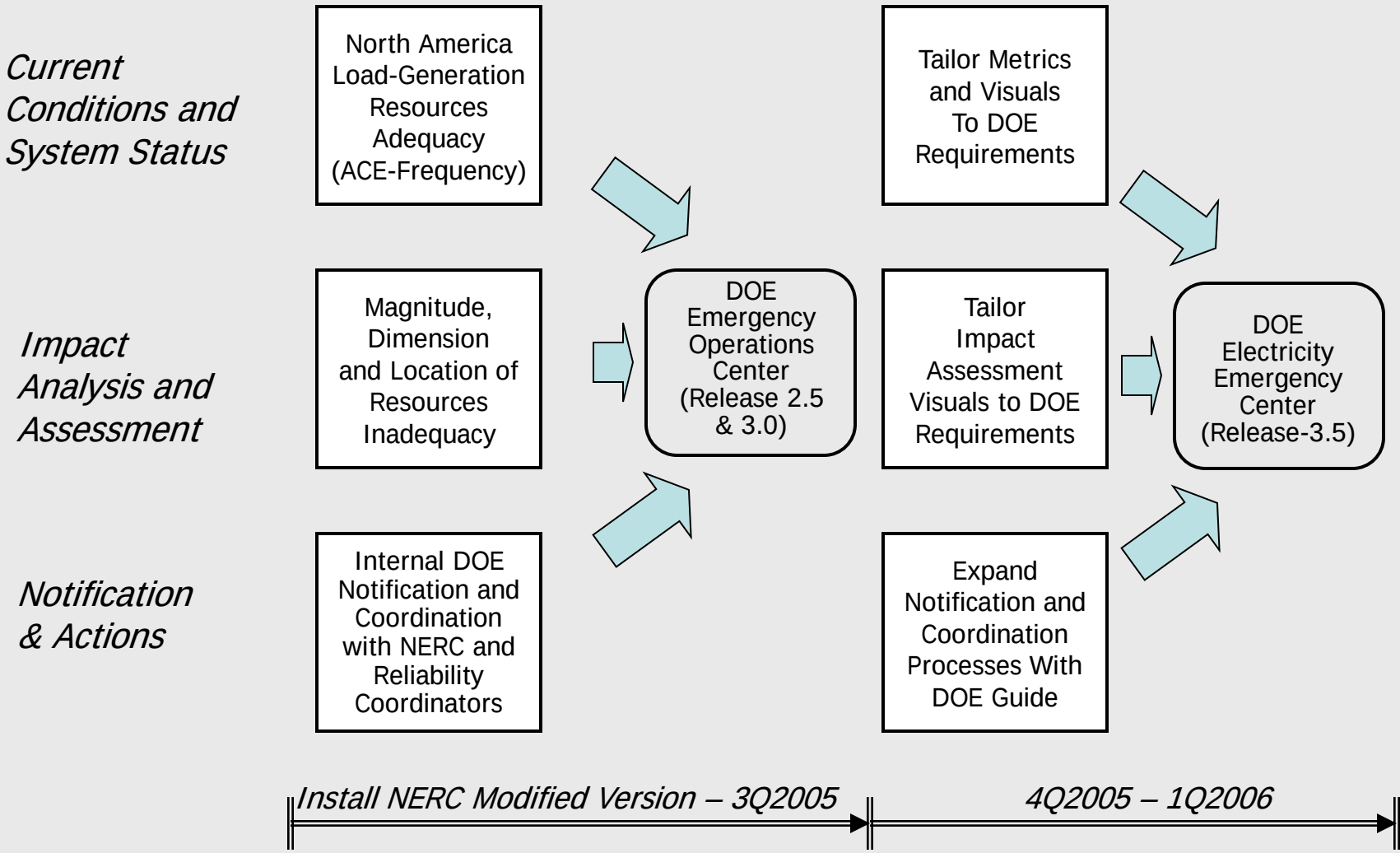
WIDE-AREA RESOURCES ADEQUACY MONITORING AND TRACKING (NERC ACE-FREQUENCY) Release 3.0

Plan for DOE Deployment, And User Training

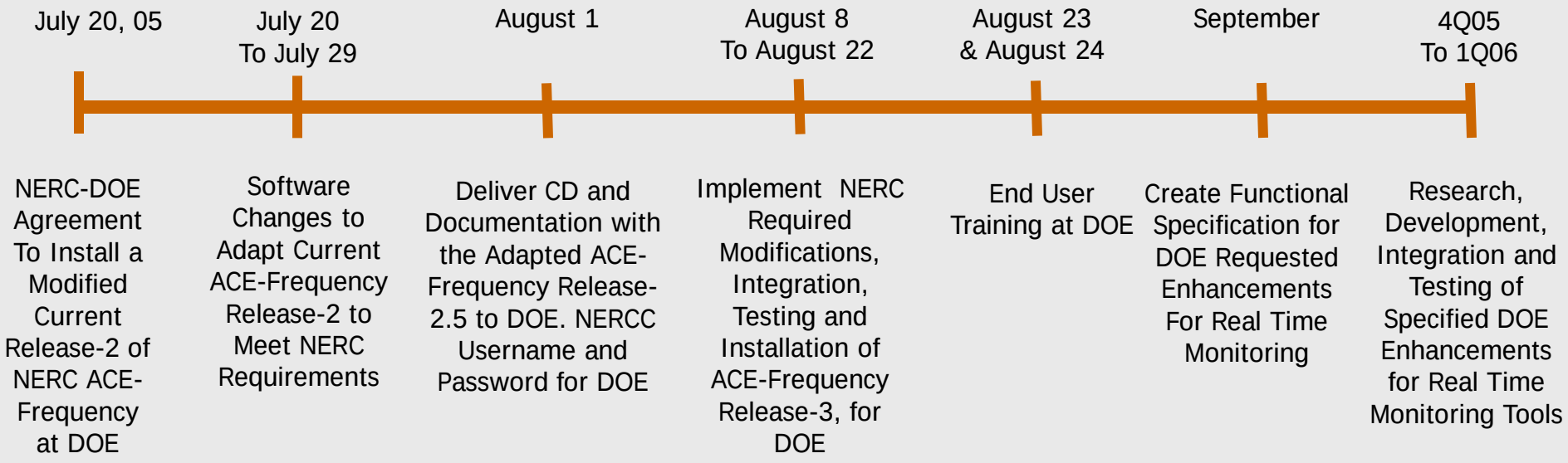
August 23 and 24 2005

PLAN AND TIMELINE TO DEPLOY THE NERC ACE FREQUENCY APPLICATION AT DOE EMERGENCY CENTER

Recommended Approach for Enhancing DOE-EOC Electric Grid Monitoring



Recommended Timeline for DOE Enhancements



CERTS-NERC TOOLS PORTFOLIO ADDRESSING BLACKOUT RECOMMENDATIONS

Blackout Causes

- Failure to maintain adequate reactive power support
- Failure to ensure operation within secure limits
- Inadequate operator training
- Failure to identify emergency conditions and communicate that status to neighboring systems
- Inadequate regional-scale visibility over the bulk power system

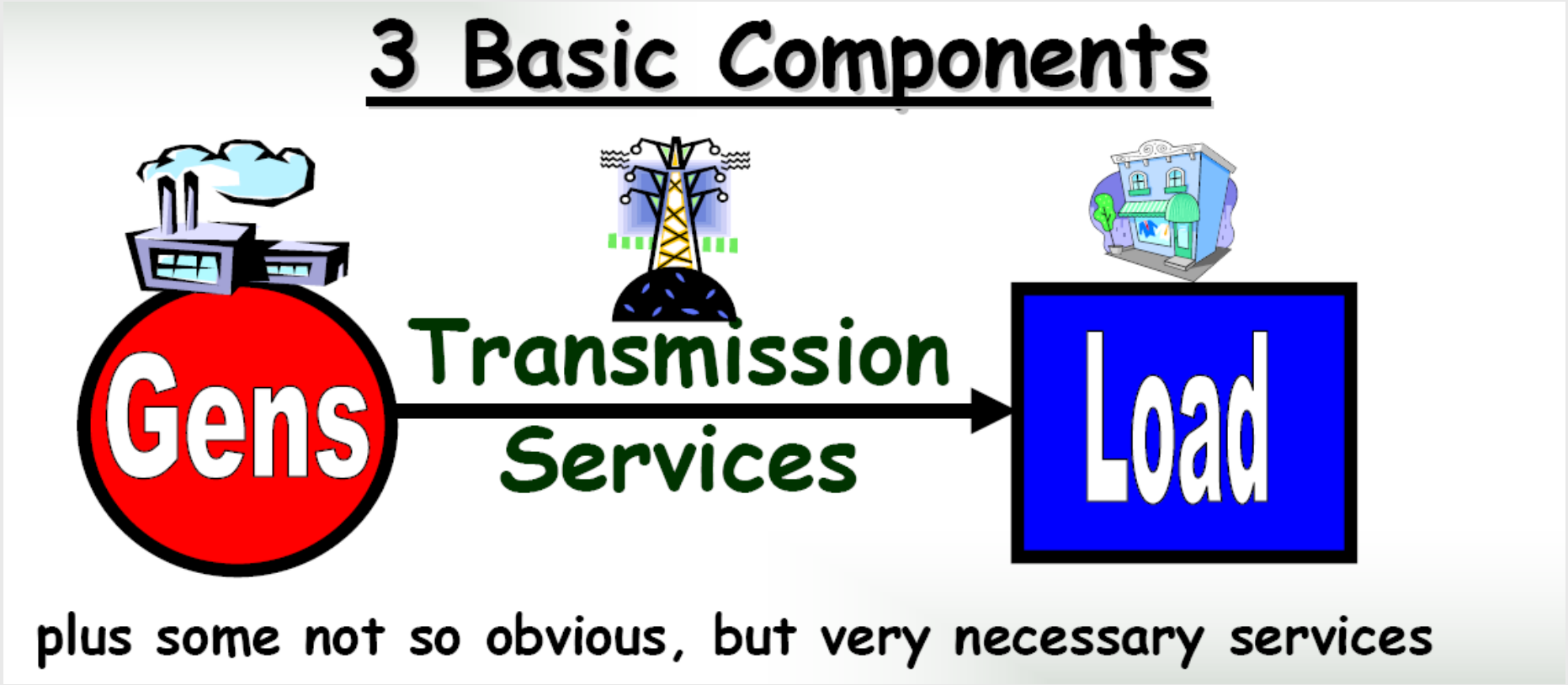
Blackout Recommendations

- Develop reliability related tools and technologies
- Adopt better real time tools for operators and reliability coordinators
- Strengthen reactive power and voltage practices
- Improve quality system modeling data and data exchange practices
- Required use of time synchronized data recorders

CERTS-NERC Tools

- Resource Adequacy – ***ACE-Frequency, (AIE, CPS, Inadv.)***
- Generation Control Adequacy – ***Frequency Response and Data Arching Using Phasor Measurements***
- Transmission Adequacy – ***Real Time Dynamic Monitoring System -RTDMS***
- Reactive Adequacy – ***VAR Management***
- Wide Area Visibility – ***Grid-3P™***

POWER FUNDAMENTALS FROM NYISO TRAINING PROGRAM



From NYISO "Power Fundamentals"

Four basic Power System Concepts: The Physical World

#1 "Load customers" determine Demand

#2 "Dispatch" determines where it's generated

#3 The Laws of Physics normally determine how the power gets there

#4 Flows must be controlled

From NYISO "Power Fundamentals"

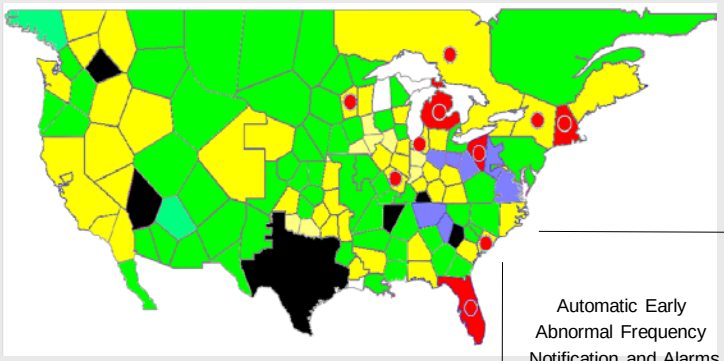
A Constant Balancing Act

- Load changes constantly
- Generation chases load
- Available generation changes
- Flows must be controlled
- Transmission system limitations
- 24 hours a day, 7 days a week

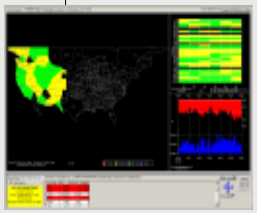
From NYISO "Power Fundamentals"

FUNDAMENTALS FOR DEMAND-RESOURCES ADEQUACY MONITORING AND TRACKING USING NERC-CERTS ACE-FREQUENCY APPLICATION (Release 3.0)

NERC ACE-Frequency Infrastructure



Automatic Early Abnormal Frequency Notification and Alarms



Multi- View, Geo - Graphic

Reliability Coordinators Client (22)

For Real- Time Monitoring of Abnormal Interconnection Frequency and For Root Cause Identification

A

- ACE- Frequency *Data Collection*
- *Data Validation*
- *Data Processing*

123 CONTROL AREAS SEND 1 - MINUTE DATA THROUGH SECURE NERC - NET

NERC Database Server

NERC Secure Ethernet (Princeton)

