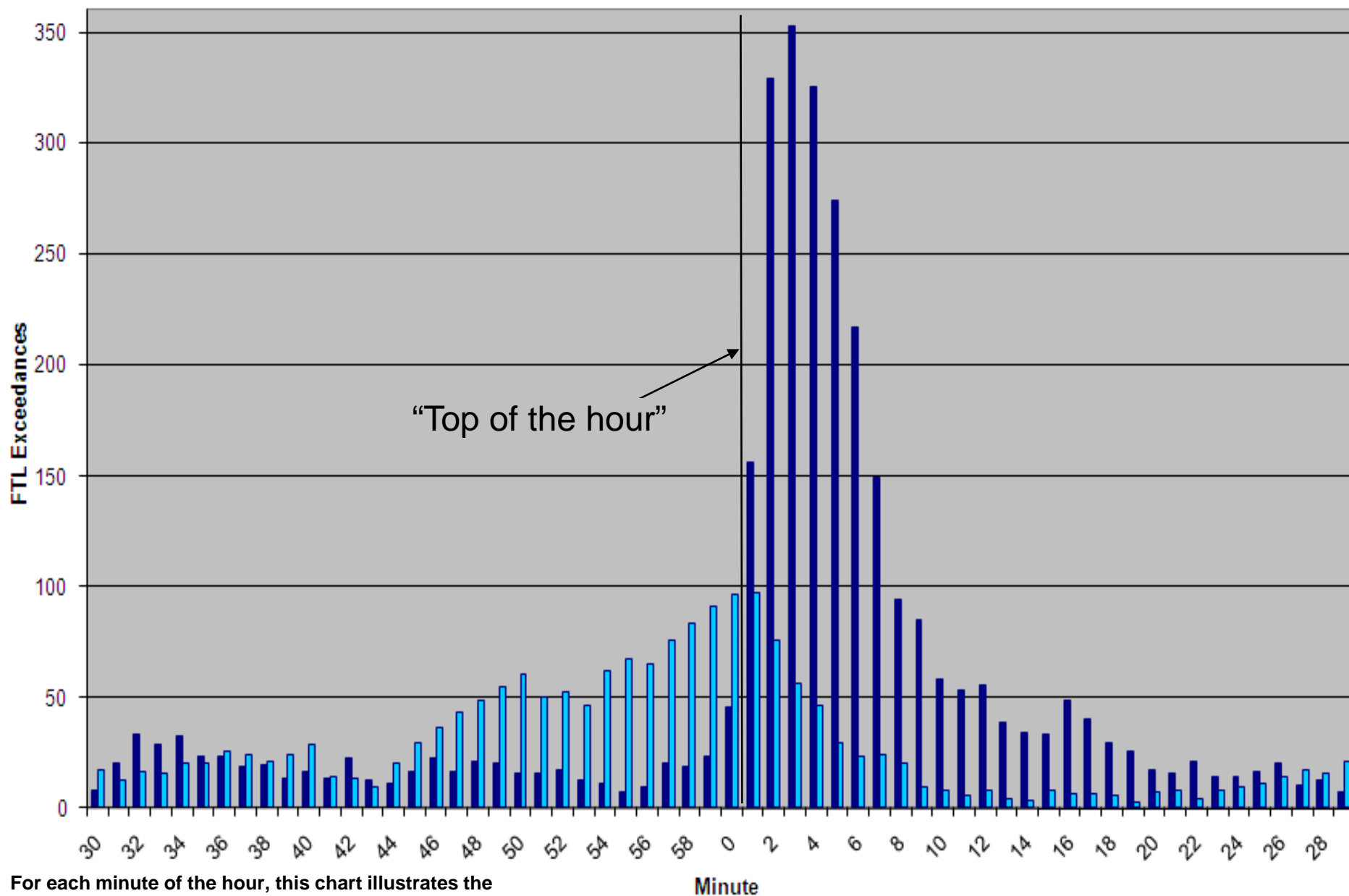
Total Clock-Minutes less than Low FTL or greater than High FTL Eastern Interconnection



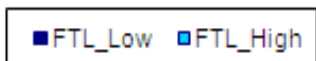
*March 2007- change to the new Daylight Saving Time.

■ Total Minutes at 60 Hz
 ■ Addition Minutes During Time-Error Corrections

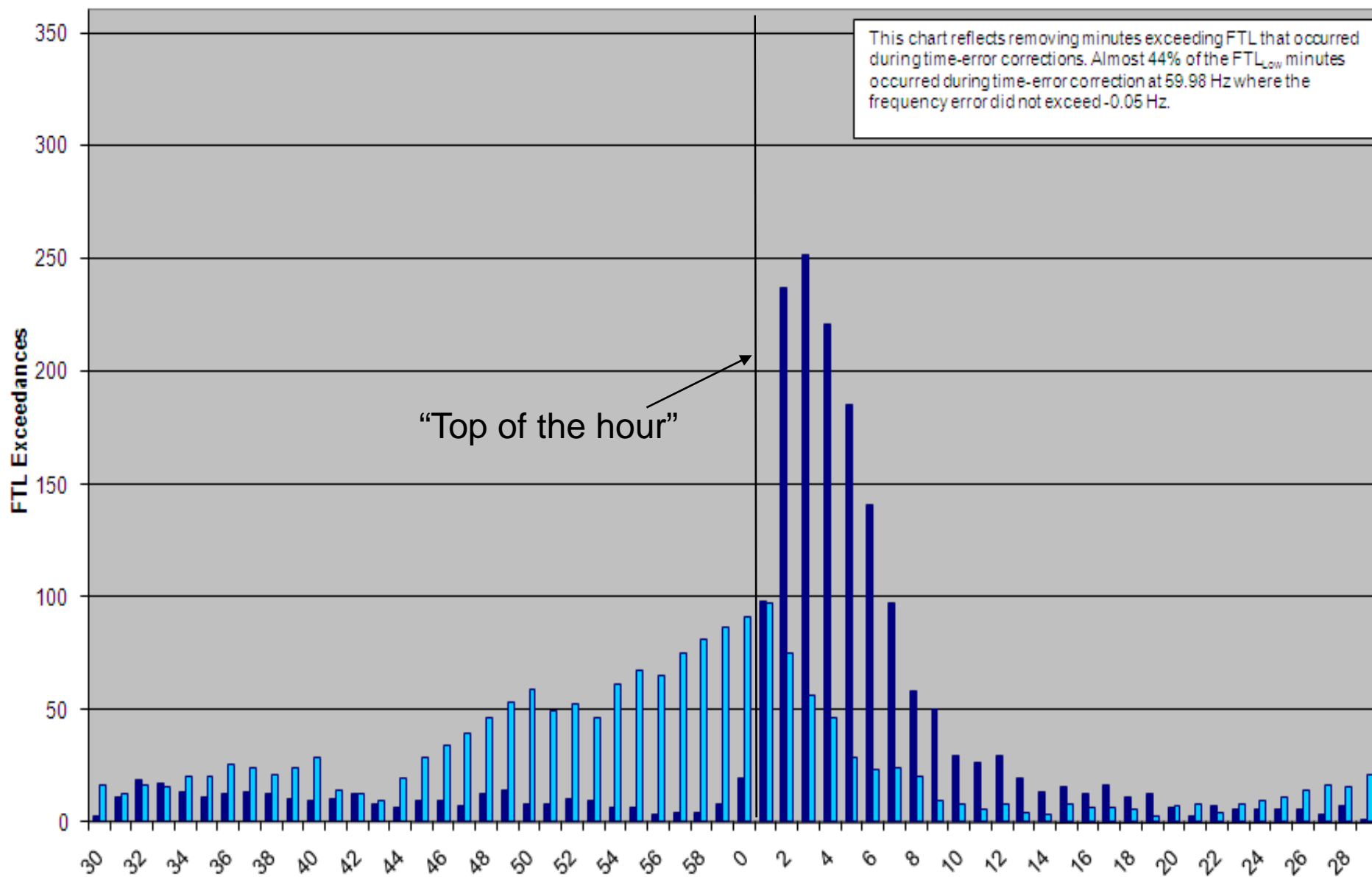
Count of FTL Exceedances by Minute (Weekdays)



For each minute of the hour, this chart illustrates the accumulated minutes that the Frequency Trigger Limit (FTL) has been exceeded, based upon data gathered since the start of the Field Trial.



Count of FTL Exceedances by Minute (Weekdays)

