Consortium for Electric Reliability Technology Solutions

DOE Wide-Area Situational Awareness For Resources Adequacy

Using NERC Resources Adequacy Monitoring

FUNCTIONAL AND DESIGN SPECIFICATION

Version 1.3.5

DOE WIDE-AREA SITUATIONAL AWARENESS FOR LOAD-GENERATION ADEQUACY USING

NERC RESOURCES ADEQUACY MONITORING (Release 3.5)

By
ELECTRIC POWER GROUP

For
DEPARTMENT OF ENERGY (DOE)

Date: May, 2006

Electric Power Group

CERTS

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EXECUTIVE SUMMARY

Subcontract[1] 41817M3100, entered into between Research and Development Solutions, LLC ("RDS") and Electric Power Group, LLC ("EPG"), calls for EPG to research, develop, and implement a software application based on the phase-1 NERC ACE-Frequency monitoring currently in use at the Department of Energy Headquarters. This subcontract was executed by EPG on May 8, 2006.

This document describes the functions and design requirements to be incorporated in the Department of Energy Phase-2 Situational Awareness (DOE-SA) application for resource adequacy using NERC Resources Adequacy Monitoring Release 3.5 as a base. This project will complement and enhance DOE Phase-1 Wide-Area Real Time ACE-Frequency Monitoring System™ developed and deployed by Consortium for Electric Reliability Technology Solutions-Electric Power Group (CERTS-EPG) and currently installed at Department of Energy Situation Awareness Room.

The DOE-SA Phase-2 will be designed to present simplified wide-area real time metrics, detection, alarming, trace and trend visualization solutions for situational awareness resource adequacy performance. This new DOE-SA application will enable management to:

- Monitor wide-area resources adequacy and identify load-generation unbalances.
- Initiate automatic notification and/or alarm when load-generation unbalances are large enough to risk customer load drops, and be able to follow in real time the status and trends of interconnections load-generation balance.
- Identify and display automatic load shedding and corresponding customer drops when interconnections frequency reach under-frequency relays thresholds

Phase-2 of the DOE-SA application is designed to help provide DOE situational awareness information for load-generation resources adequacy and imbalances and help answer high level policy type situational awareness questions such as:

- What is the current status of the four interconnections, reliability regions and reliability coordinators in terms of generation adequacy – normal, alert, emergency, and automatic load shed?
- What is the magnitude and geographic location of load-generation imbalances?
- What is the current trace and near-term trend of the four interconnections load-generation imbalance abnormalities – stable, improving, worsening?
- What does the load generation unbalance translate into in terms of customer loads, number of customers, and location of customer?

The updated application is targeted for installation during summer 2006. The original target of June 30, 2006 is likely to be delayed by approximately four weeks due to delays

[1] Prime Contract DE-AC26-04NT41817 U.S. Government awarded to RDS, LLC

in approval of the Contract from April to May. In addition, following the summer installation of the application, research will continue to receive user feedback and develop and prototype additional functionalities that will be incorporated into a Phase-3 release, including:

- Incorporate additional resource adequacy performance metrics
- Expand and Refine Data and Process to Estimate Load and Customers Drop
- Explore Alternatives to Acquire and Integrate Jurisdictions Load-Data
- Research Tailoring of Adequacy Trace-Trend Dashboard for Situational Awareness
- Research Integration of DOE Weather Maps Into SA Resources Adequacy

Phase-3 is targeted for completion by October 2006 but may be delayed to the end of the year due to delays in project start.

Beyond phase-3 CERTS will be research technical feasibility for integrating Situational Awareness for transmission using NERC TLR data.

1. INTRODUCTION

1.1 Purpose and Specification Organization

The purpose of this document is to define the functional requirements and design approaches for the Department of Energy (DOE) Situational Awareness resources adequacy application using as a base NERC Release 3.5 Resources-Adequacy Real Time Monitoring system. In addition to the functional requirements, the specification will also describe the requirements for situational awareness metrics, probabilistic alarming and status, trend analysis, multi-view geo-graphic visualization solutions and data requirements. The document also describes the design approaches for both the probabilistic alarm algorithms and visualization solutions. Appendix A describes the visualization approach for resources adequacy correlation with severe weather for phase-3 of the DOE-SA application, and Appendix B describes in detail the risk and probabilistic approach use for DOE-SA resources adequacy, status and near-term trends.

1.2 Background

The vulnerability of the U.S. economy due to electricity supply disruptions and power outages has become vividly clear as a result of the Aug 2003 Eastern Interconnection blackout, hurricane Katrina and other events. Voltage dips, momentary outages, and wide-area blackouts disrupt critical customer processes that lead to large economic losses. Traditionally, the nature of electrical loads in an industrial manufacturing economy and the conservatism inherent in the traditional planning and operational approaches produced a highly reliable grid and customers were not impacted by real time perturbations in grid power quality.

The situation has changed dramatically. Today, ISOs and RTOs are using this same transmission system to operate new, larger control areas with increased regional energy transfers under old and some new grid reliability operational standards and models. Regional Reliability Coordinators and Local Control Area operators are being challenged to manage adequacy of supplies and power flow configurations under new operational environments they never experienced before. As the August 2003 Eastern Interconnection blackout and the 2005 major weather related events impacting electricity supply have shown, accommodating new electricity market needs, new operational levels and scenarios, and new reliability performance metrics into grid operation can be best realized by making available common real time reliability monitoring tools and situational awareness to uniformly and effectively monitor wide-area resources adequacy and system security, at all operational and monitoring levels from local control areas, regional reliability coordinators to national reliability monitoring.

DOE policy and decision makers need timely information on the health of the electricity infrastructure and emerging trends to be able to take necessary actions to help prevent blackouts, contain the geographical footprint of disturbances, and mobilize emergency response.

Figure 1 below shows the wide-area visualization solutions and the resource adequacy research areas DOE-CERTS and the North American Electric Reliability Council (NERC) have being investigating, with its results used for the development of the current portfolio of NERC wide-area resources adequacy real time monitoring applications. The wide-area visualization infrastructure is currently the base used for visualization solutions for the NERC ACE-Frequency, CPS-BAAL, and Inadvertent and AIE real monitoring applications. Research results and prototypes on resources adequacy are being used by NERC Reliability Coordinators, DOE and FERC to monitor in real time load-generation adequacy using a probabilistic, modeless process approach with the following sub-processes characteristics:

- Reliability performance metrics - definition and testing
- Wide-area real-time monitoring
- Analysis, sensitivities and trends
- Post-assessment and feedback

Figure-1 also shows a new third area of research, Situation Awareness which DOE-CERTS started in 1Q2006, and has been focusing in four specific wide-area real time situational awareness processes: real time situational awareness for resources adequacy status and alarming, impacts of severe weather in customer loads and in geographic areas were load is dropped, resource adequacy near-term trends, and levels of resource adequacy actions and information to disseminate.

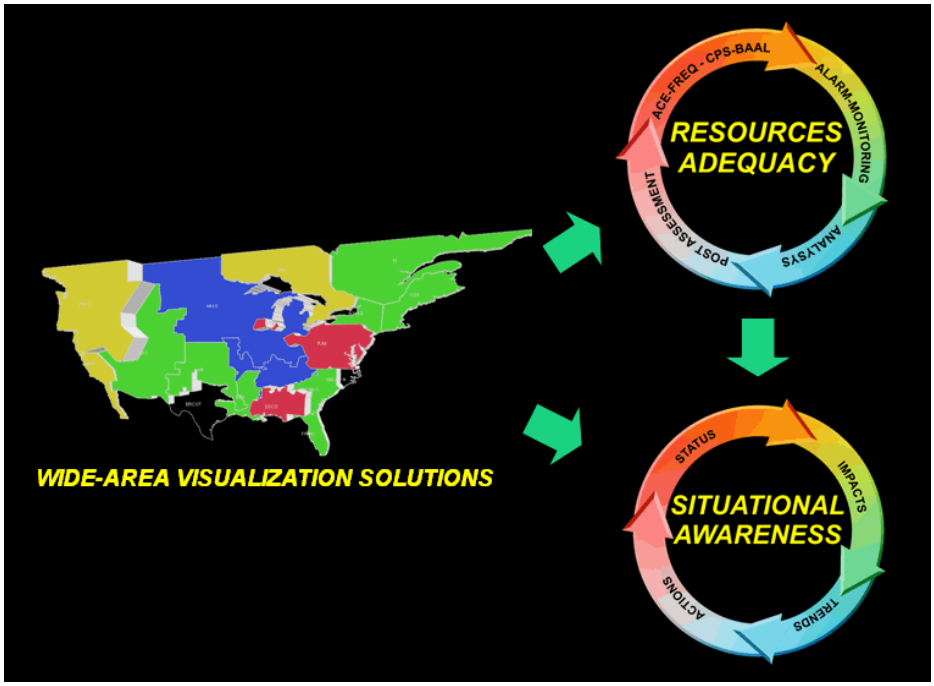

Figure 1 – DOE-CERTS-NERC Research and Prototypes on Wide-Area Visualization, Resources Adequacy and Situation Awareness

The North American Electric Reliability Council-Consortium for Electric Reliability Technology Solutions (NERC-CERTS) Wide-Area Real Time ACE-Frequency Monitoring System was installed at Department of Energy Situational Awareness Room in 3Q05, consisting of Release 3.0 of the NERC-CERTS tool adapted for DOE

The existing DOE Release 3.0 tool provides wide-area reliability monitoring by using multi-view geo-graphic visualization techniques to monitor, track and assess compliance by the 15 North American Reliability Regional Councils with rules designed to ensure resource adequacy reliability. It relies on data generated every four seconds by all control areas and transmitted to NERC to create real-time synchronized visual displays of the North American power grid. The tool users are instantly notified of emerging abnormal resources-load imbalances within each interconnection, and then can pin-point the control areas causing the violations. Using this information, they can initiate appropriate preventive or corrective actions to prevent further reliability degradation of the system.

This Functional-Design Specification discusses Phase-2 of DOE-SA requirements to enhance the current DOE Release 3.0 version that currently allows DOE management to monitor resource adequacy compliance with NERC rules that ensure the reliable supply of electricity. This common monitoring application allows the nation's Reliability Coordinators, DOE and FERC to immediately be alerted of electricity reliability threats originated by abnormal resource adequacy giving them time to work with out-of-compliance control areas or other operational organizations to make course corrections, thereby reducing the chances of unplanned blackouts.

2. FUNCTIONAL REQUIREMENTS

2.1 Major Functional Objectives - Overview

DOE objectives for this Phase 2 is to research, modify, and enhance the NERC-CERTS Wide Area Real Time ACE-Frequency Monitoring System to meet the following situational awareness objectives:

- Simplify and adapt information displays – both for resources adequacy alarming and for situational awareness visuals for DOE users.
- Impact assessment on customer load and enable correlation of resource imbalance to geographical location, e.g., state or county
- Correlate resources adequacy conditions with weather, for example through overlay of weather data over power system monitoring map, and with potential customer load drop

2.2 Situational Awareness Major Functional Requirements

NERC Wide-Area ACE-Frequency Real-Time Monitoring Release 3.5 is to be modified and enhanced to comply with the DOE requirements from their Release 3.0, and with added special situational awareness functions.

Phase-2 enhancements should achieve the following key DOE situational awareness requirements:

- Situational awareness of the health of the power grid for interconnections for which data is available from NERC
- Automatic Early Notification and Probabilistic Alarming for disturbances and system vulnerabilities. Examples of Vulnerability Due To:
  - Severe Weather Pattern Changes (phase-3)
  - Load-generation inadequacy
- Assessment of Major Events and Vulnerabilities:
  - Magnitude, location, geographic footprint
  - Customer interruptions
- Utilize NERC data base, infrastructure and uniform wide-area monitoring visuals in use by regional Reliability Coordinators
- Enable DOE to initiate actions to request information or/and mobilize emergency response

Figure 2 and the following sections summarize DOE-SA phase-2 situational awareness for resources adequacy functional requirements.

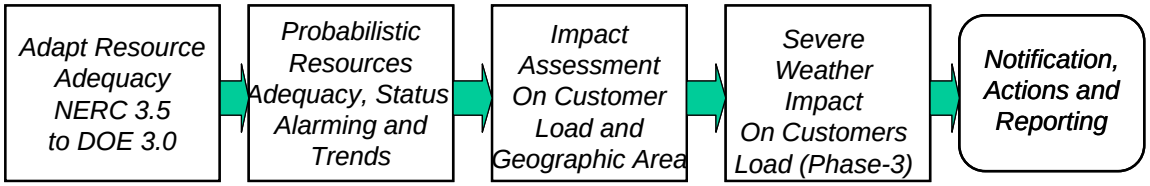

Figure 2 – DOE Situational Awareness Functional Requirements Overview

Following is a brief description of each functional capability shown in Figure-2, with detail descriptions in the following specification sections.

- NERC current resource adequacy release 3.5 functions should be adapted to comply with DOE 3.0 special visualization.
- Probabilistic resources adequacy Status Alarming and Trend - Timely awareness for system reliability abnormalities due to abnormal generation-load imbalances
- Impact Assessment on Customer Load - Awareness of abnormalities dimension and severity on customer load – simplified color-coded displays
- Severe Weather Impact on Load - Facilitate assessment of severe weather impact on load-generation adequacy
- Notification, Actions, and Reporting

2.2.1 NERC Release 3.5 Functions Adapted to DOE Version 3.0 Visualization

All new functionalities developed for NERC ACE-Frequency release 3.5 are required in the DOE SA application. The new functions in ACE-Frequency release 3.5 which will be relevant for this DOE phase-2 project are:

Alarming and Monitoring Functional Categories:

- New operational Jurisdictional boundaries requested by NERC-Staff (Reliability First, IESO to ONT, etc.)
- Display 10 worst-ACE circles segmented to indicate alarm ranking
- New automatic notification alarm for out of BAAL-violation alarm condition
- Capability to use set boundary focus for any single jurisdiction i.e. interconnection, region, etc.
- Enhanced options-display with capability to modify frequency alarm thresholds and calculation types
- Display, track, report availability for primary/secondary frequency data sources
- Enhanced user interactive on-line help based on application functionality
- Capability for user to print any graphical panel
- Capability for user to rearrange and tailor the multi-view graphic display panels

Analysis and Assessment Functional Categories

- Data Quality and Performance Reports, user-selectable for last 24-hours, 7-days, 30-days
- CPS-BAAL Epsilon tracking displays for last 24-hours, and last 30 days for analysis and tracking Resources adequacy and control compliance
- Graphic displays for new Resources adequacy performance metrics, BAAL-violations, BAAL events and minutes under BAAL events
- New multi-variable circular plot for simultaneous analysis, benchmarking and tracking of Resource Adequacy or any performance metric

System Hardware-Software Infrastructure

- New NERC dedicated computer-hardware for monitoring applications
- Reduce user displays response time by redesigning current Web-Service
- Removed password for easier use of interactive online help displays

2.2.2 Probabilistic Approach for Situational Awareness for Resources Adequacy

Non-traditional issues impacting today's reliability such as competitive market behaviors, wide-area control areas and operations human factors can not be accounted for by using traditional engineering models to alarm and evaluate resources adequacy states.

