Human Performance during Winter Weather

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Introduction

Courtesy of weather.gov: The Historic Blizzard of March 2-5, 1966

Introduction

- What is an Extreme Cold Weather Event?
- Cold Weather in the Western Interconnection
- 2011 Southwest Cold Weather Event, February 1–5

What is an Extreme Cold Weather Event?

- Cybersecurity and Infrastructure Security Agency (CISA)
  - Extreme Cold is temperatures that are lower than historical averages to the point that they create a dangerous environment for people, animals, and critical infrastructure. What constitutes "extreme cold" can vary across the country, as some regions are less accustomed to winter weather and freezes.

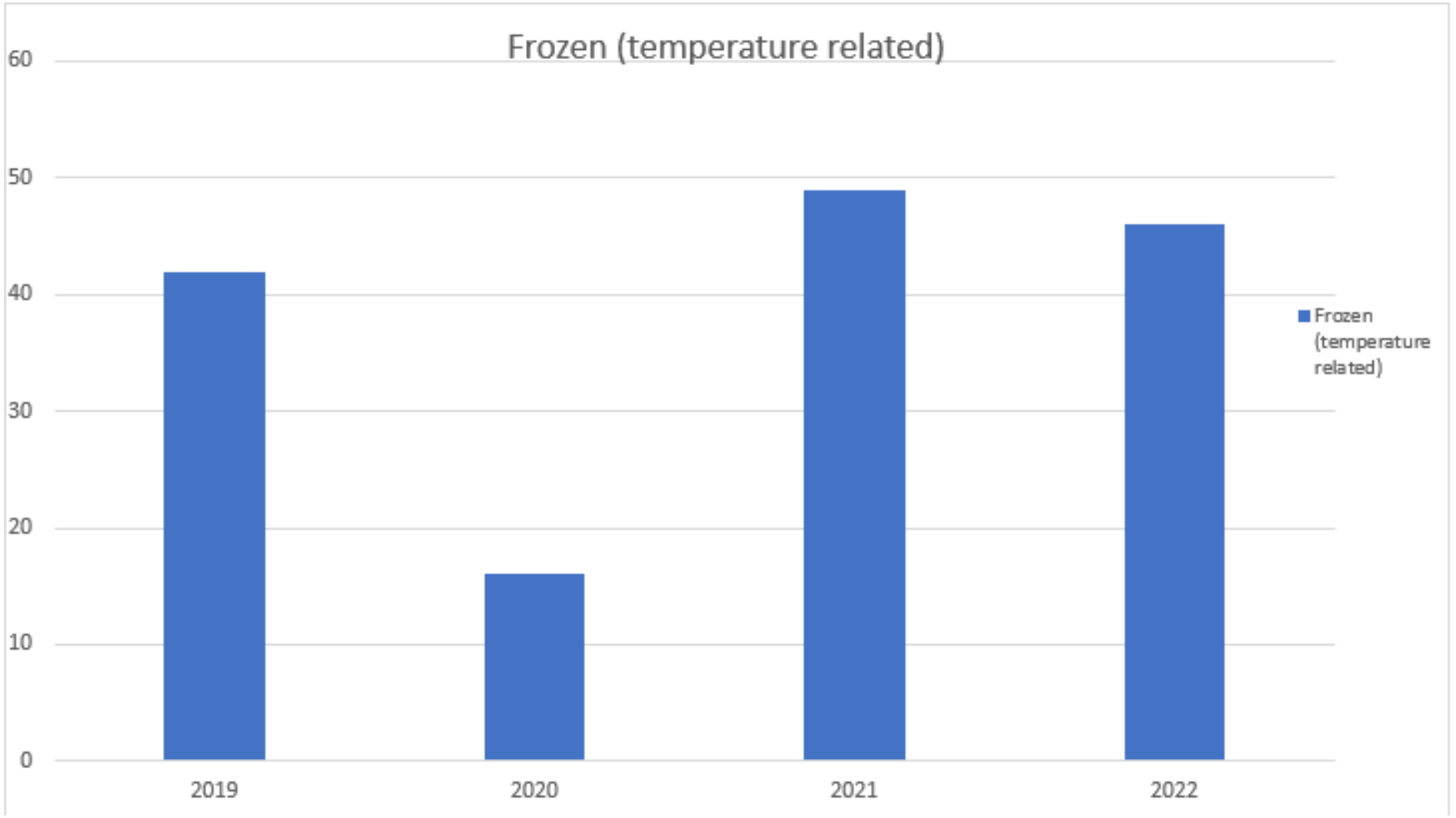
Average Winter Temperatures in the West

- Arizona: 43.6 °F
- California: 46.2 °F
- Colorado: 25.8 °F
- Idaho: 25.4 °F
- Montana: 21.2 °F
- Nevada: 32.2 °F
- Oregon: 34 °F
- New Mexico: 36.1 °F
- Utah: 28.2 °F
- Washington: 33 °F
- Wyoming: 21.2 °F

Cold Weather Extremes in the West

- Arizona: -40 °F
- California: -45 °F
- Colorado: -61 °F
- Idaho: -60 °F
- Montana: -70 °F
- Nevada: -50 °F
- Oregon: -54 °F
- New Mexico: -50 °F
- Utah: -50 °F
- Washington: -48 °F
- Wyoming: -66 °F

Generating Availability Data System (GADS)



Historic Cold Weather Events

December 1983
February 1989
December 1989
January 1994
February 2003
January 2004