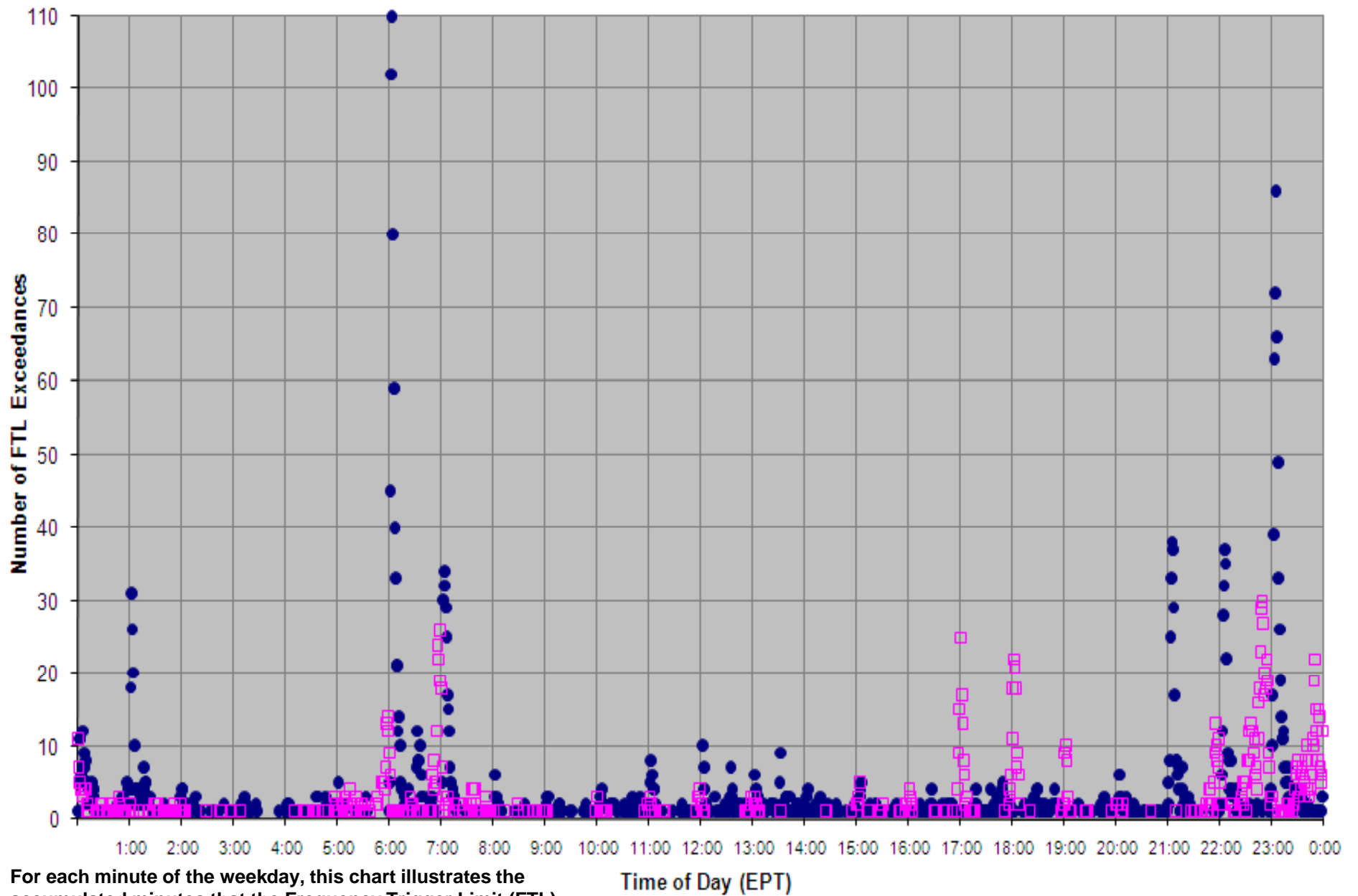


For each minute of the hour, this chart illustrates the accumulated minutes that the Frequency Trigger Limit (FTL) has been exceeded, based upon data gathered since the start of the Field Trial.

■ FTL_Low ■ FTL_High

Reduction in FTL events

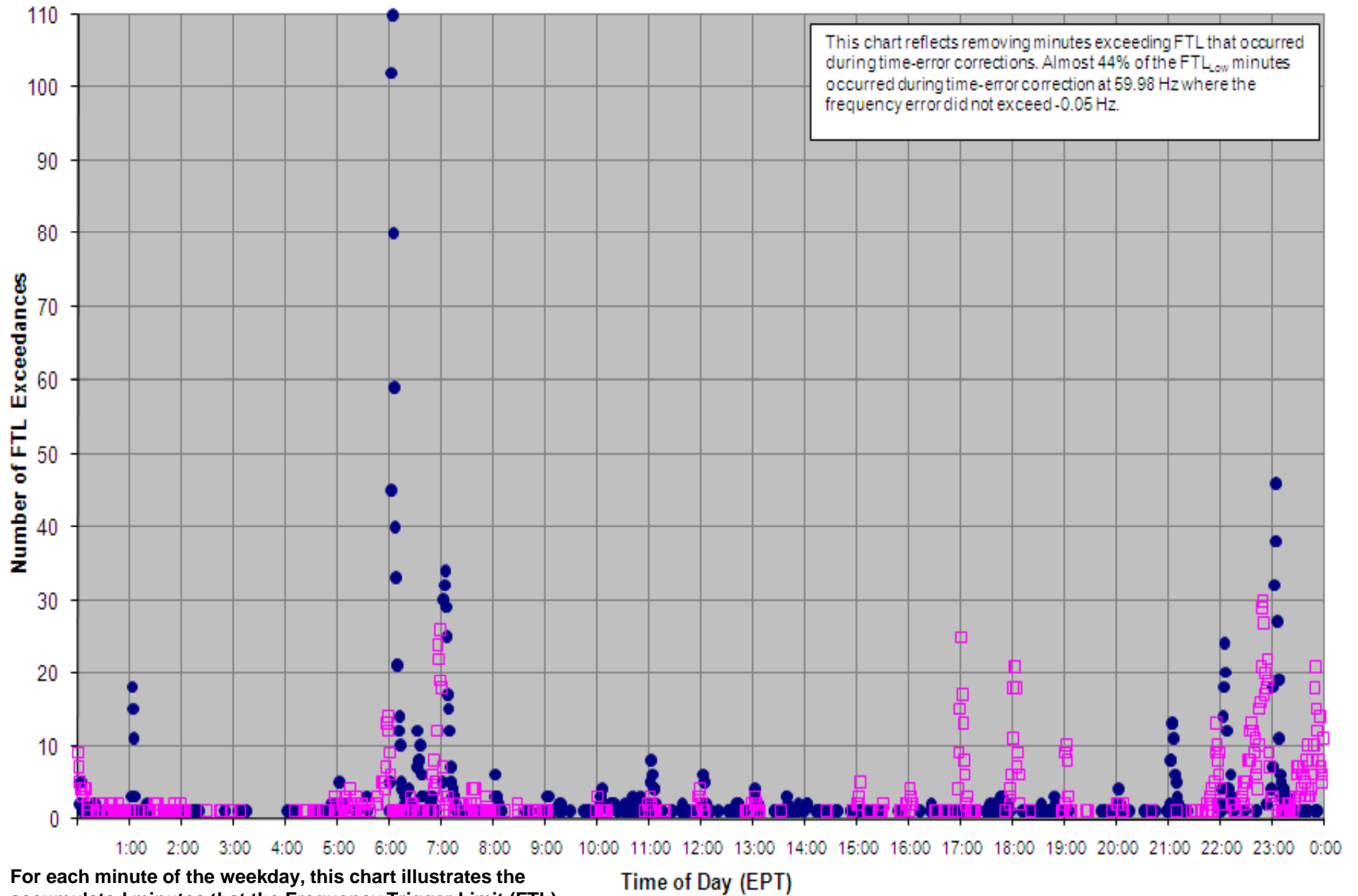
Count of Frequency Trigger Limit (FTL) Exceedances (Weekdays)



For each minute of the weekday, this chart illustrates the accumulated minutes that the Frequency Trigger Limit (FTL) has been exceeded, based upon data gathered since the start of the Field Trial.

● FTL_Low □ FTL_High

Count of Frequency Trigger Limit (FTL) Exceedances (Weekdays)



Balancing Authority ACE Limit Proof-of-Concept Field Trial

Project 2007-18 Reliability-Based Control

Dates in this presentation:

Clock-minute Frequency less than FTL_{Low} on April 5, 2010,
ending 6:04 EDT: 4 consecutive clock-minutes¹

Clock-minute Frequency less than FTL_{Low} on April 20, 2010,
ending 22:07 EDT: 5 consecutive clock-minutes, 59.98 Hz Scheduled Freq.

Clock-minute Frequency greater than FTL_{High} on April 19, 2010,
ending 21:57 EDT: 6 consecutive clock-minutes

Clock-minute ACE less than the $BAAL_{Low}$ on April 4, 2010,
ending 9:34 EDT: 27 consecutive clock-minutes, 59.98 Hz Scheduled Freq.

Clock-minute Frequency less than FTL_{Low} on April 28, 2010,
ending 6:03 EDT: 3 consecutive clock-minutes

¹ Under draft BAL-008, a proposed FTL_{Low} violation would occur when the actual frequency is lower than FTL_{Low} for more than 30 consecutive clock-minutes and a proposed FTL_{High} violation would occur when the actual frequency is greater than FTL_{High} for more than 30 consecutive clock-minutes. Under draft BAL-007, a proposed $BAAL_{Low}$ violation would occur when the ACE is lower than $BAAL_{Low}$ for more than 30 consecutive clock-minutes and a proposed $BAAL_{High}$ violation would occur when the ACE is greater than $BAAL_{High}$ for more than 30 consecutive clock-minutes.