Instead of complex models, the approach taken is based on NERC new performance metrics based on risk and probabilistic approaches, and on the utilization of NERC real

time data to identify and alarm resources adequacy states and near-term trends using the NERC metrics as the reference framework

The probabilistic approach uses a visual representation of four alarm-areas defined using probability frequency calculations and thresholds to show when resource adequacy unbalances will move to unacceptable states within particular operational time horizons. The alarm-areas defined for normal, alert, manual load shedding required, and automatic load shedding conditions are used as visual guides to alarm and inform when resource balance states do or do not follow most recent behaviors and trends.

The probabilistic approach used for DOE-SA is based on the conceptual, validation and field-trial work the NERC Resources and Demand Standard Drafting Team has been doing for the last fours years to migrate current NERC deterministic reliability performance metrics to new metrics base on risk and probabilities

CERTS-EPG has researched, extended and prototyped the NERC concepts, and applied them for situational awareness of resources adequacy for wide-areas, using multi-view geo-graphic visualization solutions. CERTS research results and prototype have been presented for review and discussion to:

- NERC Technical Staff
- NERC Reliability Coordinators Working Group
- NERC Resources Subcommittee
- NERC Resources and Demand Standards Drafting Team

All four groups have supported the proposed approach and offered feedback for improvements. PJM already had implemented an equivalent approach for use by Reliability Coordinators in their control room.

CERTS-EPG have defined the following resource adequacy four alarm-areas for load-generation unbalance following both industry traditional system security concepts and the NERC work and definitions for their new Balancing Authority ACE Limit (BAAL) performance metric:

- Normal
- Alert
- Manual Load Shedding Required
- Automatic Load Shedding

2.2.3 Impact Assessment on Customer Loads and Geographic Location

Resource adequacy unbalances impact on customer load drop is based on NERC guides once unbalances force operational points to enter the automatic load-shedding area. Once an interconnection load-generation is within the Manual Load-Shedding region, customers load could have been dropped manually under the direction and coordination of Reliability Coordinators, and if the operational point enters the Automatic Load Shedding region, load has been already dropped automatically by under-frequency relays.

Reliability regions under-frequency load drop schemas will be identified and customer load drop at different frequency levels will be summarized and display in the proposed visualization solution.

The ability to overlap state/county boundaries on the jurisdictional maps will help in relating the geographical location of each Reliability Coordinator with the state and county boundaries. This will help in coordinating follow-up actions as warranted by the situation. A new user option to display state/county map boundaries over the current ACE-Frequency jurisdictional maps will be added to existing user options menu. This new capability will require the shape files for state/county boundary maps be included in the DOE-SA application package.

2.2.4 Severe Weather Impact on Resources Adequacy and Customer Load Drop (Phase-3)

The requirement to correlate resource adequacy with weather patterns will be implemented by displaying weather data over jurisdictional ACE color-coded maps. The Jurisdictional map panel will have the option to display the weather data overlaid on the ACE-Frequency map. The temperature/humidity data will be displayed as contours with the option of displaying the numerical value as labels on the contours. The hurricane/storm data will be displayed as circles (location) joined by line segments (path).

2.2.5 Notification Actions and Reports

The data quality and performance reports displays, infrastructure and capabilities from the NERC Release 3.5 version will be use for dissemination of the key situational awareness information in specific monthly reports.

3. VISUALIZATION SOLUTION AND DASHBOARD APPROACH

Figure-3 shows the required visualization solution overview for the DOE Situational Awareness application. Figure-3 shows the NERC Resources Adequacy Release 3.5 is being used as the base infrastructure for the Situational Awareness functions. To respond to the three fundamental functional requirements for an effective Situational Awareness system, detection, comprehension and trend, two basic dashboards have been researched and defined:

- Detection-Alarm Dashboard
- Adequacy Trace-Trend Dashboard

Users will interact between the two dashboards. One of the dashboards should allow for identification of abnormal balance resource conditions, and the other will help to identify possible root causes for unbalances, its dimension and impact. As shown in Figure-3, two complementary functions are also required for helping the situational awareness process.

- Automatic Alarm Broadcasting and Archiving
- Performance Reports

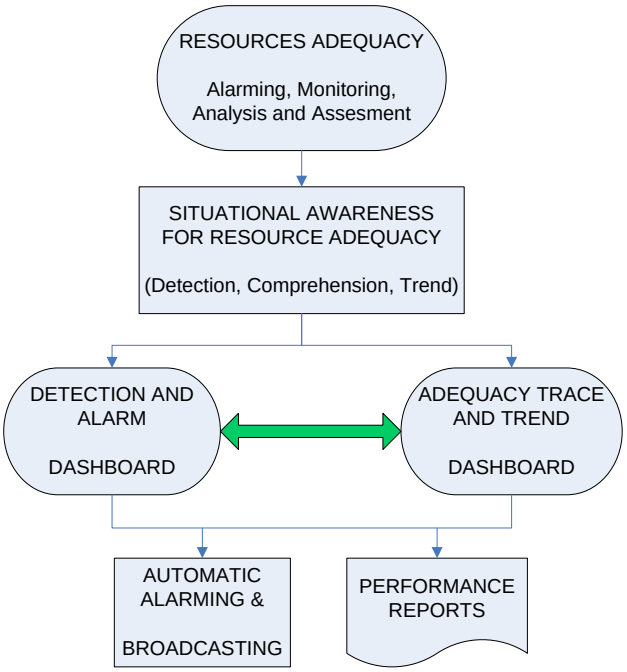

Figure 3 – Situational Awareness Visualization Solution Overview

3.1 Detection-Alarm Dashboard for Situational Awareness

The definition and layout of the DOE-SA load-generation alarms for the detection-alarm dashboard follows very closely the current reliability coordinators local-area operating generation/capacity alert conditions shown at the top of Table-1 below. Coordinators will start operating with this local alerts starting in summer-2006. The DOE-SA wide-area situational awareness alarms are based in the theoretical-operational principles and frequency thresholds from NERC Balancing Authorities ACE limit (BAAL) definitions and results of its Field Trial. They follow very closely the format and nomenclature of its equivalent alerts at the local-area level shown in Table-1. Table-1 shows the four situational awareness alarm types and definitions categorized under the following four wide-area operational conditions:

- **Normal** - System can tolerate a generation or load contingency without abnormal load-generation unbalances and without violating any frequency limits.
- **Alert** - The risk and impact of a second contingency becomes greater than acceptable.
- **Emergency Manual Load Drop** - System is exposed to unacceptable level of risk. Customers load maybe be manually dropped, restoration procedures in place.
- **Automatic Load Shed** - Load has already being dropped by under-frequency relays, restoration procedures in place.

Table 1 – Local and Wide Area Alarm and Alert Conditions

OPERATING GENERATING/CAPACITY ALERT CONDITIONS AT THE BALANCING AUTHORITY, RESERVE SHARING GROUP AND LOAD SERVING ENTITY LEVELS				
Condition Level>>>>	**Normal**	**Alert Level 1**	**Alert Level 2**	**Alert Level 3**
Threat Level>>>>	**Low**	**Elevated**	**High**	**Severe**
Condition/Threat Color>>>>	**Green**	**Yellow**	**Orange**	**Red**
NERC Local-Area Balancing Authority Reserve Sharing Group, Load Serving Entity Resource Adequacy (Generating/Capacity)	No Energy Emergency Alert (EEA) In Effect	EEA 1-All Available Resources in Use	EEA 2 Load Management Procedures in Effect	EEA 3- Firm Load Interruption Imminent or In Progress
RESOURCES ADEQUACY LOAD-GENERATION ALARMS AT THE INTERCONNECTION, RELIABILITY REGIONS AND RELIABILITY COORDINATOR LEVELS				
Condition Level>>>>	**Normal**	**Alert**	**Emergency**	**Load Shed**
Threat Level>>>>	**Low**	**Elevated**	**High**	**Severe**
Condition/Threat Color>>>>	**Green**	**Yellow**	**Orange**	**Red**
CERTS-EPG Wide-Area Interconnection, Reliability Region, Reliability Coordinators Situational Awareness for Resource Adequacy (Load-Generation)	System can tolerate a generation or load contingency without violating any frequency limit. Load-generation unbalance does not force system frequency to violate any of the three BAAL frequency performance thresholds	The risk and impact of a second contingency becomes greater than acceptable. Reliability Coordinators required to take remedial action. Load-generation unbalance is violating the first BAAL frequency threshold (FTL)	System is exposed to unacceptable level of risk. Customers load maybe be manually dropped, restoration procedures in place. Load-generation unbalance is violating the second BAAL frequency threshold (FAL)	Load has already being dropped by underfrequency relays, restoration procedures in place. System frequency violated the third BAAL frequency threshold (FRL)

Figure-4, 5 and 6 show the required 3-panel detection-alarm dashboard for interconnections, reliability regions and reliability coordinators with panel-1 showing alarm-conditions for each wide-area jurisdiction. Following are detail functional descriptions for this dashboard three panels.

3.1.1 Panel-1 Color-coded Alarms

Panel-1 on the left side shows color-coded the Normal, Alert, Manual Load Shedding required and Automatic Load shedding alarms for all fourth North America interconnections which are the alarm default jurisdiction.

3.1.2 Panel-2 Geographical Boundaries of Jurisdiction Selected

Panel-2 on the right side shows the geographical boundaries for the jurisdiction selected together with the total MW that already were dropped. The state boundaries are shown in the background. Any map will have the capability to display state or county boundaries.

3.1.3 Panel-3 Alarms Condition and Duration and Load Shed Tabular Text Tables

Panel-3 shows two tabs. The Alarms Condition and Duration Tab shows a table with the jurisdiction selected, the current interconnection frequency, the time the system has been in a particular alarm mode. The Load-Shed Tab shows the jurisdiction frequency,

jurisdiction name, the estimate numbers of customers dropped, and the cumulative total customers dropped.

Besides interconnections, users can select reliability regions and reliability coordinators jurisdictions via the tabs at the top-left. Both the alarms in panel-1 and the geographic maps in panel-2 will change accordingly to visualize the corresponding data for the selected jurisdiction.

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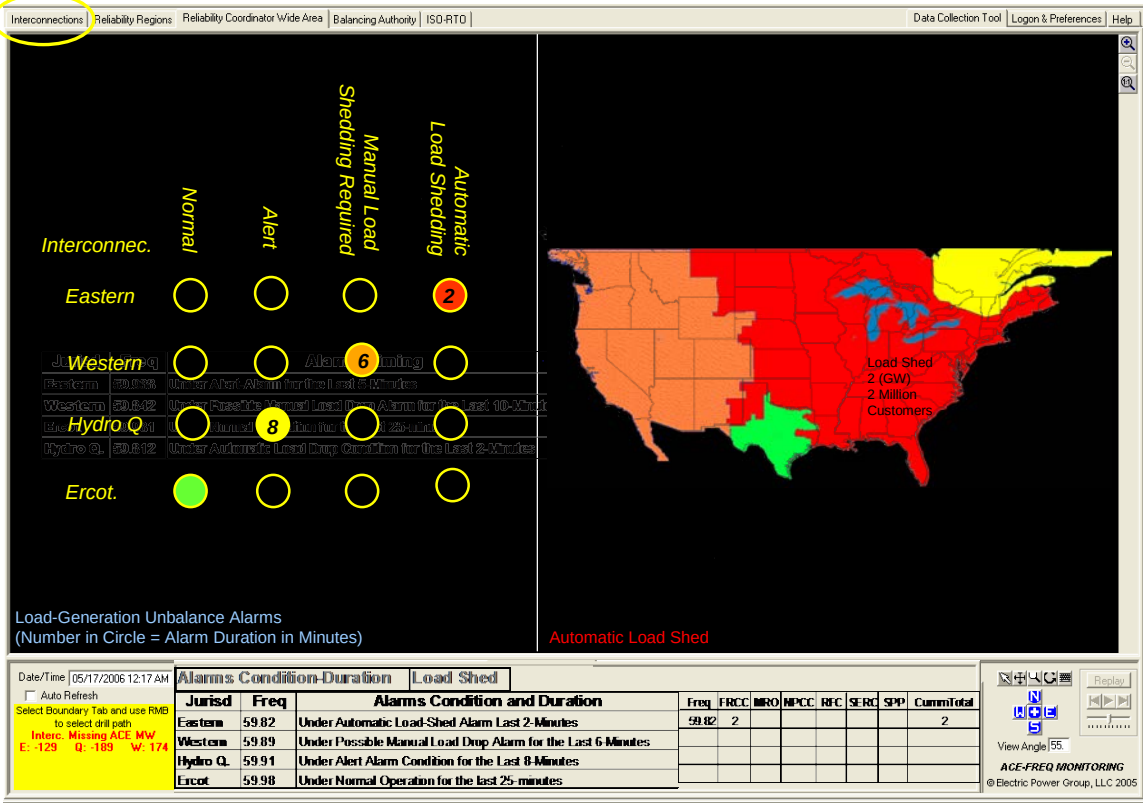

Figure 4 – Detection-Alarm Dashboard for Interconnection

The different formats, labels, names, and colors shown in figures 4, 5, and 6 are the ones required for DOE-SA detection-alarm dashboard.