B

- *Abnormal Frequency Notification*
- *Frequency Alarms*

ACE - AIE KEY DATA BROADCAST OVER WEB TO RELIABILITY COORDINATORS EVERY MINUTE

NERC Web Server

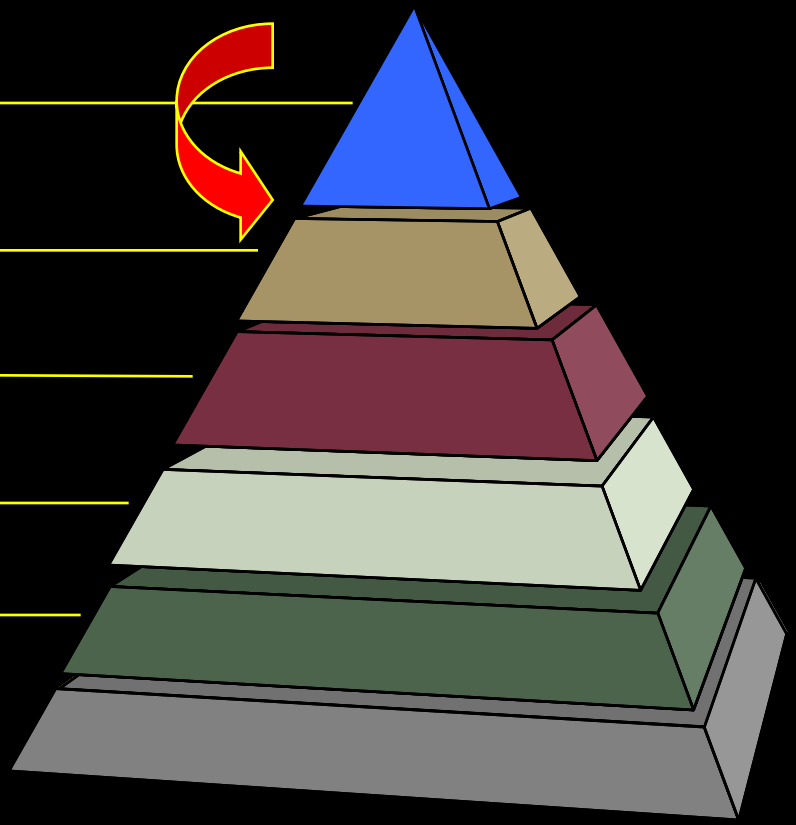
C

- *Real - Time Monitoring and Tracking*
- *Root Cause Identification*

POWER INDUSTRY OPERATIONAL, MONITORING AND TRACKING HIERARCHICAL LEVELS

Data is Produced at All Different Levels

Integrated Information Is Required at New Levels



Wide-Area Reliability Tracking

16 Reliability Coordinators – Need to have a wide-area view of their operational jurisdictions

ISOs and RTOs

Transmission Providers

Generation Serving Entities

Load Serving Entities

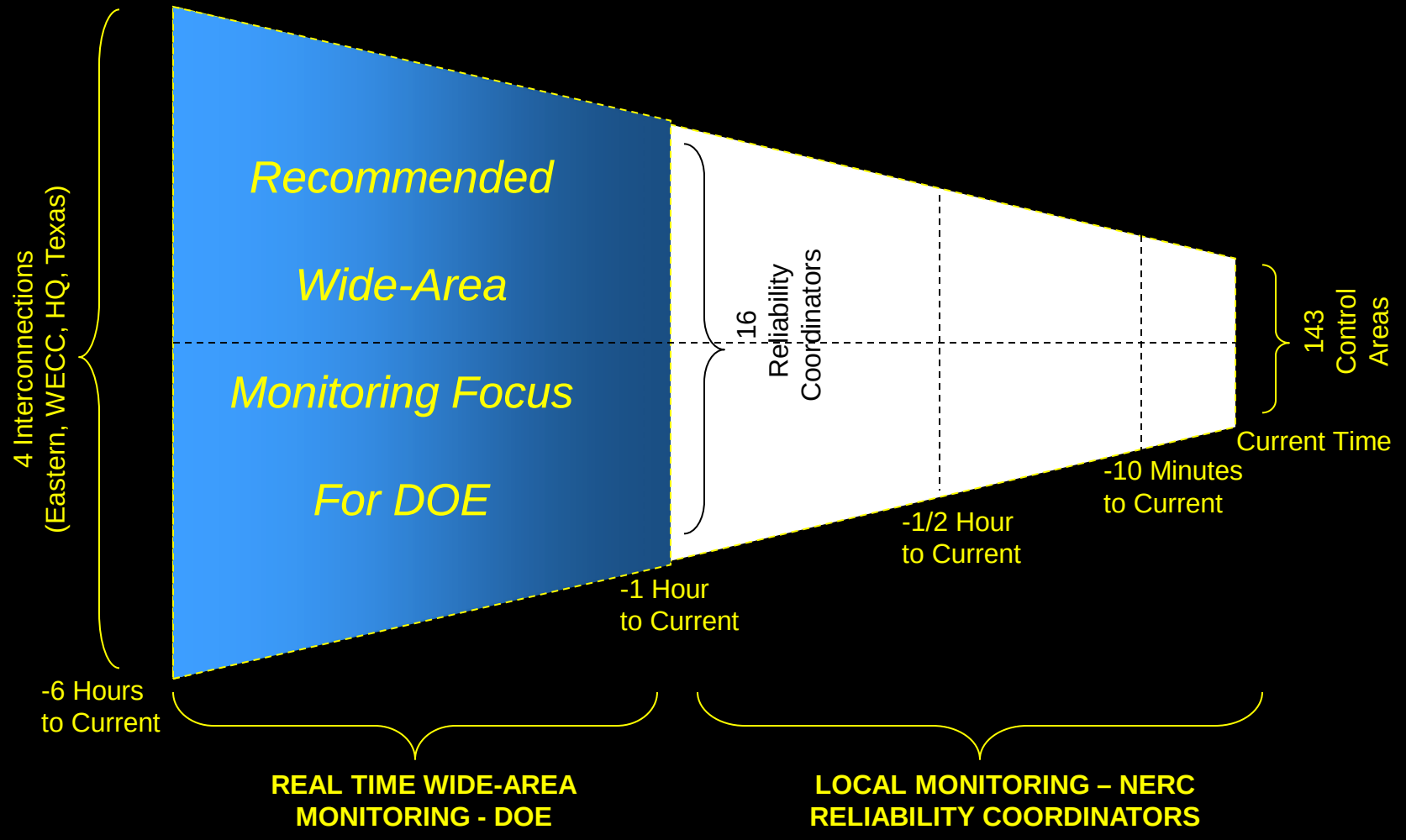
Visualization Solutions with Adequate Operational Information:

- ***Simple***
- ***Intuitive***
- ***Integrated***
- ***Meaningful Information***

Resource Adequacy 3 Fundamental Monitoring and Tracking Parameters:

- ***Time***
- ***Operational Levels or Jurisdictions***
- ***Performance Metrics***

DEMAND-RESOURCES ADEQUACY MONITORING-TRACKING USING NERC-CERTS ACE-FREQUENCY APPLICATION - TIME AND OPERATIONAL LEVELS -

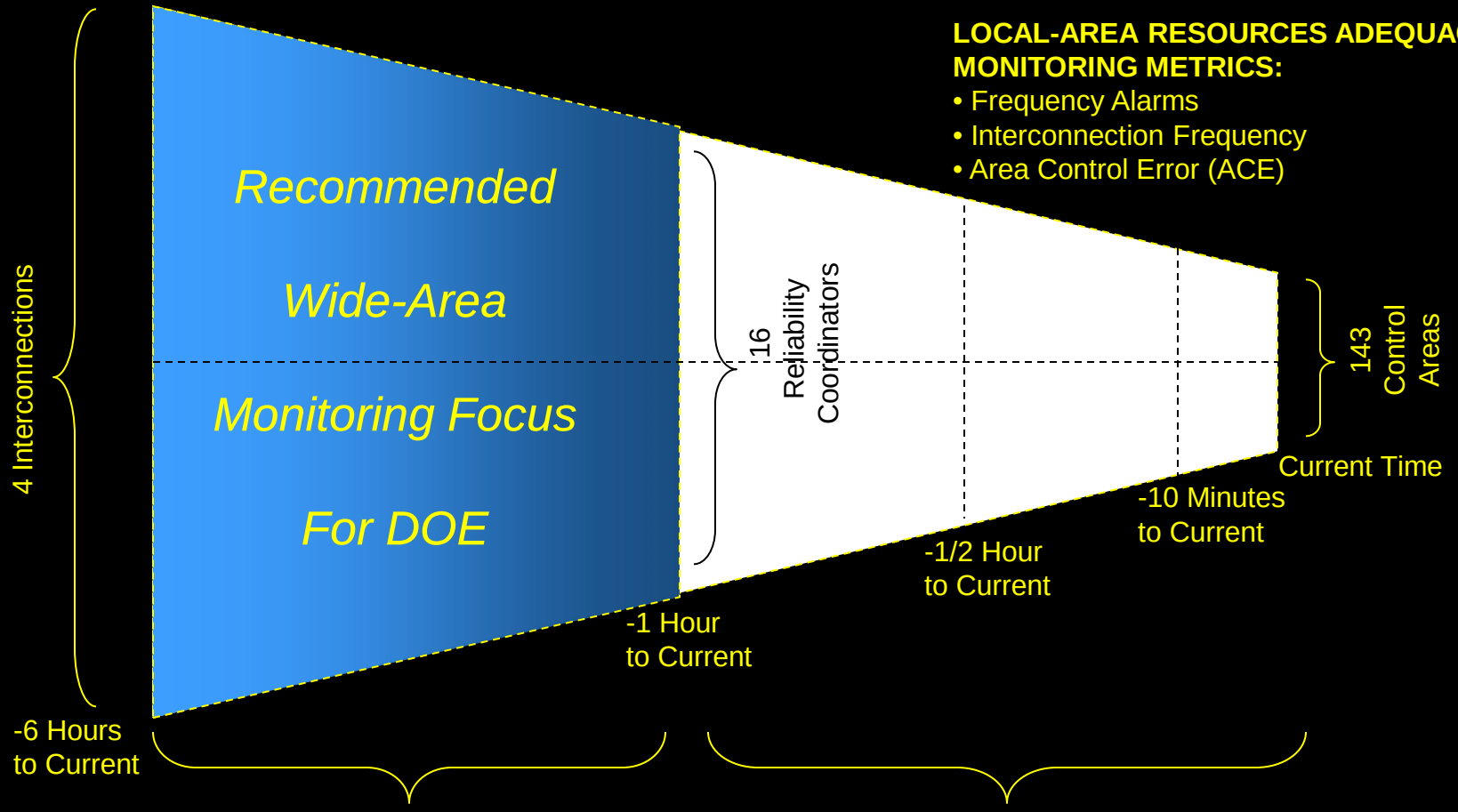


By: Carlos Martinez

DEMAND-RESOURCES ADEQUACY MONITORING-TRACKING USING NERC-CERTS ACE-FREQUENCY APPLICATION - METRICS

WIDE-AREA RESOURCES ADEQUACY MONITORING METRICS:

- Real Time Interconnections Frequency Alarms
- 1-Minute Interconnections Frequency
- Last Hour 10-Min Average Jurisdictions ACE
- Last ½ Hour 1-Min Control Performance Standard (CPS1)
- Last ½ Hour 1-Min Balancing Authority ACE Limit (BAAL)



LOCAL-AREA RESOURCES ADEQUACY MONITORING METRICS:

- Frequency Alarms
- Interconnection Frequency
- Area Control Error (ACE)

REAL TIME WIDE-AREA MONITORING – DOE

LOCAL MONITORING – NERC RELIABILITY COORDINATORS

RECOMMENDED FUTURE RESOURCES ADEQUACY MONITORING DASHBOARD TYPE VISUAL AND TRACKING PROCESS

CERTS RECOMMENDED FUTURE WIDE-AREA RESOURCES ADEQUACY CHANGES - DASHBOARD TYPE VISUAL

	EASTERN INTERCONNECTION RESOURCES ADEQUACY			
	Actual / Contingency	Within Normal Limits	Outside Normal But Within Emergency	Outside Emergency Limits
Release 3.0	Within Normal Limits	**SECURE 1** Above 59.95 Hz *	**INSECURE 1** Below 59.908 Hz	**EMERGENCY** Load Drop Below 59.82 Hz
Release 3.5	Outside Normal But Within Emergency	**SECURE 2** Below 59.95 Hz	**INSECURE 1** Below 59.908 Hz	
Release 3.5	Outside Emergency Limits	**SECURE 2** Below 59.95 Hz	**INSECURE 2** Below 59.908 Hz	

DEFINITIONS:

- ***SECURE 1*** - Operation under acceptable load-generation balance able to sustain a worst first generation contingency
- ***SECURE 2*** - Operation under normal load-generation balance and generation contingencies indicate risk that an abnormal second generation contingency becomes greater than acceptable
- ***INSECURE 1*** - Operation under risk of an abnormal second generation contingency
- ***INSECURE 2*** - Operation under risk of an abnormal second generation contingency and contingencies indicating risk that an abnormal second contingency becomes greater than acceptable or that load has dropped
- ***EMERGENCY*** - Customers load has dropped, frequency relays operated