4/05/2010 6:00-6:04 EDT

4 minute duration below FTL_{Low}

EI Clock-Minute Average Frequency

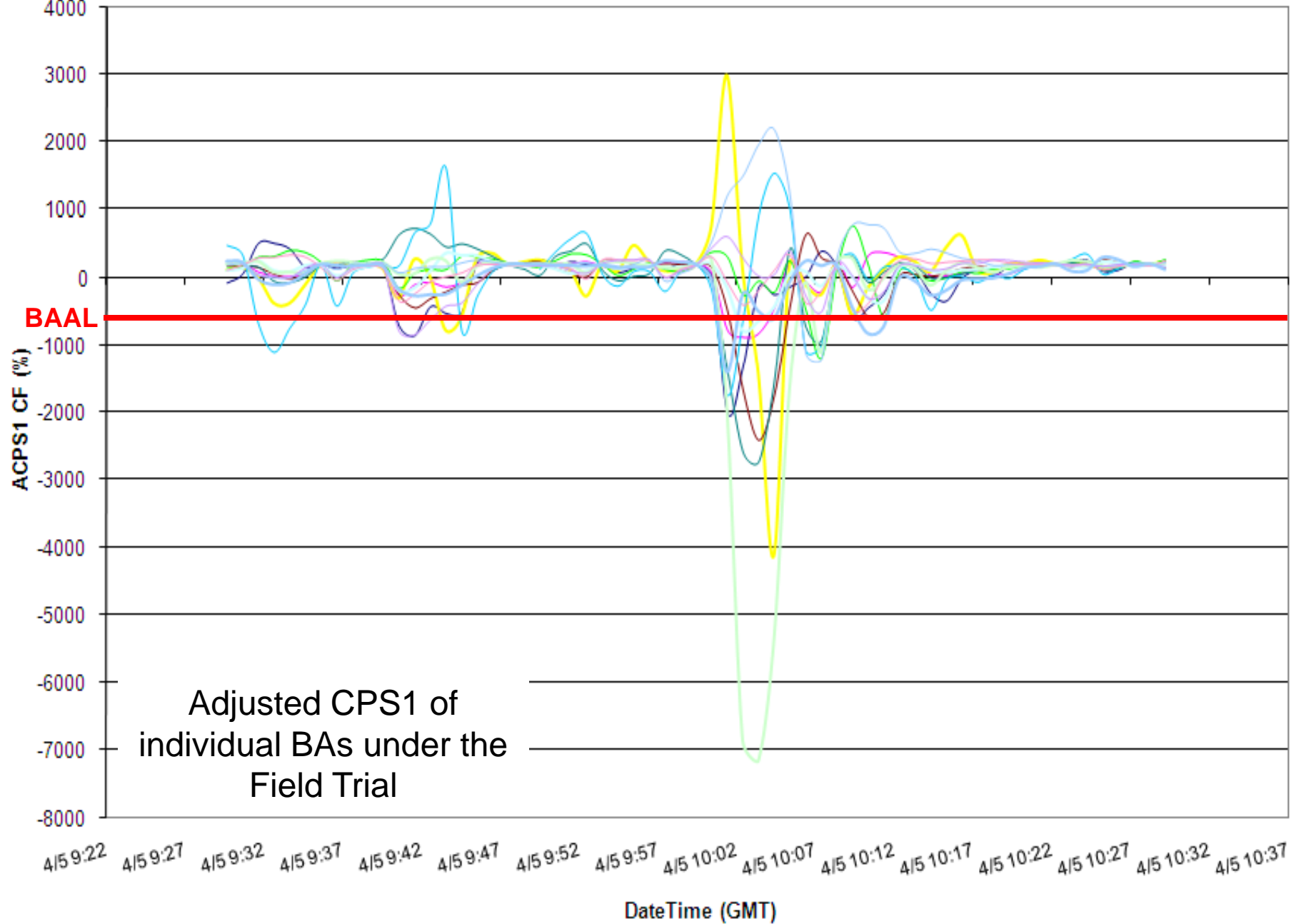


Clock-minute Actual Frequency of Participants

4/05/2010 6:00-6:04 EDT

4 minute duration below FTL_{Low}

ACPS1 Clock-Minute Averages

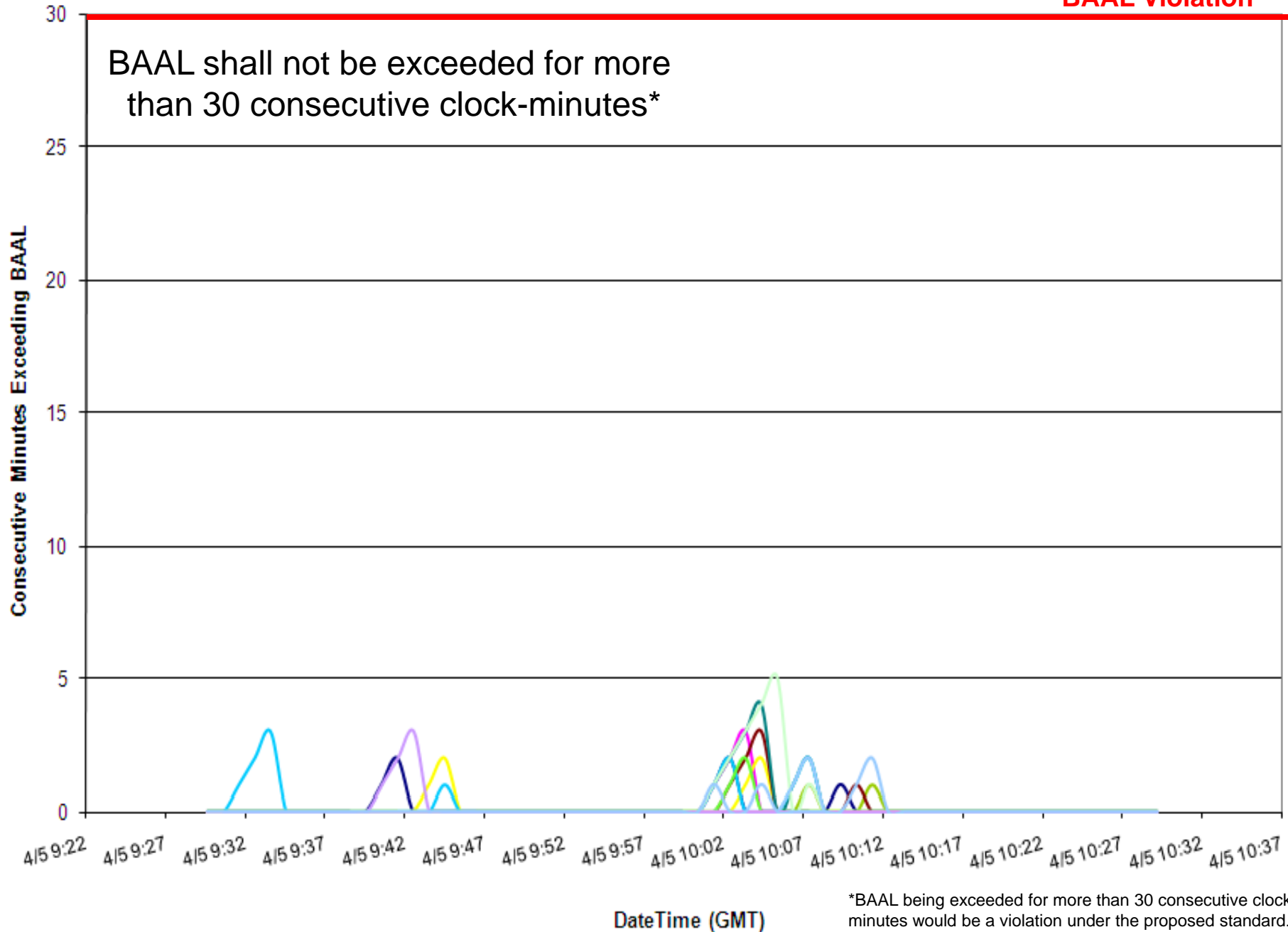


4/05/2010 6:00-6:04 EDT

4 minute duration below FTL_{Low}

Consecutive Minutes Exceeding BAAL

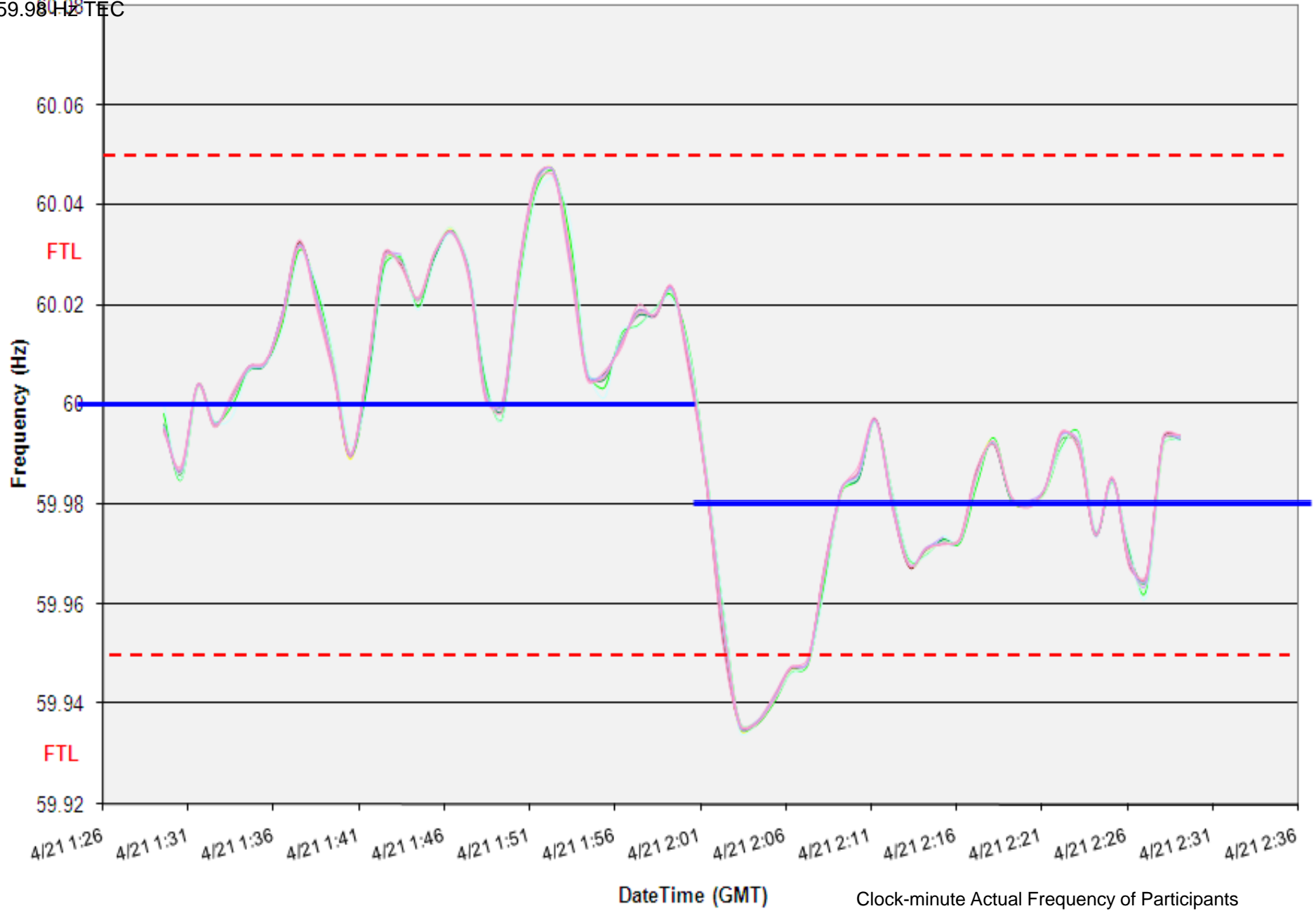
BAAL Violation*



4/20/2010 22:02-22:07 EDT

