

Texas Reliability Entity Event Analysis

Event:
June 27, 2011 EEA-1 Event

Texas Reliability Entity
July 15, 2011

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Executive Summary

On June 27, 2011 beginning at 12:54, the ERCOT Region experienced the loss of three (3) generation units loaded at 1744 MW over a one hour, and 45 minute period. The loss of generation combined with high system loads, caused system reserves to decrease. The Reliability Coordinator (RC) declared an Energy Emergency Alert (EEA) Level 1 at 15:25 after the Physical Responsive Capacity (PRC) dropped below the 2300 MW minimum level required by the Balancing Authority (BA). The EEA-1 was cancelled at 16:50. This report provides: (1) an overview of the event; (2) background on system conditions just prior to the event; (3) the detailed sequence of events; (4) an analysis of the causal and contributing factors for concerns that arose in this event; and (5) recommendations for follow-up action.

I. Event Overview

On June 27, 2011 at 12:54, the Generating Station A Unit B tripped while loaded at 679 MW (nameplate capacity of 745 MW). Cause of the unit trip appears to be the drop in gas pressure at the pressure reducing station during the change from flow control to pressure control from one gas supplier to another.

At 13:07, the Generating Station A Unit C tripped while loaded at 576 MW (nameplate capacity of 749 MW). Cause of the unit trip was the loss of both boiler feedwater pumps.

At 14:38, the Generating Station D Unit E, comprising one combined cycle train, tripped while loaded at 489 MW (nameplate capacity of 533 MW) due to human error while trouble-shooting problems with a communication module card between the plant control system and the Generator Operator.

1744 MW tripped during the event.

Physical Responsive Capability (PRC) level dropped below the 2300 MW minimum level at 15:25. The RC declared an EEA-1 at 15:25. The EEA-1 was cancelled at 16:50.

The event did not meet the definition of a reportable event under NERC's Event Analysis Working Group (EAWG) procedure since the multiple generation loss did not occur within one minute.

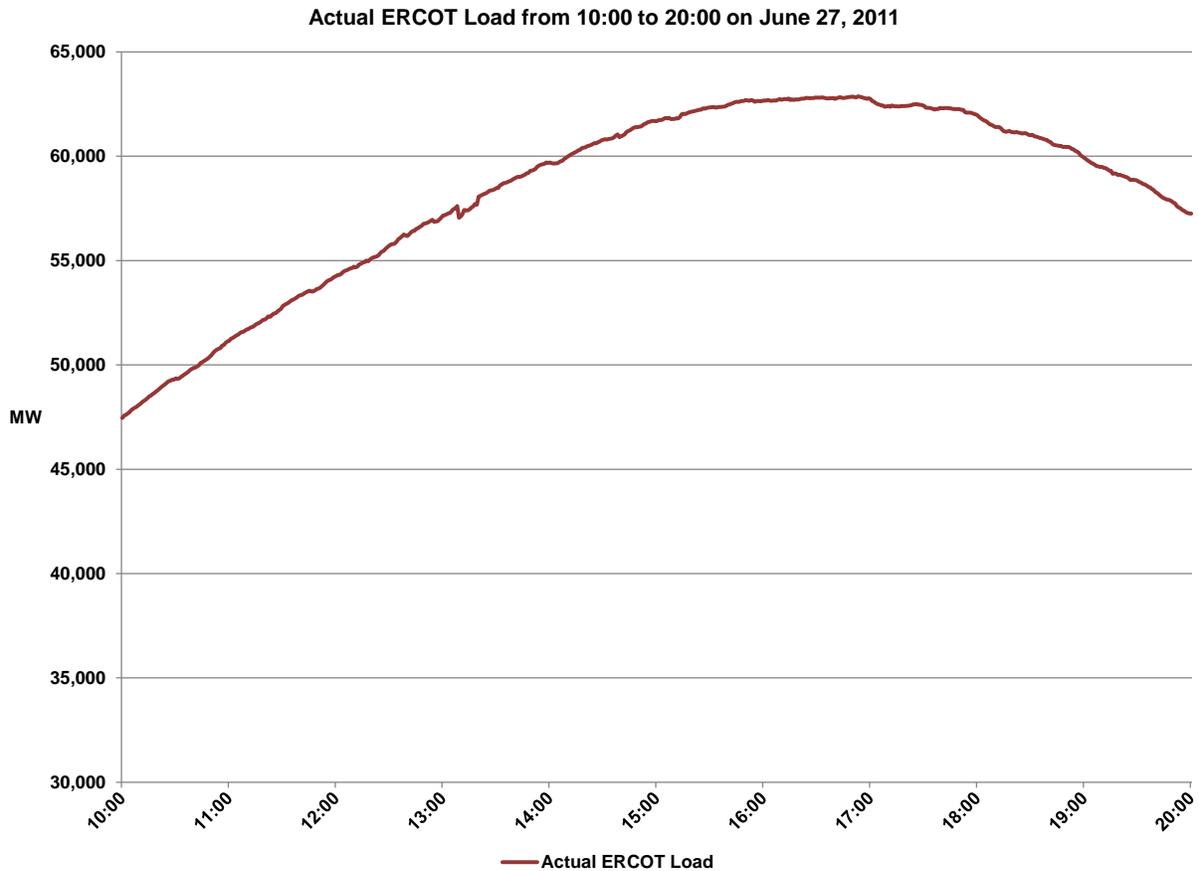
II. Initial System Conditions Prior to Event