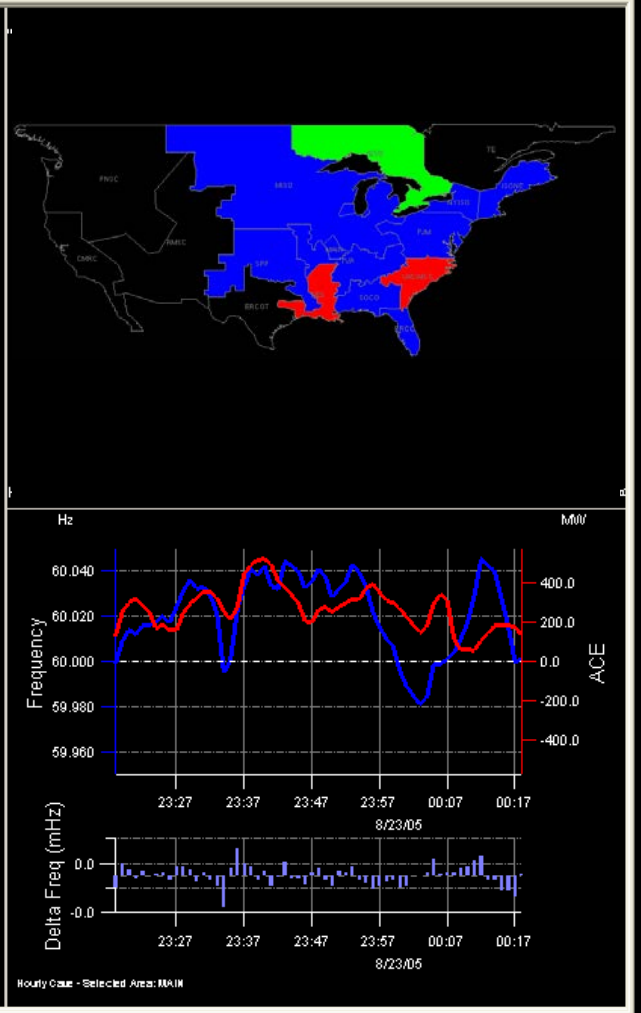
* Frequency thresholds taken from NERC new Balancing Authority ACE Limit (BAAL) performance metric for Eastern Interconnection

SAMPLE FOR A DOE MULTI-VIEW, GEO-GRAPHIC VISUAL

Interconnections | Reliability Regions | Reliability Coordinator Wide Area | Control Area Operating Authority | ISO-RTO | Data Collection Tool | Logon & Preferences | Help

EASTERN INTERCONNECTION RESOURCES ADEQUACY			
Actual / Contingency	Within Normal Limits	Outside Normal But Within Emergency	Outside Emergency Limits
Within Normal Limits	**SECURE 1** Above 59.95 Hz *	**INSECURE 1** Below 59.908 Hz	**EMERGENCY Load Drop** Below 59.82 Hz
Outside Normal But Within Emergency	**SECURE 2** Below 59.95 Hz	**INSECURE 1** Below 59.908 Hz	
Outside Emergency Limits	**SECURE 2** Below 59.95 Hz	**INSECURE 2** Below 59.908 Hz	

(Alarms Criteria and Recipients to Be Defined)



Date/Time 08/23/2005 12:18 AM

Auto Refresh

Jurisdiction ACE-Frequency Hourly
10-Minute Avg ACE/Frequency
Interc. Missing ACE MW
E: 357 Q: -223 W: 100

Overview | Worst/Best Rel Coordinators | Interconnection Frequency ACE Quality | Rel Coordinator(Inner Circles) | Current Reliability Coordinator Area Map | Hourly Image

Interconnection	Date_Time	Frequency	Freq_Delta	Expected_ACE	Actual_Net_ACE	Missing_ACE	Missing_ACE_Perc
E	08/23/2005 00:18	60.001	0.001	43.9	-313.3	357.3	813
Q	08/23/2005 00:18	59.968	-0.007	-194.5	28.5	-222.9	115
W	08/23/2005 00:18	60.005	0	100.2	0	100.2	100

N W E S

View Angle 55.

Replay

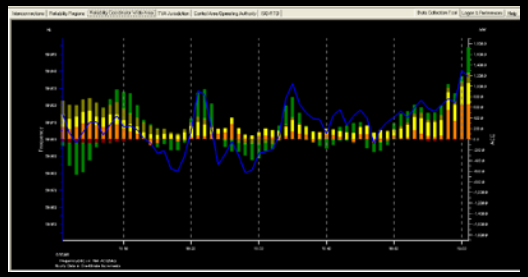
ACE-FREQ MONITORING

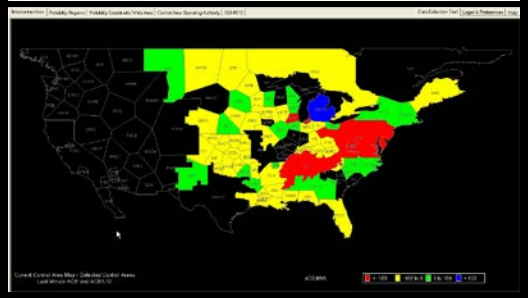
The A, B, C, D For Monitoring and Tracking Demand-Resources Adequacy Using ACE-Frequency

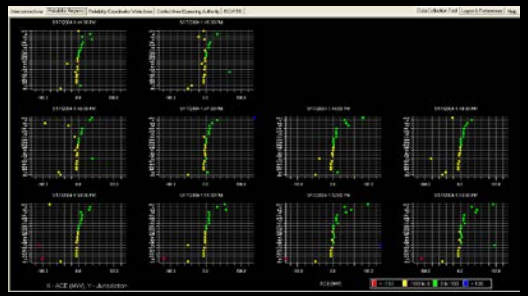
OBJECTIVE: Real time monitoring of demand and resources adequacy, using interconnection frequency, and quick identification and corrective action of root causes

A

Monitor jurisdictions ACE and its impact on interconnection frequency



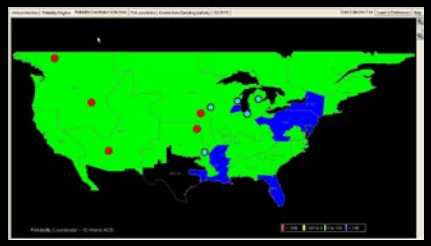




B

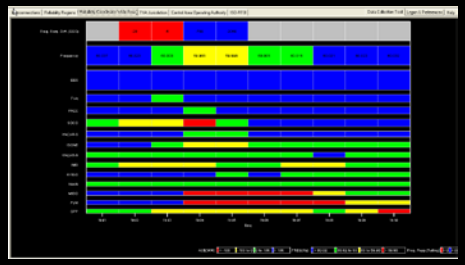
Watch for frequency and ACE alarms

```
SHORT-TERM:  -EAST
6/15/2005 8:04:00 AM(EDT) -
Frequency Absolute value of
two most recent 1-Minutes:
ABS(59.997-
60.034)=0.037Hz>=0.035Hz.
```



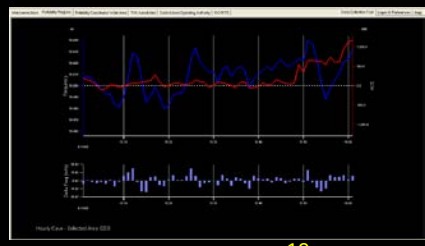
C

Verify Abnormalities with Disturbance Overview Display



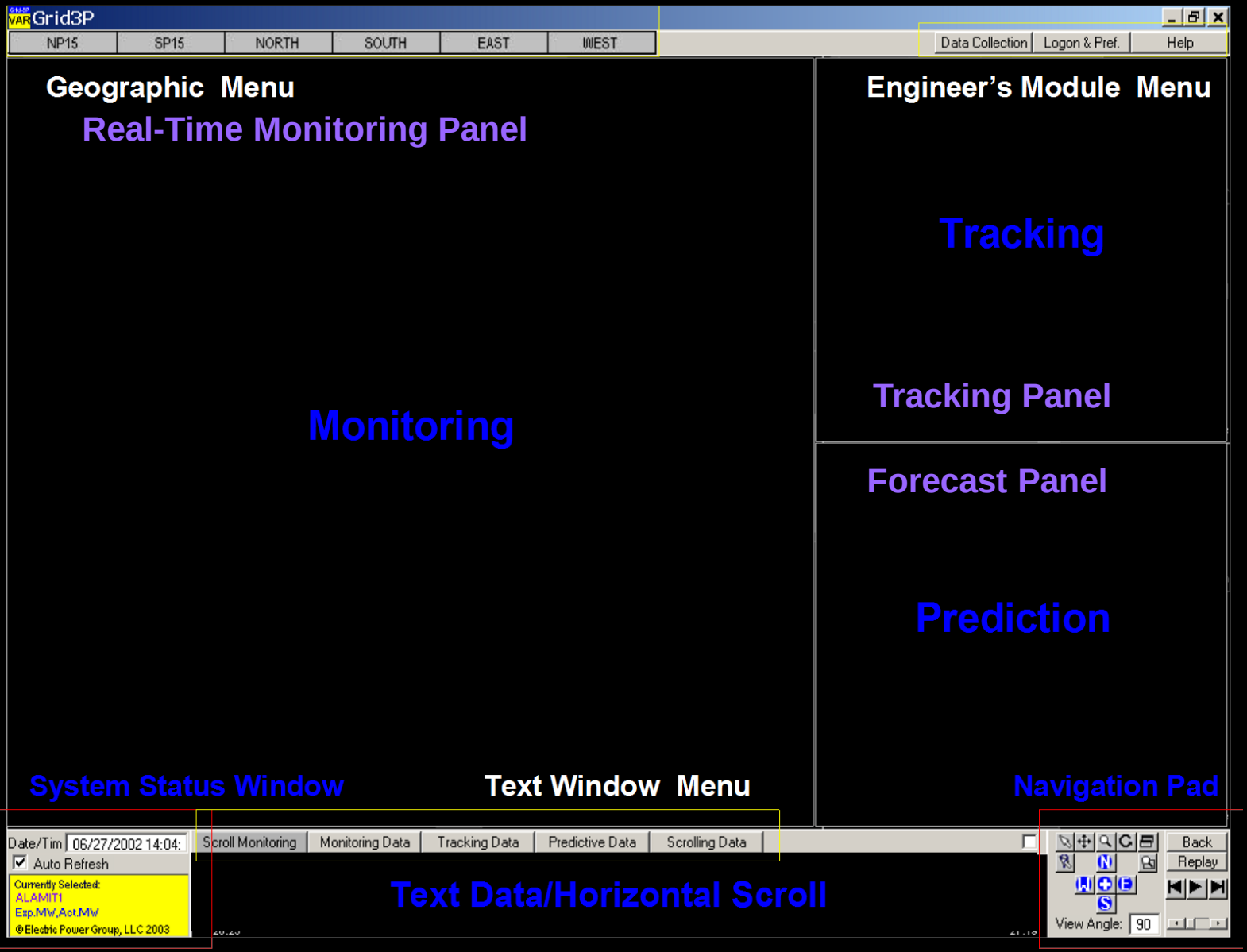
D

Zoom–In to identify, verify and correct root causes

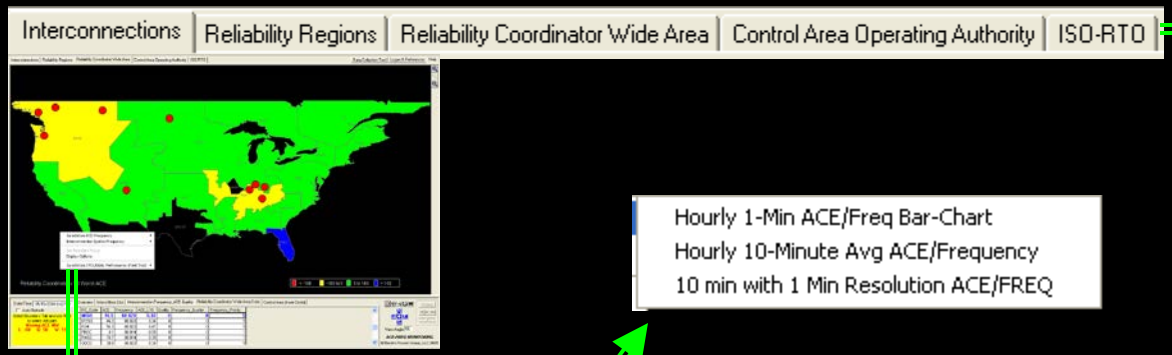


ACE-FREQUENCY MONITORING APPLICATION RELEASE 3.0 VISUALS ARCHITECTURE MENU STRUCTURE AND NAVIGATION

MULTIPLE-VIEW VISUALIZATION ARCHITECTURE

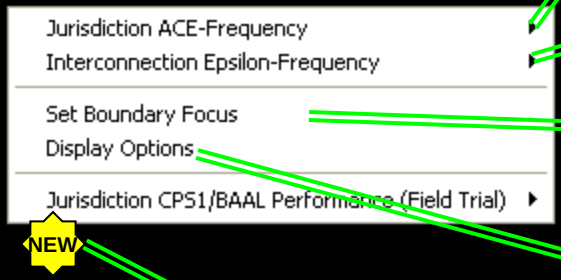


RELEASE 3.0 MENU STRUCTURE



JURISDICTION SELECTION

MASTER MENU (RMB)

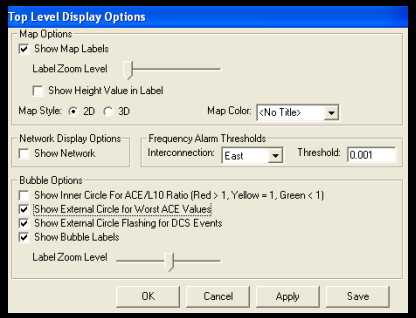


Jurisdictional ACE-Frequency Graphs:
- 1 Minute ACE Cumulative Bars – 1 Hour
- 10 Minute Average ACE – 1 Hour
- 1 Minute ACE-Frequency Plots – 10 Min