3.1.4 User Options to Rearrange Graphs and Plots in Panels

Panel-1 of the detection-alarm dashboard is required to display the four interconnections, all reliability regions and all reliability coordinators for all interconnections grouped together by the major jurisdiction the user has selected. Also the detection-alarm dashboard needs to have the user option to display in panel-2 the default map or the reliability regions load-shed bar-graph shown in panel-2 from Figures-5. By default, the states boundaries need to overlap the jurisdictions boundaries as shown in panel-2 from Figure-4 and Figure-6.

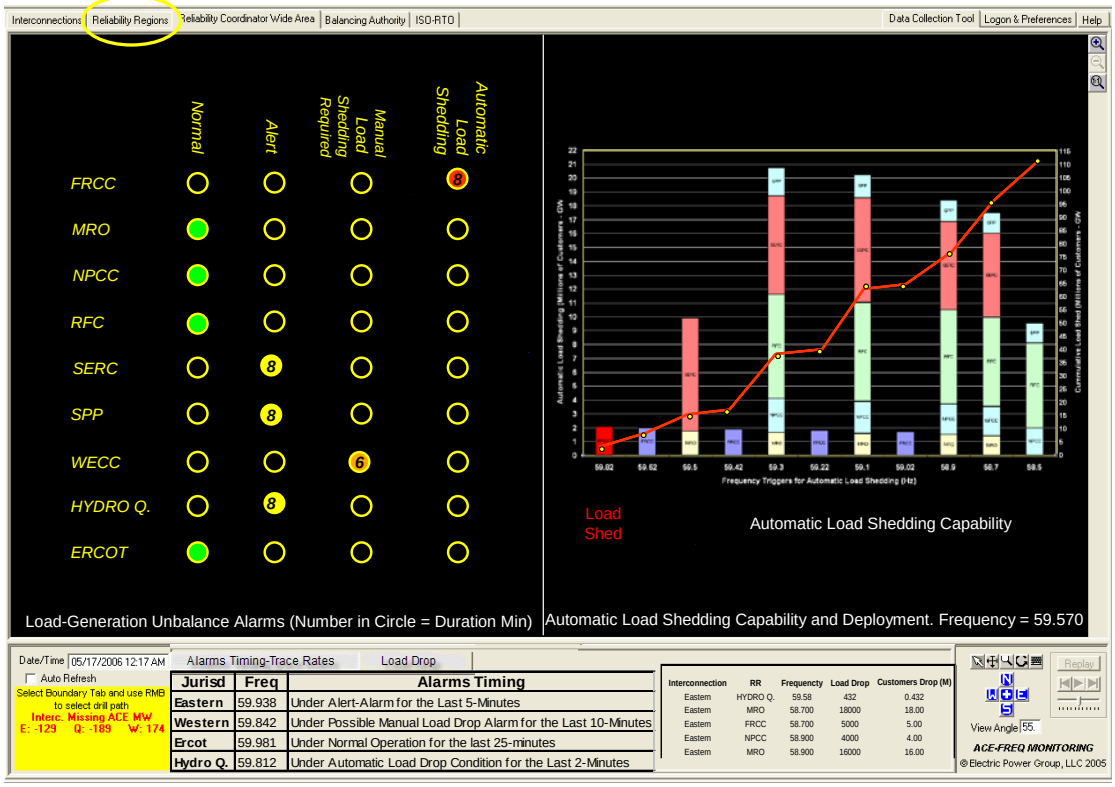

Figure 5 - Detection-Alarm Dashboard for Reliability Regions

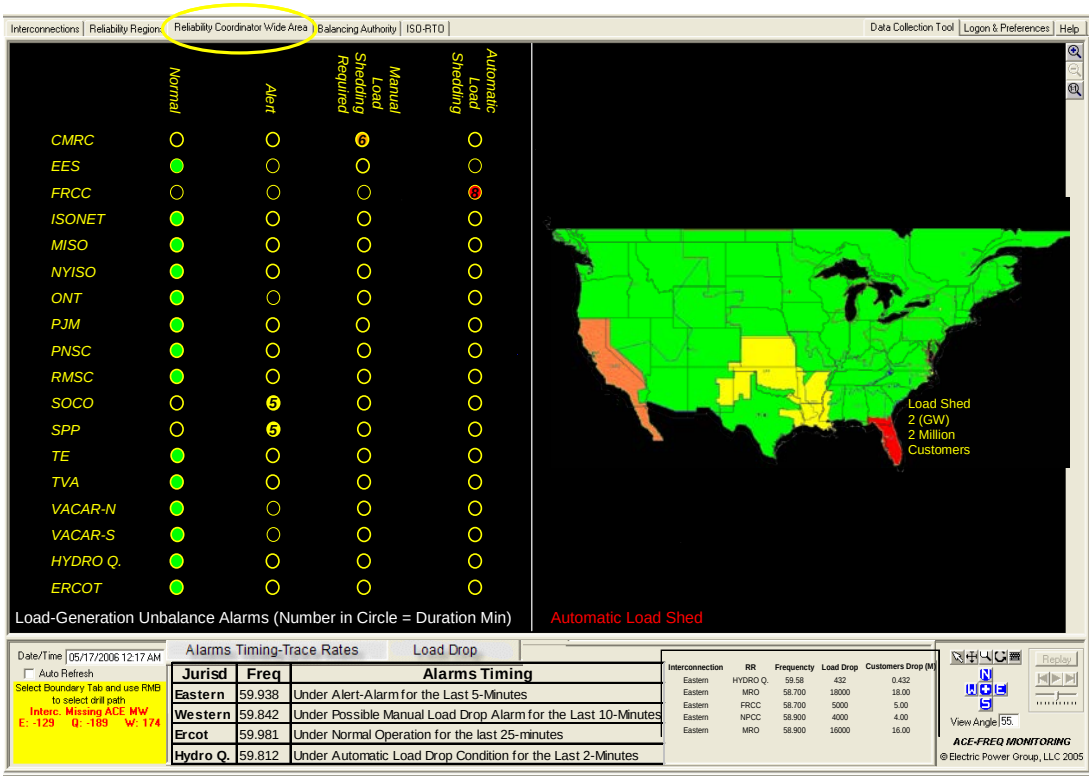

Figure 6 - Detection-Alarm Dashboard for Reliability Coordinators

3.2 Adequacy Trace-Trend Dashboard for Situational Awareness

After users have been alarmed and notified of abnormal resource adequacy unbalances via the detection-alarm dashboard, they can navigate by clicking on the any of the alarm-circles to a second dashboard showing a 4 panel visual solution to allow investigation of possible root-causes and reasons for the resource abnormal unbalances. Figure-7 shows this multi-view visual containing four major functions: a trace for the resources adequacy status in panel-1, a color-coded reliability coordinators geographic view with its color-code ACE in panel-2, load-shed bars or alarm-map plots in panel-3, and in panel-4 the tabular text tables showing the magnitudes of the data corresponding to the plots or graphs showing in each of the other three panels. All four functions are presented as an integrated and coordinated trace-trend dashboard.

As shown in Figure-7, the text-labels for the trace and the two references data shown at the bottom-right corner of panel-1 and the red-coloring of the bars in panel-3 showing load already shed are visual requirements.

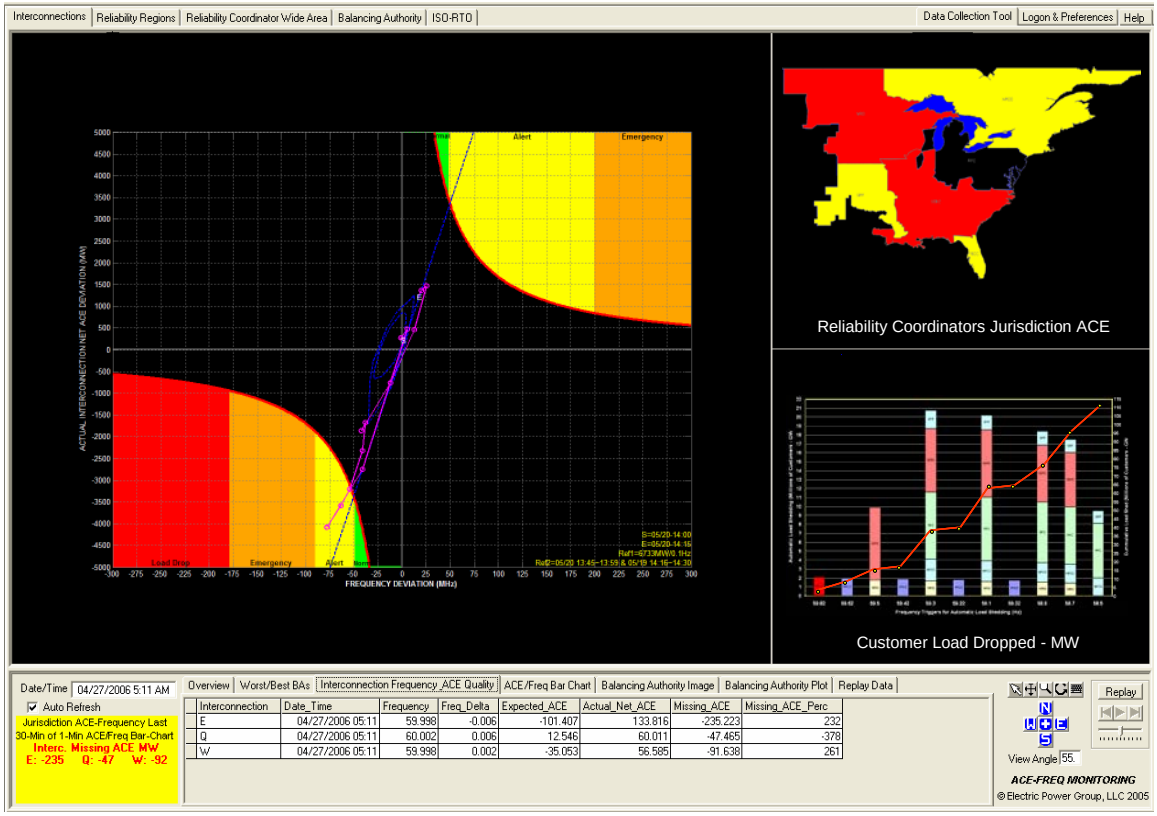

Figure 7 – Adequacy Trace-Trend Dashboard Visualization Solution

Following are brief descriptions of each panel of the trace-trend dashboard:

- Panel-1 shows for the interconnection the minute-by-minute resources adequacy trace for the last 10-minutes as a default, the trace-length in minutes can be selected by users. Three major operational references are also shown: the alarms

BAAL boundaries, the frequency bias rate-line, and probabilistic grouped historical-data selected by user.

- Panel-2 shows the color-coded ACE magnitude and geographic location for those reliability coordinators having the most impact in the resources adequacy imbalances shown in panel-1. The visual and information in panel-2 complements panel-1 information by directing users to identify the root-causes, magnitude and geographic location of resources adequacy imbalances.
- Panel-3 gives user additional information by showing per reliability region the estimated number of customers whose load has been dropped and the equivalent GW already shed when the resources adequacy trace-trend in panel-1 is already in the automatic load-shed red-area.
- Panel-4 gives the parameters magnitudes in a tabular text format. There will be a tab for each of the three panels of the dashboard. The data table for each tab will contain all the data used for the corresponding plot in either of the panels.

The following sections give the details for the data and functionality for each of the four panels

3.2.1 Panel-1 Load-Generation Resources Adequacy Trace, Trend and References

Figure-8 shows the type of plot that will be shown in panel-1 to show the minute-by-minute ACE-Frequency adequacy trace-trend for a user selected period of time. The figure also shows the rate and magnitude operational references, use to compare the current load-generation (NET ACE – Frequency Deviation) trace behavior and trend with the load-generation balance behavior for a specific user selected period to time.

The trace shown in Figure-8 is based on real data for May 20, 2006 when a generation outage of about 2200 MW occurred in the Eastern Interconnection. The trace shows the load-generation points entered the alert yellow area for 4 minutes before start returning to a zero frequency deviation at a rate very close to the interconnection frequency bias line being use as a rate reference.

The historical data, Net-ACE and frequency deviation selected by users to use as magnitude reference is grouped in two envelops that define probabilities of occurrence based in the percentage and type of data contained in each envelop. This process is equivalent to the uni-variate standard deviation statistic. For the sample shown in Figure-8 the percentages of data in each envelop are 90 and 50 percent.

Figure-9 shows another instance of the type of plot to be shown in panel-1 for the adequacy trace-trend dashboard.

The shown ACE-Frequency 10-minute trace in Figure-9 is for the blackout from August 14, 2003 at 4:13 PM when 50 million people ended up with not electricity. The 2003 Eastern interconnection frequency and 1-minute historical data from August 14th from 8AM to 4PM were selected as the operational references. The figure shows the resource adequacy trace at the time of the blackout deviated completely from both the rate and magnitude references selected. It also should be noticed that the historical reference

envelops selected show the eastern interconnection was under-generating for more than 50-percent of the time of the reference data selected, 8AM to 4PM. Also, it should be noticed, that before the blackout the resource balance trace did not indicate any abnormal deviation from the operational references selected.

The x and y axes cuts will be different for the three jurisdictions: Interconnections, Reliability Regions, and Reliability Coordinators.