Initial system conditions just before the event of June 27, 2011 were:

System Load: 56,957 MW
 System Frequency: 59.978 Hz
 Physical Responsive Capability: 3728 MW
 Area Control Error: -124 MW

Weather in the major cities around the ERCOT Region just before the event:

City	Temp (F)	Conditions
Austin	101	Sunny
DFW	100	Sunny
Houston	98	Sunny
San Antonio	99	Sunny
Brownsville	95	Sunny



III. Sequence of Events on 06/27/2011

- 12:54 Unit B unit trips while loaded at 679 MW
- 13:07 Unit C unit trips while loaded at 576 MW
- 13:34 RC issues Advisory for PRC level below 3000 MW
- 13:40 BA requests deployment of 1909 MW of Non-Spin Reserve Service (NSRS)
- 14:38 Generating Station D Unit E tripped while loaded at 489 MW
- 14:40 BA deploys 203 MW of responsive reserve (RRS) due to being out of UpReg
- 14:44 RRS recalled
- 14:55 RC issues Watch for PRC level below 2500 MW
- 15:00 Media appeal issued
- 15:25 PRC level drops below 2300 MW
- 15:25 RC declares EEA Level 1
- 15:45 Exports to Mexico curtailed to zero through DC ties
- 15:46 Unit B unit returned to service
- 15:53 Generating Station D Unit E returned to service (one gas-turbine of combined cycle train)
- 16:24 Generating Station D Unit E returned to service (one gas-turbine of combined cycle train)
- 16:30 Generating Station D Unit E returned to service (one steam-turbine of combined cycle train)
- 16:50 RC cancels EEA Level 1
- 17:05 Unit C unit returned to service

IV. Analysis of Event

A. Generating Station A

The Generator Operator reported the following element outage causes and sequence of events.

Unit B

The initiating event appears to be the drop in gas pressure at the pressure reducing station during the change from flow control to pressure control from one gas supplier to another. When the gas pressure recovered it caused excessive fuel supply to the unit, over-firing the boiler. While in the process of regaining control of the fuel supply, main steam supply temperatures reached dangerous levels, and the operator acted to prevent damage to the unit by initiating a manual trip.

Unit C

At the time of the Unit B trip, Unit C was operating near its high sustained limit with reduced operating margin. Control system response from the frequency excursion acted to open the main turbine throttle valves. This resulted in both feed pumps ramping to maximum output, which in turn, reduced the boiler feedwater tank level to the trip setpoint for both boiler feed pumps. The loss of both boiler feedwater pumps initiated a unit trip.

Sequence of Events

12:17	Unit B Began to adjust gas from one supplier to another
12:35	Unit B Gas pressure reducing valve was slow to respond, with the reduced header pressure, the gas supply valves fully opened and then tripped to manual, unit load at 605 MW
12:38	Gas pressure reducing valve began to open, increasing gas supply header pressure and flow (supply valves are still in manual)
12:38	Operator began taking manual action to control gas flow
12:48	Unit B began uncontrolled ascension to 739 MW, main steam temperatures begin rising quickly
12:54	Unit B tripped by operator from 679 MW due to exceeding main steam temperature limits to prevent damage to the unit
12:54-13:06	Frequency excursion from Unit B trip began to "swing" Unit C
13:06	Unit C operator took manual action by dropping load to try and prevent an automatic trip
13:07:48	Unit C tripped automatically at 576 MW, due to loss of both feedwater pumps on low feedwater tank level

All breakers involved operated as per design during this event. No personnel injuries or other equipment damage were identified.