5 minute duration below FTL_{Low} during
59.98 Hz TEC

EI Clock-Minute Average Frequency

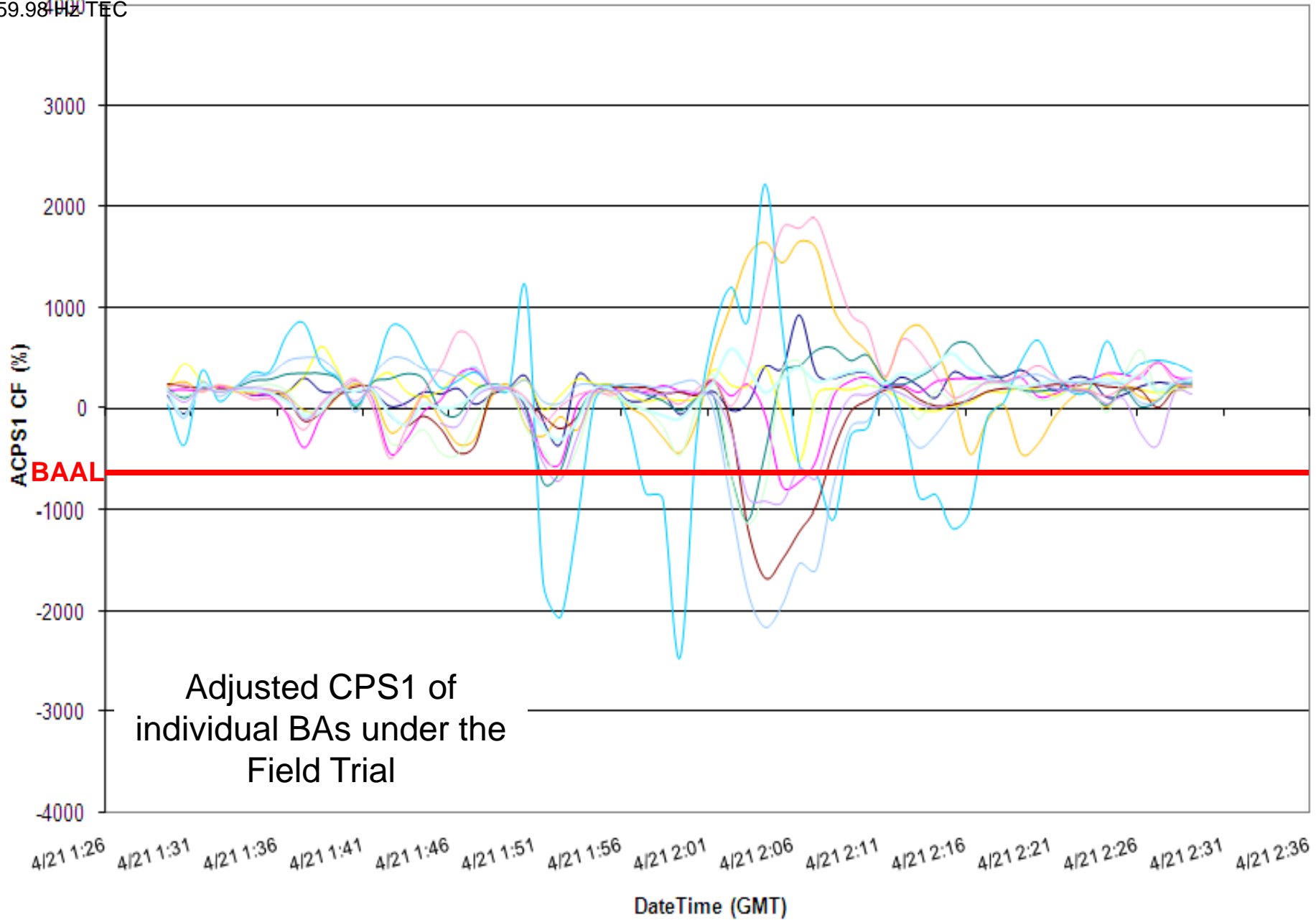


Clock-minute Actual Frequency of Participants

4/20/2010 22:02-22:07 EDT

59.98 Hz TEC
5 minute duration below FTL_{Low} during

ACPS1 Clock-Minute Averages

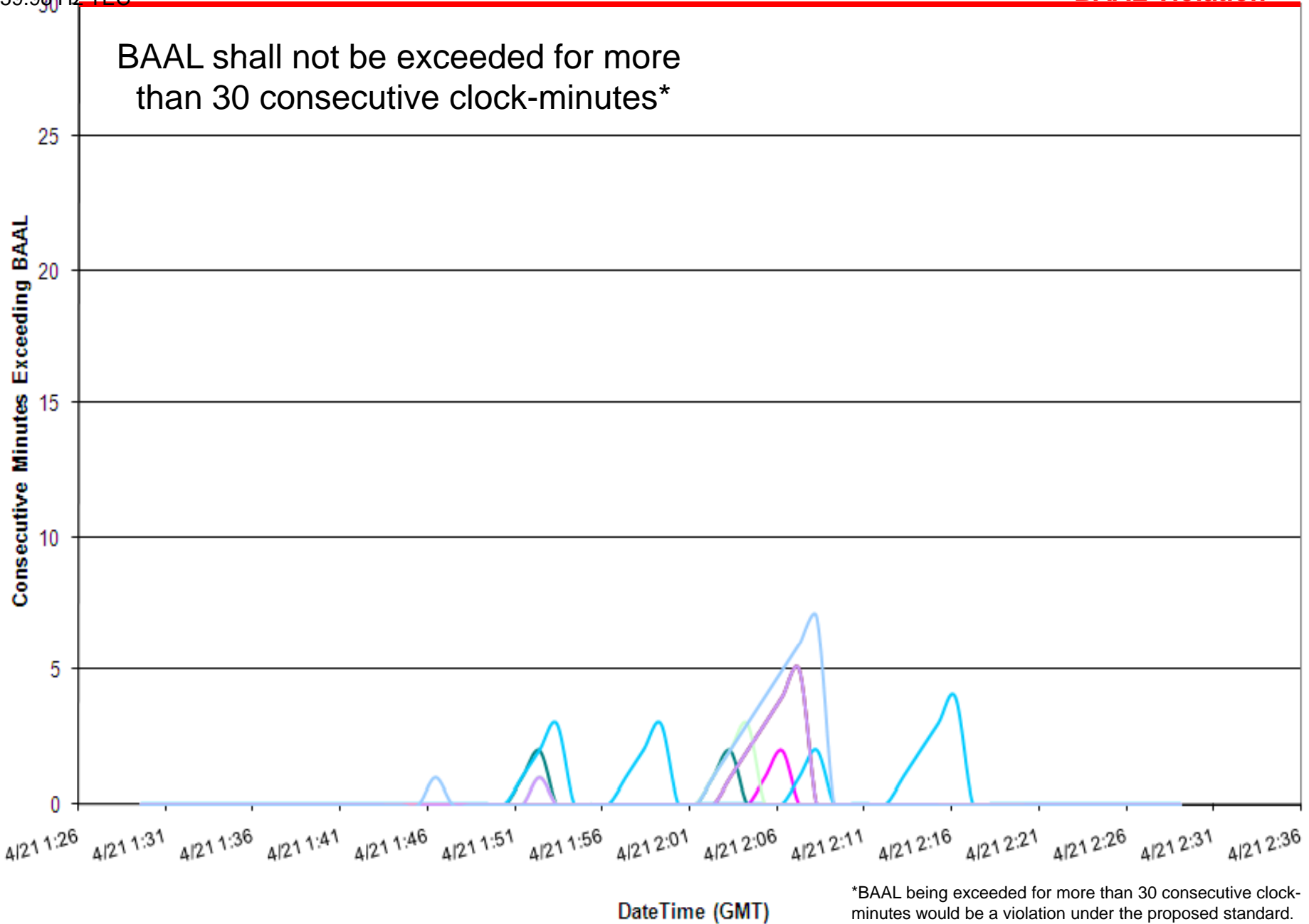


4/20/2010 22:02-22:07 EDT

5 minute duration below FTL_{Low} during
59.98 Hz TEC

Consecutive Minutes Exceeding BAAL

BAAL Violation*



4/19/2010 21:53-21:57 EDT

6 minute duration above FTL_{High}

