

Texas Reliability Entity, Inc.  
Protocol and Operating Guide Compliance Report  
For The  
February 2, 2011, Energy Emergency Alert Level 3 Event  
May 13, 2011

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## I. Introduction

During the period from February 2, 2011, through February 4, 2011, the ERCOT region experienced record cold temperatures that caused numerous electric generating facilities to trip off-line, fail to start, or have their available capacity de-rated. Between February 1, 2011, at 09:00 and February 3, 2011, at 18:00, a total of two hundred twenty five (225) generation units experienced a unit trip, a unit de-rate, or a failure to start during freezing conditions.<sup>1</sup> Except for nuclear facilities, all power plant types, including coal/lignite-fired plants, simple-cycle and combined cycle natural gas plants, and wind resources, experienced problems. Ultimately, firm load shed was required to maintain system frequency.

On February 6, 2011, the Public Utility Commission of Texas (PUCT) directed Texas Reliability Entity, Inc. (Texas RE), in its capacity as the PUCT's Reliability Monitor, to investigate the ERCOT Energy Emergency Alert (EEA) Level 3 that occurred on February 2, 2011, and subsequent related events and developments on February 3-4, 2011. Texas RE has investigated the February 2, 2011, event to determine whether ERCOT Protocols and Operating Guides were followed during the period leading up to the EEA event and throughout the event. Numerous requests for information were issued to ERCOT and Market Participants, and Texas RE has experienced a high level of cooperation in conducting its investigation.

Texas RE's investigation focused on determining whether entities subject to the ERCOT Nodal Protocols (Protocols) and ERCOT Nodal Operating Guides (Operating Guides) were in compliance with those requirements. Because Texas RE's investigation is ongoing, specific ERCOT region entities, other than ERCOT, are not identified in this report to preserve confidentiality of the investigation. Texas RE will perform further review and analysis of potential violations of Protocols and Operating Guides associated with the February 2 EEA event. Confirmed violations will be documented and forwarded to the PUCT for further action, as appropriate.

Texas RE, in its capacity as the North American Electric Reliability Corporation (NERC) Regional Entity for the Texas Region, is also preparing an Event Analysis.

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<sup>1</sup> This figure is higher than the number reported by ERCOT (152 units) due to the inclusion of de-rated units during the period. For the purposes of this report, combined cycle plants are reported as separate units (i.e. a 2x1 combined cycle plant is considered as 3 separate units).

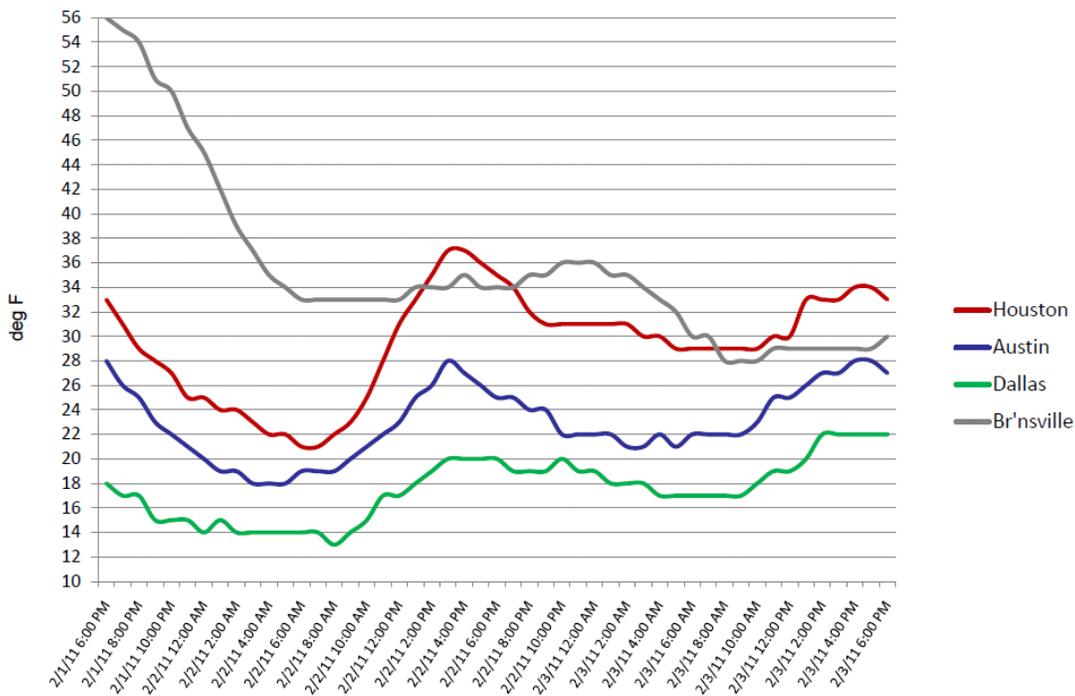
Primary findings are as follows:

- The February 2, 2011, EEA event was caused by either insufficient or ineffective preparation of generating facilities for prolonged freezing weather.
- ERCOT Market Participants committed potential violations of the ERCOT Protocols and Operating Guides in connection with the event. Texas RE will conduct additional investigations as necessary and forward information to the PUCT for further action, as appropriate.

## II. Overview of Event

### A. Weather

Prolonged freezing temperatures were forecast several days in advance of February 1, 2011. The freezing temperatures that were experienced across the state were accompanied by significant winds, resulting in wind chill factors ranging from -5 degrees in the Dallas area to the low teens in Austin and Houston. The chart below shows the temperatures that were actually experienced.



February 2, 2011,<sup>2</sup> was one of the coldest days in the last 25 years. The table below shows a comparison with other record cold days.

<sup>2</sup> Hereafter references to February 2 are to February 2, 2011, unless otherwise stated.

### ERCOT Region Coldest Days

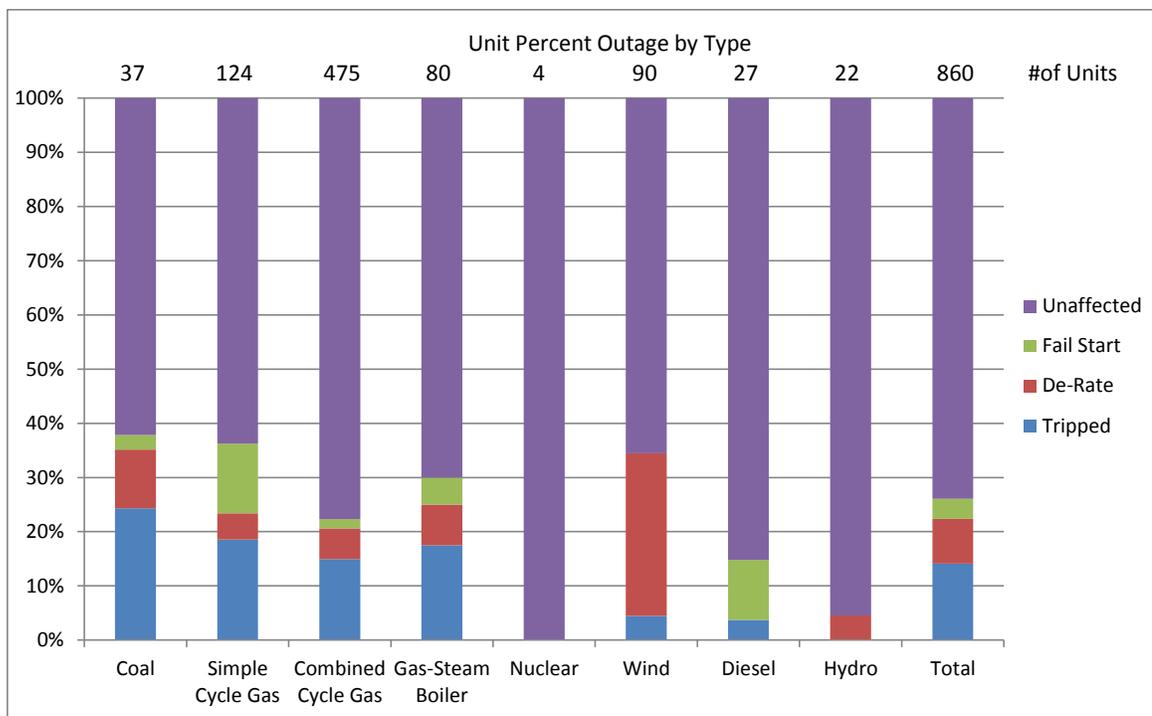
		<u>Austin</u>	<u>Dallas</u>	<u>Houston</u>
2/02/2011	Low	18	13	21
	High	28	20	37
1/08/2010	Low	15	16	25
	High	35	30	32
12/22/1989	Low	5	3	9
	High	28	14	26