B. Generating Station D

The Generator Operator reported that in the process of checking for a possible communication link issue with the plant control system, pressure was placed on the branch bracket containing the communication module. Inadvertently, as this was done, connection between the branch bracket and adjacent control modules was disrupted. These adjacent modules provide control of the plant natural gas supply valves. When this disruption occurred, these valves closed, shutting off fuel supply to the plant. Within 18 seconds, plant gas pressure had dropped below minimum requirements and 16 seconds later both gas turbines and the steam turbine had taken themselves off-line. Since the cause of the plant shutdown was immediately apparent, the decision was made to restart the plant as soon as possible. Plant operations and maintenance personnel reviewed the condition of the plant, found no unusual conditions to prevent startup and began the startup process. All three units were back on-line within two hours of the trip. A corrective work order has been created to make repairs to the branch bracket/control module connections during the next planned plant outage. In the interim, a warning tag has been placed on the control cabinet warning of possible loose connections and that extra caution should be utilized when working on or near the cabinet. To further improve facility staff awareness of ERCOT system conditions, the 24 hour desk has implemented a "Screwdriver Alert" notification email which includes ERCOT-related system condition notifications (i.e. Advisory, Alert, and OCN's).

Sequence of Events

Shortly before noon	Received a call to investigate noon recurring "Raise Inhibit" signal that was being received from the plant control system. Indicated this signal was preventing effective controlling the units
1:15 pm	Received e-mail identifying the point in question
1:30 pm	Meeting concerning the inability to control the units. Performed some preliminary checks of the communication links between the plant control system. No problems were apparent.
2:30 pm	Identified an alarm on the SLC card. Began to perform some non-invasive troubleshooting (no probes, no card removal, no rebooting processors, etc.). Initial step was to look for a possible loose connection in the Cat V wire for the communication link. In the process of checking this connection, pressure was placed on the branch bracket containing the communication module. Inadvertently, as this was done, connection between the branch bracket and adjacent control modules was disrupted. These adjacent modules provide control of the plant natural gas supply valves. When this disruption occurred, these valves closed, shutting off fuel supply to the plant. Within 18 seconds, plant gas pressure had dropped below minimum requirements and 16 seconds later both gas turbines and the steam turbine had taken themselves off-line.
2:38 pm	Plant at 0 MW. Since the cause of the plant shutdown was apparent, the decision was made to restart the plant as soon as possible. Plant operations and maintenance personnel reviewed the condition of the plant, found no unusual conditions to prevent startup and began the startup process.
3:53 pm	Unit E gas turbine On-line
4:24 pm	Unit E gas turbine On-line
4:30 pm	Unit E steam turbine On-line

All breakers involved operated as per design during this event. No personnel injuries or equipment damage were identified. No protective system misoperations were reported.