EI Clock-Minute Average Frequency

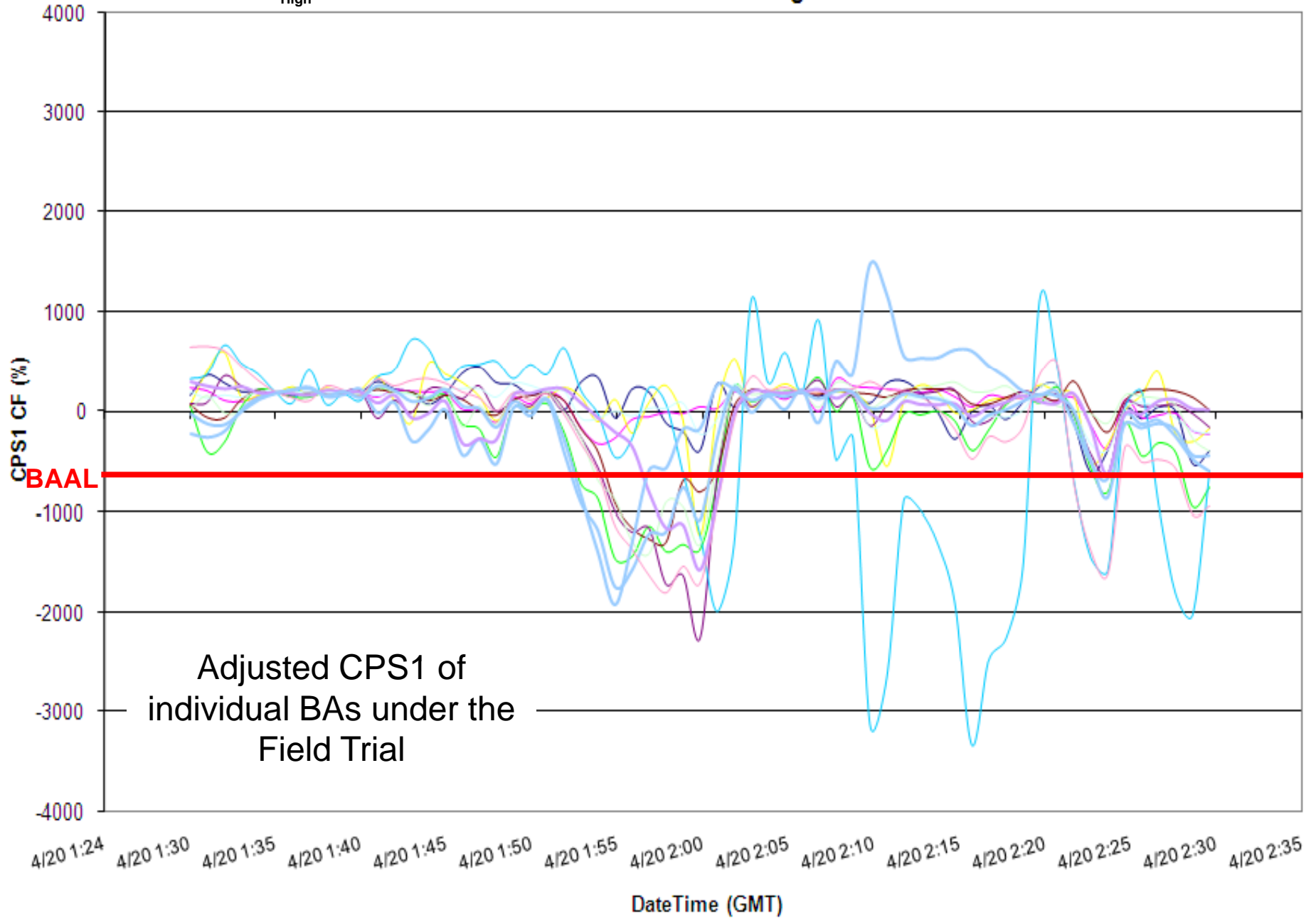


Clock-minute Actual Frequency of Participants

4/19/2010 21:53-21:57 EDT

6 minute duration above FTL_{High}

ACPS1 One-Minute Averages

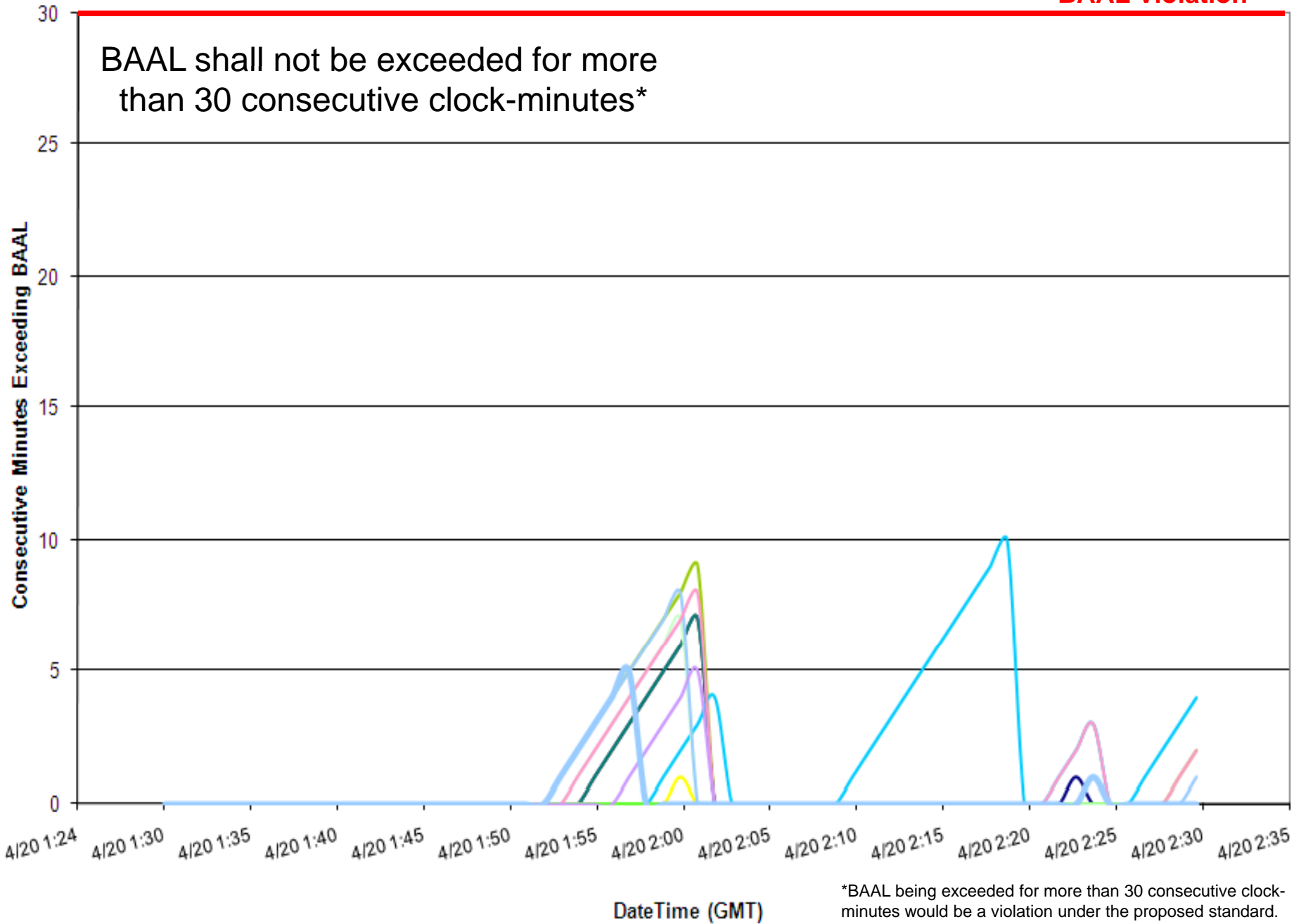


4/19/2010 21:53-21:57 EDT

6 minute duration above FTL_{High}

Consecutive Minutes Exceeding BAAL

BAAL Violation*



4/04/2010 9:17-9:34 EDT

27-minute duration below BAAL_{Low}
during 59.98 Hz TEC

El Clock-Minute Average Frequency