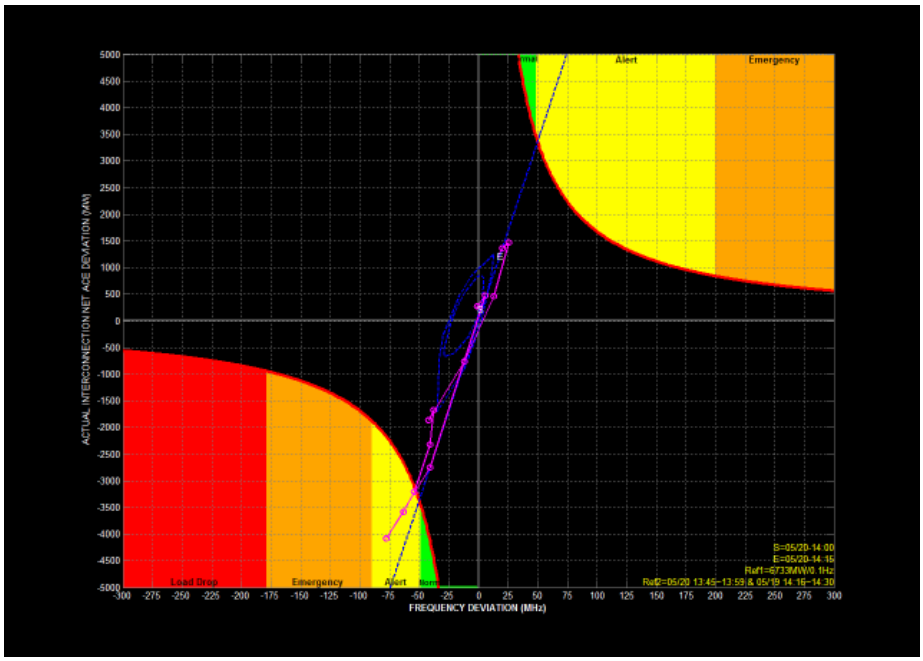

Figure 8 – Balance Resources Adequacy Trace-Trend on May 20, 2006

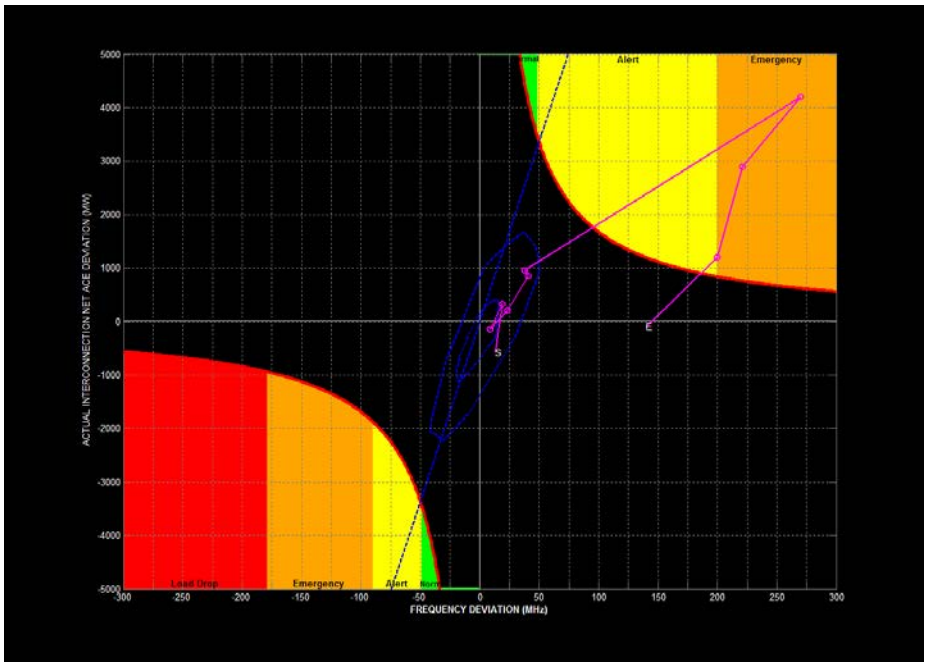

Figure 9 – Real Case Trace for August 14, 2003 Blackout

3.2.2 Panel-2 Load-Generation Resources Adequacy Correlation with Reliability Coordinators' ACE and Geography

Figure-10 shows geographically and color-coded the ACE for all the Reliability Coordinators that have the biggest contribution to the Load-generation Resources Inadequacy shown in panel-1. This will allow end users to identify by geography the ACE directions and magnitude of those coordinator jurisdictions that have contributed the most for any resource adequacy unbalances shown in panel-1.

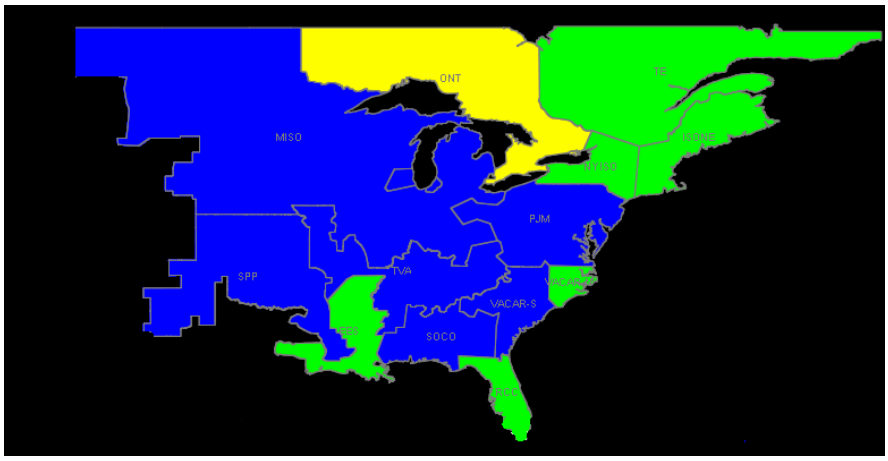

Figure 10 – Panel-2 Resources Adequacy Correlation with ACE and Geography

3.2.3 Panel-3 Automatic Load Shed

Figure-11 shows the cumulative-bars plot that will be displayed in panel-3. It shows per reliability region at the right-y-axis in red the customers dropped, and at the left-y-axis in white the GW already shed by under-frequency relays. Each cumulative-bar shows the Reliability Regions load that will be shed by under-frequency relays once the interconnection frequency reaches the frequency of each bar. In Figure-11, the first cumulative bar shows in red the FRCC load already shed automatically.

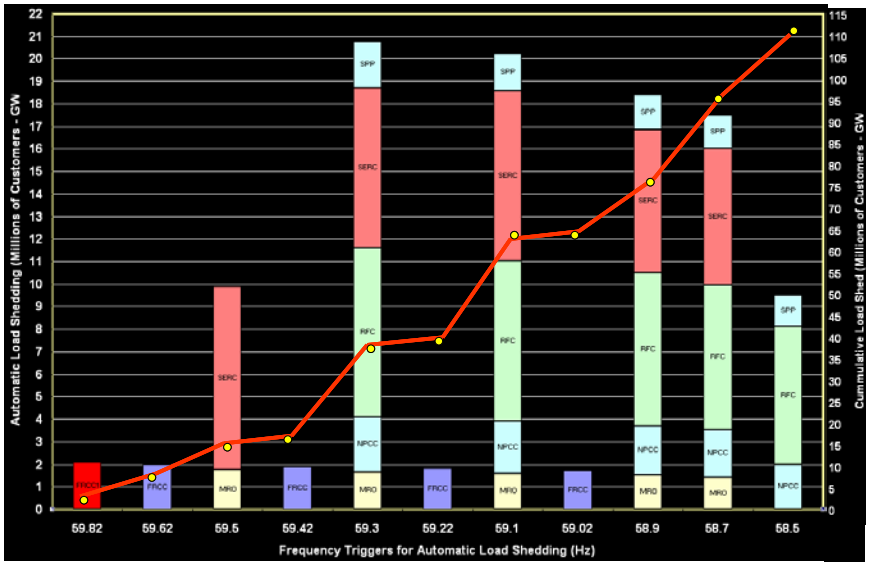

Figure 11 – Panel-3 Automatic Load Shed

The bar-chart have two y-axis, the left y-axis will show the interconnection customers and GW dropped or that could be dropped at each of the under-frequency settings pre-defined for each reliability region. The right y-axis will show for the line-plot the cumulative number of customers and GW dropped or that could be dropped. For the future when load and load-drop data becomes available, the bars will be presented not just for reliability regions, but also for the other jurisdictions.

Tables-2 and 3 show the data that the application will use in phase-2 to estimate the load the reliability regions under-frequency relays will shed.

The first column from Table-2 shows the under-frequency relays load-shed frequencies for each reliability region. The remaining columns show the percent of the regions peak load that will be shed for each under-frequency trigger.

Table-3 shows for a typical jurisdiction in column-1 the yearly peak, in columns 2 and 3 the hourly peak and its average for each hour type for a full year, and in column-5 the percent that will be applied to the already available jurisdictions' yearly peak to calculate load-shed in phase-2. During Phase-3, research will be done to identify load-shed calculations accuracy improvements, and availability of appropriate data.

Table 2 – Reliability Regions Under-Frequency Relay Settings

Reliability Regions Under Frequency Load Shedding (UFLS) Settings								
Reliability Regions (Peak Load)	FRCC (48.69)	RFC (209.44)	SERC (178.00)	MRO (48.15)	SPP (41.49)	NPPC (91.08)	ERCOT (62.15)	WECC (164.57)
Frequency Settings	Load Shed Percentage at Each Frequency Setting							
59.82	5.0%							
59.62	5.0%							
59.50		5.0%	5.0%					
59.42	5.0%							
59.30		5.0%	5.0%	10.0%	10.0%	10.0%	5.0%	
59.22	5.0%							
59.10		5.0%	5.0%					5.3%
59.02	5.0%							
59.00				10.0%	10.0%			
58.90		5.0%	5.0%				10.0%	5.9%
58.80						15.0%		
58.70		5.0%	5.0%	10.0%	10.0%			6.5%
58.50			5.0%				10.0%	6.7%
58.30								6.7%

For phase-2 the application will use Table-3 column-5 for all Reliability Regions load-shed calculations. It is expected that for phase-3 there will be an equivalent Table-3 for each Reliability Region.

Table 3 – Percent of Yearly Peak Load for Load-Shed Calculations

Hour	Typical Year Peak Load (GW)	Typical Hour Peak Load (GW)	Typical Hour Average Load (GW)	Hourly Percent from Year Peak	Hourly Percent from Hour Peak
0	42.89	26.61	21.51	50.1%	80.8%
1	42.89	25.23	20.70	48.3%	82.1%
2	42.89	24.60	20.26	47.2%	82.3%
3	42.89	24.37	20.09	46.8%	82.4%
4	42.89	24.32	20.36	47.5%	83.7%
5	42.89	25.39	21.36	49.8%	84.1%
6	42.89	27.48	23.26	54.2%	84.6%
7	42.89	29.87	24.83	57.9%	83.1%
8	42.89	32.20	26.02	60.7%	80.8%
9	42.89	34.08	26.99	62.9%	79.2%
10	42.89	35.99	27.82	64.9%	77.3%
11	42.89	37.41	28.26	65.9%	75.5%
12	42.89	38.61	28.45	66.3%	73.7%
13	42.89	39.93	28.75	67.0%	72.0%
14	42.89	41.22	28.90	67.4%	70.1%
15	42.89	41.99	28.92	67.4%	68.9%
16	42.89	42.01	28.96	67.5%	68.9%
17	42.89	40.82	29.39	68.5%	72.0%
18	42.89	38.74	29.34	68.4%	75.8%
19	42.89	37.83	29.05	67.7%	76.8%
20	42.89	37.72	28.80	67.1%	76.3%
21	42.89	35.61	27.49	64.1%	77.2%
22	42.89	32.16	25.24	58.8%	78.5%
23	42.89	28.70	23.02	53.7%	80.2%

3.2.4 Tabular Text and Replay Option

Panel-4 displays the magnitudes for all the data used for each of the plots and graphs shown in the other panels. There will be a tab for each of the three panels on the dashboard. The data table for each tab will contain all the data for the corresponding plot in the panel utilized.

The replay option will show the dashboard with the trace-trend in panel-1 starting at the first trace minute selected by the user, going by each minute until the last or current minute selected.

3.2.5 User Display Rearrangement Options

Panel-2 and panel-3 of the Adequacy Trace-Trend dashboard need to have the option for the user to display either the alarm-map from panel-2 of the detection-alarm dashboard or the alarm-circles from panel-1.

4. NAVIGATION AND EXTENDED MENU STRUCTURE

4.1 Navigation Overview for Situational Awareness

Figure-12 shows an overview of DOE Situational Awareness Navigation. The different arrows and RMB menus in the right-side of Figure12 show the navigation from the top functions, starting with the application icon and ending on the adequacy trace-trend dashboard. The different arrows and RMB menus in the left-side of the figure show the navigation from the bottom functions starting at the trace dashboard and going back to alarming and monitoring functions on the 1-panel display.

Because DOE initial focus and utilization will be with the detection-alarm dashboard, the current top-left jurisdictional tabs will be used to obtain the detection- alarm dashboard for the interconnections, reliability regions and reliability coordinators. Any jurisdictional change required for the adequacy trace-trend dashboard will require the user to go back, via the RMB, to the detection-alarm dashboard and select the jurisdiction required from any of the alarms circles in panel-1.

To navigate between the two situational awareness dashboards and have access to the options window that will allow users to define parameters for the trace-trend and reference plots, a new RMB has being designed and is shown in Figure-12 with its different options.

4.2 New RMB Menu for Default View

Figure-13 shows the expanded and categorized RMB menu including the situational awareness alarm and trace dashboards options. When users select the “Detection-Alarm Dashboard” option, the DOE-SA Detection-Alarm Dashboard will be displayed. If the user selects “Adequacy Trace-Trend Dashboard”, the respective dashboard will be displayed. See Figure-13.