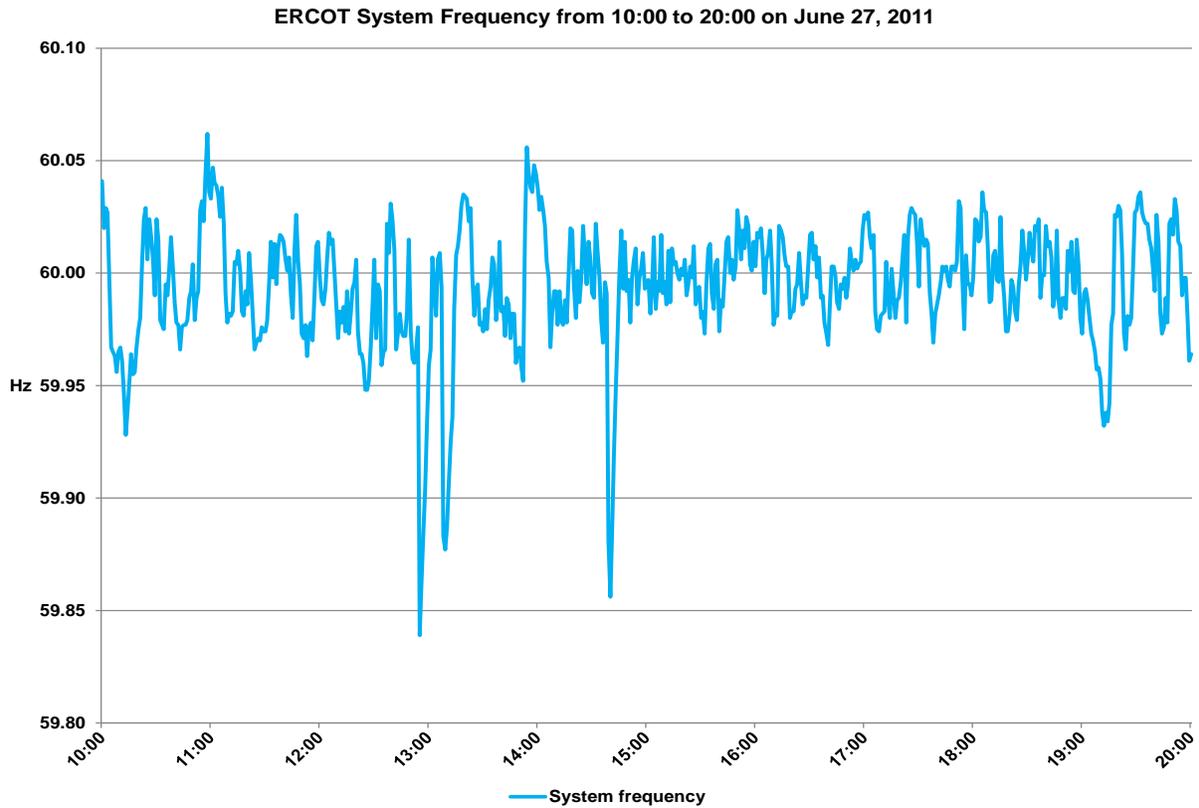
V. Response Analysis

A. Initial Response

The loss of multiple BES elements in the ERCOT Region on June 27, 2011 constituted a significant disturbance to grid operations (generation loss represented 3.5% of ERCOT load). The BA used the Region's resources and reserves to balance resources and demand and return system frequency to pre-disturbance frequency well within the 15 minute target set by NERC Standards.