#### B. Generation Outages

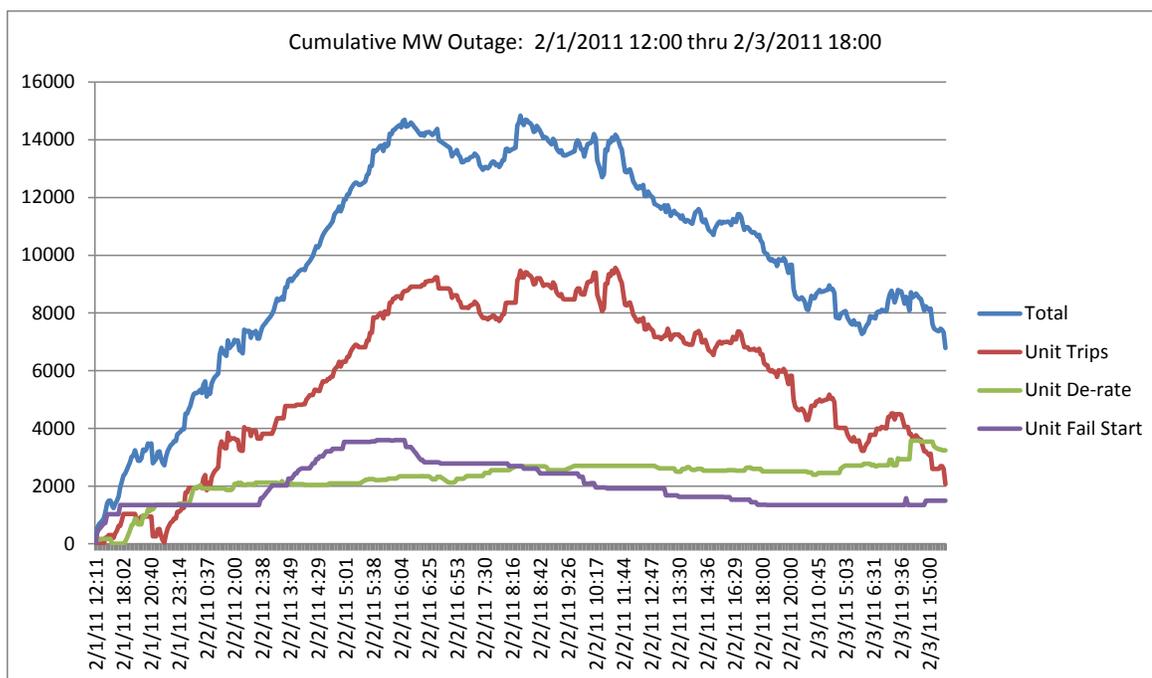
Beginning January 27, 2011, ERCOT took appropriate steps, such as adjusting load forecasts, scheduling additional generation, adjusting reserve levels and cancelling or delaying planned maintenance outages for transmission facilities, in anticipation of the high energy demands expected between February 1, 2011, and February 3, 2011. Market participants also prepared for the expected cold weather.

However, ultimately the preparations proved to be insufficient or ineffective. During the February 1<sup>st</sup> through 3<sup>rd</sup> period an extraordinary number of generating units tripped offline, de-rated their maximum capacity available, or failed to start when called upon to do so. These problems were due mostly to freezing instruments and pipes, but some fuel availability issues occurred as well, which were also due to the cold weather.

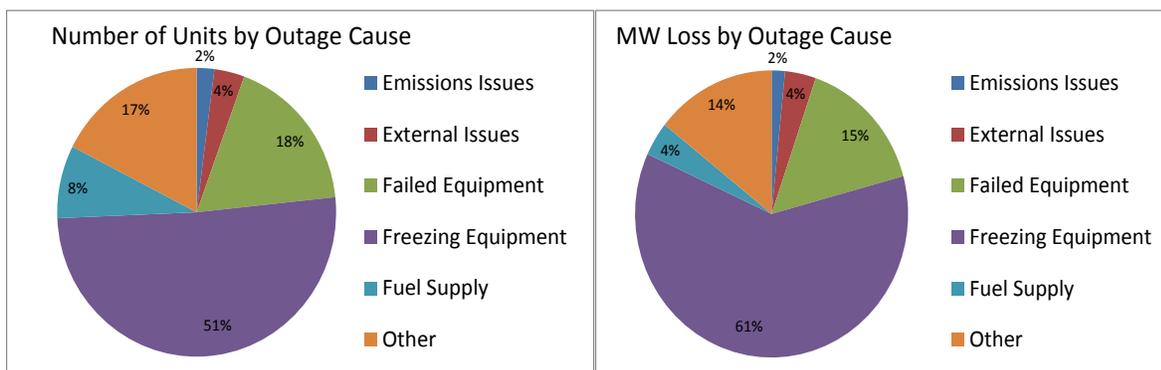
The following chart shows the percentage of generating units of various types that experienced problems due to the freezing weather. All plant types, except nuclear, experienced problems. As can be seen, the majority of plants did not experience problems. This chart shows the number of units that had problems; some units had multiple instances of tripping off-line or failing to start.



The chart below shows the magnitude of the generation capacity lost due to the prolonged freezing weather during the February 2 event, beginning at 12:00 on February 1, 2011. According to the NERC 2010/2011 Winter Reliability Assessment for the ERCOT Region, dated November 2010, 84,133 MW of existing generation was expected to be in service during the 2010/2011 winter period. The peak forced outage MW associated with the February 2 event represented 17.6% of this total capacity.



The charts below show the percentage of generating units affected by outage cause, and MW loss by outage cause. By far, the biggest issue was freezing equipment, piping, and instrumentation, which accounted for 51% of the unit issues and 61% of the unavailable capacity. Failed equipment accounted for an additional 18% of the unit issues and 15% of the unavailable capacity. Transmission issues external to the power plants accounted for 4% of the unit issues and 4% of the unavailable capacity.



The cause of the unexpected freezing in some cases appears to have been the aggravating factor of high winds accompanying the very cold temperatures over an extended period of time, which effectively removed heat from critical instruments faster than it could be applied by supplemental means (i.e. portable heaters). Generator operators responded by erecting temporary tarps or plastic sheeting to block the wind.

Plants and instrumentation experienced freezing issues even though temperatures were above the design criteria for the facilities. Temperature design criteria for the insulation and heat trace systems of the power plant facilities ranged from -5<sup>0</sup> F to 20<sup>0</sup> F, with average wind speeds up to 20 mph. The quality of the insulation and heat trace was definitely a factor in these cases, as instrumentation, piping, or equipment still experienced freezing issues. There were multiple reports of instrumentation freezing when heat trace electrical circuits tripped. In some cases, insulation was missing or insufficient, which allowed piping and instrument lines to freeze. This indicates that the winterization plans and preparations for the plants were either inadequate, insufficient, or ineffective.

Wind generation was also impacted, as demonstrated by multiple wind plants reporting issues with low temperature operating limits for the wind turbines. Several wind turbine manufacturers have a low temperature operating limit of -10<sup>0</sup> C (+14<sup>0</sup> F). Ambient conditions below this temperature will cause the turbines to shut down. Low temperatures also affected the gearbox oil viscosity as well as hydraulic oil temperatures of turbines, causing turbine shutdown. Blade icing was also an issue at several wind plants.

Emissions limitations were not a major factor for generators during this period, accounting for approximately 2% of the unit de-ratings and unavailable generating capacity. On February 2, in response to the emergency situation, the Texas Commission on Environmental Quality (TCEQ) announced that it would exercise enforcement discretion concerning emission

limits for power plants responding to the emergency. At 12:12 on February 2, a Hot-line call was made to all QSEs informing them of TCEQ's decision and at 12:19 ERCOT issued a Market Notice via email. The TCEQ enforcement discretion period ended at 12:00 on February 5, 2011.

### **C. Energy Emergency Alert**

The unavailable generation capacity resulted in an inadequate level of generation reserves for ERCOT to call upon to serve load. The Protocols and Operating Guides dictate that certain levels of reserves must be maintained as a cushion in the event of contingencies, such as the loss of generating units or transmission lines. When reserves fall below certain trigger levels, ERCOT is required to issue various levels of emergency notices and to take specific actions to restore the reserves. These actions are designed to prevent the risk of a total system collapse.