Interconnection Frequency Plots:
- Daily Epsilon
- Monthly Epsilon

Select & Monitor Specific Jurisdiction

Visual Presentation Options



Balancing Authority ACE Limit (BAAL)
- 30 Minutes CPS1-BAAL Monitoring
- 30 Minutes CPS1-BAAL Tracking

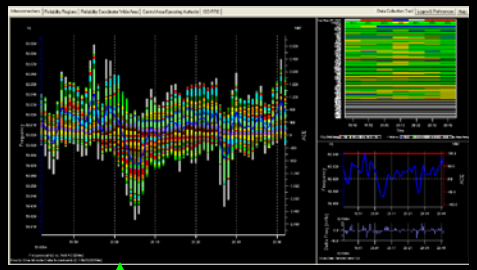
RELEASE 3.0
NEW FUNCTIONS AND ENHANCEMENTS

R3 KEY FUNCTIONS AND ENHACEMENTS

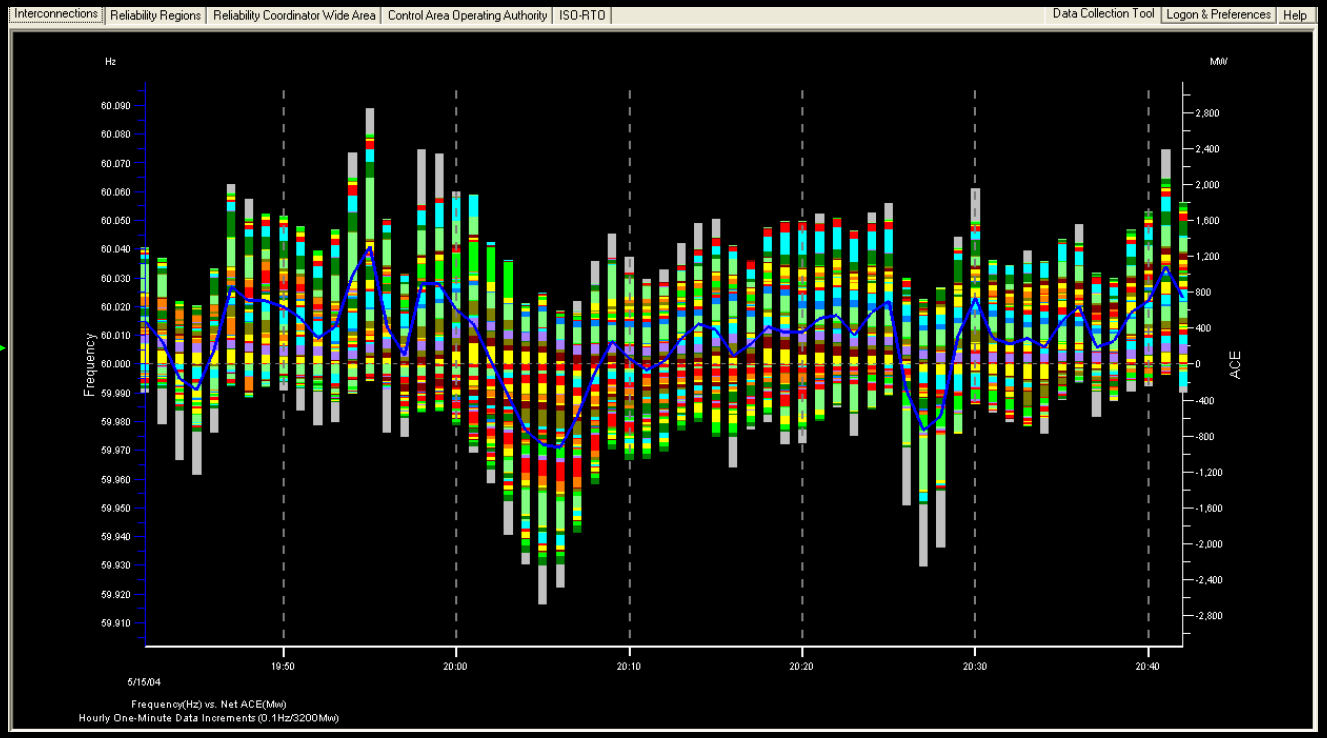
1. ACE-Cumulative Bars and Frequency Line Plots
2. Enhanced Set Boundary Focus
3. On Display Alarms and Reports
4. Online Application News and Help
5. Enterable Frequency Alarm Thresholds
6. User Adjustable Monitoring Time-Window
7. CPS1 and BAAL Monitoring and Tracking
8. Alarm and Database Enhancements

1- ACE-BARS AND FREQUENCY PLOTS – *Release 3*

Cumulative ACE bars overlapping a Frequency line-plot to show the selected jurisdiction control areas Net-ACE vs. Interconnection Frequency. The ACE value of each control area from the selected jurisdiction will be displayed as a segmented-cumulative bar chart in one-minute increments for the last hour. The summation of the entire bar for one-minute is equal to the net ACE value of the selected jurisdiction. The interconnection frequency is plotted on the same chart as a line-plot in one-minute increments for one hour on a secondary y-axis. Jurisdiction Control Areas with bad or missing ACE data are displayed in grey-color bar with a value derived from their yearly L_{10}

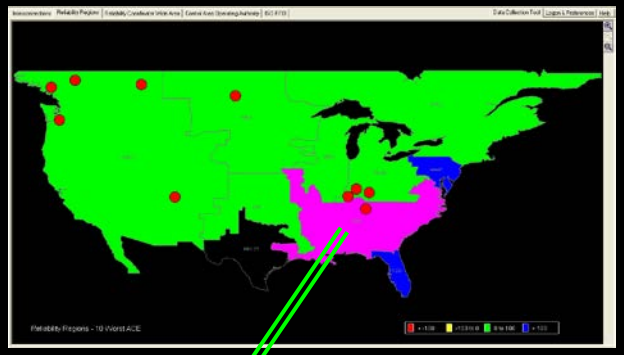


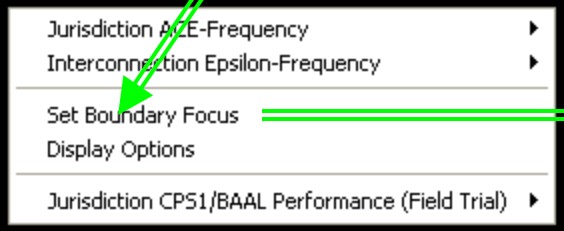
Hourly 1-Min ACE/Freq Bar-Chart
Hourly 10-Minute Avg ACE/Frequency
10 min with 1 Min Resolution ACE/FREQ

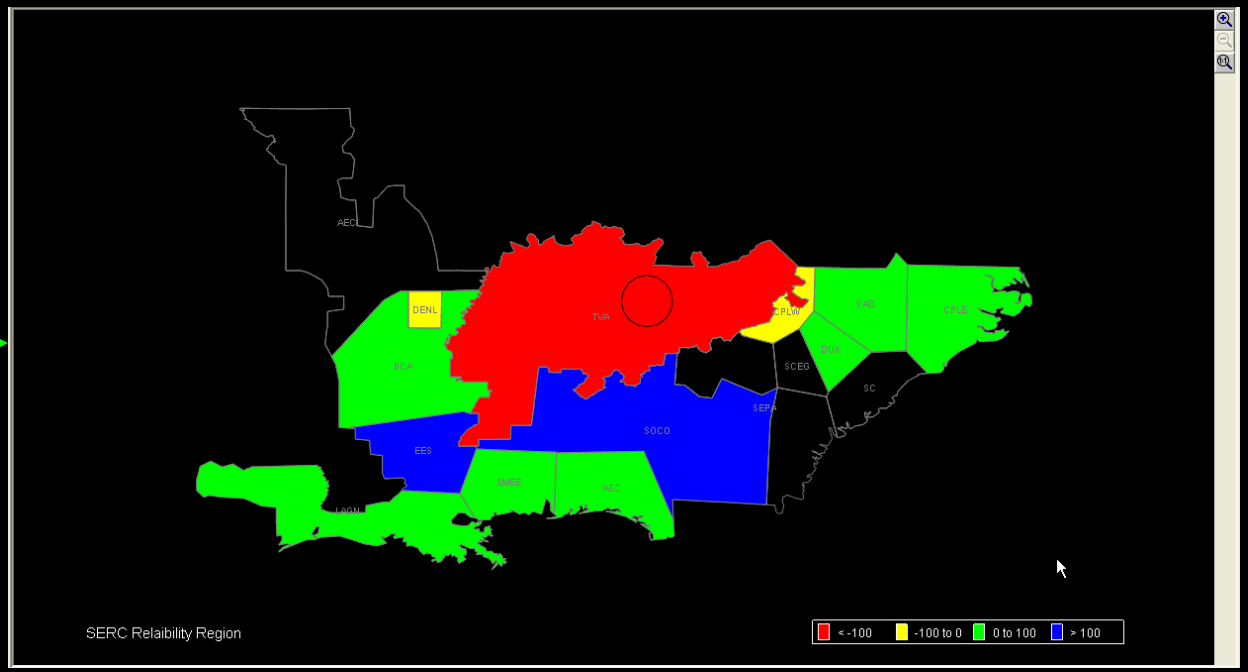


2 - ENHANCED SET BOUNDARY FOCUS – *Release 3*

The Set Boundary Focus option now allows user selection of any jurisdiction to focus user monitoring only for the control areas belonging to the user selected jurisdiction

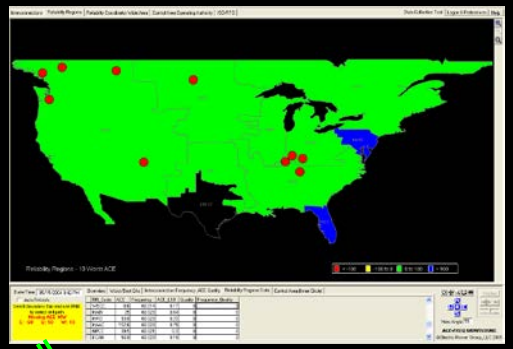






3 - ON DISPLAY ALARMS AND REPORTS – *Release 3*

On display alarm and report capabilities have been added to the yellow information-window in the lower left-hand corner of the application to alarm two conditions: a) display the accumulated amount of missing ACE data per interconnection using Control Areas yearly L10 values for those control areas not reporting ACE data. When user clicks on the missing ACE values a report is displayed with appropriate data for users to take pro-active action to correct data quality problems, b) short, blink messages indicating “Failed Data Connection”….