February 2006
December 2006
January 2007
February 2008
January 2010
February 2011
January 2014
January 2018
January 2021
December 2022
?

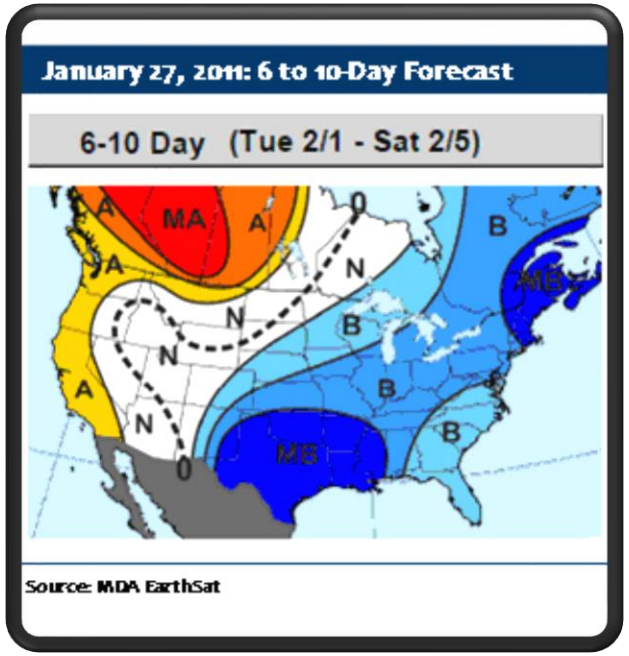
Not Without Warning

A severe arctic cold front hit the central and northeastern United States and southern Canada on February 1, 2011, and lasted for several days. It was dubbed the "Groundhog's Day Blizzard of 2011."

The front was not unexpected.

About a week before the event, long-range forecasts predicted very cold temperatures for the first week of February, with wind, ice, and snow from Texas to Mississippi. Arctic air was expected to extend southward to the Gulf by February 2, bringing daytime highs to as low as 30 degrees below normal.

Sustained winds of 20–25 mph, with higher gusts, were also anticipated.



Color legend:
N = normal
B = below normal
MB = much below normal
SB = strong below normal

Proper Preparations

"By failing to prepare, you are preparing to fail."

Electric:

" Going into the February 2011 Storm, neither ERCOT nor the other electric entities that initiated rolling blackouts during the event expected to have a problem meeting customer demand."

They all had adequate reserve margins, based on anticipated generator availability. But those reserves proved insufficient for the extraordinary amount of capacity that was lost during the event from trips, derates and failures to start."