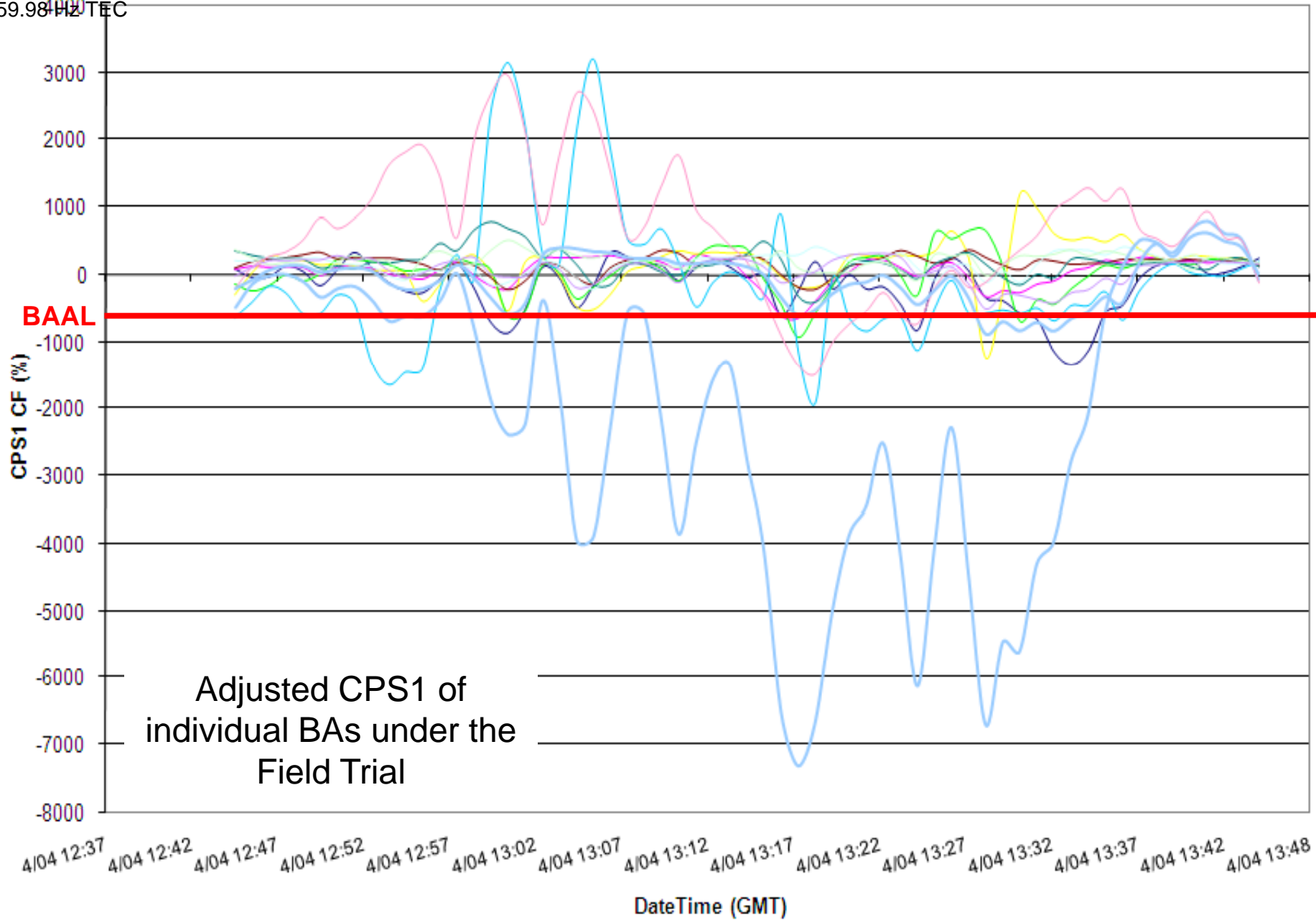


Clock-minute Actual Frequency of Participants

4/04/2010 9:17-9:34 EDT

27-minute duration below BAAL_{Low} during
59.98 Hz TEC

ACPS1 One-Minute Averages

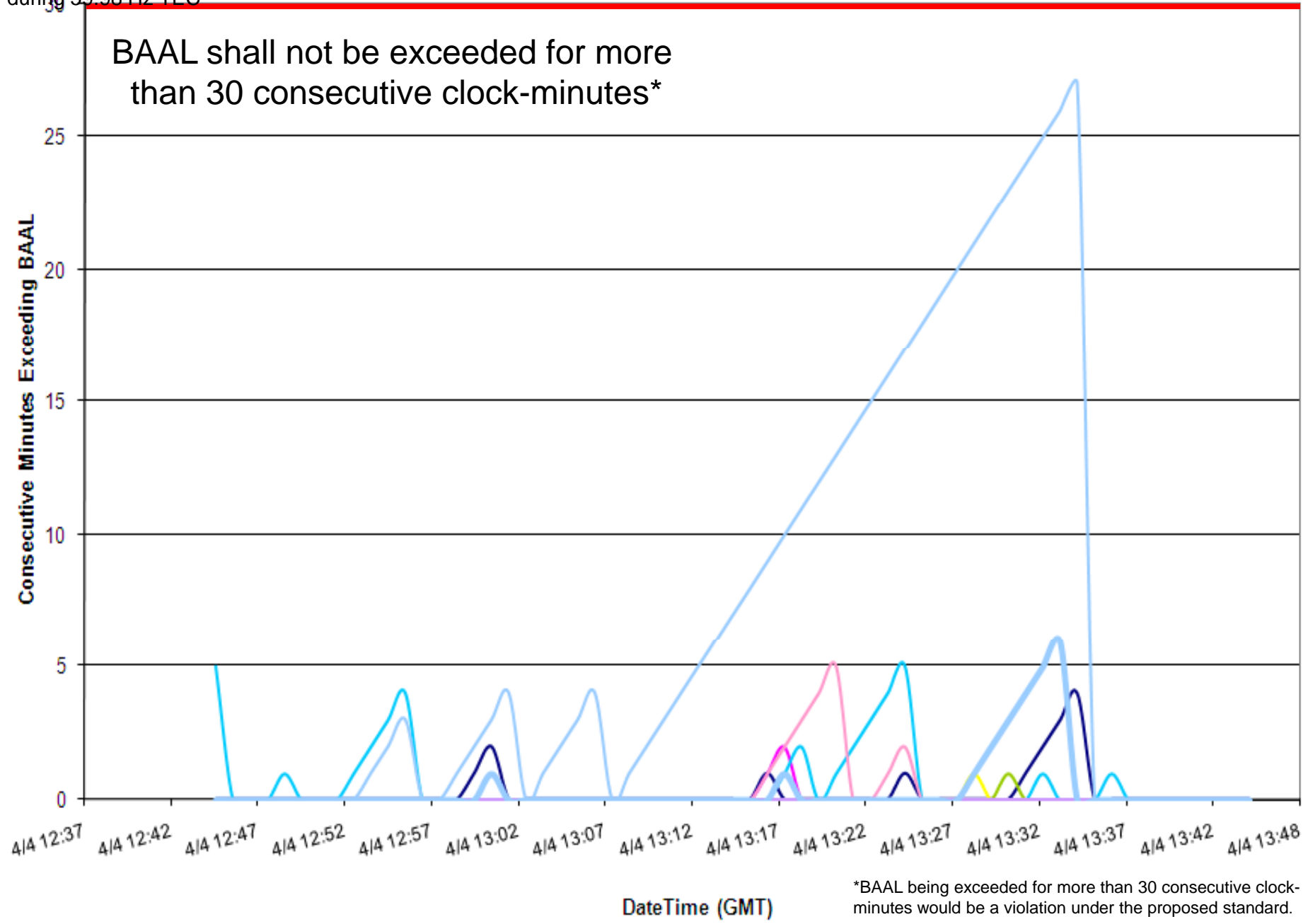


4/04/2010 9:17-9:34 EDT

27-minute duration below BAAL_{Low}
during 59.98 Hz TEC

Consecutive Minutes Exceeding BAAL

BAAL Violation*

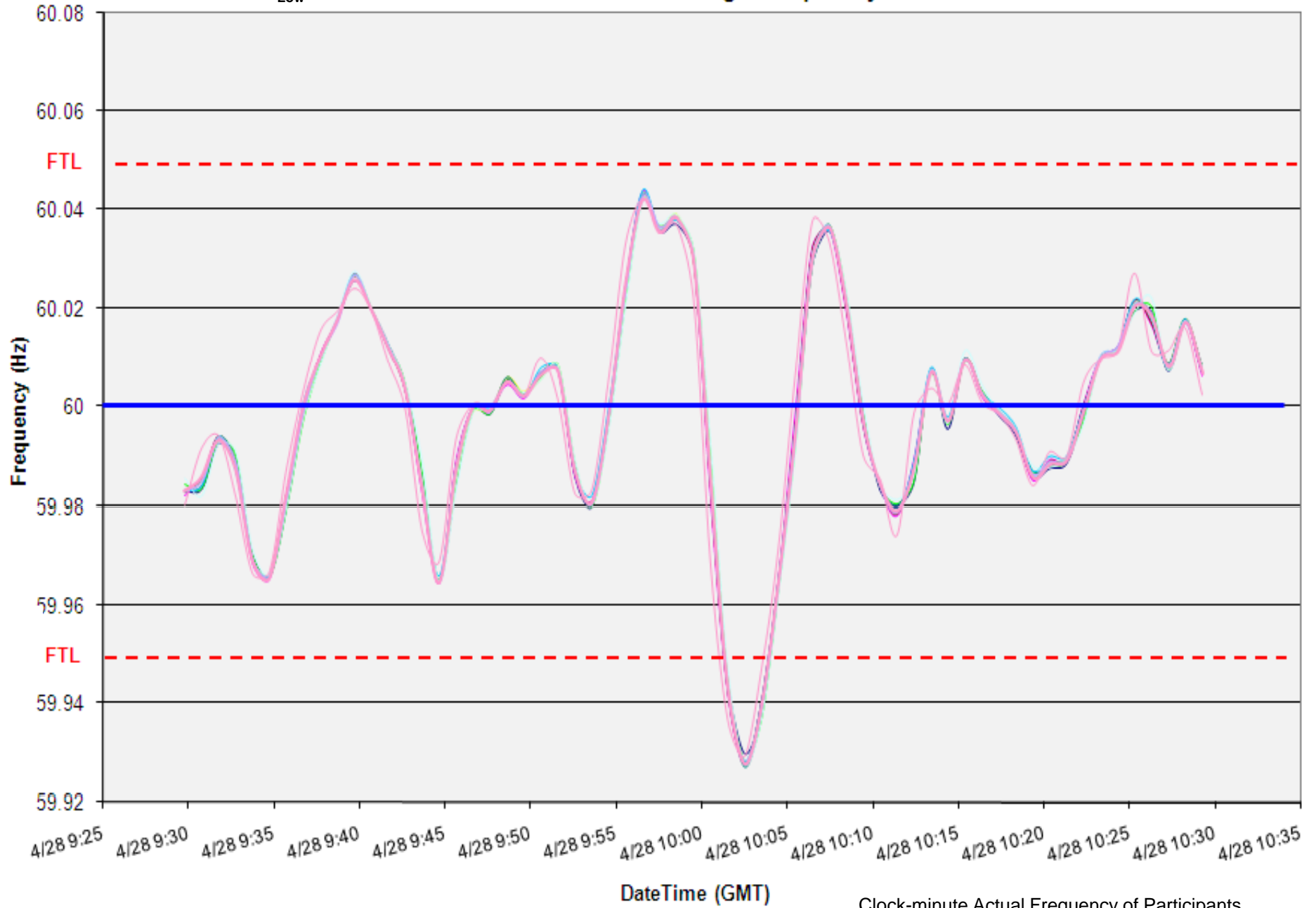


*BAAL being exceeded for more than 30 consecutive clock-minutes would be a violation under the proposed standard.