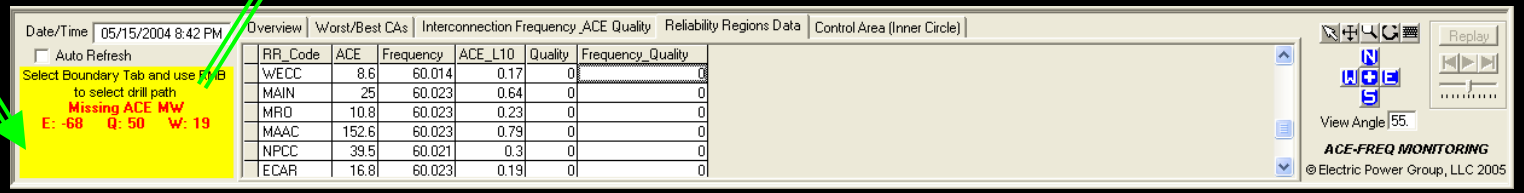


Eastern Interconnection

22 Control Areas Not Sending ACE Data

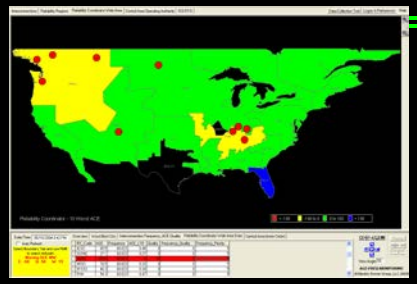
5/15/2004 8:42:00 PM — Pacific Time

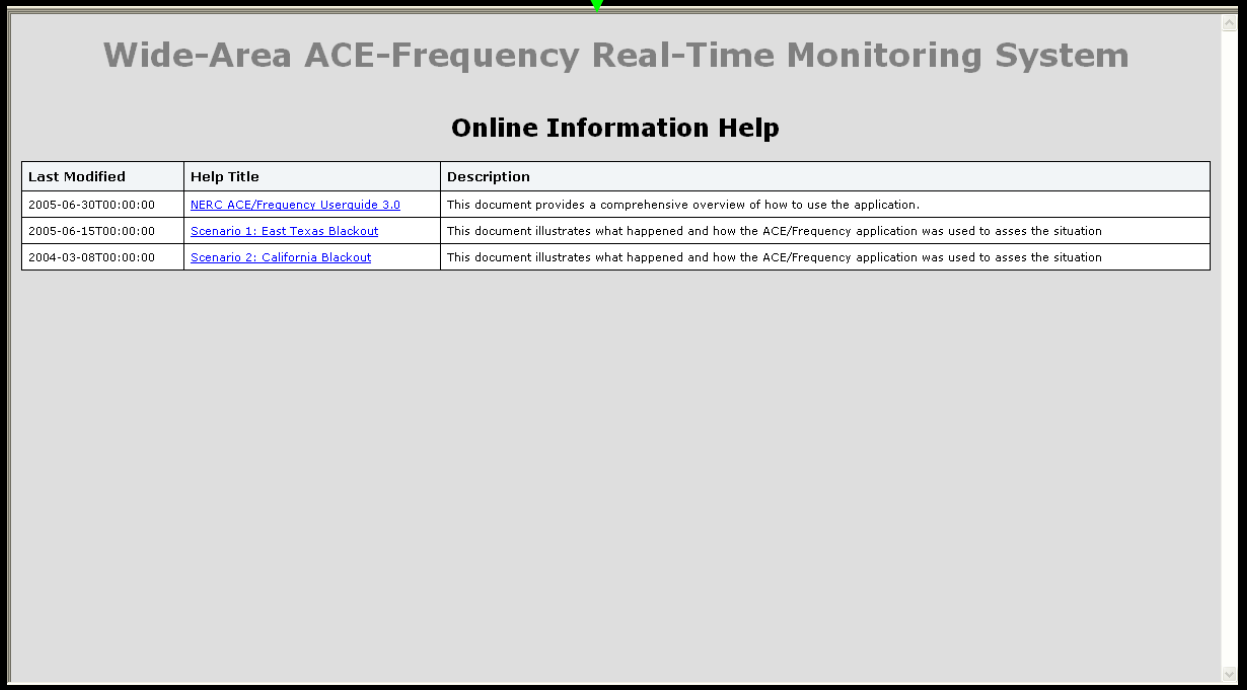
CA Code	Control Area Name	L10 Yearly	CA Missing ACE	Minutes Unavailable	Dispatch Desk
AEBN	AESC, LLC - AEBN	10.7	0.2	6453	
AECI	Associated Electric Cooperative, Inc.	61	14.7	90042	(417)885-9200
AMRN	Ameren Transmission	109.7	0.2	35298	(314)554-4037
CE	Commonwealth Edison	112.8	50.1	69103	
CWLD	Columbia Water & Light	13.1	0.7	85797	(573)874-6239
DELI	DECA, LLC - Lee County	19.1	0.2	35344	
DELO	DECA, LLC - DELO	26.6	0.2	6453	
DEVI	DECA, LLC - Vermilion	19.1	0.2	85797	(877)379-0336
EEI	Electric Energy, Inc.	18.5	1.4	35343	(618)543-9254
IP	Illinois Power Co.	53.5	11.3	69088	(217)424-6536
MCLN	McClain	17.1	0.2	6453	
MGE	Madison Gas and Electric Company	21.4	1.8	69090	(608)252-7254
MP	Minnesota Power, Inc.	43.5	7.5	90042	(218)720-2682
MPW	Muscatine Power and Water	9.3	0.3	81477	(563)262-3376
OVEC	Ohio Valley Electric Corporation	41.5	6.8	80039	(740)289-7210
SC	Santee Cooper	56.2	12.4	90042	(843)761-4033
SCEG	South Carolina Electric & Gas Company	63.7	16	90042	(803)217-8864
SEHA	Southeastern Power Administration	6.4	1.1	90042	(706)213-3864
SERU	Southeastern Power Administration	6.4	1.1	90042	(706)213-3864
SETH	Southeastern Power Administration	6.4	1.1	90042	(706)213-3864
UPPC	Upper Peninsula Power Co.	10.7	0.5	85797	(920)617-4111
WAUE	Western Area Power Administration - UGPR	56.1	12.4	90042	(605)882-7584



4 - ONLINE APPLICATION NEWS AND HELP–*Release 3*

The help-tab functions have been enhanced to present an index of application related news and help documents. Double clicking on any of the documents index, will display the full document in PDF-format. Help documents are archived now in a central location to facilitate its periodic update without issuing client updates.

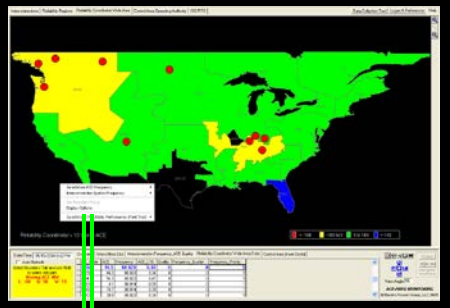


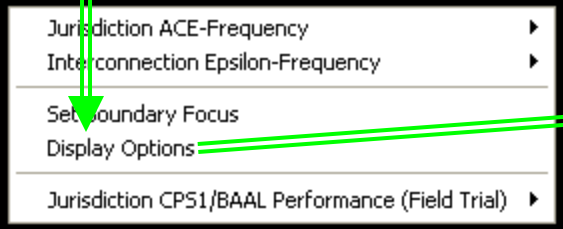


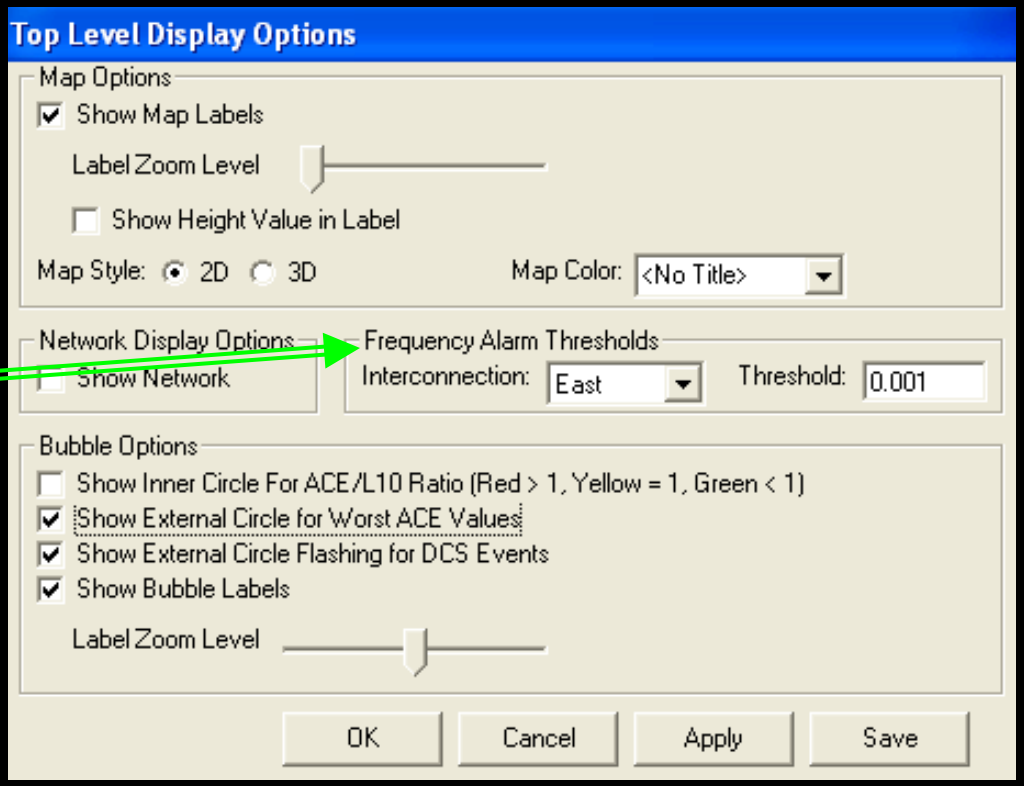
Last Modified	Help Title	Description
2005-06-30T00:00:00	NERC ACE/Frequency Userguide 3.0	This document provides a comprehensive overview of how to use the application.
2005-06-15T00:00:00	Scenario 1: East Texas Blackout	This document illustrates what happened and how the ACE/Frequency application was used to asses the situation
2004-03-08T00:00:00	Scenario 2: California Blackout	This document illustrates what happened and how the ACE/Frequency application was used to asses the situation

5-ENTERABLE FREQUENCY ALARM THRESHOLDS *Release 3*

The visual presentation option window have been expanded to include the capability for setting the frequency alarm threshold per interconnection to something other than the recommended thresholds from NERC.

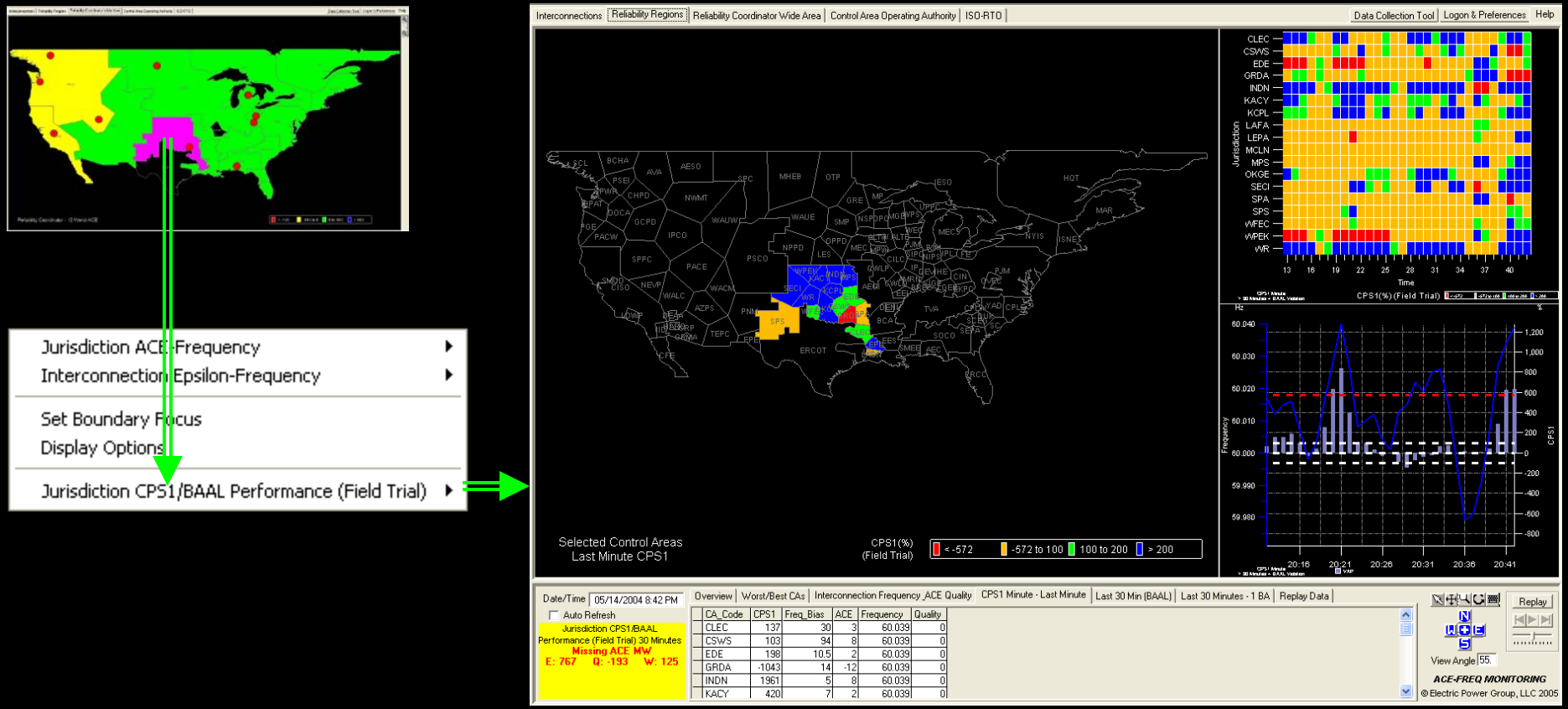






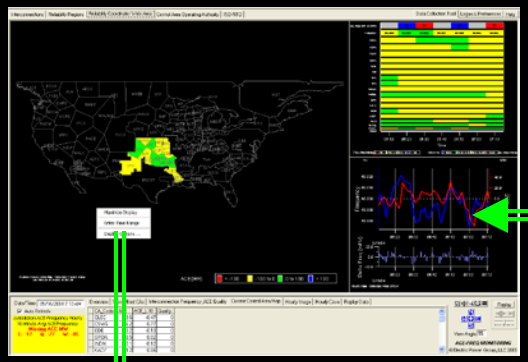
6 - CPS1 AND BAAL MONITORING (Field Trial)

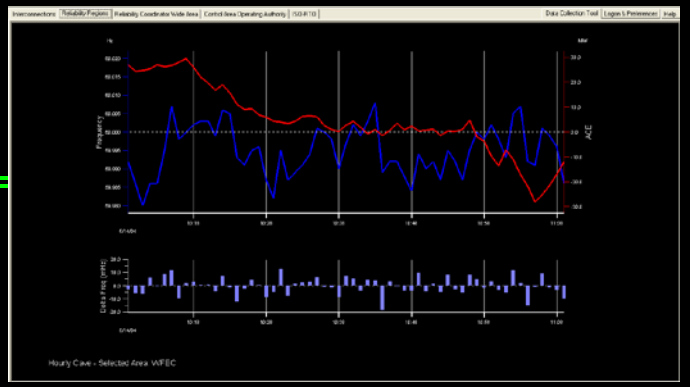
To help monitor and track the impact of the new Balancing Authority ACE Limit (BAAL) metric during the Field-Trial in the Eastern Interconnection, a new 4-panel display has been created. Panel-1 shows last minute CPS1 geographically for the jurisdiction Control Areas selected, panel-2 shows, color-coded, the CPS1 for the last 30-minutes for all the selected Control Areas, panel-3 shows CPS1 line-plots for the last 30-minutes with thresholds indicating CPS1 and BAAL violations, and panel-4 shows the numerical values for data for the other 3 panels.