Physical Responsive Capability (PRC) is a representation of the total amount of system-wide on-line capacity that has a high probability of being able to respond quickly to system disturbances. PRC is continually measured by ERCOT and used as a benchmark for determining whether the ERCOT system is operating reliably. PRC is also used as a basis for issuing notices and declaring EEA.<sup>3</sup>

Under the Emergency Operations provisions of the Protocols and Operating Guides, the minimum target for PRC plus the amount of Responsive Reserve Service<sup>4</sup> supplied by Load Resources is 2300 MW. When reserve levels drop below 2300 MW, ERCOT is required to declare EEA.<sup>5</sup> Reserve levels dropped below 2300 MW at 05:15 on February 2, and at 05:18, ERCOT bypassed EEA Level 1 and moved directly to EEA Level 2A.<sup>6</sup> As the situation continued to deteriorate, ERCOT declared EEA Level 3 at 05:43 and ordered 1000 MW manual firm load shed. During the following approximately 2 hours, ERCOT ordered an additional 3000 MW of firm load shed (4000 MW total). The lowest ERCOT Region frequency was 59.576 Hertz (Hz) recorded at 06:05 on February 2.<sup>7</sup> The lowest ERCOT reserve level recorded was 447 MW at 06:25. All shed load was restored by 13:27, and ERCOT moved from EEA Level 3 to EEA Level 2B at 14:01, and to EEA Level 2A at 15:14. The EEA was cancelled at 10:00 February 3, 2011.

The chart that follows shows the relationship between generation capacity (available generation minus forced outages plus energy obtained from non-ERCOT Control Areas using the DC Ties pursuant to ERCOT's authority under Protocol 6.5.9.4 (6)) and demand on February 2. The chart also shows the reserve levels throughout the same period.

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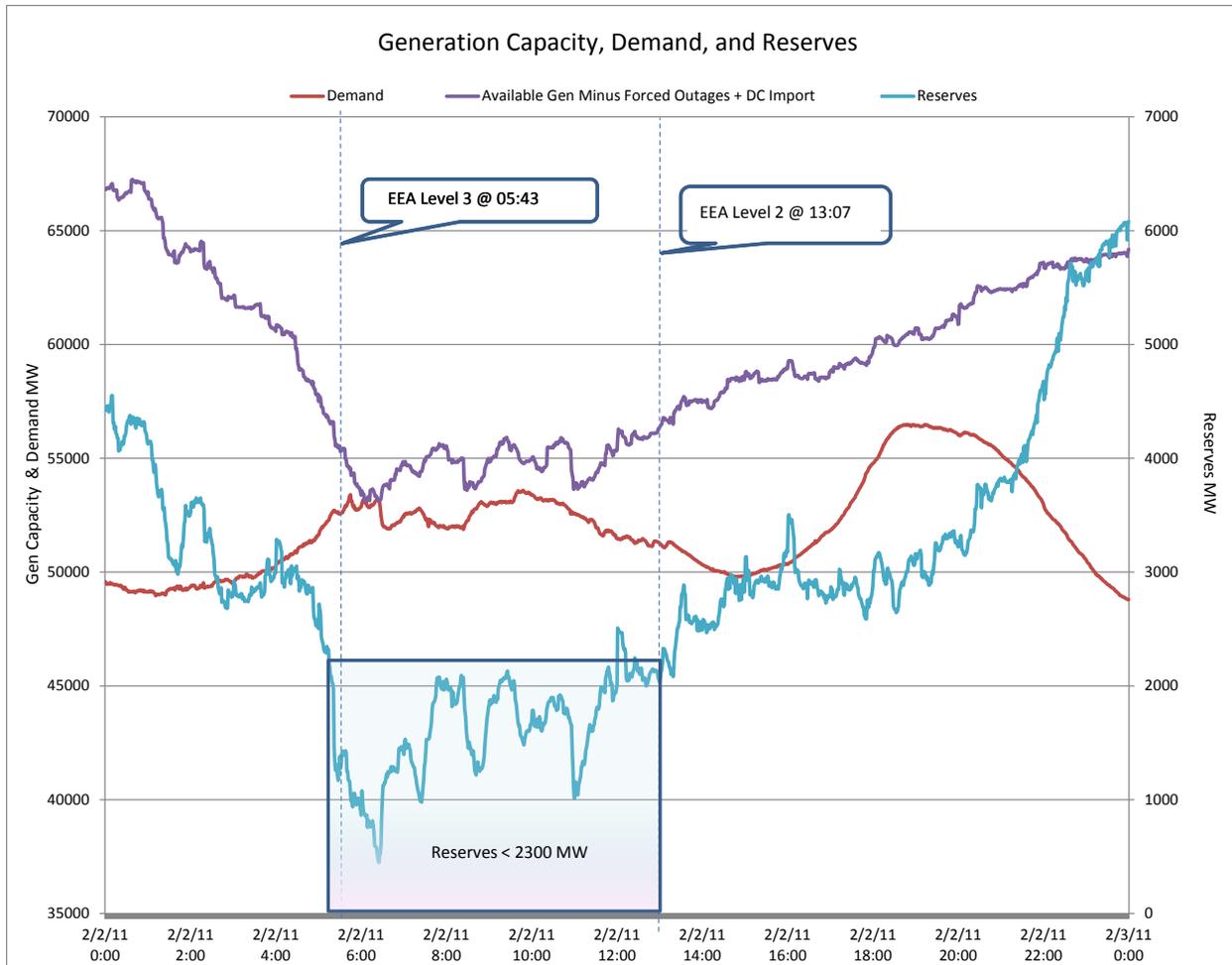
<sup>3</sup> Protocol 6.5.9.4.1 (f)

<sup>4</sup> Responsive Reserve Service is operating reserves used by ERCOT to help control the system frequency.

<sup>5</sup> Protocol 6.5.9.4.2 and Operating Guide 4.5.3.3

<sup>6</sup> Operating Guide 4.5.3 (4) recognizes that there may be insufficient time to implement all levels in sequence.

<sup>7</sup> System frequency is ordinarily maintained at 60 Hz. Automatic under-frequency load shed begins at 59.3 Hz.



### III. Planning and Preparation

This section describes requirements in the Protocols and Operating Guides relating to overall and event-specific severe weather preparedness and addresses whether actions taken by ERCOT and Market Participants were consistent with those requirements.

#### A. Winter Weather Planning and Preparations

##### 1. Severe Weather Drill

Zonal Operating Guide 1.8.5, which was in effect prior to December 1, 2010, required ERCOT to conduct a severe weather drill each year to test the scheduling and communications functions of the primary and/or backup centers and train operators in emergency procedures.<sup>8</sup> Zonal Operating Guide 1.8.5 required ERCOT to appoint an ERCOT drill coordinator, who, with

<sup>8</sup> Zonal Operating Guide 1.8.5 was replaced by Nodal Operating Guide 1.5.4, which contains the same requirements except that operators for Qualified Scheduling Entities that provide Ancillary Services and Transmission Operators (as opposed to QSEs and TOs) are required to participate, and Texas RE, rather than ERCOT Compliance, is now required to verify and report participation to the Reliability and Operations Subcommittee.

assistance from the Operations Working Group (OWG), developed and coordinated the annual severe weather drill. The OWG was required to review and critique the results of the completed severe weather drill to ensure effectiveness and recommend changes as necessary.

ERCOT alternates the type of severe weather drill conducted each year, holding Winter Storm Drills in odd-numbered years, usually in November, and Hurricane Drills in even-numbered years, usually in May. The most recent Winter Storm Drill was conducted in November 2009. The November 2009 Winter Storm Drill provided a realistic training basis for virtually all of the emergency actions that ERCOT and other Transmission Operators were required to take on February 2. However, the November 2009 Winter Storm Drill did not provide a means for transmission and generation facilities to review or verify their winter weather plans, equipment, or response.

Zonal Operating Guide 1.8.5 required all Qualified Scheduling Entities that provide Ancillary Services and Transmission Operators to participate in the drill. Zonal Operating Guide 1.8.5 did not set out specific requirements for participation in the Severe Weather Drill or how participants were to document their participation. Texas RE requested information from QSEs and Transmission Operators about their participation in the Severe Weather Drills for 2008, 2009, and 2010. While there was a lack of uniformity in the way QSEs and TOs participate in and document participation in the Severe Weather Drill, all QSEs and TOs that were required to participate in the Severe Weather Drills for 2008, 2009, and 2010 did so.

Zonal Operating Guide 1.8.5 required that Severe Weather Drill results be analyzed for effectiveness by the ERCOT Operations Working Group (OWG). Although drill participants submitted drill critiques, it does not appear that a formal analysis of the 2009 winter drill was prepared by or for OWG.