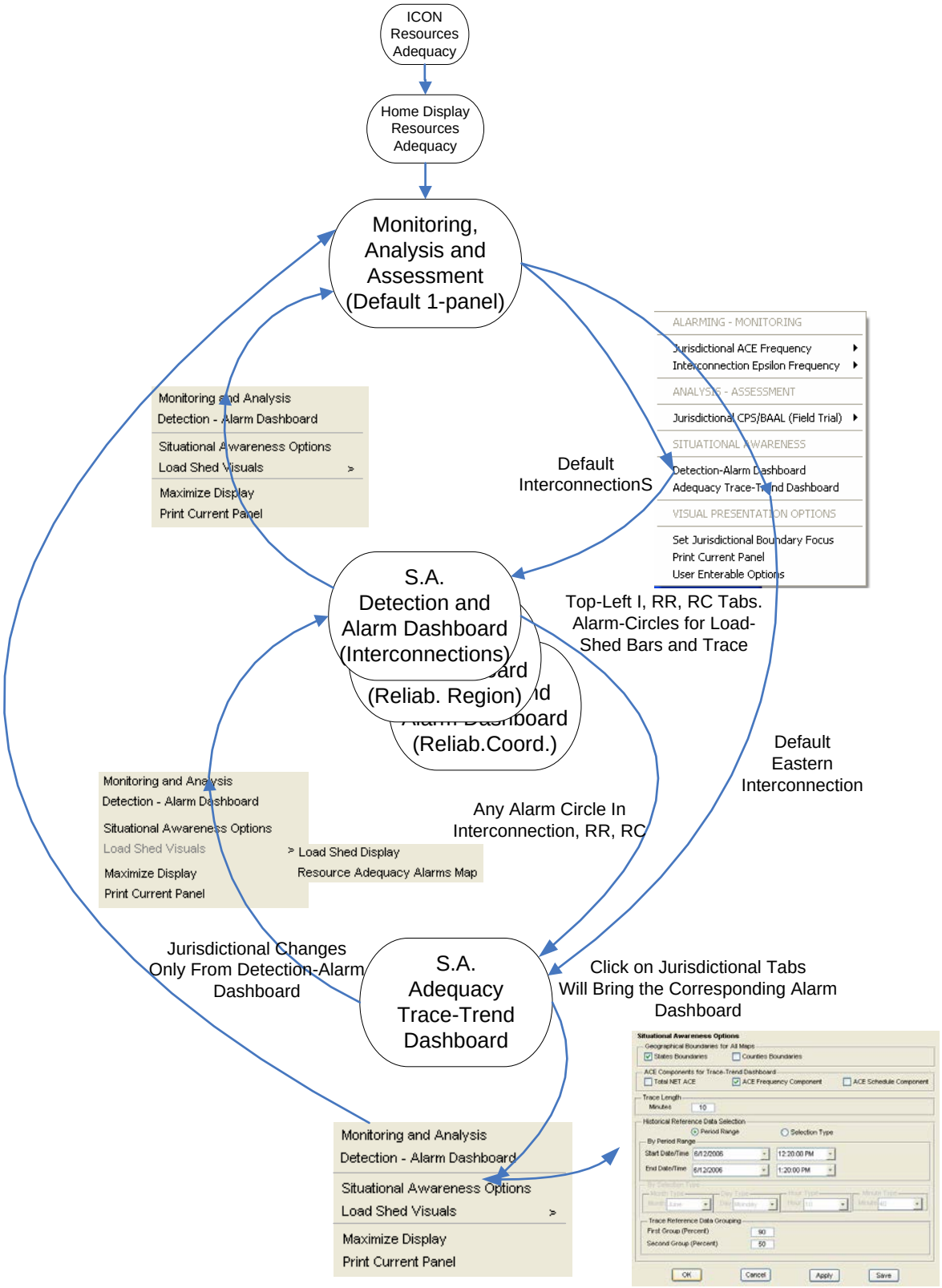

Figure 12 –Navigation Overview for Situational Awareness

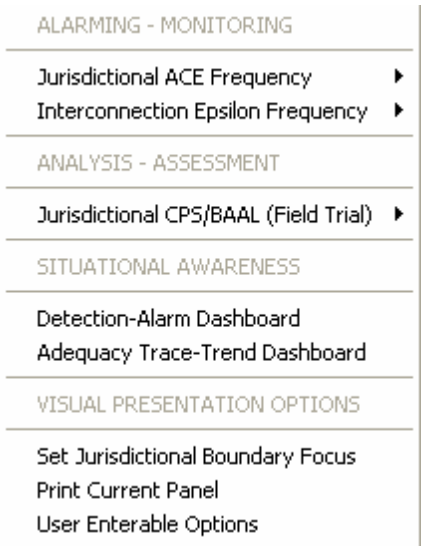

Figure 13 – Expanded RMB Menu to Include Situational Awareness

4.3 RMB Menu Options for Alarm and Trace-Trend Dashboards

Figure-14 shows the new RMB menu options for the detection-alarm and the adequacy trace-trend dashboards. Right clicks on any of the dashboards will bring the new RMB for situational awareness with its different options shown in Figure-14. Following is a brief description of each of the situational awareness RMB menu options

- Monitoring and Analysis – This option will display the Monitoring, Analysis, and Assessment default 1-Panel visual.
- Detection-Alarm Dashboard – This option will display the Detection-Alarm Dashboard
- Situational Awareness Options – This option will display the window shown in Figure-15 for users to enter trace and reference parameters.
- Load Shed Visuals – This option will bring a second menu for the user to select the plot they will like to show in panel-2 or panel-3 of the dashboards.
- Maximize Display
- Print Current Panel

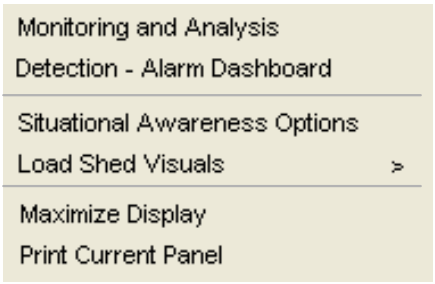

Figure 14 – Situational Awareness Dashboards RMB Options

5. USER OPTIONS FOR TRACE DASHBOARD, ALARM FREQUENCY THRESHOLDS AND DATA COLLECTION

5.1 User Selection of Adequacy Trace-Trend Dashboard Parameters

When the user selects "Situational Awareness Options" on the Dashboards RMB menu, the window shown in Figure--15 will appear with the following options.

- Geographical Boundaries for All Maps – States or Counties Boundaries
- ACE Components for Trace-Trend Dashboard – Total Net-ACE, ACE Frequency Component, ACE Schedule Component
- Trace Length (Minutes) – The total minutes for the resource adequacy trace
- Historical Reference Data Selection – The total minutes for the magnitude reference loop by period range or by selection type

The trace-reference data grouping will be fixed at 90 and 50 percent for this phase-2 release.

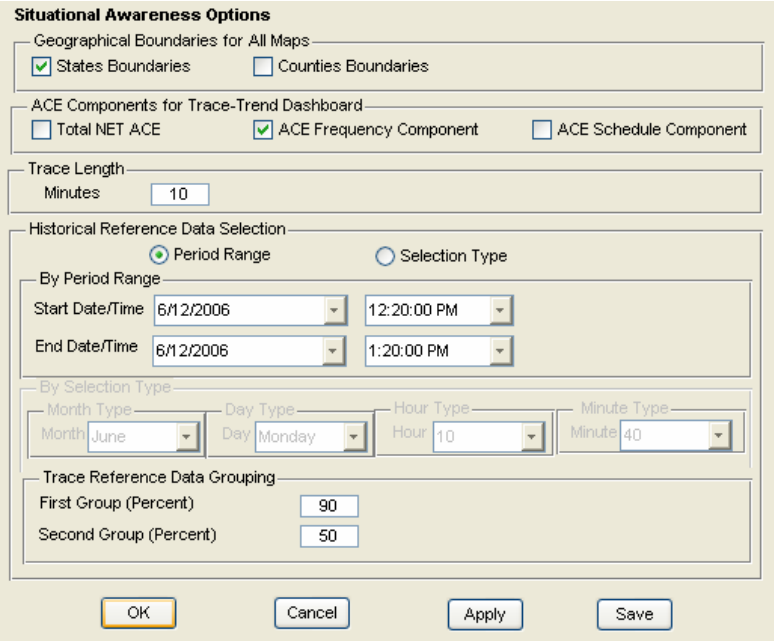

Figure 15 – User Trace-Trend Dashboard Parameters Options

5.2 User Options for Alarm Frequency Thresholds

The current User Enterable Options window will be extended to include the Situational Awareness tab selection. The ACE-Frequency tab will have the same options window as R3.5 and the SA tab will have six new Alarm Thresholds: one for Alert condition, another for Emergency condition, and the other for Drop Load. Each one will have Low and High mode.

Figure-16 shows the User Enterable Options window for the ACE Frequency Tab and Figure-17 shows the Options window for the Situational Awareness Tab.

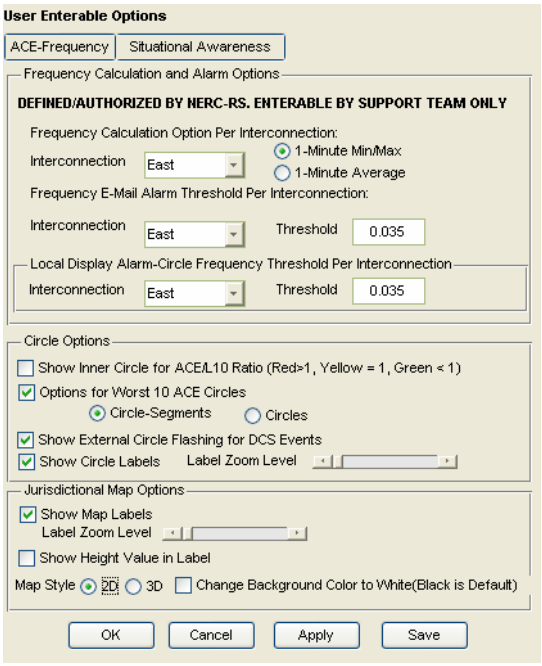

Figure 16 – Current User Enterable Options for the ACE Frequency Tab

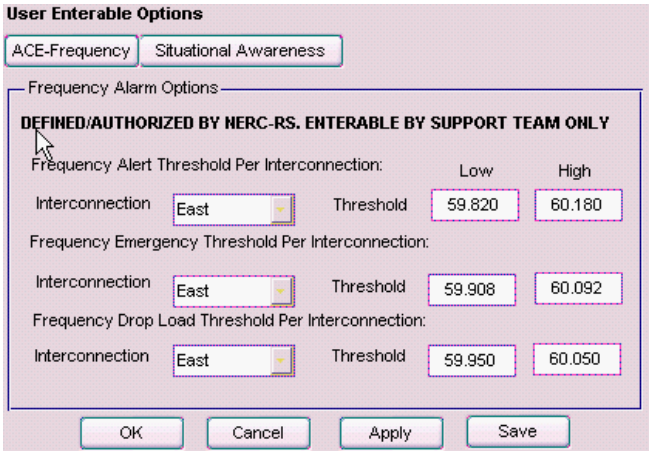

Figure 17 - User Enterable Options for SA Alarm Frequency Thresholds

5.3 User Options for Data Collection and Archive DOE-SA Data

The Data Collection Tool selection window will have two tabs similar to the window for user enterable options. The ACE-Frequency tab will allow collecting and archiving Resources Adequacy Alarm and Monitoring data. The Situational Awareness tab will allow collection of DOE-SA data.

The Data Collection Tool for release 4.0 needs to use the same remote .Net service, as the DOE-SA application.

Figure-18 shows the data collection tool window. Table-4 shows the situational awareness data available for users to collect and archive.

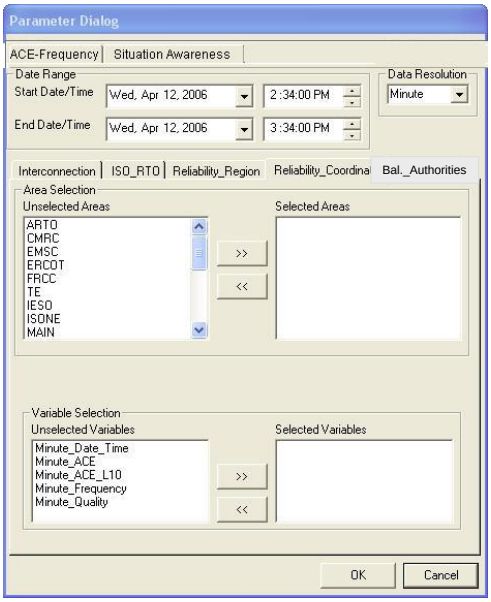

Figure 18 - Data Collection Tool Window

Table 4 – List of Data for Collection or Archiving as CSV files

Variables	Data Type	Description	Database Status	Unavailable Variable Create Method
Freq_Bias	float	Jurisdiction Frequency Bias: Sum of Frequency Bias of ALL BAs in the Jurisdiction	Not Available	Stored Procedure
L10_Yealy	float	Jurisdiction Yearly L10: Sum of Frequency Bias of ALL BAs in the Jurisdiction	Not Available	Stored Procedure
Frequency	float	Interconnection Frequency	Available	
NetACE	float	Jurisdiction Net ACE: Sum of ACE of ALL BAs in the Jurisdiction	Not Available	Stored Procedure
Date_time	date_time	Date, Time Tag of the Jurisdiction Net ACE Data	Available	
Jurisdiction_ID	integer	Jurisdiction ID	Available	
NetACE	float	Jurisdiction Net ACE: Sum of ACE of ALL BAs in the Jurisdiction	Not Available	Stored Procedure
NetACE_Freq_Component	float	Jurisdiction Net ACE Frequency Component	Not Available	Stored Procedure
NetACE_Sched_Component	float	Jurisdiction Net ACE Scheduled Component	Not Available	Stored Procedure
Load Drop	float	Total Dropping MW of Jurisdiction When Frequency Under Frequency Relay Threshold	Not Available	Import into Database
Temperature	float	Temperature of the Balancing Authority	Not Available	Import into Database
Quality Code	integer	Quality Code of Temperature	Not Available	Import into Database

6. SITUATIONAL AWARENESS ALARMS FORMAT AND ROUTE CRITERIA

The alarm description and format below should be use as the format template for the SA four alarm types described in Table-5. The SA alarms will be a new AFN category.

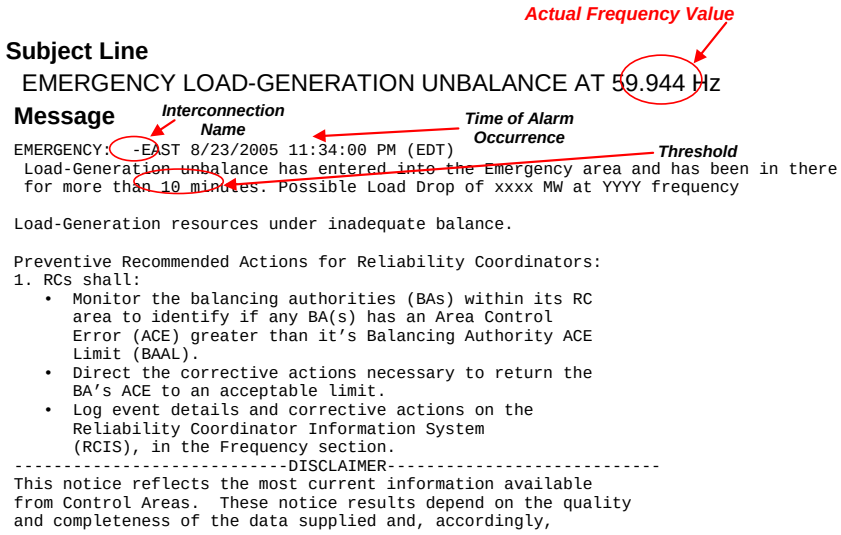

Figure 19 – Alarm Description and Format

Table-5 shows the alarms criteria and conditions for the Situational Awareness balance resources application. A un-alarm equivalent to Release 3.5 BAAL un-alarm is required for each of the SA alarms. The alarming heading should flash in the yellow information window each time an alarm is triggered. The Alarm criteria and conditions on Table-5 should apply to Reliability Regions and Reliability Coordinators. The system unavailable alarm and the system available un-alarm must be broadcasted when the DOE-SA application can not be accessed by DOE for more than 1 continuous hour. Unavailability alarm data should be archived for creating last 30-days system unavailability reports.