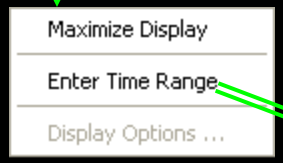


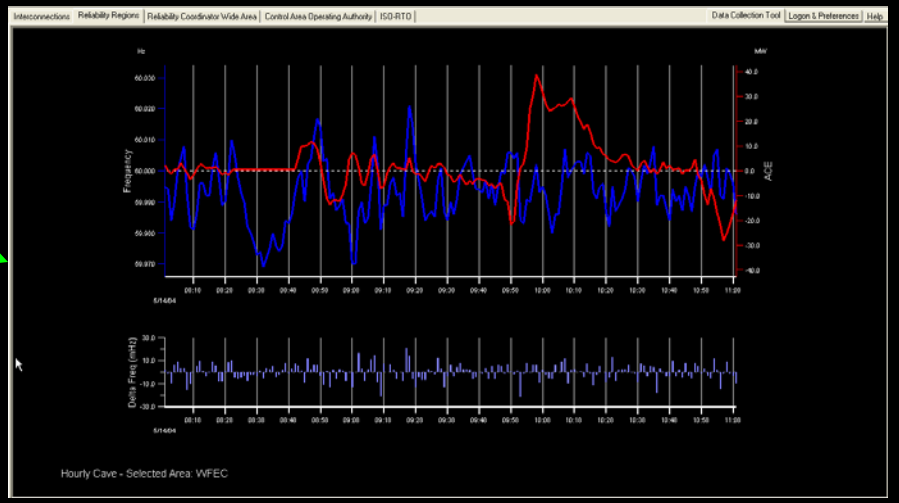
7 - USER ADJUSTABLE TIME-WINDOW - *Release 3*

The application was limited to 1-hour and 10-minute monitoring windows. Now users can adjust the time window for any of the monitoring and tracking panels of the 4-panel displays for up to 6 hours with 1-minute resolution.









8 - ALARMS AND DATABASE ENHACEMENTS

- **New Frequency Alarm Threshold** – Instead of using the average frequency per minute to compare with alarm thresholds, the new frequency calculation uses the maximum frequency value if frequency has been below 60 Hz during the last minute, or the minimum frequency if the frequency has been below 60 Hz for the last minute. The average frequency is only use if the sample is above and below 60 Hz during the last minute

- **New Frequency Alarms –** New frequency alarms have been created to indicate proximity to the three frequency thresholds that define the new BAAL performance metric

- **Online and Archived Data -** The primary ACE-Frequency database will keep 90-days of data available online. A secondary database has been established that will archive up to 3 years of ACE/Frequency data. A utility application is embedded in Release 3 that will allow the user to query the archive data and save it to their local computer as comma-separated values (CSV) file

RELEASE 3.0
CPS1 AND BAAL REAL TIME MONITORING AND TRACKING

CPS1 AND BAAL REAL TIME MONITORING (Field-Trial)

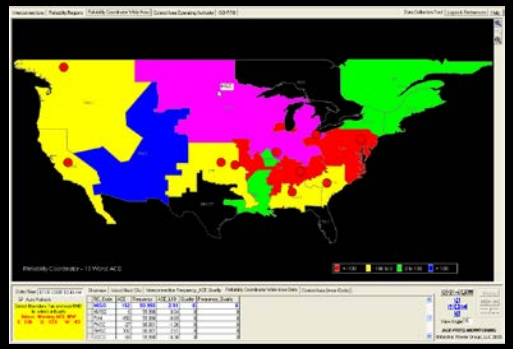
OBJECTIVE: Real time monitoring and tracking of 1-minute CPS1 and BAAL-Low and Baal-High violations correlating with interconnection frequency, and using CERTS ACE-Frequency Geo-Graphic, Multi-View Visualization.

Users can select any jurisdiction and monitor its 1-minute CPS1 performance, its BAAL high and low (CPS1 during last 30-minutes) correlating with interconnection frequency, and allowing users to track CPS1 and BAAL performance for any jurisdiction for the last 6-hours

CPS1 AND BAAL REAL TIME MONITORING (Field-Trial)

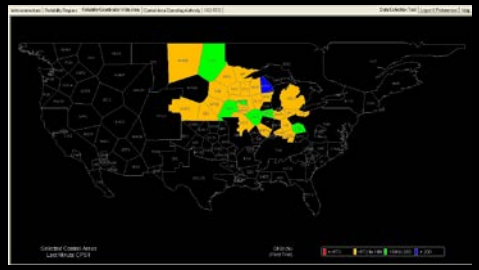
A

Select Jurisdiction to Monitor 1-Minute CPS1 And BAAL



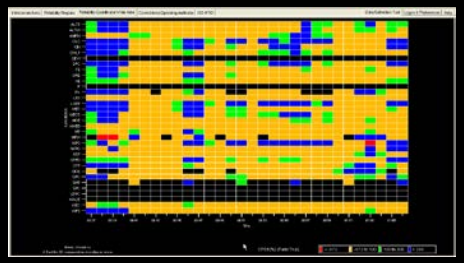
B

Monitor Geographically Last Minute CPS1



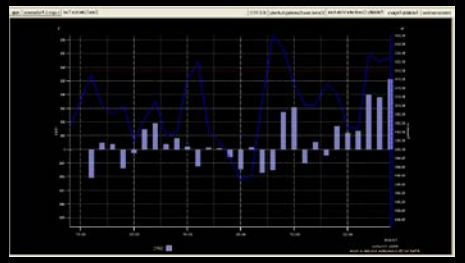
C

Monitor BAAL Violations Via CPS1 for the last 30-minutes or Beyond For Multi Control Areas

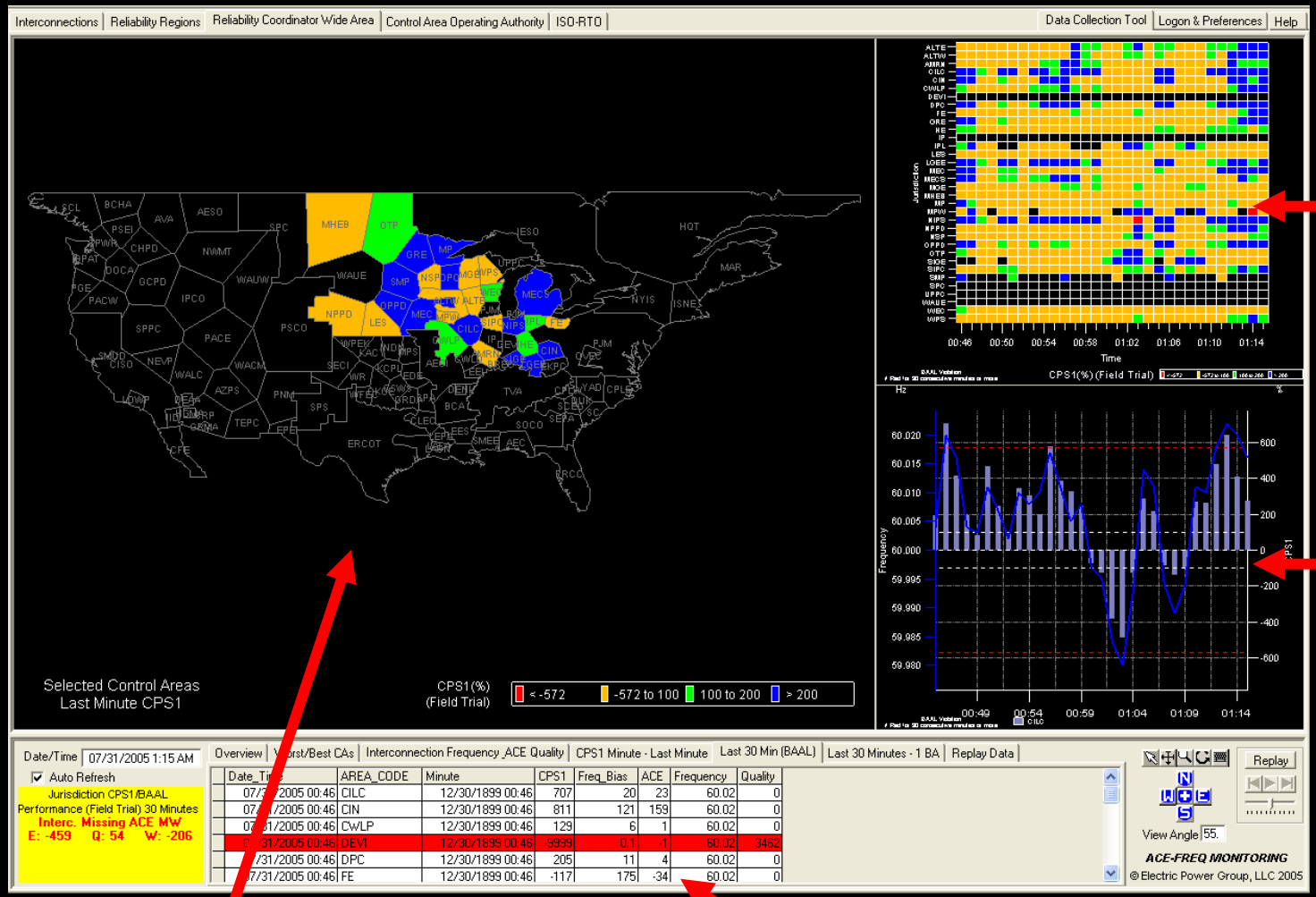


D

Monitor and Track CPS1-BAAL for Selected Control Area



CPS1 AND BAAL REAL TIME MONITORING (Field-Trial)



Panel 2: 2D-Plot with BAAL Violation (Last 30-Minute of CPS1) for Control Areas of Selected Jurisdiction

Panel 3: Bar-chart for last 30-Min of CPS1 with Thresholds for CPS1 and BAAL violations correlated with frequency

Panel 1: Geographic View with Last Minute CPS1 for Control Areas in Selected Jurisdiction

Panel 4: Dynamic Data Text Window with actual data displayed in tabular fashion for each selection criteria

Recommended Enhancements for DOE Emergency Center

ACE-Frequency Enhancements for DOE Emergency Center – Conditions, Analysis

Eastern, Western, and Ercot interconnections load-generation adequacy condition

CONDITIONS

System analysis and assessment at the interconnection and Reliability Coordinator levels

ANALYSIS

For Eastern and Western interconnections:

Normal – EI Freq >59.950 Load-generation under acceptable balance and control

Alarm – EI Freq <59.950 for more than 30-minutes. Risk of 2nd contingency becomes greater than acceptable

Emergency – EI Freq >59.820. Frequency-related relays had tripped, load has been dropped

Magnitude - EI MW of unbalance or drop originating alarm or emergency condition=Delta between EI current net ACE and net EI Balancing Authorities ACE Limits (BAAL). 24-hours tracking-scale

Location – Geo-graphic color-coded map showing EI Balancing Authorities with the worst delta MW

Interregional Transfers – Net interregional transfer MW = Estimated values, calculated as the difference between region net ACE minus its net frequency contribution, displayed geo-graphically

Customers With Not Power – Estimate based on correlation between unbalance delta or drop MW and estimated average MW consumption per Balancing Authority per customer

ACE-Frequency Enhancements for DOE Emergency Center – Actions, Events and Warnings

Notifications and Actions

Event summary when emergencies and blackouts occur

Advance warning and tracking during critical system conditions

ACTIONS ***EVENTS*** ***WARNING***

Notifications – Automatic cell-phone and/or email alarm to Secretary and DOE-NERC designees for emergency conditions

Actions – Immediate access to names and phone numbers for the Reliability Coordinator(s) with jurisdiction over the worst unbalance Balancing Authorities. Direct line to NERC

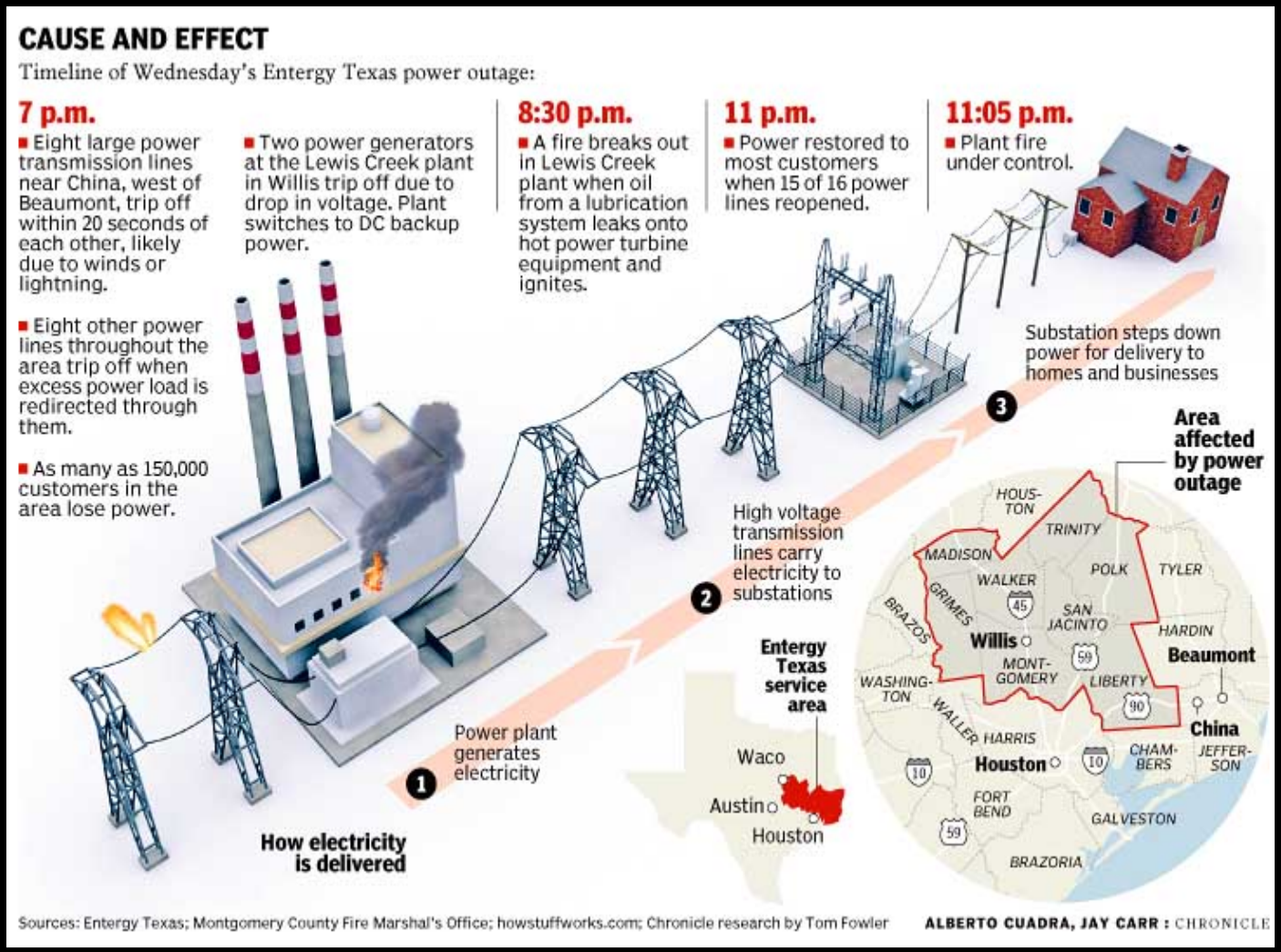
Summaries – pre and post emergency data as above, arranged chronologically per minute and per jurisdiction