## **2. Operator Training**

Operating Guide 1.5.2 establishes system operator training requirements, which include specific requirements for participation in training and drills for system emergencies. Texas RE requested information concerning compliance with the training requirements for emergencies. The information provided indicates that ERCOT QSEs and TOs are in compliance with the operator training requirements.

## **3. Facilities Preparation**

The Protocols and Operating Guides do not establish requirements for specific actions that must be taken to prepare facilities for extreme weather. Protocol 6.5.9.3.1 (5) states:

QSEs and TSPs are expected to establish and maintain internal procedures for monitoring actual and forecasted weather and for implementing appropriate measures when the potential for adverse weather or other conditions (which could threaten ERCOT system reliability) arise.

Further, Protocol 6.5.9.3.3 (7) states in part:

On notice of a Watch, each QSE, TSP, and DSP shall prepare for an emergency in case conditions worsen.

Texas RE requested and reviewed data submitted by generation resource owners related to the cause of the generation outages, winter preparation plans, and emergency operation plans. Generation resource preparation for the impending cold weather included the following:

- On-site plant meetings
- Increased staffing
- Verification of proper operation of heat trace circuitry
- Preparation for running on alternate fuel supplies
- Obtaining emergency supplies (portable heaters, blankets, tarps, etc.)
- Increasing frequency of operator rounds and equipment monitoring

There is no indication that QSEs, TSPs and DSPs failed to act to prepare for an emergency. The issue is that the steps that were taken in many cases proved to be inadequate or ineffective. Evaluation of the specific steps taken by each QSE, TSP and DSP would provide insight into why, overall, the actions taken were not effective in avoiding an emergency. However, the Protocols and Operating Guides themselves do not provide benchmarks for such an evaluation.

## **B. Preparation for Week of January 31 – February 4**

### **1. Outage Scheduling**

Pursuant to Protocol 3.1, ERCOT is responsible for coordinating all outage schedules for maintenance and repair of transmission facilities and generating facilities within the ERCOT system. A significant amount of generation, approximately 17,519 MW, was out of service prior to February 2 due to scheduled outages, maintenance, repairs, or forced outages. The total of 17,519 MW included 6640 MW for planned outages, 5106 MW for forced outages, plus 5773 MW of mothballed units.<sup>9</sup> Of the 41 units in forced outage prior to midnight February 2, 24 were related to cold weather issues and 16 were related to failed equipment.

The current method for scheduling generation outages gives ERCOT virtually no discretion in approving requested outages that are submitted more than eight days prior to the requested outage for a generating resource other than a Reliability Must-Run (RMR) or Black Start Resource.<sup>10</sup> For RMR and Black Start Resources, ERCOT must approve planned outage requests unless the requested outage would cause ERCOT to violate applicable reliability

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<sup>9</sup> ERCOT's practice of including mothballed units in the Outage Schedule may give a false impression of available resources because such units are not capable of being returned to service in the near term.

<sup>10</sup> Protocol 3.1.6 (1)

standards.<sup>11</sup> ERCOT's options for cancelling scheduled generation outages are limited to emergency situations where ERCOT believes it cannot meet applicable reliability standards, in which case it may contact generators and attempt to reach mutually agreeable solutions.<sup>12</sup> It appears that ERCOT did not attempt to cancel or postpone any scheduled generating outages in anticipation of the February 1-4 cold weather event, but because there is no requirement to make such attempts, ERCOT's actions were consistent with Protocol requirements.

## **2. Reserve Planning**

ERCOT used normal operating practices to manage preparation for the cold weather expected the week of January 31, 2011. Section 6.5 of the Protocols contains a detailed description of how planning occurs for normal operations.

Between January 27, 2011, and February 2, 2011, several red flags indicated that ERCOT should adjust planning to accommodate the forecast for prolonged freezing weather:

- The prolonged cold weather and wind chill conditions expected to hit Texas on February 2 were expected to be among the coldest days on record in the last 25 years.
- The projected peak ERCOT region load for February 2 was significantly higher than the previous winter peak.
- Generation outages scheduled for February 2 totaled 6,640 MW. This was 45% higher than the 2011 winter peak forecast of 4568 MW used in the NERC 2010/2011 Winter Reliability Assessment for the ERCOT Region. An additional 5,106 MW of generation was on forced outage prior to the event as of midnight February 2. This unavailable generation capacity helped set up and exacerbate the emergency, as these units could not be called upon to bolster reserves. These numbers do not include mothballed units
- Two generation facilities reported on February 1, 2011, that they had zero natural gas supplies.

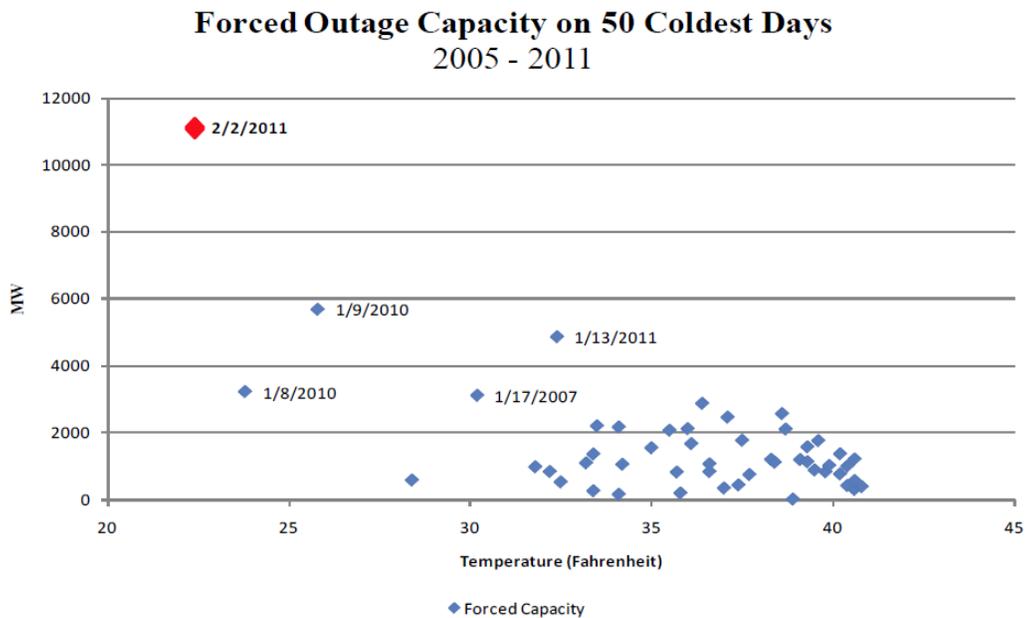
In anticipation of what was expected to be a near-record peak usage day on February 2, 2011, ERCOT recalculated the load forecast to account for wind chill temperatures, cancelled planned transmission facility outages, directed one generation facility that had a long start-up time to begin start-up, instructed another plant to convert to fuel oil, and committed an additional thirteen (13) generating units with a nameplate capacity of 3,088 MW to come online through the day-ahead market process. Two (2) of the additional units were committed for system capacity and the remaining eleven (11) units were committed for transmission contingency or congestion concerns.

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<sup>11</sup> Protocol 3.1.7.1 (1)

<sup>12</sup> Protocol 3.1.4.7

The following chart, which shows the number of forced outages on the fifty coldest days from 2005 to 2011, indicates a higher than normal level of generation outages should be anticipated and planned for during prolonged freezing weather. A concern about ERCOT's planning approach is whether ERCOT made an underlying assumption that forced outages for generation units were expected to occur at the same rate at a temperature of 18°F as would be expected at a temperature of 70°F. That is, it appears the planned reserves took into account a forecasted increase in demand, but may not have adequately taken into account the possibility of an increase in the number of generating facilities that might fail due to weather. However, because of the extraordinary number of plant failures that occurred on February 2, it would have been very difficult for ERCOT to predict or plan for so many generation units being impacted by the cold weather.



Similar weather conditions occurred in the ERCOT Region on February 9-10; however, freezing equipment issues did not have the same impact as on February 2. ERCOT and many generation facilities implemented lessons learned from the February 2 event and prevented similar issues during the cold weather that followed on February 9-10. These lessons learned include improving winterization of the power plant equipment, starting combustion turbines further ahead in advance of severe temperatures to keep lube oil warm, and exercising moving equipment to ensure that the units will be available.

#### IV. Emergency Operations

This section describes requirements in the Protocols and Operating Guides relating to emergency operations and addresses whether actions taken by ERCOT and Market Participants were consistent with those requirements.