2011 Southwest Cold Weather Event

Between February 1 and 5, a significant winter storm caused a loss of power in the southwestern United States that resulted in a loss of 56,344 MW and left 1.3 million customers without power and 225 tripped generators.

On February 14, FERC initiated an inquiry into the Southwest outages and service disruptions.

The inquiry had two objectives:

1. Identify the causes of the disruptions.
2. Identify any appropriate actions to prevent recurrence of the disruptions.

Affected Entities

- ERCOT—A total of 210 individual generating units experienced either an outage, a derate, or a failure to start, leading to total load shed of 4,000 MW.
- Salt River Project—Lost 1,050 MW of generation and shed 300 MW of load, affecting some 65,000 customers.
- El Paso Electric—Lost approximately 646 MW of generation It was forced to implement rotating load shedding totaling over 1,000 MW and affecting some 253,000 customers.

Event Analysis

On August 16, 2011, FERC and NERC released a staff report that made recommendations to help prevent a recurrence of the events experienced by customers in the Southwest during February 2011.

At the conclusion of a six-month inquiry, recommendations and lessons learned were published for review and implementation where appropriate.

Event Report Findings

Many generators failed to adequately apply and institutionalize knowledge and recommendations from previous severe winter weather events, especially as to winterization of generation and plant auxiliary equipment.

The reason blackouts had to be initiated was that over 29,000 MW of generation that was committed in the day ahead market or held in reserve either tripped, was derated, or failed to start.

Transmission operators and distribution providers generally did not identify natural gas facilities such as gathering facilities, processing plants or compressor stations as critical and essential loads.

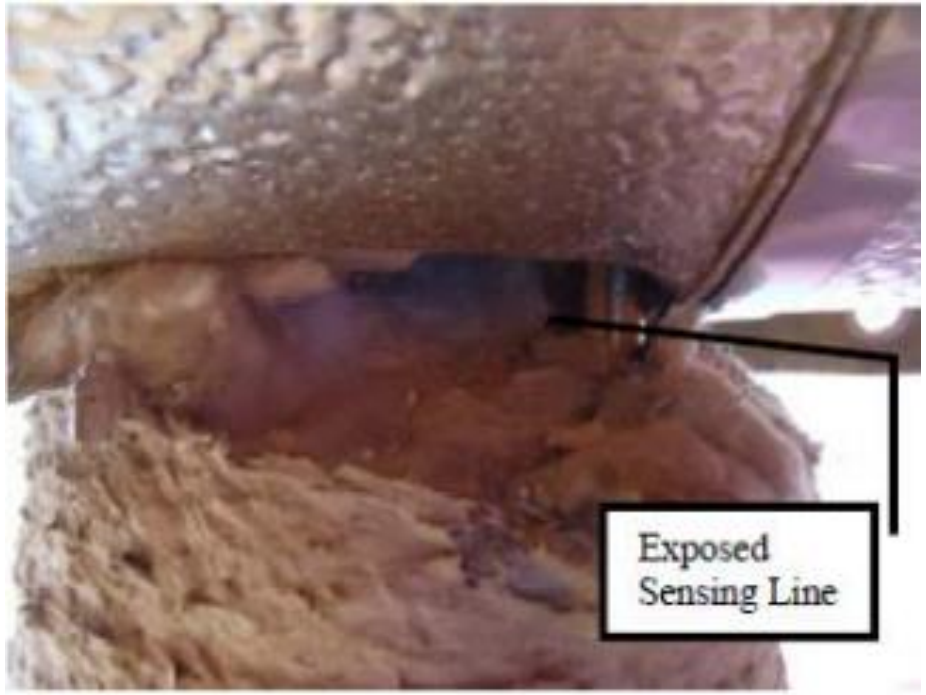
Recommendations not Followed

- Despite the recommendations of the PUCT in its report on the 1989 event, most of the problems generators experienced in 2011 resulted from failures of the same type of equipment that failed in the earlier event. In many cases, these failures were experienced by the same generators.
- Of the over 56 units and 16,805 MW of generating capacity that became unavailable during the December 1989 event, 43 units (representing 13,606 MW of capacity) are still in service in 2011. Twenty-six of those units, representing 5,654 MW of capacity, experienced problems again during the February 2011 cold weather event.