4/28/2010 6:00-6:03 EDT

3 minute duration below FTL_{Low}

El Clock-Minute Average Frequency

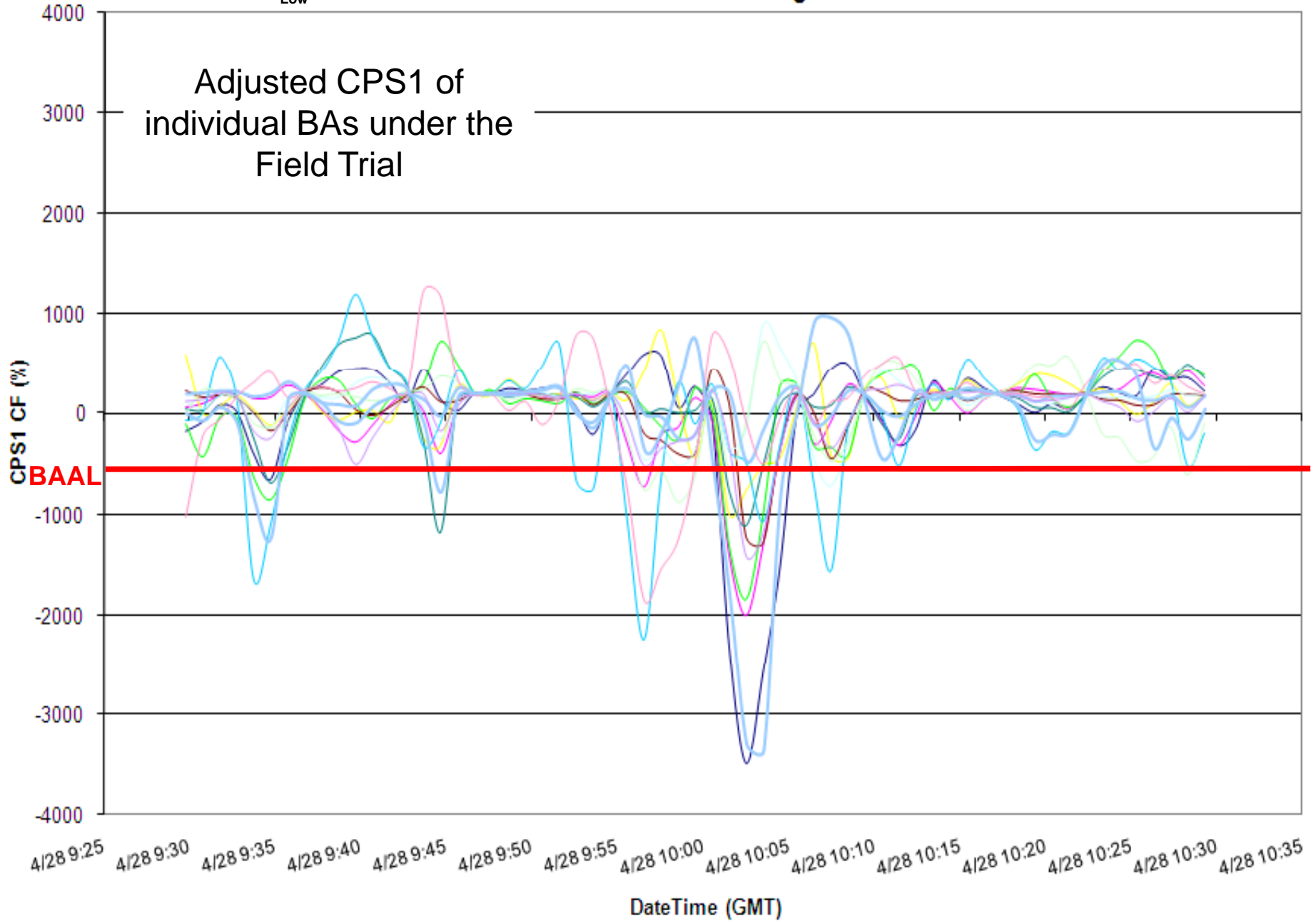


Clock-minute Actual Frequency of Participants

4/28/2010 6:00-6:03 EDT

3 minute duration below FTL_{Low}

ACPS1 One-Minute Averages

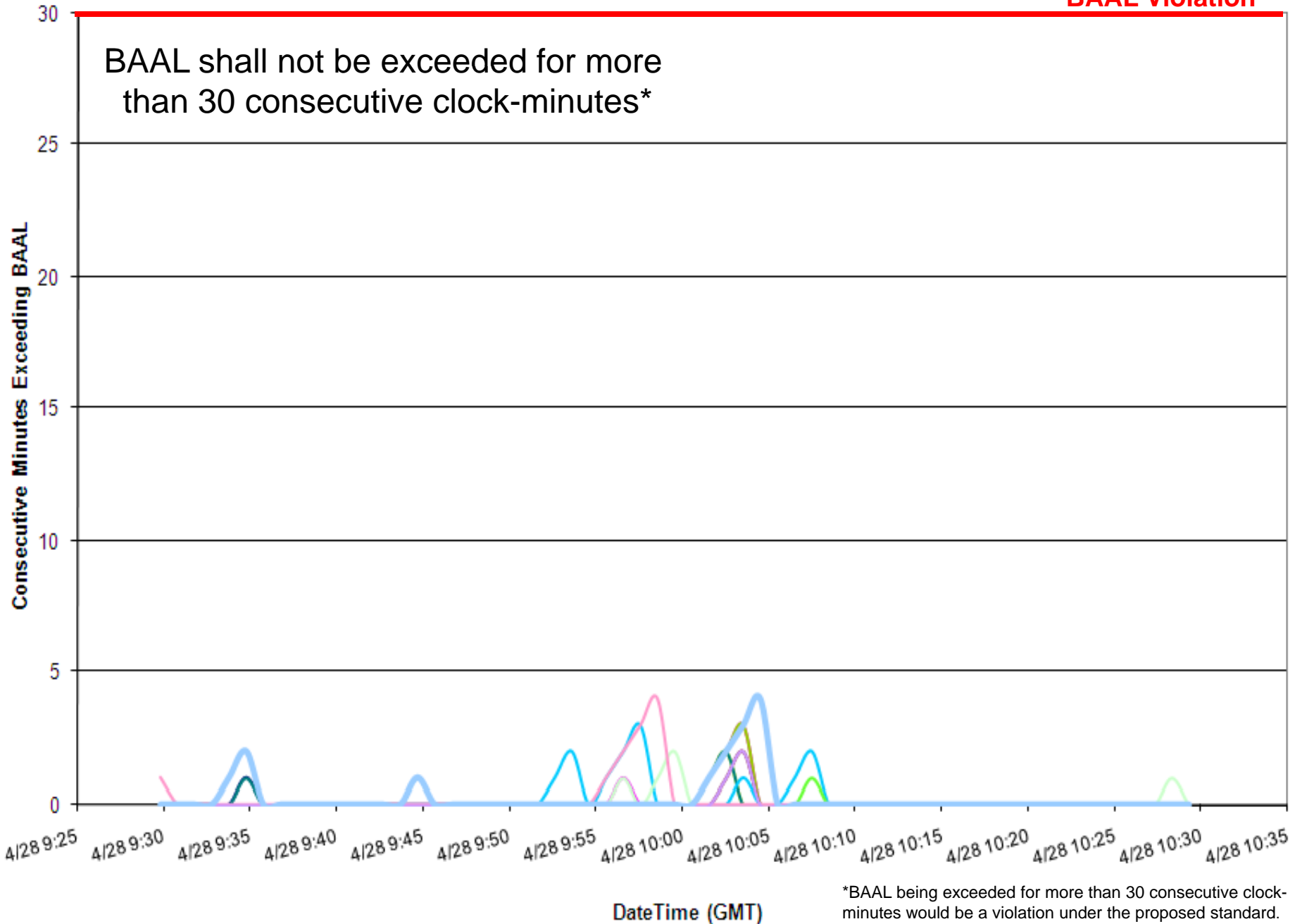


4/28/2010 6:00-6:03 EDT

3 minute duration below FTL_{Low}

Consecutive Minutes Exceeding BAAL

BAAL Violation*



*BAAL being exceeded for more than 30 consecutive clock-minutes would be a violation under the proposed standard.

Project 2007-18 Reliability-Based Control - examples of ACE exceeding the BAAL

Project 2007-18 Reliability-Based Control Proof-of-Concept Field Trial

Monthly Review of ACE Exceeding the Balancing Authority ACE Limit

On a monthly basis, each Balancing Authority will review its performance for the prior month and identify any periods where the ACE exceeded the low BAAL ("BAAL_{Low}") or the high BAAL ("BAAL_{High}") for more than ten consecutive clock-minutes. To help the RBCSDT gain a better understanding of the circumstances that all Balancing Authorities may be faced while operating under BAL-007, each Balancing Authority will provide a brief explanation of the circumstances related to any periods where the duration of consecutive clock-minutes exceeded twenty minutes. In the event that no period exceeded twenty minutes in the prior month, but the longest duration exceeded ten minutes, the Balancing Authority will provide a brief explanation of the circumstances related to that longest-duration event.

Clock-minute of ACE exceeding the BAAL (mm/dd/yy hh:mm)	Clock-minute of ACE returning within the BAAL (mm/dd/yy hh:mm)	TimeZone	Total duration of ACE exceeding the BAAL (minutes)	Event associated with a DCS-Reportable Event? (0=No, 1=Yes)	Event associated with a resource loss other than a DCS-Reportable Event? (0=No, 1=Yes)	Brief explanation of circumstances and notable actions taken if applicable
4/4/10 8:08	4/4/10 8:35	CDT	0:27	0	0	Time error correction in effect. 280 MW Coal Unit delayed in starting, 700 MW Coal Unit swinging, wind generation steadily falling. 90 MW purchased on the half-hour. Two 110 MW quick-start peakers fired at 08:24, one failed. Additional 110 MW quick-start peaker fired at 08:28. 75 MW sale cut at 08:32, effective 08:35.
4/6/10 20:02	4/6/10 20:23	CDT	0:21	0	0	Time error correction in effect. Load forecast underestimated the actual load. Generation scheduled from JOU reduced by 20 MW. Wind generation steadily falling. 110 MW quick-start peaker fired at 20:13.
4/8/10 21:04	4/8/10 21:18	EST	0:14	0	0	Generation wasn't able to keep up with climbing demand due to steel load. Operator increased generation to return ACE to acceptable levels.
4/15/10 6:47	4/15/10 7:00	EDT	0:13	0	0	High ACE caused by demand being lighter than expected. No notable actions taken to recover.
4/28/10 3:14	4/28/10 3:27	EDT	0:13	0	0	A BAAL low event occurred during a time error correction when an industrial customer began running two furnaces while the operator was reducing the system's generation. ACE was also low.