## A. Emergency Operations Procedures

The Protocols and Operating Guides establish a complex set of processes to operate the ERCOT system using market-based approaches to provide necessary services. ERCOT, as the single Control Area Authority, is responsible for maintaining reliability in normal and emergency operating conditions. Although ERCOT is required to use the market-based processes set out in the Protocols and Operating Guides to the fullest extent practicable, the Protocols do not preclude ERCOT from taking any action to preserve the integrity of the ERCOT system.<sup>13</sup>

The Protocols and Operating Guides set out a series of actions ERCOT is required to take when there is concern that an emergency situation may develop and during an emergency. The first steps are a series of notices issued by ERCOT to alert Market Participants when additional resources may be required due to changing conditions. The table below sets out the notification levels, triggering events, and action taken.

Level	Triggering Event	System Operations Action
Operating Condition Notice (OCN) <sup>14</sup>	Possible need for more resources due to conditions that could affect system reliability. Informational purposes only.	ERCOT may require information from QSEs and TOs. Verbal notice to QSEs and TOs and post message electronically. QSEs notify Resources, Retail Electric Providers (REPs) and Load Serving Entities. TOs notify TSPs.
Advisory <sup>15</sup>	Conditions have changed and more Ancillary Services will be needed; weather or system conditions require more lead-time than normal; communications or other controls are significantly limited.	ERCOT may require information from QSEs and TOs. ERCOT may increase Ancillary Services. Verbal notice to QSEs and TOs and post message electronically. QSEs notify Resources, Retail Electric Providers (REPs) and Load Serving Entities. TOs notify TSPs.
Watch <sup>16</sup>	An insecure operating state exists or is imminent.	ERCOT may procure Ancillary Services from existing offers, and may issue Dispatch Instructions to a resource even if there is not an existing offer. Verbal notice to QSEs and TOs and post message electronically. QSEs notify Resources, Retail Electric Providers (REPs) and Load Serving Entities. TOs notify TSPs.
Emergency Notice <sup>17</sup>	ERCOT is in an emergency operating condition. ERCOT cannot maintain minimum reliability standards using every Resource practicably available; ERCOT is in an unreliable condition; immediate action must be taken to avoid or relieve an overloaded Transmission element.	Actions depend on nature and severity of the situation. If the Emergency Condition is the result of Ancillary Service insufficiency, ERCT shall follow EEA procedures. Verbal notice to QSEs and TOs and post message electronically. QSEs notify Resources, Retail Electric Providers (REPs) and Load Serving Entities. TOs notify TSPs.

<sup>13</sup> Protocol 6.5.9.1

<sup>14</sup> Protocol 6.5.9.3.1; Operating Guide 4.2.1

<sup>15</sup> Protocol 6.5.9.3.2; Operating Guide 4.2.2

<sup>16</sup> Protocol 6.5.9.3.3; Operating Guide 4.2.3

<sup>17</sup> Protocol 6.5.9.3.4; Operating Guide 4.2.4

If it becomes necessary to reduce demand because of a temporary decrease in available electricity supply, EEA provisions in the Protocols and Operating Guides provide orderly, predetermined procedures for curtailing demand during such emergencies. The goal of the EEA is to provide for maximum possible continuity of service while maintaining the integrity of the ERCOT System to reduce the chance of cascading outages.<sup>18</sup>

ERCOT may perform operations prior to declaring EEA Level 1 in order to restore normal operating conditions. These operations include issuing dispatch instructions for resources, increasing Responsive Reserve levels, committing available resources that can respond in the timeframe of the emergency, starting Reliability Must-Run (RMR) units, suspending any on-going resource testing, and utilizing available Non-Spin services.<sup>19</sup>

During an EEA, ERCOT is responsible for monitoring system conditions, initiating the EEA levels, notifying QSEs and TOs, and coordinating the implementation of the EEA conditions while maintaining transmission security limits. QSEs and TOs are responsible for notifying all the Market Participants they represent of each declared EEA level. During an EEA, the ERCOT System Operators have the authority to make and carry through decisions that are required to operate the ERCOT System during emergency or adverse conditions.<sup>20</sup>

EEA Level	Triggering Event	Actions Taken
1	PRC plus the portion of RRS which is supplied by Load Services falls below 2300 MW.	ERCOT will act to procure additional generation capacity and energy from DC ties. QSEs notify ERCOT of uncommitted but available Resources.
2A	PRC plus the portion of RRS which is supplied by Load Services falls below 1750 MW.	ERCOT will act to take the measures associated with EEA-1 and will instruct QSEs to deploy Responsive Reserve Service that is supplied from Load Resources.
2B	System frequency drops below 60 Hertz (cycles per second). Frequency drop is an indication that generation is not sufficient to meet demand.	In addition to the measures deployed for EEA-1 and EEA-2A, ERCOT will deploy Emergency Interruptible Load Service (EILS) and issue a media appeal for the public to conserve electricity voluntarily.
3	System frequency drops below 59.8 Hertz (cycles per second).	ERCOT will direct TSPs and DSPs to shed “firm” load (i.e. manual load shed) according to an allocation set annually and documented in the Operating Guides. Firm load makes up the portion of electrical demand that is not contractually interruptible. This load is shed in 100 MW blocks to maintain frequency at 59.8 Hertz. At this point, TSPs and DSPs are required not to drop load associated with automatic Under-Frequency Load Shed (UFLS) relays, which provide the next level of emergency protection.

<sup>18</sup> Operating Guide 4.5.1

<sup>19</sup> Protocol 6.5.9.4.1; Operating Guide 4.5.3.1

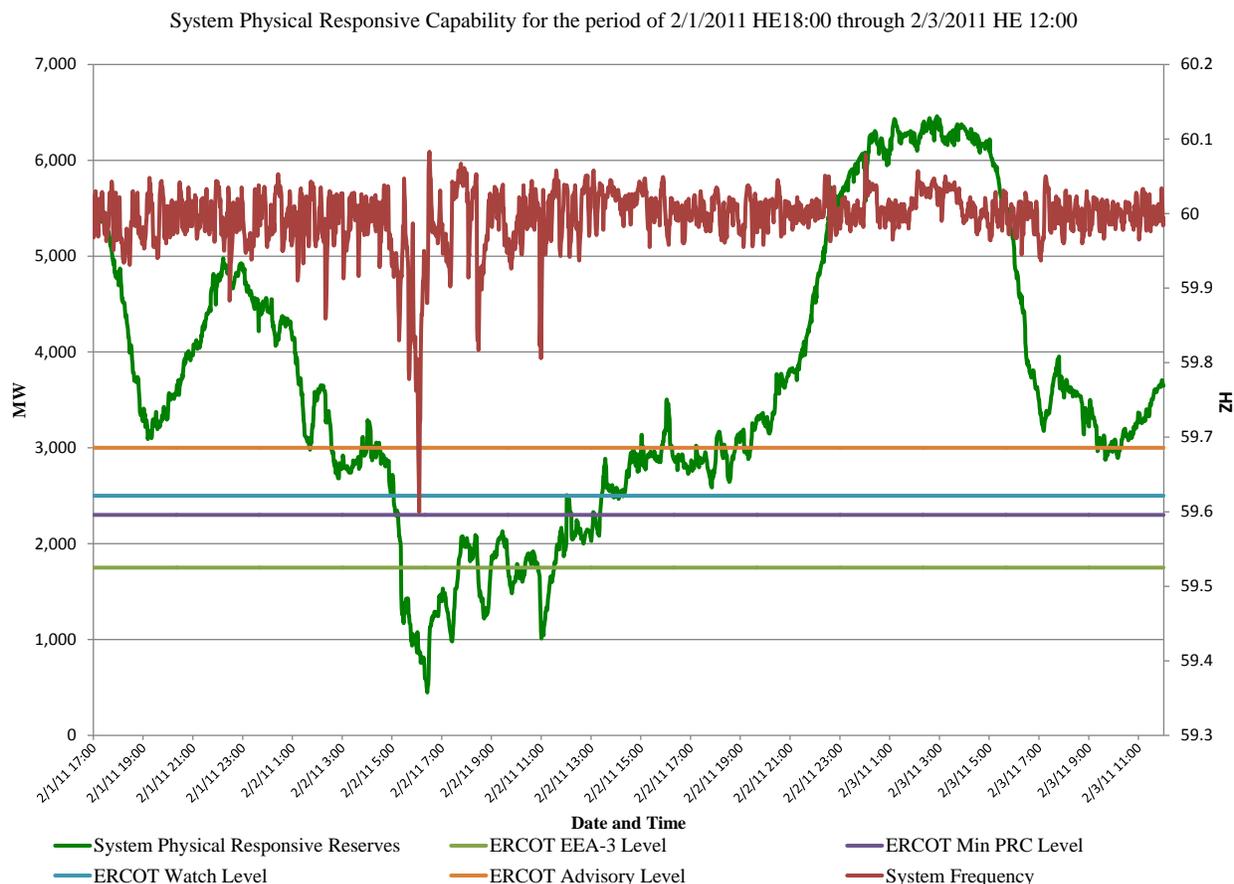
<sup>20</sup> Operating Guide 4.5.2 (1)

## B. Response to February 2, 2011, Emergency

### 1. Overview

Once it declared an EEA at 05:18 on February 2, ERCOT used prescribed EEA response actions to manage the emergency and eventually return the ERCOT system to a reliable state. These procedures were carried out as intended, although communication was sometimes poor and the February 2 EEA event was prolonged by continuing cold weather trips, de-ratings, and failures to start. By February 3, 2011, most generation units had contained and corrected their freezing problems, so no emergency notices or manual load shedding were needed on February 3<sup>rd</sup> or 4<sup>th</sup> or on subsequent cold weather days on February 9<sup>th</sup> and 10<sup>th</sup>.