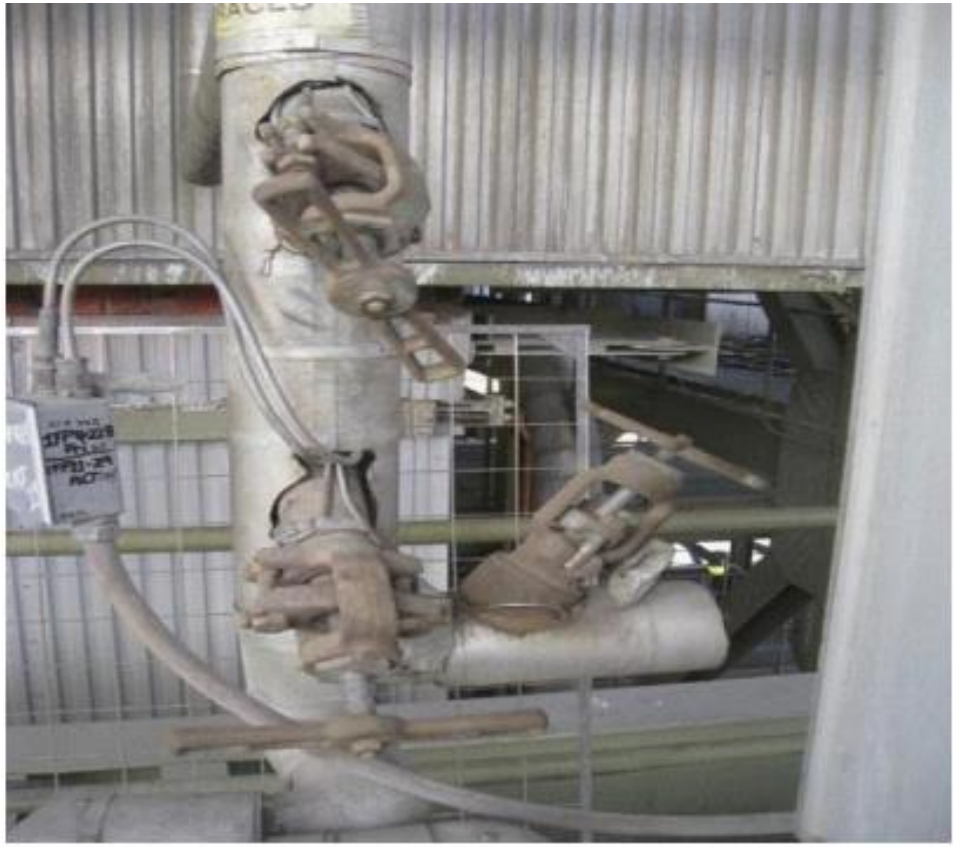
Gas-electric Interdependency

- The task force examined data from numerous electric and gas entities to gauge the severity that shortfalls in one commodity had on the other during the February event. Materials received from natural gas producers indicate that the rolling blackouts (or customer curtailments) in ERCOT were a significant cause, from 29% to 27% respectively, of production shortfalls in the Permian and Fort Worth Basins.
- Gas shortfalls caused problems for some generators in Texas, although not nearly to the extent as did direct weather-related causes such as equipment failure from below-freezing temperatures.

Typical Problem Areas



Gap in insulation



Exposed valves emerge from thermal insulation and are not heat traced.

Courtesy of NERC Extreme Winter Weather Events – Training Presentation

Typical Problem Areas

Frozen Valves:
Inspect and maintain thermal insulation on all units.