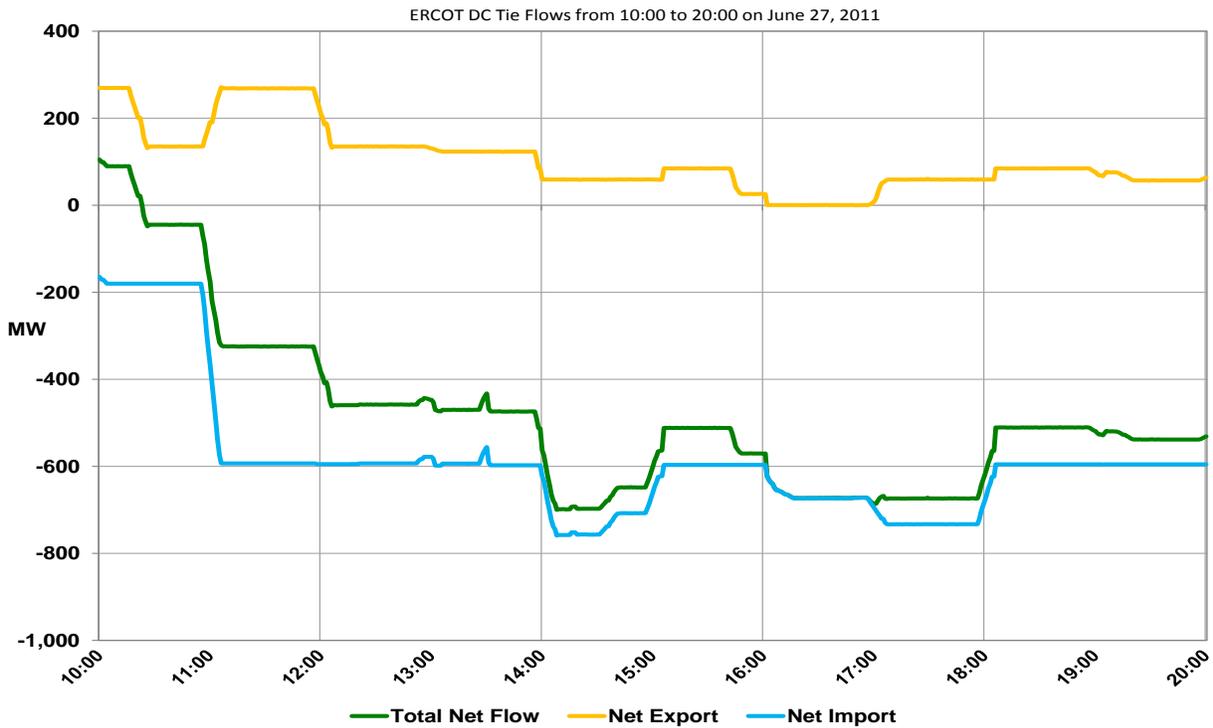
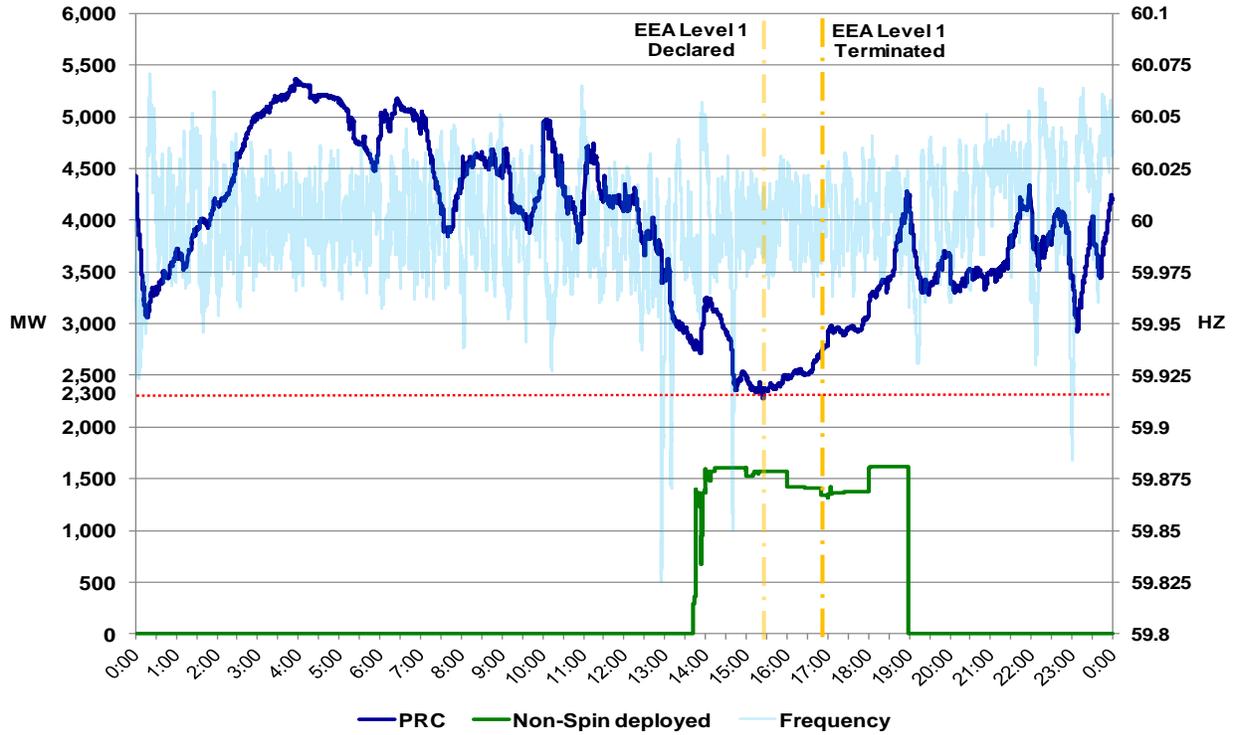
ERCOT Region system frequency (measured at the RC control center) was at 59.978 Hz immediately prior to the disturbance at 12:54. Immediately after the initial disturbance at 12:54, system frequency dropped to 59.825 Hz and recovered in 7 minutes, 44 seconds. System frequency dropped to 59.87 Hz following the second disturbance at 13:07 and recovered in 6 minutes, 14 seconds. The following are among the actions that Registered Entities initially took to stabilize the system:

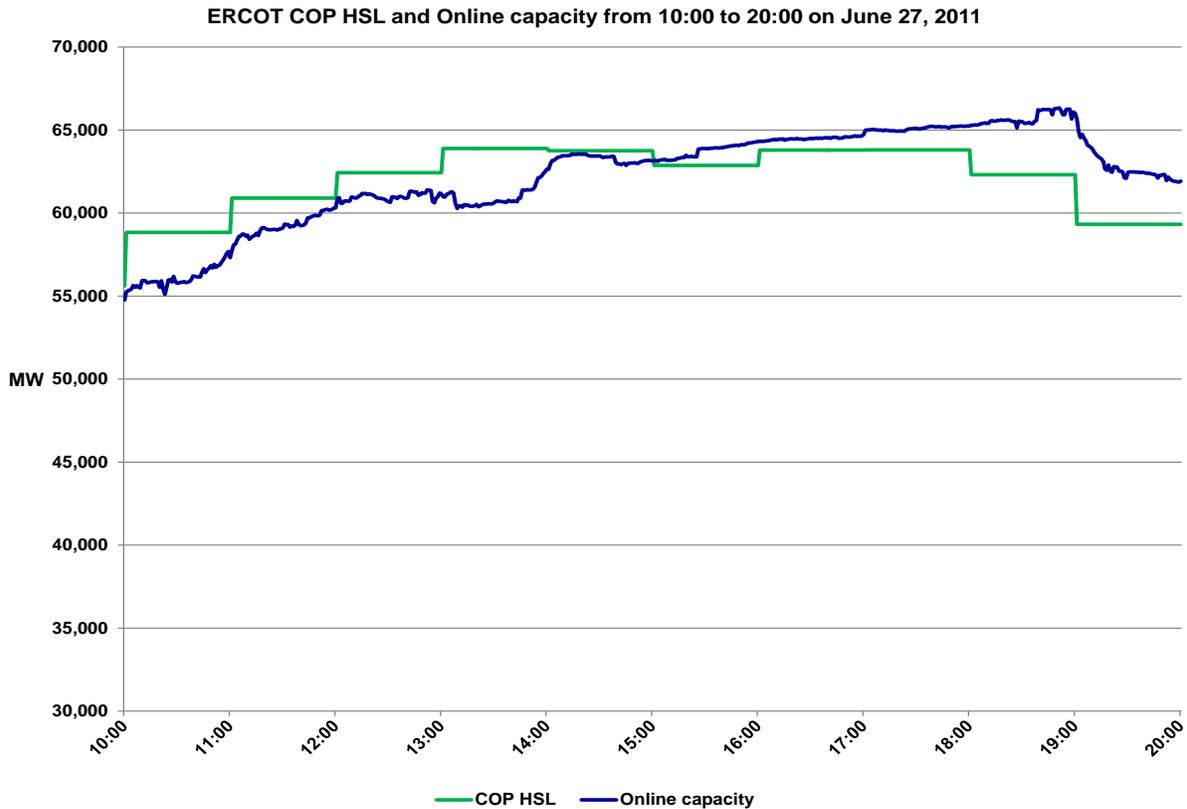
- Generator governor response arrested the frequency decline, as analyzed by the Performance, Disturbance, Compliance Working Group (PDCWG) in its report. The initial calculated system frequency response, termed the "B" point, was 393.22 MW/0.1 Hz, which failed to meet the target of 420 established in ERCOT Protocols. The second calculated response point, termed "B+30" to denote that it measures how well response is sustained 30 seconds after the event, was 361.94 MW/0.1 Hz, which also failed to meet the minimum response level.
- At 13:40, BA requested deployment of 1909 MW of Non-Spin Reserve Service (NSRS).
- At 14:40, BA deployed 203 MW of responsive reserve (RRS). RRS was recalled at 14:44
- At 15:45, 20 minutes after the EEA-1 declaration, exports to Mexico were requested to be curtailed to zero through DC ties



B. Reserves

The recovery from the initial disturbance caused the reserve level to drop below 2300 MW at 15:25. The BA had previously requested 1909 MW NSRS services to deploy at 13:40 and the RC declared an EEA Level 1 at 15:25. Reserve levels recovered and the RC cancelled the EEA Level 1 at 16:50.





VI. Conclusions and Recommendations

In general, the steps taken in the recovery from this event achieved the desired results.

Equipment owners have taken actions to address problems as noted previously.

168 out of 229 units (running that were not excluded) (73.4%) provided the ‘sustained’ governor response for this event. 61 units did not contribute to system response for the event.