The chart below shows the PRC level and system frequency for the period from February 2, 2011, at 06:00 to February 3, 2011, at 12:00. When the reserve level dropped below 3000 MW of reserves, ERCOT Operating Procedures required ERCOT to issue an Advisory notice, which occurred at 02:47. Reserve levels dropped to 2500 MW at 05:04, causing ERCOT to issue a Watch notice at 05:08. Reserve levels fell below the 2300 MW minimum level at 05:15, causing ERCOT to declare EEA Level 2A at 05:18. Reserve levels and frequency continued to worsen, and ERCOT declared EEA Level 3 at 05:43, the point at which manual load shedding is ordered.



## 2. February 2, 2011, EEA Event Timeline

<b>Time</b>	<b>Action</b>
02:34	Reserve level dropped below 3000 MW (Advisory trigger point).
02:47	ERCOT issued an Advisory for PRC and called all QSEs.
04:30	ERCOT issued directive to start Non-Spin Reserve Service (NSRS) units. Twelve of these NSRS units failed to start due to freezing temperatures.
05:04	Reserve level dropped below 2500 MW.
05:08	ERCOT declared a Watch for PRC below 2500 MW.
05:15	Reserve levels fell below 2300 MW (EEA-1 trigger point).
05:18	ERCOT bypassed EEA-1 and declared EEA-2A.
05:20 – 05:45	Eleven additional generation units went off-line, de-rated, or failed to start.
05:22	Reserve levels fell below 1750 MW (EEA-2 trigger point) ERCOT issued directives to deploy RRS loads of 900 MW.
05:26 – 05:36	RRS loads deployed.
05:43	ERCOT declared EEA-3 and issued directive to shed 1000 MW Manual Load Shed.
05:45	Cumulative 13,617 MW of generation capacity unavailable.
05:45 – 06:30	Seventeen generator units went offline or de-rated.
05:47	ERCOT issued directive to shed EILS (384 MW).
06:04	ERCOT issued directive to shed another 1000 MW Manual Load Shed (2000 MW total).
06:05	Lowest frequency of the event was recorded – 59.576 Hz.
06:23	ERCOT issued directive to shed 2000 MW Manual Load Shed (4000 MW total).
06:25	Reserve lowest level recorded (447 MW).
06:30	Cumulative 14,233 MW of generation capacity unavailable.
06:30 – 08:00	Reserve level gradually increased as load was shed and generators came on-line.

06:59	Public appeal issued.
07:57	ERCOT issued first directive to start restoring Manual Load Shed (500 MW)
08:22	ERCOT issued second directive to restore load.
08:25	A large coal unit tripped off-line. From this point forward ERCOT issued directives to restore additional load.
13:27	All shed load was restored.
14:01	ERCOT moved from EEA-3 to EEA-2B.
15:14	ERCOT moved from EEA-2B to EEA-2A.
14:55	All RRS loads recalled.
February 3, 2011, 10:00	ERCOT moved to EEA-0 and EILS was recalled.

### 3. Communications

ERCOT followed its normal notification process for severe cold weather events prior to the events of February 2-3, 2011. At 06:30 on January 31, ERCOT issued an Operating Condition Notice (OCN) for temperatures in the mid to low teens and highs at or below freezing starting at 09:00 on February 1. A follow-up Advisory was issued at 09:05 on February 1, for temperatures in the teens to low 20s and highs near or below freezing, affecting 50% or more of major areas. On February 2 at 05:08, shortly before declaring EEA, ERCOT issued a Watch.

ERCOT initially appeared to follow normal required procedures in preparing for the cold weather, but experienced significant communications problems beginning about 03:00 on February 2, 2011. Despite the forecast of unusual and prolonged cold temperatures, ERCOT did not convey urgency in its PUCT and Morning reports on the morning of February 2. Instead, ERCOT conveyed a sense that sufficient reserves were in place to deal with the forecasted increased demand. For example, the early morning PUCT report said the risk the system would experience load shed was “low,” even though by then it should have been apparent that a significant number of generating units would have difficulty meeting obligations.

During an emergency, the Operating Guides require ERCOT to communicate with QSEs and Transmission Operators.<sup>21</sup> It is the responsibility of the QSEs and Transmission Operators to notify all the Market Participants they represent of each declared EEA level. Based on information submitted by some generating facilities, there was a possible breakdown in communications between some QSEs and generating facilities. Additional analysis is required to determine whether all required communications were made by ERCOT, QSEs and TOs. Texas RE will confirm whether required communications were made, and if noncompliance is detected, will document the noncompliance and forward to the PUCT for further action, as appropriate.

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<sup>21</sup> Operating Guide 4.5.3 (1)

There are provisions in the Protocols and Operating Guides addressing appeals for energy conservation made through the news media. Protocol 6.5.9.4 (5) provides that ERCOT may at any time, at management's discretion, issue an appeal through the public news media for voluntary energy conservation. Operating Guide 4.5.3.3 (3)(g) requires ERCOT, as part of EEA Level 2B, to issue through the media an appeal for energy conservation unless one is already in effect. That appeal was made in the February 2 event, but it was made more than an hour after EEA Level 3 was declared and load shedding was first ordered, and any effect it had on the recovery has not been determined. While ERCOT's media appeal was not made in accordance with the EEA steps set out in the Protocols and Operating Guides, the timing of the media appeal does not appear to constitute a violation because Operating Guide 4.5.3 (4) recognizes that there may be insufficient time to implement all levels in sequence.

During and immediately after the EEA Event, questions arose about the adequacy of ERCOT's communications with entities such as the State Operations Center, PUCT, ERCOT Board of Directors, Media, and Public.<sup>22</sup> Other than the provisions for conservation appeals made through the media described above, the Protocols and Operating Guides do not contain any requirements for such communications. Therefore, the adequacy of those types of communications is beyond the scope of this report. However, ERCOT stated that it has implemented new practices to address some of the issues and that it will develop a full emergency communications plan.

#### **4. Generation Outages**

As previously discussed, numerous generating units experienced failures to start, trips, and de-rating of facilities during the February 2-4 cold weather. Protocol 3.9.1 requires each QSE that represents a generation resource to submit a Current Operating Plan (COP) to ERCOT that reflects expected operating conditions for each resource for each hour of the next seven operating days. QSEs must update a COP to reflect changes in availability of any resource as soon as reasonably practicable, but in no event later than 60 minutes after the event that caused the change.

Texas RE requested and reviewed information about whether QSEs submitted required updates to their COPs. It appears that to the extent updates were required, they were submitted.

#### **5. ERCOT's Management of Reserve Levels**

Protocol 6.5.9.1 (1) states that ERCOT, as the single Control Area Authority, is responsible for maintaining reliability in normal and emergency operating conditions, and that minimum standards for reliability are defined by the Operating Guides and NERC standards. Protocol 6.5.9.3.4 (4) and Operating Guide 4.2.4 (1) provide that ERCOT is considered to be in an unreliable condition whenever ERCOT Transmission Grid status is such that the most severe single-contingency event presents the threat of uncontrolled separation or cascading outages

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<sup>22</sup> Review of February 2, 2011, EEA Event, Presentation by H.B. "Trip" Doggett at Special Board of Directors Meeting, February 14, 2011.

and/or large-scale service disruption to load, and no timely solution is obtainable through market processes.<sup>23</sup> This is known as the “n-1” contingency level, which means that below this level insufficient reserve capacity would be available to compensate for the loss of the largest single generation unit in the Interconnection.