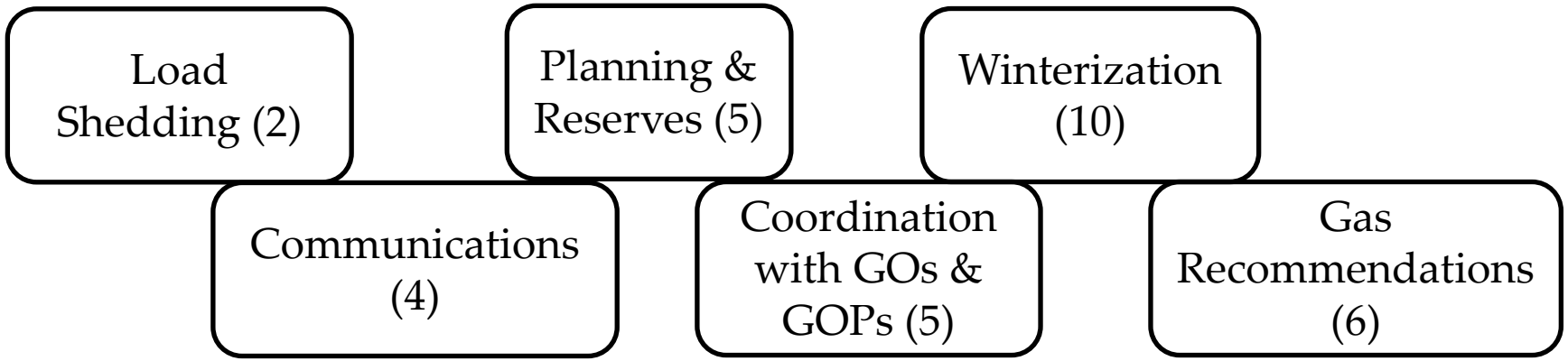
Removal of insulating blanket in summer, failure to reinstall for winter.

Low wind break

Courtesy of NERC Extreme Winter Weather Events – Instructors Manual

Recommendations

- On August 16, 2011, 26 electrical recommendations and six gas recommendations were issued.



NERC Cause Codes

A3 Individual Human Performance LTA

- A3—Human Performance LTA.
- An event or condition resulting from the failure, malfunction, or deterioration of the human performance associated with the process.

Recommendation #23

- WECC should review its Reliability Coordinator procedures for providing notice to Transmission Operators and Balancing Authorities when another Transmission Operator or Balancing Authority within WECC is experiencing a system emergency (or likely will experience a system emergency) and consider whether modification of those procedures is needed to expedite the notice process.

Recommendation #26

- Transmission Operators should train operators in proper load shedding procedures and conduct periodic drills to maintain their load shedding skills.

13 Lessons Learned

Capacity Awareness During an Energy Emergency Event	9/12/2012
Gas and Electricity Interdependency	9/12/2012
Transformer Oil Level Issues During Cold Weather	9/12/2012
Winter Storm Inlet Air Duct Icing	9/12/2012
Wind Farm Winter Storm Issues	9/12/2012
Rotational Load Shed	3/6/2012
Transmission Facilities and Winter Weather Operations	1/6/2012
Plant Onsite Material and Personnel Needed for a Winter Weather Event	1/6/2012
Plant Operator Training to Prepare for a Winter Weather Event	1/6/2012
Plant Instrument and Sensing Equipment Freezing due to Heat Trace and Insulation Failures	10/19/2011
Plant Fuel Switching and Cold Weather	10/19/2011
Adequate Maintenance and Inspection of Generator Freeze Protection	9/29/2011
Generating Unit Temperature Design Parameters and Extreme Weather Conditions	9/28/2011

Problem Statement

NERC Lesson Learned

Plant Operator Training to Prepare for a Winter Weather Event

Primary Interest Groups
Generator Owners (GO)
Generator Operators (GOP)
Balancing Authorities (BA)

Problem Statement
During a severe winter weather event, human performance errors caused generating units with a combined output of over 700 Mw to trip, which contributed to the Reliability Coordinator (RC) and Balancing Authority (BA)having to implement rolling load sheds.