Table 5 – Alarms Criteria and Conditions for Situational Awareness

Criteria Alarm	Alarm Duration	Load Shed	Alarm Condition	Alarm Broadcasting Recipients
Normal	Not Alarm	N/A	N/A	DOE to Define
Alert	15 Minutes 30 Minutes	N/A	N/A	DOE to Define
Manual Load Shedding Required	5 Minutes 10 Minutes	N/A	Steady Flash	DOE to Define
Automatic Load Shedding	1 Minute	> 1 MW	Flash	DOE to Define
System Unavailable	60 Minutes	N/A	Broadcast	DOE to Define

7. PERFORMANCE REPORTS FOR SITUATIONAL AWARENESS

The updated report generator selection window for DOE-SA application will have two tabs: Data Quality-Performance Tab and Situational Awareness Tab. The Data Quality-Performance tab will generate the same reports Release 3.5 produces but using the updated user interface shown in Figure-20. The Situational Awareness tab will produce a last 30, 60, or 90 days performance report for reliability regions grouped by interconnections with the data and format shown in Table-6 (last 30-days) using the user interface window shown in Figure-21.

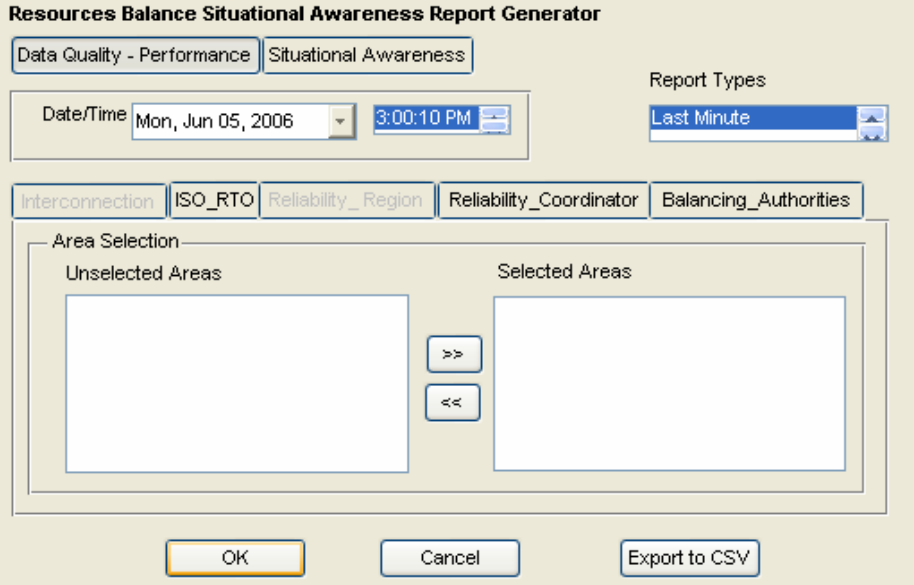

Figure 20 – Updated User Interface for Data-Quality Performance Reports

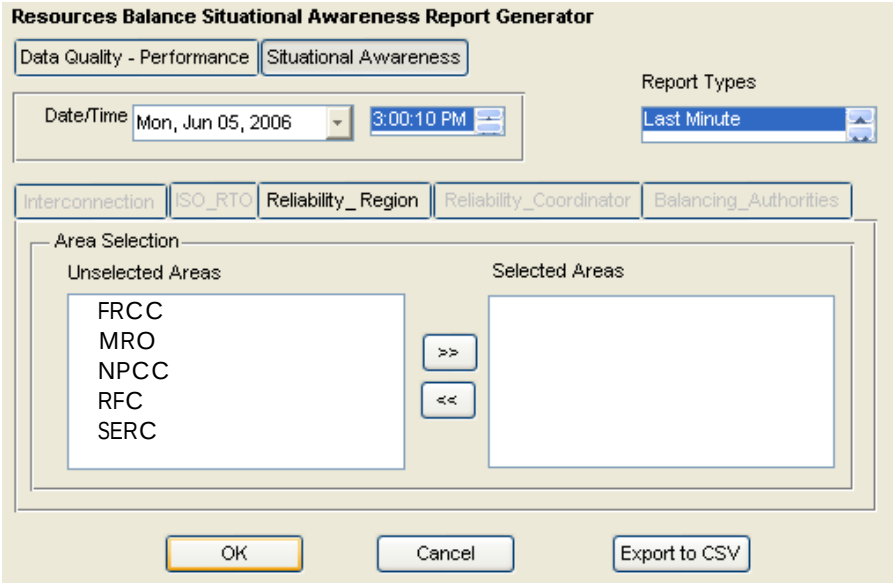

Figure 21 – Situational Awareness Performance Report Generator Window

Table 6 – Sample of Data and Format for Last 30-Days Performance Report for SA

S.A. RESOURCES ADEQUACY MONTHLY PERFORMANCE SUMMARY							
Jurisdiction	**Alarm Date**	**Alarm Time**	**Alarm Type**	**Alarm Duration (Minutes)**	**Automatic Load Shed (GW)**	**Automatic Load Shed Frequency (Hz)**	**Customers Dropped (Millions)**
		LAST 30-DAYS STARTING AT JUNE 2ND					
	EASTERN INTERCONNECTION (EST Time)						
	05.05.06	20:01:00	Alert	15			
	05.30.06	11:00:00	Alert	17			
Eastern Region 1	05.30.06	22:26:59	Emergency	6			
	05.30.06	23:32:59	Load Shed	1	2.2	59.941	2
Eastern Region 2	05.30.06	22:26:59	Emergency	2			
	05.30.06	23:29:59	Load Shed	1	3.1	59.941	3
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
	WESTERN INTERCONECTION (Pacific Time)						
	5.15.06	6:10:00	Alert	15			
	5:15:00	23:11:59	Alert	22			
Western Region 1	05.10.06	23:36:59	Emergency	2			
	05.10.06	23:40:59	Load Shed	1	1.1	59.933	1
Western Region 2	05.10.06	23:36:59	Emergency	2			
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
	DOE-SA APPLICATION UNAVAILABLITY (EST Time)						
DOE-SA Unavailablity	05.05.06	10:10:00	Unavailablity	135			
	05.30.06	20:14:00	Unavailability	320			
.	.	.	.	.	.	.	.

8. DATA REQUIREMEMENTS AND DATABASES TABLE STRUCTURE

In addition to the data used by the current ACE-Frequency Release 3.5, the following categories of data are required for phase-2 of the DOE-SA application.

8.1 Data Requirements Summary Table

The following data is required for the detection-alarm and trace-trend dashboards of the DOE-SA situational awareness application:

Table 7 – Data Requirements for DOE Situational Awareness Application

Panel -1 Jurisdiction Adequacy Status Data (Interconnection, Reliability Region, Reliability Coordinator, ISO-RTO)				
Variables	**Data Type**	**Description**	**Database Status**	**Unavailable Variable Create Method**
Jurisdiction_ID	integer	Jurisdiction ID	Available	
Jurisdiction Code	varchar	Jurisdiction Code	Available	
Jurisdiction _Name	varchar	Jurisdiction Name	Available	

Freq_Bias	float	Jurisdiction Frequency Bias: Sum of Frequency Bias of ALL BAs in the Jurisdiction	Not Available	Stored Procedure
L10_Yealy	float	Jurisdiction Yearly L10: Sum of Frequency Bias of ALL BAs in the Jurisdiction	Not Available	Stored Procedure
FTL_Low	float	Jurisdiction Frequency Trigger Low Limit.	Not Available	Import into Database
FTL_High	float	Jurisdiction Frequency Trigger High Limit	Not Available	Import into Database
FAL_Low	float	Jurisdiction Frequency Abnormal Low Limit	Not Available	Import into Database
FAL_High	float	Jurisdiction Frequency Abnormal High Limit	Not Available	Import into Database
FRL_Low	float	Jurisdiction Frequency Relay Low Limit	Not Available	Import into Database
FRL_High	float	Jurisdiction Frequency Relay High Limit	Not Available	Import into Database
Frequency	float	Interconnection Frequency	Available	
NetACE	float	Jurisdiction Net ACE: Sum of ACE of ALL BAs in the Jurisdiction	Not Available	Stored Procedure
Panel -2 Jurisdiction NetACE Component Data (Interconnection, Reliability Region, Reliability Coordinator, ISO-RTO)				
Variables	**Data Type**	**Description**	**Database Status**	**Unavailable Variable Create Method**
Date_time	date_time	Date, Time Tag of the Jurisdiction Net ACE Data	Available	
Jurisdiction_ID	integer	Jurisdiction ID	Available	
NetACE	float	Jurisdiction Net ACE: Sum of ACE of ALL BAs in the Jurisdiction	Not Available	Stored Procedure
NetACE_Freq_Component	float	Jurisdiction Net ACE Frequency Component		
NetACE_Sched_Component	float	Jurisdiction Net ACE Scheduled Component		
Panel -3 Jurisdiction Load Drop Data (Interconnection, Reliability Region, Reliability Coordinator, ISO-RTO)				
Variables	**Data Type**	**Description**		
Date_time	date_time	Date, Time Tag of the Jurisdiction Net ACE Data		
ID	integer	Jurisdiction ID		
Frequency	float	1-minute Frequency		
Load Drop	float	Total Dropping MW of Jurisdiction When Frequency Under Frequency Relay Threshold		
Weather Temperature Data (Phase-3)				
Variables	**Data Type**	**Description**	**Database Status**	**Unavailable Variable Create Method**

Date_time	date_time	Date, Time Tag of the Temperature Data	Not Available	Import into Database
BA_ID	integer	Balancing Authority ID	Not Available	Import into Database
Longitude	float	Longitude of Balancing Authority	Available	
Latitude	float	Latitude of Balancing Authority	Available	
Temperature	float	Temperature of the Balancing Authority	Not Available	Import into Database
Quality Code	integer	Quality Code of Temperature	Not Available	Import into Database

Figure-22 shows the database table structure for DOE-SA. Variables in bold in Figure-22 need to be imported into the corresponding tables.

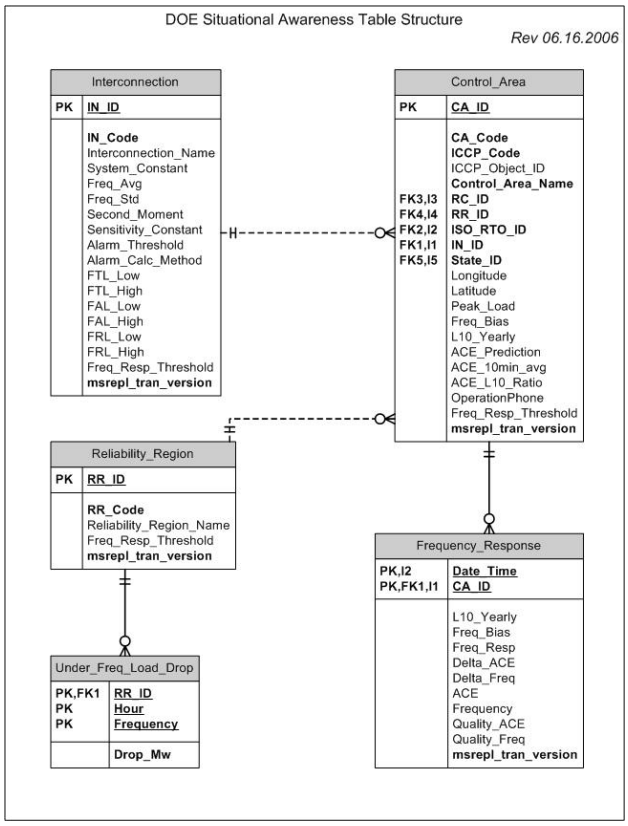

Figure 22 - Database Table Structure for DOE-SA

Figure-23 shows the database disturbance and alarm (DARA) table structure. This structure is already implemented and should be used for archiving the DOE-SA alarms for creating the required performance report. The table structure below will include the TEC schedule data.

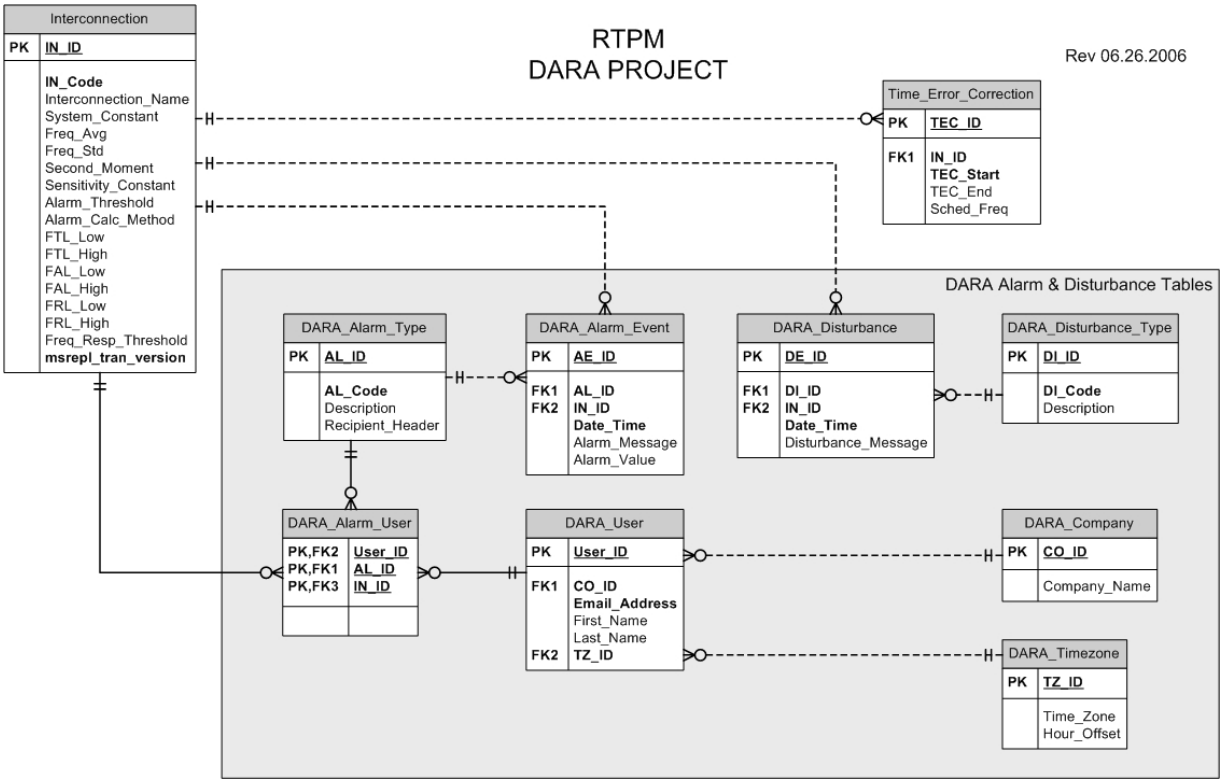

Figure 23 – DARA Database Table Structure

8.2 Shape Files for State/County Maps

The shape files for state/county boundary maps will be required to overlap over the jurisdictional boundaries for the maps of the two situational awareness dashboards.