Warning – Forecast data, Daily and Hourly Market Data.
Warning and Tracking visuals with key parameters for critical days

SCENARIO 1

Pre and Post June 15, 2005 Eastern Texas Blackout Monitoring and Analysis Using NERC-CERTS Wide-Area ACE-Frequency Monitoring Tool

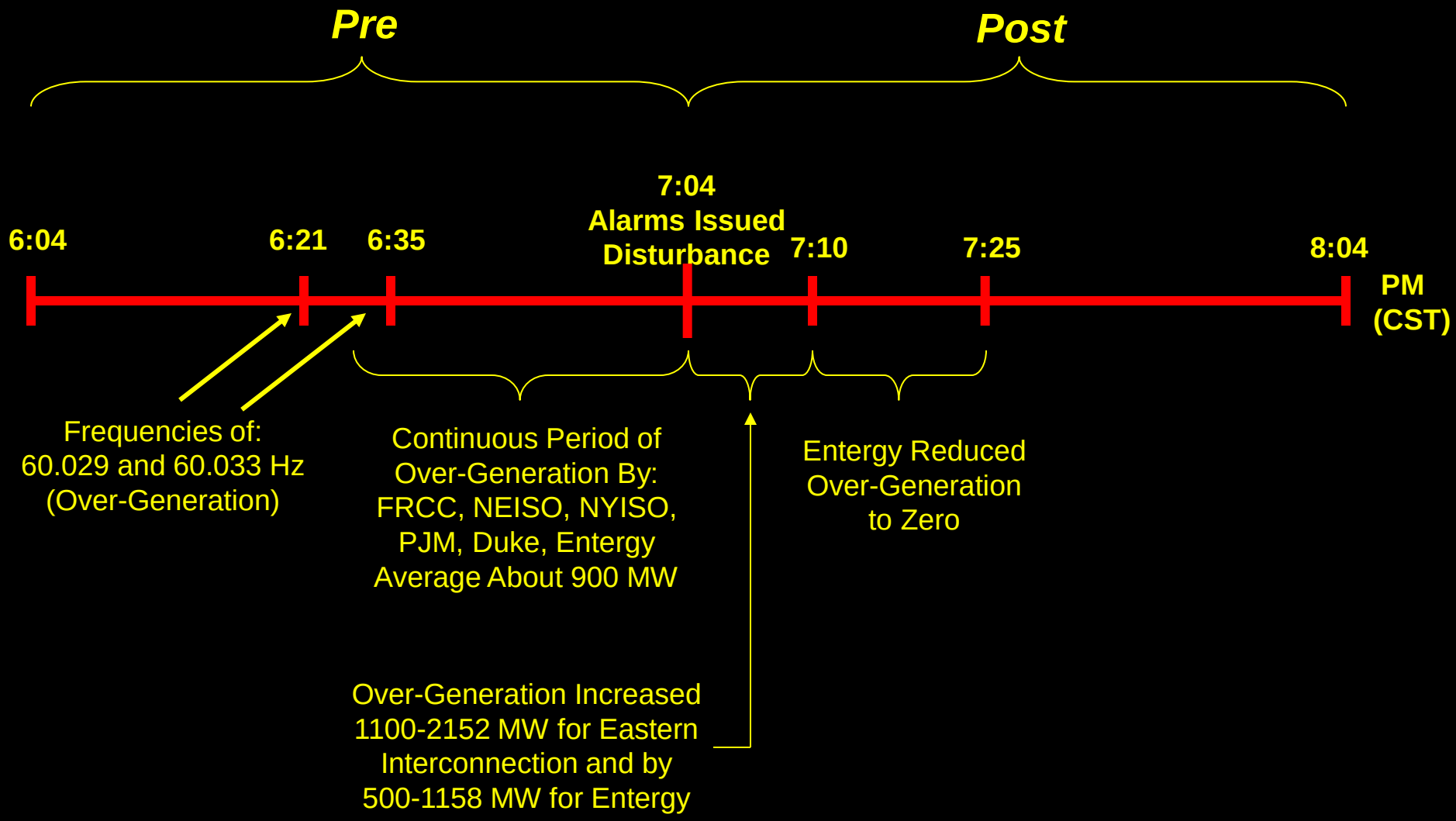
Blackout Event and Impact On Customers



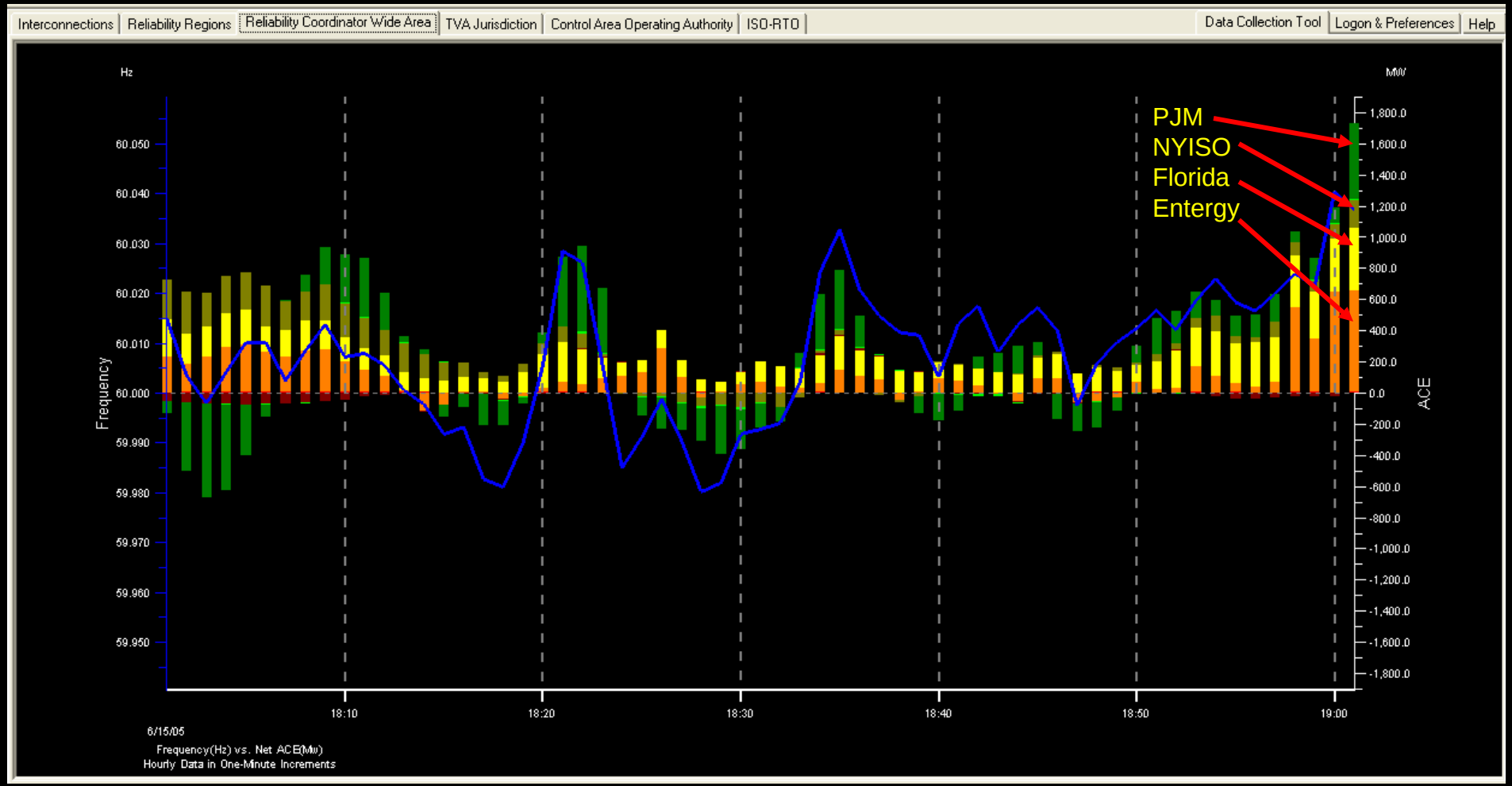
"What began as a 20-second cascade of failing power lines Wednesday evening ended with 150,000 Southeast Texas residents in the dark and a small but intense power-plant fire.

Tornadolike winds that roared through an area near China were blamed for the blackout, which stretched across eight counties served by Louisiana-based Entergy and included communities such as The Woodlands and Huntsville. By 11 that same night most of the power was restored….."

Pre-Disturbance Monitoring, Post Assessment Using NERC-CERTS ACE-Frequency Tool



Pre-Disturbance – Over-Generation Indication NERC-CERTS ACE-Frequency Tool



1750 MW of Over-Generation. It changed from about 300MW to 1724 MW from 6:50-7:04PM

Alarm - Sent at 7:04PM (CDT) Via Email, Pagers To RCs By NERC-CERTS ACE-Frequency Tool

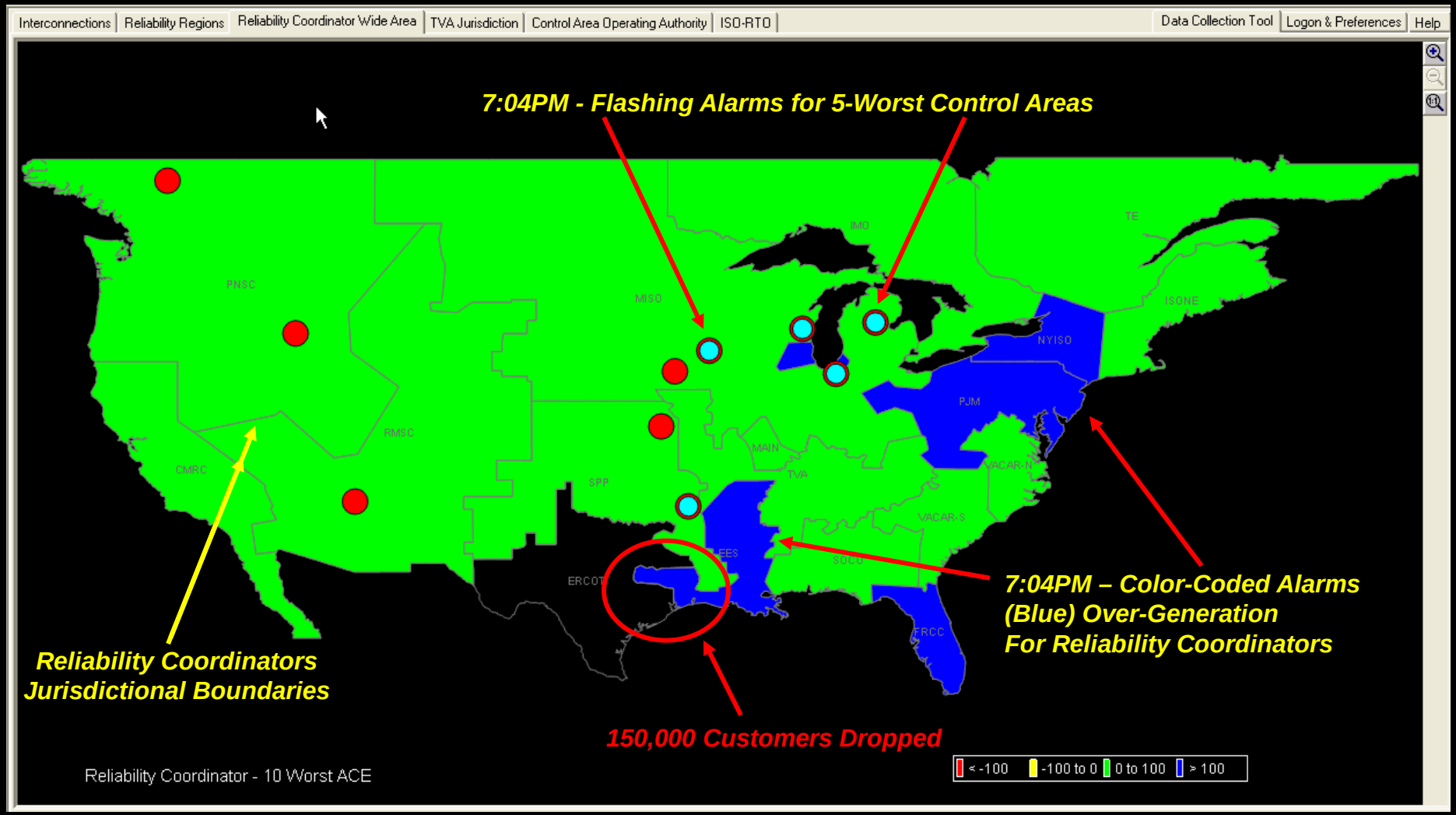
SHORT-TERM: -EAST 6/15/2005 8:04:00 AM(EDT) - Frequency Absolute value of two most recent 1-Minutes: ABS(59.997-60.034)=0.037Hz>=0.035Hz.