On February 2, ERCOT PRC levels were below the n-1 contingency reserve level of 1354 MW during four periods, totaling 2 hours and 17 minutes (05:23 to 06:51, 07:11 to 07:30, 08:39 to 08:52, and 10:58 to 11:15). During these periods, if a large nuclear unit had tripped, it is possible that automatic under-frequency load shedding would have occurred or further manual load shedding would have been necessary.

As stated above, the Protocols provide that ERCOT must operate the system in accordance with minimum standards for reliability as defined by NERC. Texas RE is examining issues of compliance with NERC standards in connection with the analysis being performed in Texas RE’s capacity as the NERC Regional Entity for the Texas Region, and possible noncompliance with NERC standards is not addressed in this report.

As provided in Protocol 6.5.9.4.2 (1)(a)(iii) and Operating Guide 4.5.3.3 (1)(a)(iii), ERCOT obtained supplemental energy to respond to the loss of generation capacity through the North, East, and South DC ties of approximately 800 MW beginning at 05:06, and increasing to approximately 1100 MW between 11:02 and 22:00.

As discussed earlier, on January 31, 2011, ERCOT scheduled thirteen (13) generating units with a nameplate capacity of 3,088 MW to come online through the day-ahead market process. Two (2) of the additional units were committed for system capacity and the remaining eleven (11) units were committed for transmission contingency or congestion concerns. Of the 13 units, eight (8) experienced a unit trip or failure to start on February 2.

Another key issue with reserves was the fact that multiple generation units that were contracted for Black Start services failed to start or tripped during the event. Of 15 generation units that were contracted for Black Start services, one unit failed to start and eight units tripped during the event. If the capacity shortage had worsened into an ERCOT-wide blackout, and Black Start services had been required, some of the contracted resources may not have been available and the ability to recover may have been impaired.

The fact that one unit contracted for Black Start services failed to start during the event needs to be further examined in light of the requirements of Protocol 8.1.1.2.1.5 – System Black Start Capability Qualification and Protocol 8.1.1.1 – Ancillary Service Qualification and Testing. Texas RE will confirm and document any potential violations and forward to the PUCT for further action, as appropriate.

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<sup>23</sup> The language in Protocol 6.5.9.3.4 and Operating Guide 4.2.4(1) is not identical. Operating Guide 1.2 states that Protocols supersede Operating Guides.

## 6. Ancillary Service Performance

ERCOT uses day-ahead, hour-ahead, and ancillary services markets to procure and commit enough generation capacity to meet demand. In addition to generation resources that are scheduled to provide the forecasted need for electricity, ERCOT arranges for reserves to ensure a safety margin for unplanned contingencies, such as the loss of a generating unit or transmission line or changes in demand. These generation resources are called Ancillary Services, and include the following reserve services:

- *Responsive Reserve Service* (RRS) is provided by operating reserves on Generation Resources and Load Resources maintained to help control the frequency of the system. RRS is deployed through automatic governor action or under-frequency relay in response to frequency deviations, by electronic signal from ERCOT, or as ordered by an ERCOT Operator during EEA or other emergencies.
- *Non-Spin Reserve Service* (NSRS) is provided by off-line Generation Resource Capacity, or reserved capacity from on-line resources, capable of being ramped to a specific output level within 30 minutes and operating at a specific output for at least one hour. NSRS can also be provided by Load Resources that are capable of being interrupted within 30 minutes and remaining interrupted for at least one hour. NSRS is deployed in response to loss-of-resource contingencies, load forecasting error, or other contingency events on the system.

### a. Generating Resource Ancillary Services Performance

With the large number of generator unit trips, de-ratings, or failures to start, ERCOT experienced numerous issues with ancillary service performance, including both Responsive Reserve Service (RRS) and Non-Spin Reserve Service (NSRS). The most significant ancillary service problem was the failure to provide NSRS. NSRS failures were one of the key factors in the loss of generation reserves prior to the event.

QSEs providing RRS must update the unit's RRS Ancillary Service Schedule(s) within one minute after receiving a deployment instruction.<sup>24</sup> A QSE providing NSRS must, after deployment, update the unit's NSRS Ancillary Service Schedule within twenty (20) minutes. The unit must be generating at or above its Low Sustainable Limit (LSL) at the twenty-five (25) minute mark.<sup>25</sup>

It appears that potential violations occurred due to the failure of numerous market participants to update Ancillary Service Schedules during the event period. A total of ten (10) QSEs did not update their RRS or NSRS resource schedules for a total of twenty-one (21) generating units. Eight (8) NSRS units failed to start and three (3) more did not reach their Low Sustainable Limit within 25 minutes for a total of 681 MW of NSRS failures. Texas RE will

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<sup>24</sup> Protocol 8.1.1.4.2

<sup>25</sup> Protocol 8.1.1.4.3

confirm and document the potential violations and forward to the PUCT for further action, as appropriate.

**b. Load Resource Ancillary Services Performance**

Under the Protocols, load resources are allowed to provide Ancillary Services for either Responsive Reserve Service (RRS) or Non-Spin Reserve Service (NSRS). There are two types of Load Resources—Controllable Load Resources (CLR) and Non-Controllable Load Resources (NCLRs). The word controllable refers to the capability to control the load from a control room rather than switching it in the field. On February 1<sup>st</sup> through 3<sup>rd</sup>, a total of 899.5 MW of NCLRs were providing RRS Ancillary Services.

Protocol 8.1.1.4.2 requires that a QSE and its active Load Resources must deploy at least 95% of the requested capacity within ten minutes of receiving the verbal dispatch instruction (VDI). On February 2 a total of 885.9 MW of NCLR load (98.4%) deployed within 10 minutes of the directive at 05:26. However, two NCLR providers failed to meet either their minimum obligation level or failed to deploy 95% within the 10 minute time requirement. Texas RE will confirm and document the potential violations and forward to the PUCT for further action, as appropriate.

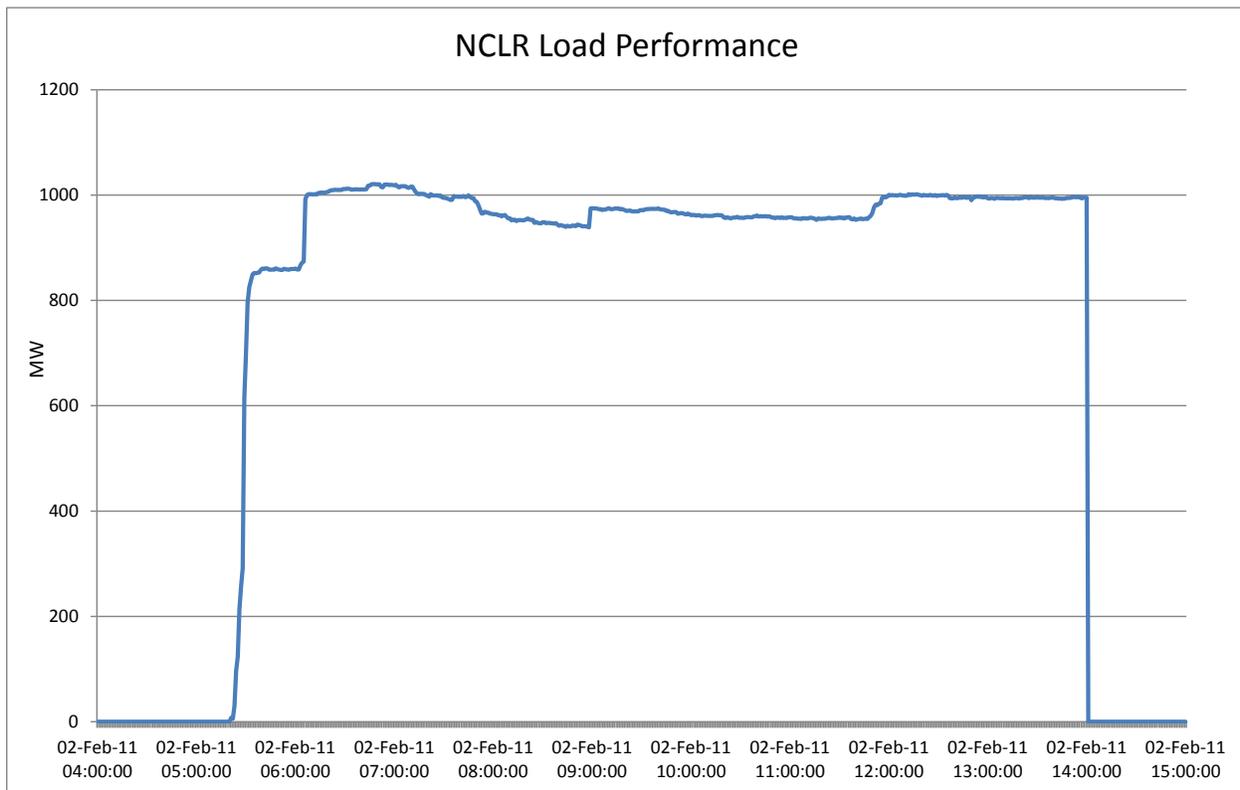
In contrast, several NCLR providers reduced load well in excess of their commitments, helping maintain the reliability of the grid during a critical period. In addition, at 06:02, one QSE called an ERCOT operator and told the operator that the QSE had additional NCLR load that was available but not yet committed in the ancillary service market.<sup>26</sup> The ERCOT Operator issued a VDI and asked the Operator to dispatch the additional capacity. Over the next five minutes NCLR load was reduced by approximately 140 MW.