Balancing Authority ACE Limit Proof-of-Concept Field Trial

Discussion

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Clock-Minutes of Actual Frequency <= FTL_Low (59.95 Hz)												
Year	Month	>=1 Min	>=2 Min	>=3 Min	>=4 Min	>=5 Min	>=6 Min	>=7 Min	>=8 Min	>=9 Min	>=10 Min	Max_Duration
2005	7	32	14	7	3	2						5
2005	8	56	36	20	12	8	2	1	1	1	1	10
2005	9	33	20	9	4	2	1	1	1			8
2005	10	43	21	12	5	2	2	1	1	1	1	11
2005	11	58	26	14	5	4	1					6
2005	12	41	18	5	4	2	2	1				7
2006	1	43	20	7	2	2	1					6
2006	2	39	17	4	2	1	1					6
2006	3	50	23	4	2							4
2006	4	58	30	10	5	2						5
2006	5	54	30	15	10	4	4	1	1			8
2006	6	41	22	11	4	1						5
2006	7	34	18	9	4	2	1	1	1	1		9
2006	8	49	26	15	8	3						5
2006	9	39	21	11	4	3	1					6
2006	10	51	26	9	6	2	1					6
2006	11	47	22	10	8	4						5
2006	12	34	14	3	1							4
2007	1	44	21	10	7	3	2	1				7
2007	2	33	13	2								3
2007	3	76	39	18	10	3	2	2	1	1	1	15
2007	4	45	18	7	4	3						5
2007	5	64	32	10	7	3						5
2007	6	47	24	12	6	2	1					6
2007	7	33	19	8	4	2	1					6
2007	8	31	16	9	3	2	1					6
2007	9	41	27	12	6	4	2	2	1			8
2007	10	73	25	15	8	1						5
2007	11	60	23	10	2							4
2007	12	38	13	4	2	1	1					6
2008	1	34	21	11	4	2	1	1	1			8
2008	2	46	27	8	4	1	1	1	1			8
2008	3	55	27	10	7	2	1					6
2008	4	60	28	11	4	3						5
2008	5	63	31	9	3							4
2008	6	34	16	6	4	1						5
2008	7	29	17	9	1	1	1	1				7
2008	8	35	18	5	1	1						5
2008	9	39	20	9	1							4
2008	10	38	18	8	3	1						5
2008	11	13	5	2	1	1						5
2008	12	35	11	3	1							4
2009	1	16	7	3	2							4
2009	2	18	10	5	1							4
2009	3	23	10	4	2	2						5
2009	4	37	14	5	2	1						5
2009	5	31	9	2	1							4
2009	6	28	19	8	2	1						5
2009	7	22	12	2								3
2009	8	20	6									2
2009	9	21	10	2								3
2009	10	44	24	12	5	2	2					6
2009	11	33	12	4								3
2009	12	20	9	3	1	1						5
2010	1	35	14	6	3	2	2					6
2010	2	24	11	4								3
2010	3	65	28	11	3	1	1					6
2010	4	65	22	10	3	1						5
SUM		2370	1130	464	207	92	36	14	9	4	3	

This chart lists the number of times that the duration of the FTL_{Low} exceedance was greater than or equal to 1 minute, 2 minutes, 3 minutes and so on, with the maximum duration for the month noted in the right column. *The 15-minute duration in March 2007 was for the Monday morning after the change to the new Daylight Saving Time.

Clock-Minutes of Actual Frequency <= FTL_Low (59.95 Hz) and 60 Hz Scheduled Frequency												
Year	Month	>=1 Min	>=2 Min	>=3 Min	>=4 Min	>=5 Min	>=6 Min	>=7 Min	>=8 Min	>=9 Min	>=10 Min	Max_Duration
2005	7	16	8	4	1	1						5
2005	8	39	23	13	9	6	1					6
2005	9	16	9	6	3	2	1	1	1			8
2005	10	22	10	5	2	2	2	1	1	1	1	11
2005	11	26	10	4	1	1	1					6
2005	12	23	8	2	1	1	1					6
2006	1	21	7	2	1	1	1					6
2006	2	39	17	4	2	1	1					6
2006	3	33	15	2	1							4
2006	4	46	25	9	4	2						5
2006	5	33	19	8	5	1	1					6
2006	6	19	9	5	1							4
2006	7	22	11	6	1							4
2006	8	38	22	14	8	3						5
2006	9	30	17	8	2	2	1					6
2006	10	24	14	2	2							4
2006	11	19	8	4	3	1						5
2006	12	10	5	2	1							4
2007	1	14	7	3	2	1	1	1				7
2007	2	22	8	1								3
2007	3	41	17	7	6	2	1	1	1	1	1	15
2007	4	21	10	4	3	3						5
2007	5	26	10	4	4	2						5
2007	6	18	10	2								3
2007	7	12	5	2	1							4
2007	8	9	6	5	2	2	1					6
2007	9	28	22	10	6	4	2	2	1			8
2007	10	33	14	11	6	1						5
2007	11	14	5	2								3
2007	12	14	5	1	1	1	1					6
2008	1	34	21	11	4	2	1	1	1			8
2008	2	39	21	5	2	1	1	1	1			8
2008	3	38	19	4	3	1						5
2008	4	38	16	6	3	2						5
2008	5	23	12	3	1							4
2008	6	13	6	1	1							4
2008	7	10	5	2								3
2008	8	13	5	1								3
2008	9	25	11	7	1							4
2008	10	19	9	3	2							4
2008	11	6	2	1								3
2008	12	23	7	3	1							4
2009	1	15	6	3	2							4
2009	2	18	10	5	1							4
2009	3	23	10	4	2	2						5
2009	4	37	14	5	2	1						5
2009	5	25	7	2	1							4
2009	6	17	8	3								3
2009	7	14	7	1								3
2009	8	8	2									2
2009	9	13	8	1								3
2009	10	22	12	6	3	1	1					6
2009	11	14	4	1								3
2009	12	12	6	3	1	1						5
2010	1	13	7	2	2	1	1					6
2010	2	11	5									2
2010	3	40	19	7	3	1	1					6
2010	4	24	8	4	2							4
SUM		1315	623	246	116	53	21	8	6	2	2	

This chart lists the number of times that the duration of the FTL_{Low} exceedance was greater than or equal to 1 minute, 2 minutes, 3 minutes and so on, when Scheduled Frequency = 60 Hz, with the maximum duration for the month noted in the right column. *The 15-minute duration in March 2007 was for the Monday morning after the change to the new Daylight Saving Time.

Clock-Minutes of Actual Frequency >= FTL_High (60.05 Hz)												
Year	Month	>=1 Min	>=2 Min	>=3 Min	>=4 Min	>=5 Min	>=6 Min	>=7 Min	>=8 Min	>=9 Min	>=10 Min	Max_Duration
2005	7	11	4	1								3
2005	8	21	7	4	2	1						5
2005	9	21	9	3	2	2	1	1				7
2005	10	23	6	2	1	1						5
2005	11	22	7	4	1	1	1	1				7
2005	12	19	6	2								3
2006	1	27	15	11	6	2						5
2006	2	24	10	7	5							4
2006	3	33	12	4	2	1	1	1	1			8
2006	4	46	22	3	1	1	1	1	1			8
2006	5	39	20	9	4	1						5
2006	6	24	10	7	4	4	3	3	2	1	1	10
2006	7	29	11	8	2							4
2006	8	26	13	10	5	1	1	1	1			8
2006	9	33	14	4	2							4
2006	10	28	14	4	3	2	1	1	1			8
2006	11	22	11	4								3
2006	12	29	12	7	3	2	1					6
2007	1	31	14	5	2	1	1	1				7
2007	2	21	13	4	1							4
2007	3	38	21	10	4	2	1	1	1			8
2007	4	31	15	8	4							4
2007	5	49	20	11	7	4	4	1	7			7
2007	6	25	14	7	2	1	1	1				7
2007	7	20	12	8	2							4
2007	8	32	14	7	3	2						5
2007	9	16	6	4	2	1						5
2007	10	36	16	4	1	1						5
2007	11	24	7	5	2	1						5
2007	12	38	16	7	2							4
2008	1	24	16	8	1							4
2008	2	24	11	6	3	3	2	1	1			8
2008	3	34	6									2
2008	4	33	12	8	3	3	1					6
2008	5	20	10	6	4	1						5
2008	6	19	10	3	2	1						5
2008	7	12	4	1								3
2008	8	17	6	3	1	1	1					6
2008	9	21	11	6	5	3	3	3	3	2	1	11
2008	10	19	7	1								3
2008	11	9	2	1	1							4
2008	12	8	2	1								3
2009	1	9	6	4								3
2009	2	11	3	1	1	1	1					6
2009	3	11	4	3	2	1	1	1	1	1		9
2009	4	20	6	1								3
2009	5	15	4	2	2	1	1	1	1			8
2009	6	16	8	1								3
2009	7	16	7	2	1	1	1					6
2009	8	10	3									2
2009	9	14	4	1	1							4
2009	10	10	5	3								3
2009	11	21	8	4	1							4
2009	12	15	5	2								3
2010	1	9	6	1								3
2010	2	16	10									2
2010	3	22	9	3	3	2	1					6
2010	4	34	16	4	1	1	1					6
SUM		1327	572	250	107	51	30	19	13	4	2	

This chart lists the number of times that the duration of the FTL_{HIGH} exceedance was greater than or equal to 1 minute, 2 minutes, 3 minutes and so on, with the maximum duration for the month noted in the right column.