8.3 Recipients of Resource Adequacy Alarms and Reports

Alarm recipient names, e-mails, and cell phone numbers will be supplied by DOE, and will be integrated within the application using the current mechanism used in Release 3.5. For Phase-3, CERTSEPG will explore a mechanism to give DOE control for the support and administration of the alarms and reports recipients list.

9. SYSTEM COMPUTER HARDWARE AND DATA COMMUNICATIONS

Figure-24 shows the hardware and data communications for DOE-SA. The architecture is the same currently in use by the NERC resources adequacy real time monitoring applications. Alarms will be broadcasted any time they occur to subscribers to the alarm dissemination list. The two dashboards for the DOE situational awareness clients will be updated every minute with the appropriate data.

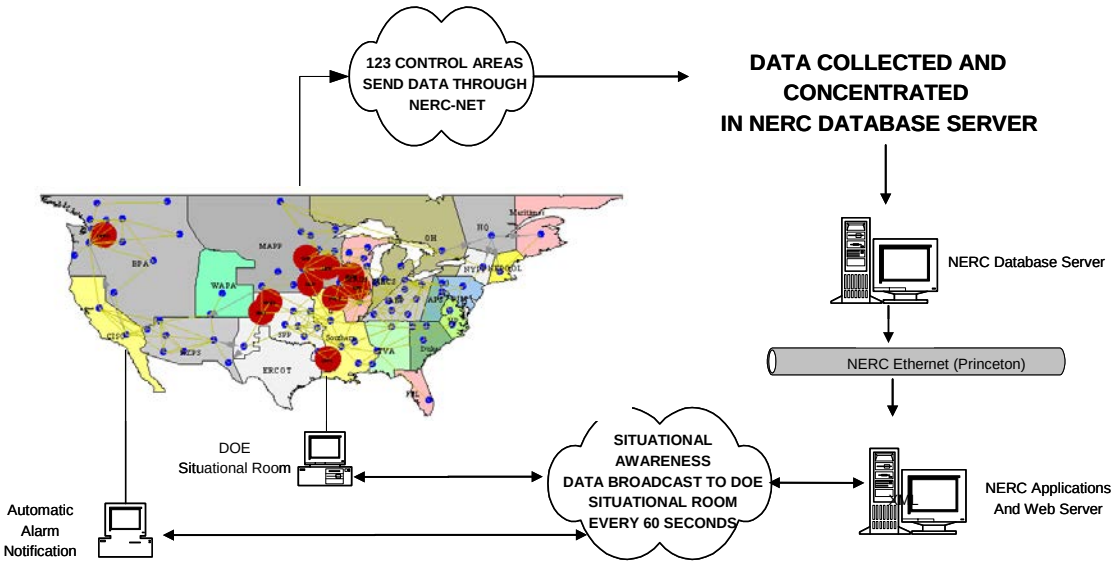

Figure 24 – Computer Hardware Architecture

Figure-25 show the DOE-SA data flow going in and out from the following four data centers used by the application:

- CERTS-EPG Support Server
- NERC Database Server (Princeton, NJ)
- NERC Database Server (Co-Location)
- CERTS-EPG Development Server

Dashboards data flows in and out from the NERC database servers, and local and broadcasted alarming and reports data flows out from the support server.

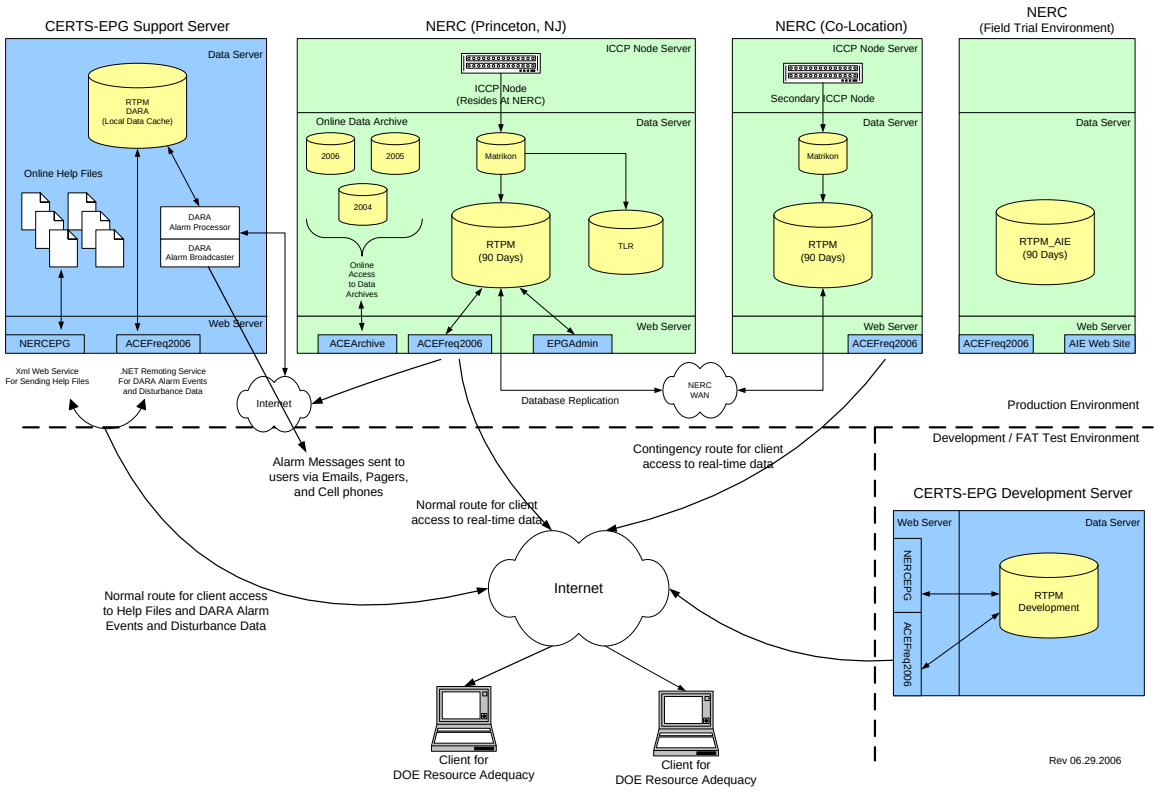

Figure 25 –DOE-SA Data Communications

10. SCHEDULE, TASKS AND DELIVERABLES

Following are the DOE-SA project phase-2 and phase-3 with the major tasks required for the implementation of the functional and design requirements of this functional-design specification document. They should be integrated in NERC Release 3.5 with the special visualization up to Reliability Coordinators available in the DOE Release 3.0 version.

- Phase-2 – Design, development, prototype and testing of the algorithms and visualization solutions for the detection-alarm dashboard and a basic trace-trend dashboard for situational awareness purposes, together with appropriate alarming and performance reports.

- Phase-3 – Expand and refine phase-2 data and processes to estimate load and customers drop, explore alternatives to acquire and integrate jurisdictions load-data, research further tailoring of operational trajectory dashboard for situational awareness, research integration DOE weather maps into SA resources adequacy, event verification and notification.

Beyond phase-3, CERTS-EPG will research feasibility and develop prototype for integrating situational awareness for transmission using NERC TLR Data.

10.1 Project Tasks Work Plan and Schedule

Following are the tasks, work plan and schedule for the DOE-SA phase-2 project. The DOE-SA must incorporate all enhancements and changes done and delivered for NERC Release 3.5 and listed in section 2.2.1.

Table 8 – DOE-SA Tasks, Work Plan, and Schedule

Task No.	DOE-SA - Phase-2 – 2Q06	Responsible	Completion Date	Progress
1	Define requirements for DOE review and approval	EPG, LBNL	May 14	Completed
2	Prepare functional specification	Carlos-Ajay-Martha	May 15	Completed
3	Define data requirements and implement database	Frank-Song	May 17	Completed
4	Design and develop panel-1 displays for detection-alarm and Adequacy Trace-Trend dashboards for DOE-SA resources adequacy alarm, status, and trends	DOE/LBNL -Carlos-Song	May 26	Completed
5	Define the DOE-SA alarms and performance and notification reports	DOE-LBNL-Carlos	June 1	Completed
6	Define project design requirements	Pasadena-EPG.B	June 2	Completed

7	Integrate Functional and Design Requirements into one Spec	Carlos, Martha, Frank, Song	June 10	Completed
8	Creation and release of the States/Counties boundary shapes	Frank	June 14	Completed
9	Implementation of the DOE-SA performance and notification report as extension of current data quality reports	Ajay	June 14	Completed
10	Implementation of DOE-SA Alarm Categories into AFN. Interface software for yellow window	Frank	June 29	6/29 – It will be delivered to EPG.B for integration
11	Implementation of DOE-SA Alarm Categories into AFN. Complete AFN changes.	Frank	July 5	7/5 – It will be delivered to EPG.B for integration
12	System and functional Factory Acceptance Test plan document	Carlos, Nand	June 30	Major Revision
13	Coordinate, implement, and test the DOE-SA database in NERC RTPM Server	Frank	July 7	Deliver for verification by Nand/Carlos
14	Integrate the DOE-SA panel-1 detection-alarm, Adequacy Trace-Trend Dashboards, Alarms and Reports within the NERC Release 3.5 application	EPG.B	July 7	6/30 – Code completed 7/3 – Internal test completed 7/7 – Release to Ajay for FAT
15	Execution and completion of system and functional factory test at EPG.B following version 1.0 of EPG FAT plan	Ajay-EPG.B	July 13	July 7 – July 13 – FAT execution. Daily conference call
16	Final Field test in Pasadena	Nand, Carlos	July 18	7/14 – Frank will integrate with NERC database
17	Installation, documentation and training at DOE	Carlos-LBNL-NERC-Ajay	July 27-28	DOE confirming
Task No.	**DOE-SA - Phase-3 - 3Q06**			
18	Expand and refine data and process to estimate load and customers drop	DOE/LBLN/ EPG		
19	Explore alternatives to acquire and integrate jurisdictions load-data	DOE/LBNL/ EPG		

20	Research further tailoring of operational trajectory dashboard for situational awareness, research	Song		
21	Integration DOE weather maps into SA resources adequacy	Ajay		
22	Event verification and notification	Ajay		
Task No.	**DOE-SA - Phase-3 - 4Q06**			
23	Review DOE experience with the July DOE-SA release, and define changes or enhancements	Joe, Carlos		
24	Expand phase-2 functional-design specification to incorporate phase-3 new functionality and enhancements. Submit to DOE for review and approval	Ajay, Carlos, Joe		
25	Integration of weather data and visualization implementation	EPG.B		
26	Final development, integration and testing including DOE feedback and weather component	Pasadena, EPG.B		
27	Phanse-3 Installation, documentation and training at DOE	Carlos-LBNL-NERC-Ajay		

APPENDIX A
VISUALIZATION APPROACH FOR DOE-SA RESOURCES ADEQUACY CORRELATION WITH SEVERE WEATHER (PHASE-3)

1. Weather Events Integration

Figure-26 shows the integrated, coordinated three panels proposed for the integration of weather event data for situation awareness for resource adequacy purposes.

- Panel-1 shows geographically weather event contours overlapping a user selected wide-area jurisdiction showing the color-coded ACE for the components of the selected jurisdiction. This will allow users to visualize geographic correlations between severe weather patterns and resource adequacy unbalances.

- Panel-2 will zoom-in those user selected areas where a correlation is identified between resources adequacy and severe weather conditions, to establish the impact that severe weather patterns area having in resources adequacy.

- Panel-3 will show the total load dropped because of resources adequacy under-frequency conditions. Users can select to show the color-coded state/county boundaries were load has been dropped.