----------DISCLAIMER----------

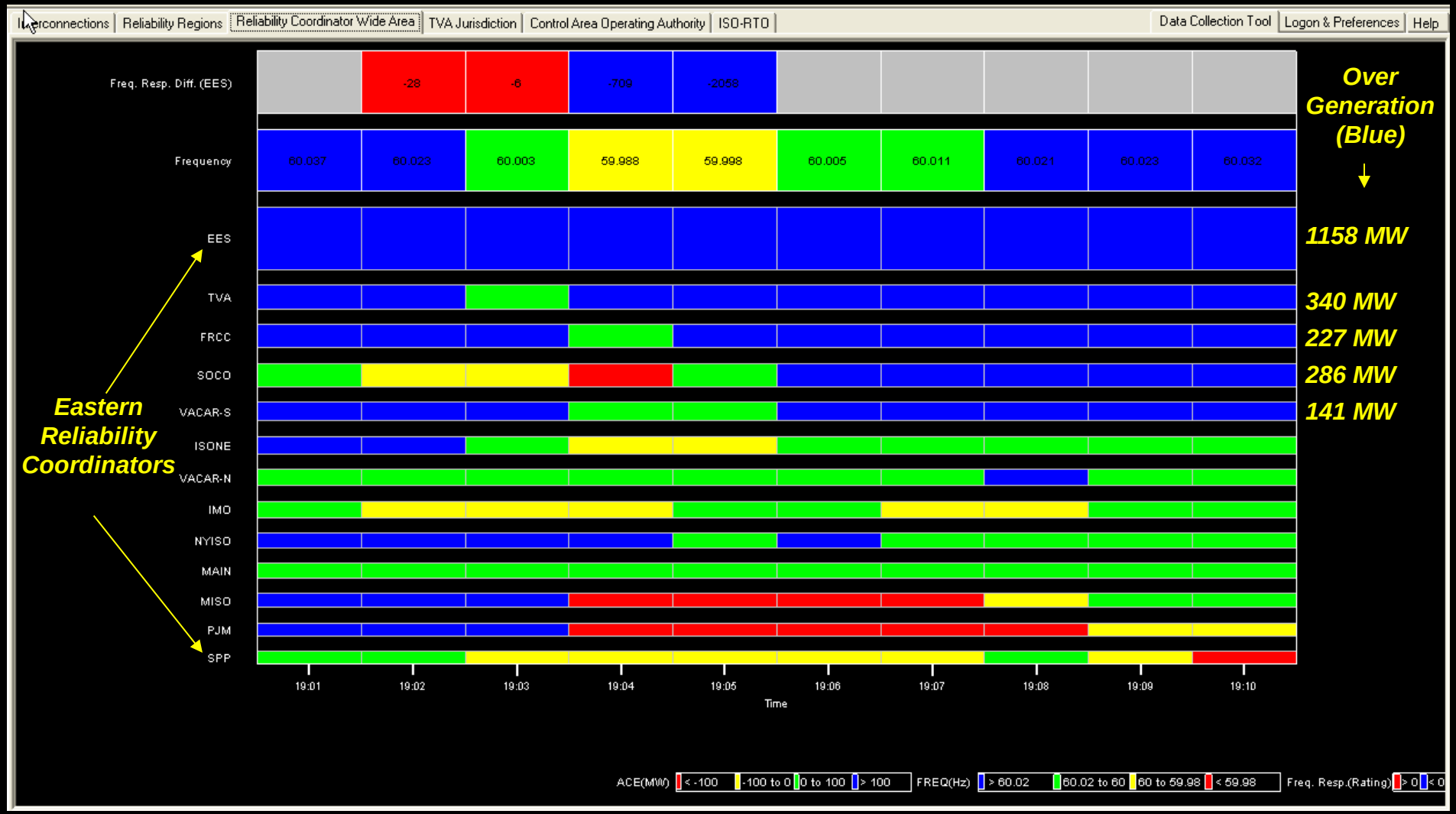
This notice reflects the most current information available from Control Areas. These notice results depend on the quality and completeness of the data supplied and, accordingly, the accuracy of this notice cannot be assured.

This notice is provided solely for informational purposes.

Alarms - Worst Reliability Coordinators and Control Areas At 7:04PM by NERC-CERTS Frequency-ACE Tool



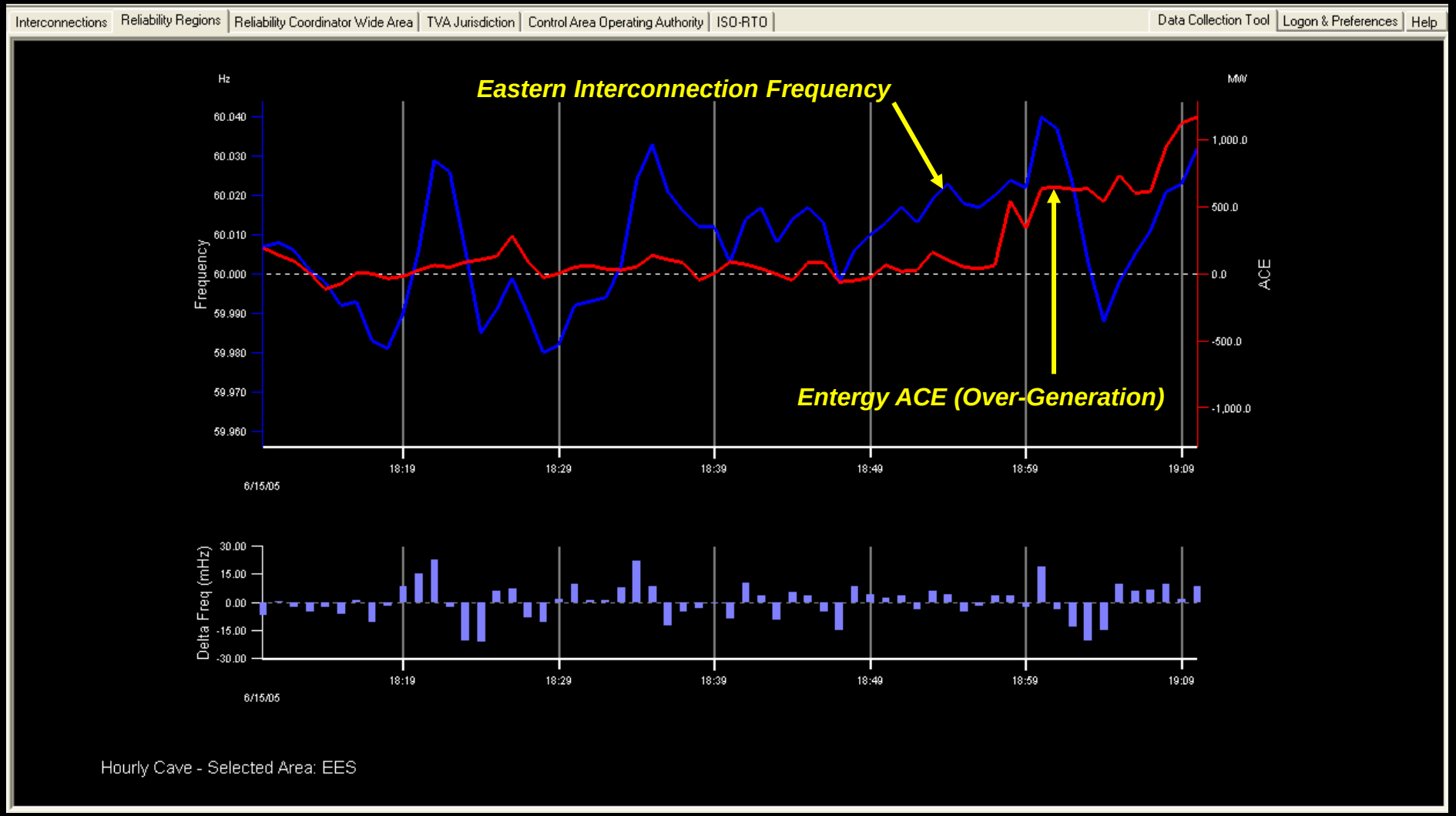
Disturbance – Eastern Interconn. Performance NERC-CERTS ACE-Frequency Tool



At 17:10 PM The Eastern Interconnection Reached About 2152 MW of Over-Generation

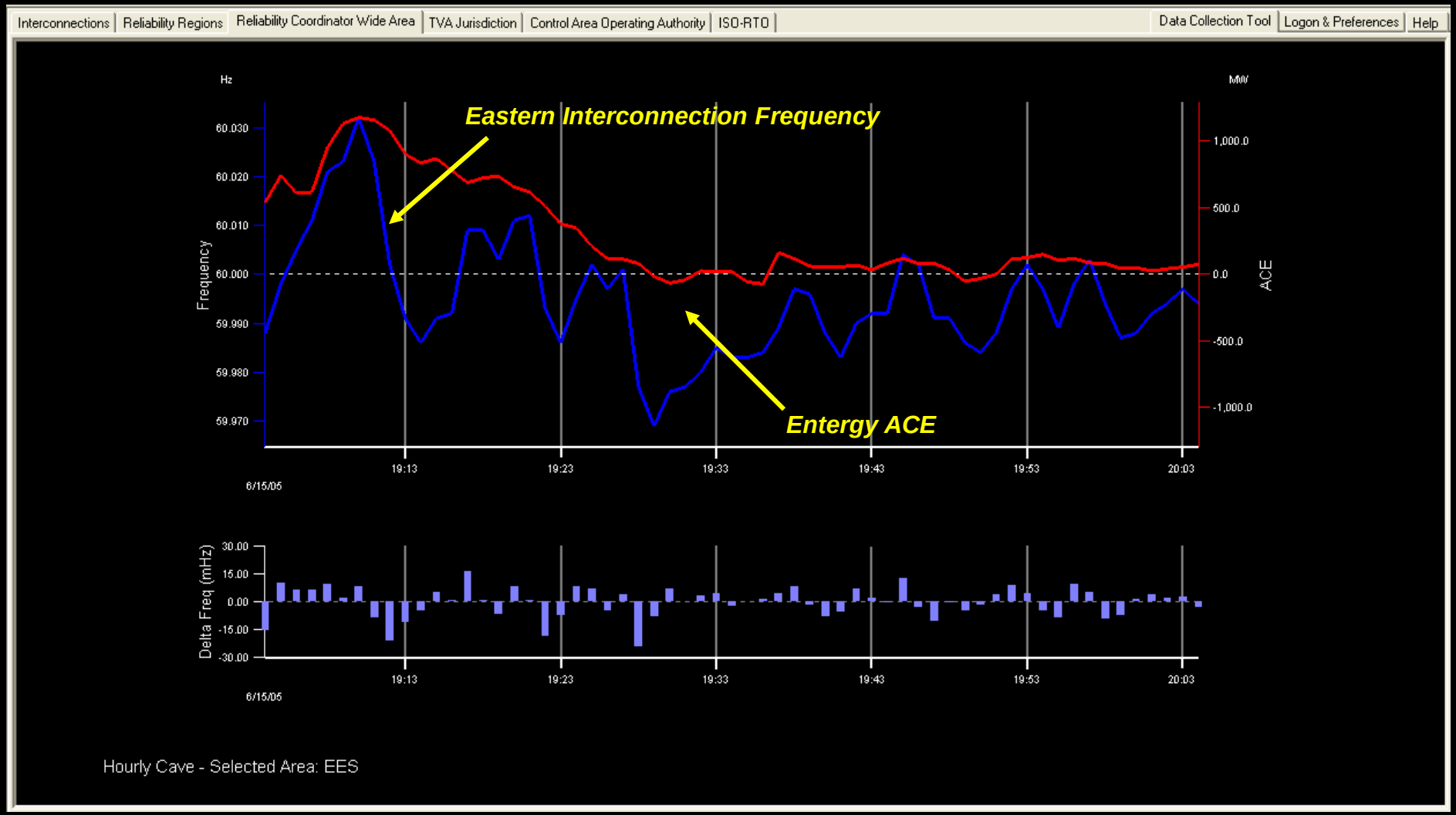
At 7:01 PM (Alarms Issued) 9 From the 13 Reliability Coordinators Jurisdiction Were Over-Generating

Disturbance – Entergy Performance
NERC-CERTS ACE-Frequency Tool



About 1158 MW of Over-Generation. It changed from about 500 MW to 1158 MW from 7:01-7:10PM

Post Disturbance Frequency and Entergy ACE NERC-CERTS ACE-Frequency Tool



Entergy Reduced Over-Generation from 1158 MW to Zero MW in About 20-Minutes
(Reduction Maybe Was Required Because of a Drop of 1158 MW of Customer Load)