Details

- The Generator Owner/Generator Operators (GO/GOP), using detailed checklists, performed their annual weatherization program on their plants in the Fall/Winter of 2010 to prepare for the cold weather.
- As the weather forecast began calling for freezing temperatures, the plants implemented pre-defined freeze protection procedures.
- These procedures are specific to each plant and unit and include tasks such as ensuring that generating equipment is protected and ready for a freeze event, heaters are fueled and ready to operate, the station has spare food and accommodations for staff, and that subsidiary plant equipment is protected.
- During the cold weather event, the plants experienced temperatures below freezing for 65 hours and wind chills as low as in the single digits

Details

At two plants, four units tripped due to human performance errors. The human performance errors experienced by these two plants were:

- Frozen instrument sensing lines caused false instrumentation signals to be transmitted. Operators did not recognize that data integrity had been affected which led to incorrect operator decisions and actions.
- Plant operators, who were manually operating units, made mistakes by not compensating for the colder temperatures.
- Plant changes were made in violation of the plant's tag lockout procedure.
- It's mentioned in Bullet 3 and 4 in lessons learned about possible communication issues.

Corrective Actions

- The GO/GOP evaluated their plant training programs and addressed the human performance issues.
- They incorporated training, which improved the situational awareness of operators, by informing them of the additional unit parameters which should be cross referenced with other critical system measurements to aid them in their ability to identify inaccurate instrument measurements.
- The training organization also evaluated and implemented changes in each plant control room and unit console to minimize the potential for human performance error.

Lessons Learned

- To maximize plant operator human performance during cold weather operations, GO/GOPs should consider the following:
- Have operators trained on the winter freeze protection plan and the emergency winter operation plan to provide them better insight into the plant operation during winter events including awareness of the capabilities and limitations of the freeze protection monitoring system.

Lessons Learned

- It is likely that operators will accept critical metering as always being accurate, as it usually is reliable most of the time.
- Hence, there is a need for data integrity training and reminders that critical unit data may be inaccurate and should always be correlated with other data to help determine its accuracy.
- Also, procedures should be developed and practiced where operators are dependent on manually receiving critical operating data to simulate conditions where parameter sensing transmitters malfunction or freeze.
- Simulators would be ideal to provide this training.

Lessons Learned

- Plant operators communicate with many other entities and during a period of high stress operations events, common with severe winter weather, operators will be communicating with other entities such as BAs, which are also experiencing high stress conditions.
- Due to possible miss-communications, plant operators should ensure, just as with normal communications, the use of 3-way communications protocol is used when receiving or giving instructions.

Lessons Learned

- During high stress situations such as capacity emergencies, human performance errors could occur due to terminology differences between entities.
- For example, a BA communicates to its Transmission Operator (TOP) to "shed 500 Mw of load" from the system. To accomplish this, the TOP removes power from enough customers to reduce 500 Mw of load on the system.
- This terminology has a different meaning to plant operators. In many cases, if a plant operator received the same message, it would be interpreted to mean to shed their customer load by reducing their generation output 500 Mw.
- BAs must be very careful in using this terminology. If such terminology is used where both TOPs and GOPs see the same message, the BA should consider adding the verbiage "For plants – do NOT reduce generation".

Lessons Learned

- If staff cannot be housed near the plant, GO/GOPs should ensure that additional staff such as Operations, Maintenance and Engineering personnel, who are trained to be able to perform certain critical jobs, are at the plant prior to the onset of an extreme cold weather event and throughout the extreme cold weather.
- Human performance errors increase dramatically if personnel have to perform duties which they have not been trained to do and which are normally done by others.

Resources

- NERC Information on Cold Weather Preparation and BPS Impacts
- NERC Major Event Reports
- NERC Lessons Learned
- Southwest Cold Weather Event of February 1-5, 2011 NERC Event Analysis Cause Codes
- LL20120102 Plant Operator Training to Prepare for a Winter Weather Event

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WECC

Electric Reliability and Security for the West

www.wecc.org