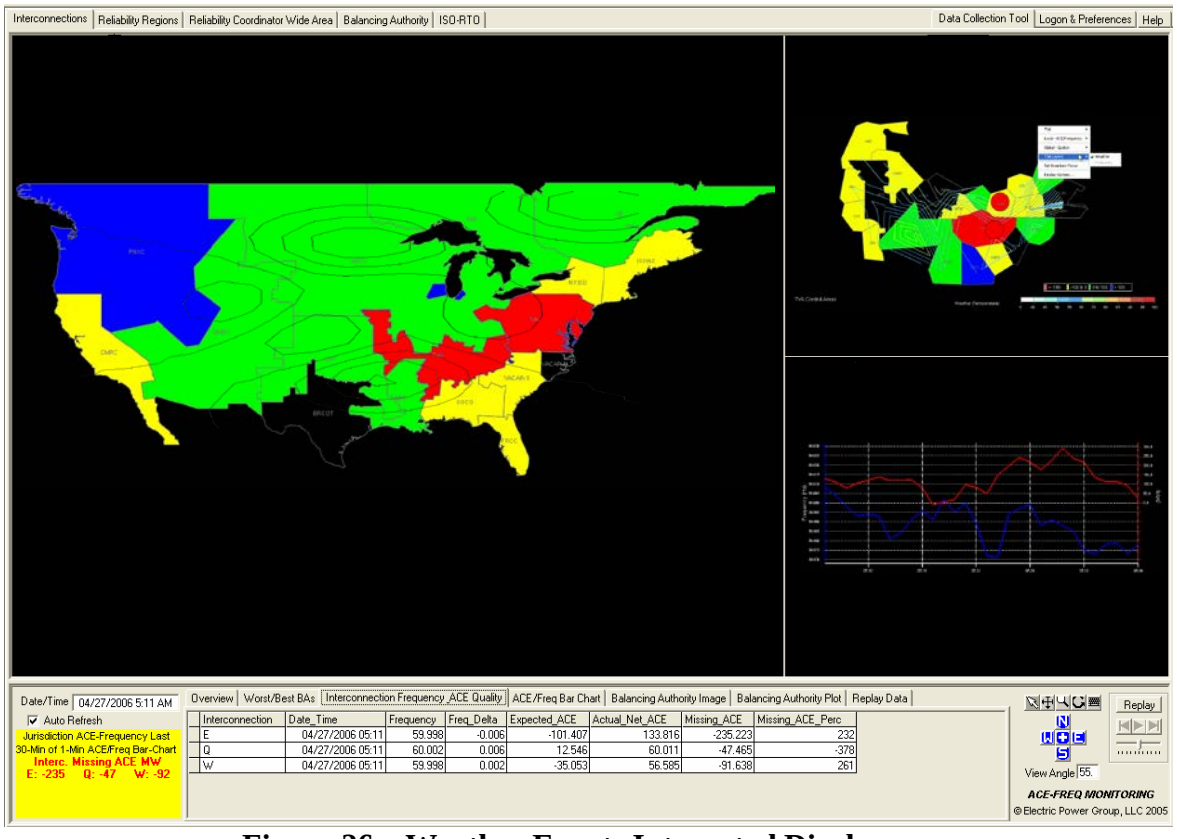

Figure 26 – Weather Events Integrated Display

2. Hurricane/Storm Path (location) Display (Phase-3)

The current location of Hurricane/Storm will be displayed over a 1-panel jurisdictional map using a red flashing circle. The previous locations for the hurricane/Storm will be displayed as red dots connected by line segments showing the path of the hurricane. The label for hurricane/storm would display short message regarding its intensity.

Figure 27 shows sample hurricane/storm path (location) indicated by red flashing circle and a trail of connected circles (path) overlaid on the interconnection map

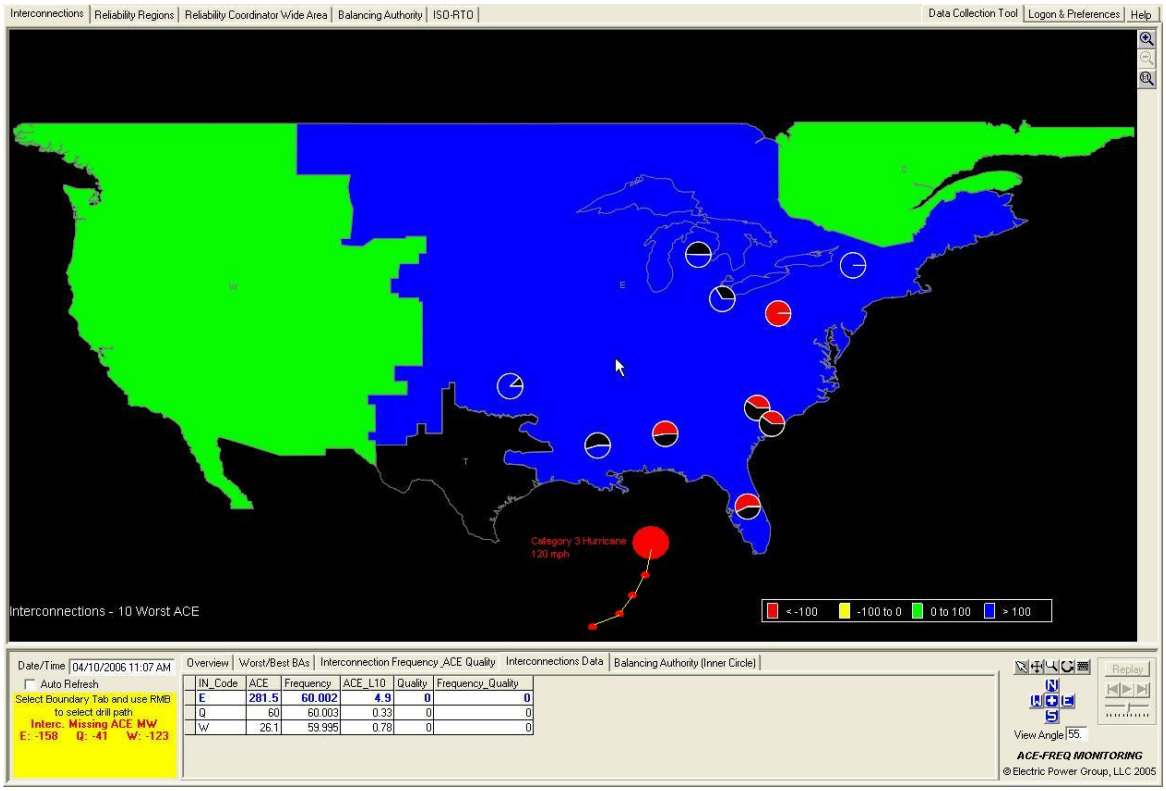

Figure 27 - Hurricane/Storm Path (location)

3. Weather Data

3.1 Hurricane and Storm Data

The data for the coordinates of hurricane and storms and their intensity (severity of impact) is needed to plot them on the map.

3.2 Temperature and Humidity Data

Data needed to plot contours for the temperature. Any other relevant weather data that is needed for analysis is also needed to be made available.

APPENDIX B

RISK AND PROBABILISTIC APPROACH USE FOR DOE-SA RESOURCES ADEQUACY ALARMING, STATUS AND NEAR-TERM TRENDS

CERTS-EPG have defined the following resource adequacy four alarm-areas for load-generation unbalance following both industry traditional system security concepts and the NERC work and definitions for their new Balancing Authority ACE Limit (BAAL) performance metric:

- **Normal Area –** Load-generation unbalance does not force interconnections frequency to violate any of the three BAAL frequency performance thresholds, and system can tolerate generation or load contingency without violating any BAAL frequency limit.
- **Alert Area –** Load-generation unbalance is violating the first BAAL frequency threshold (FTL) and the risk and impact of a second contingency become greater than acceptable. Reliability Coordinators required to take remedial action.
- **Emergency Area –** Load-generation unbalance is violating the second BAAL frequency threshold (FAL) and the system is exposed to unacceptable level of risk. Customers load maybe be dropped, restoration procedures in place.
- **Load Drop Area –** System frequency violates the third BAAL frequency threshold (FRL) and frequency relays have triggered and load has already being dropped, restoration procedures in place.

Figure-28 shows the load-generation operational space defined by two metrics: system frequency deviation and jurisdictions Net ACE. Also shown is the first resources adequacy operational reference, the yearly NERC frequency bias rate [MW/Frequency]

Figure-28 also shows on the ACE-Frequency plane the NERC BAAL normal, alert, emergency and load-drop alarm areas defined above, and which will be used for situational awareness resources adequacy purposes.

The alarm areas on Figure-28 have been defined using traditional industry security concepts and bounded by the BAAL metric equation and its NERC-BAAL frequency thresholds. Alarms will be broadcasted to subscribers when a resource adequacy unbalance point enter and stay within and alarm-area beyond certain time

The ACE type used for the ACE-Frequency plane in Figure-27 will be user optional between its two components: the frequency base component and the interchange component. Users will be able to select which ACE component to use within the ACE-Frequency plane.

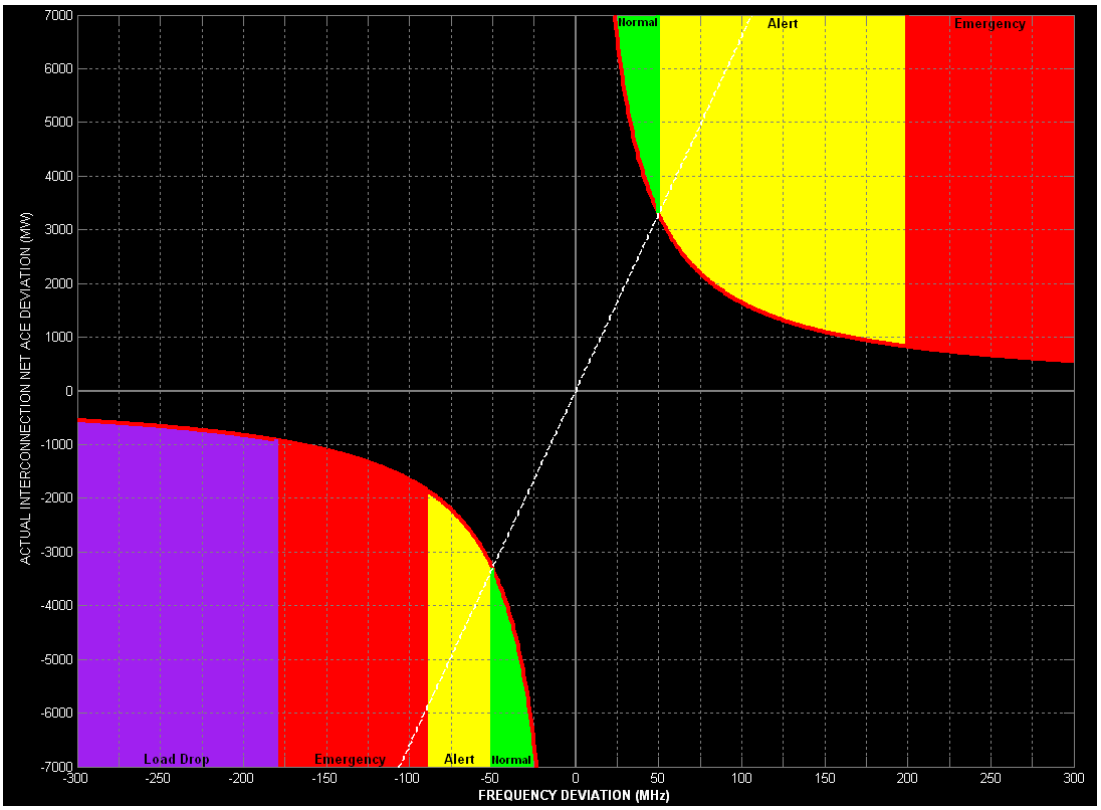

Figure 28 – Resources Adequacy ACE-Frequency Plane and Alarm Reference Areas

Figure-29 shows the 2005 1-Minute operational points overlapping on the frequency-ACE operational space. It also shows the second resources adequacy operational reference, a loop bounded by user selected, most recent frequency-ACE behavior. The reference loop for Figure-28 bounds the 2005 1-minute ACE-Frequency operational points. Notice the number of 2005 1-minute points within the alert alarm yellow area and that not points operated within the emergency alarm red area.

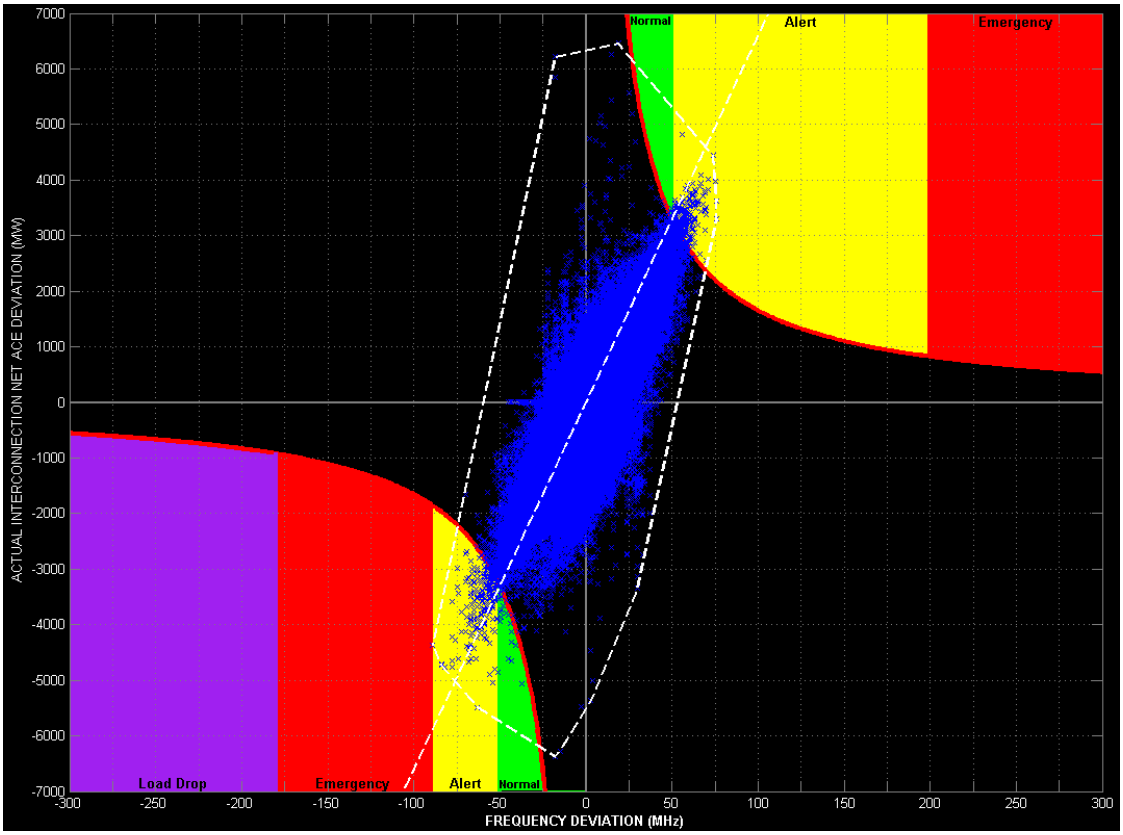

Figure 29 – 1- Minute Resource Adequacy Operations for 2005