During the course of the day, several NCLR providers contacted ERCOT to request restoration of a portion of their NCLR load. ERCOT approved these requests based on issues with freezing pipes, safety concerns, and environmental concerns. NCLR load restored due to these requests totaled approximately 80 MW of the 1021 MW peak NCLR load that was obligated or directed to be shed.

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<sup>26</sup> Protocol 6.5.9.4.2 (1)(b) and Operating Guide 4.5.3.3 (1)(b) require QSEs to notify ERCOT of any resources uncommitted but available in the timeframe of the emergency.

The chart below displays the NCLR performance during the event.



## 7. EILS Performance

Emergency Interruptible Load Service (EILS) is a special emergency demand response service procured for four-month contract periods pursuant to PUC Substantive Rule § 25.507. The aggregated EILS capacity commitments for the February-May 2011 contract period were 384.2 MW for non-business hours and 467.7 MW for business hours.

EILS is deployed by Verbal Dispatch Instruction (VDI) from ERCOT to QSEs. On February 2, EILS loads were dispatched twice, first at 05:49, and again at 08:53 following the transition to business hours when an additional 83.5 MW became available. Although EILS loads are obligated for a maximum of eight hours per contract period, Protocol 6.5.9.4.2 (3)(e) requires that once deployed, EILS loads must remain reduced until ERCOT specifically releases the deployment via a VDI.

Of the nine entities that were committed to provide EILS, it appears that five did not fully meet their obligations. Two of the five entities did not deploy after the initial VDI, although they did deploy in response to the second VDI. One of the five entities did not timely deploy after the first VDI, but did otherwise meet its obligations. The remaining two entities failed to meet their MW obligations during parts of the EILS deployment. Texas RE will further investigate and confirm these potential violations, and forward to the PUC for further action, as appropriate.

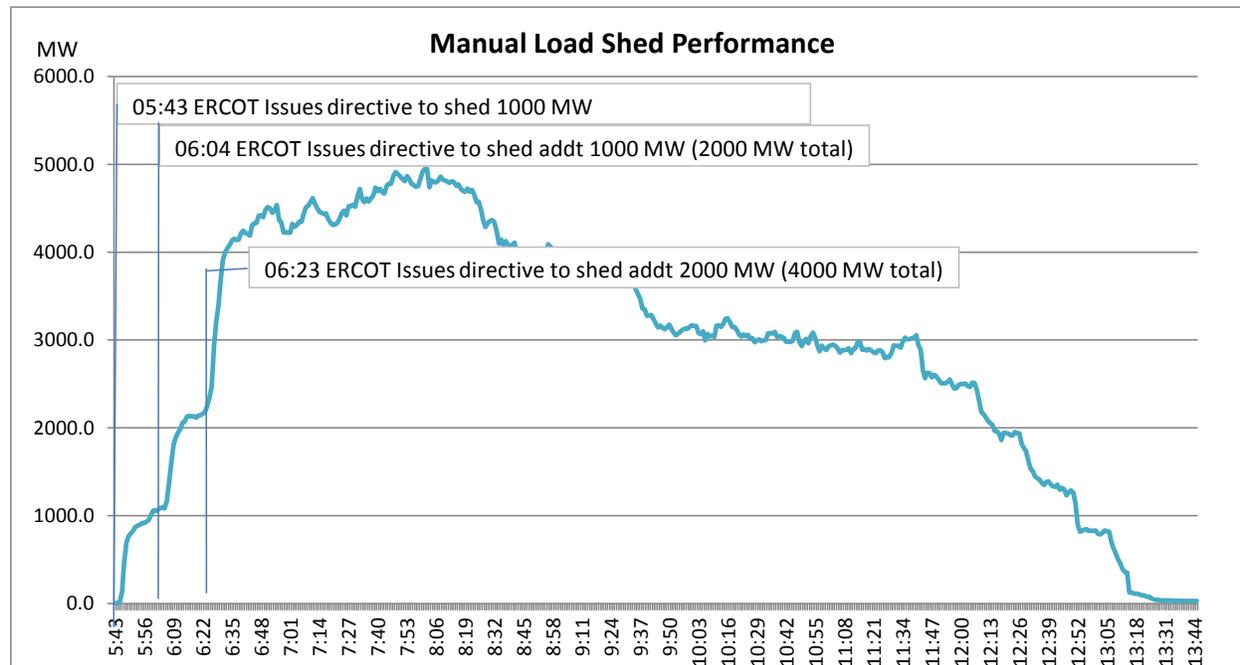
## 8. Manual Load Shed Performance

On February 2, generator outages caused an inadequate supply of electricity, even after Load Resources were deployed. When that occurred, it became necessary to shed firm load to maintain frequency and protect the stability of the electric grid. Firm load shed takes place in EEA Level 3.

ERCOT determines the amount of load to be shed and directs TSPs and DSPs to shed their portion of firm load according to the allotment described in Operating Guide 4.5.3.4, Load Shed Obligation. TSPs and DSPs are required to shed load via control room activation within 30 minutes or manually within one (1) hour of receiving the instruction to shed load. Although ERCOT determines the amount of load to be shed and how much each Transmission organization is responsible for, it is the individual ERCOT Transmission Service Provider which determines which load circuits will be shed and for how long.

Several TDSPs reported concerns that the number of circuits available for manual load shedding was limited by the number of critical or exempt customers, combined with the automatic underfrequency and undervoltage load shed circuits, which caused a small number of customers to bear the brunt of the rotating outages.

The actual performance of the manual load shed exceeded the obligation, with a peak load shed value exceeding 4900 MW at 08:02. The chart below shows the manual load shed performance over the course of the event.



One Transmission Operator and one Distribution Provider failed to meet their obligations within the 30 minute time requirement prescribed by the Protocols. A second Distribution Provider reported that it did not receive the ERCOT dispatch instruction to manually shed load.

Texas RE will confirm and document these potential violations and forward to the PUCT for further action, as appropriate.

## **9. Fuel Supply Issues**

Fuel supply issues did not contribute significantly to the February 2 EEA Event, accounting for approximately 3% of the unavailable generating capacity. Two power plants had their natural gas supply curtailed to zero. Other plants experienced reduced pressure and poor gas quality due to the high usage levels, resulting in temporary de-ratings of the generator output. In some cases, power plants were de-rated due to non-firm natural gas supply contracts. Currently, QSEs are required to notify ERCOT when they actually encounter a fuel supply problem. The QSEs that experienced fuel supply issues made the required notifications.

## **V. Conclusions**

Texas RE's investigation has revealed that, for the most part, ERCOT's and Market Participants' conduct during the Energy Emergency Alert that occurred on February 2, 2011, was consistent with requirements set out in the Protocols and Operating Guides. Loss of scheduled generation due to freezing pipes, valves, and instrumentation, and to a lesser extent issues associated with natural gas supplies, caused a shortage of generation reserves which ultimately required ERCOT to direct firm load shed in order to restore system reliability. Although ERCOT and Market Participants took steps to prepare for the expected cold weather, the actions taken proved to be inadequate or ineffective for the prolonged freezing weather which occurred February 1-4, 2011. However, ERCOT and many generation operators implemented lessons learned from the February 2 event and prevented similar issues during the cold weather that followed on February 9-10.

During the February 2 EEA Event, ERCOT Market Participants committed potential violations of the ERCOT Protocols and Operating Guides in connection with failures to meet Ancillary Services obligations, failures to meet Emergency Interruptible Load Service obligations, failures to execute manual load shed in accordance with requirements, and possibly with the performance of Black Start units. Texas RE will conduct additional investigations as necessary to determine the full extent and implications of non-compliance with the Protocols and Operating Guides, and will forward information to the PUCT for further action, as appropriate. Issues of possible noncompliance with NERC standards are being examined as part of Texas RE's analysis in its capacity as the NERC Regional Entity for the Texas Region.