ercot

TEXAS RE

Ensuring electric reliability for Texans

Winter Weatherization Workshop

September 30, 2021

TEXAS RE

Ensuring electric reliability for Texans

Welcome and Instructions

Matthew Barbour

Texas RE

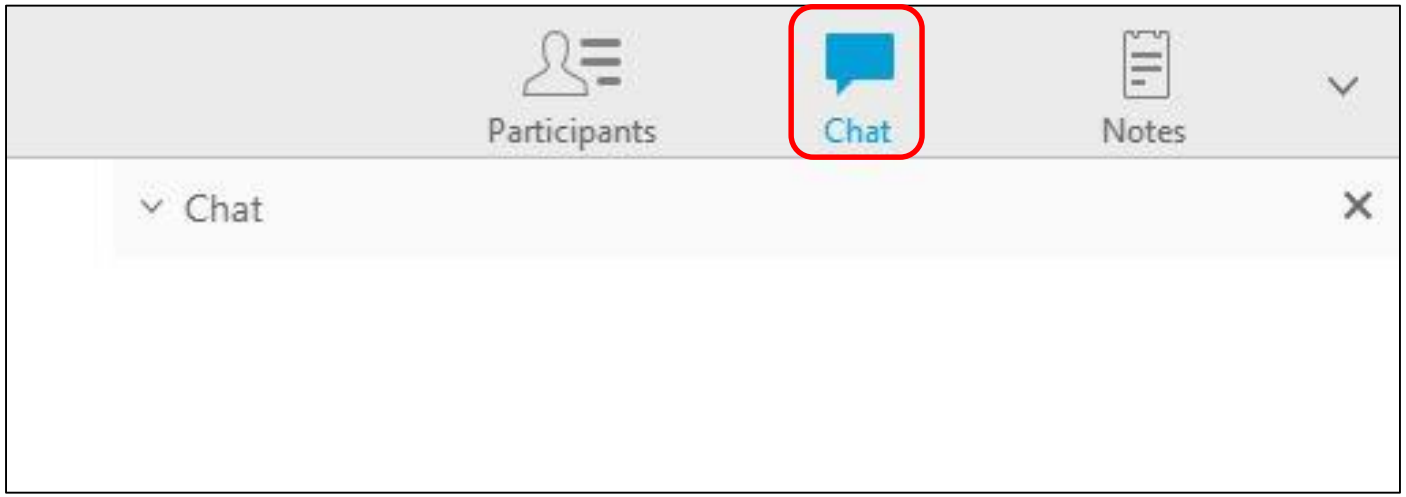
Manager, Communications and Training

Antitrust Admonition

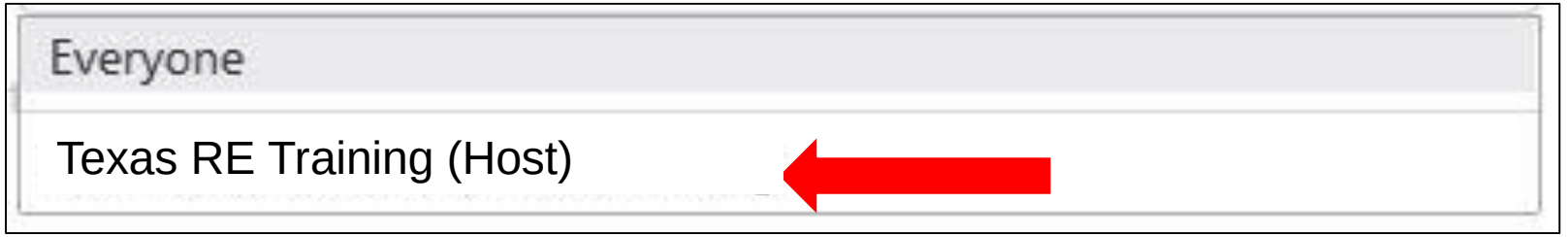
Texas Reliability Entity, Inc. (Texas RE) strictly prohibits persons participating in Texas RE activities from using their participation as a forum for engaging in practices or communications that violate antitrust laws. Texas RE has approved antitrust guidelines available on its website. If you believe that antitrust laws have been violated at a Texas RE meeting, or if you have any questions about the antitrust guidelines, please contact the Texas RE General Counsel.

Notice of this meeting was posted on the Texas RE website and the open portion of this meeting is being held in public. Participants should keep in mind that the listening audience may include members of the press, representatives from various governmental authorities, and industry stakeholders.

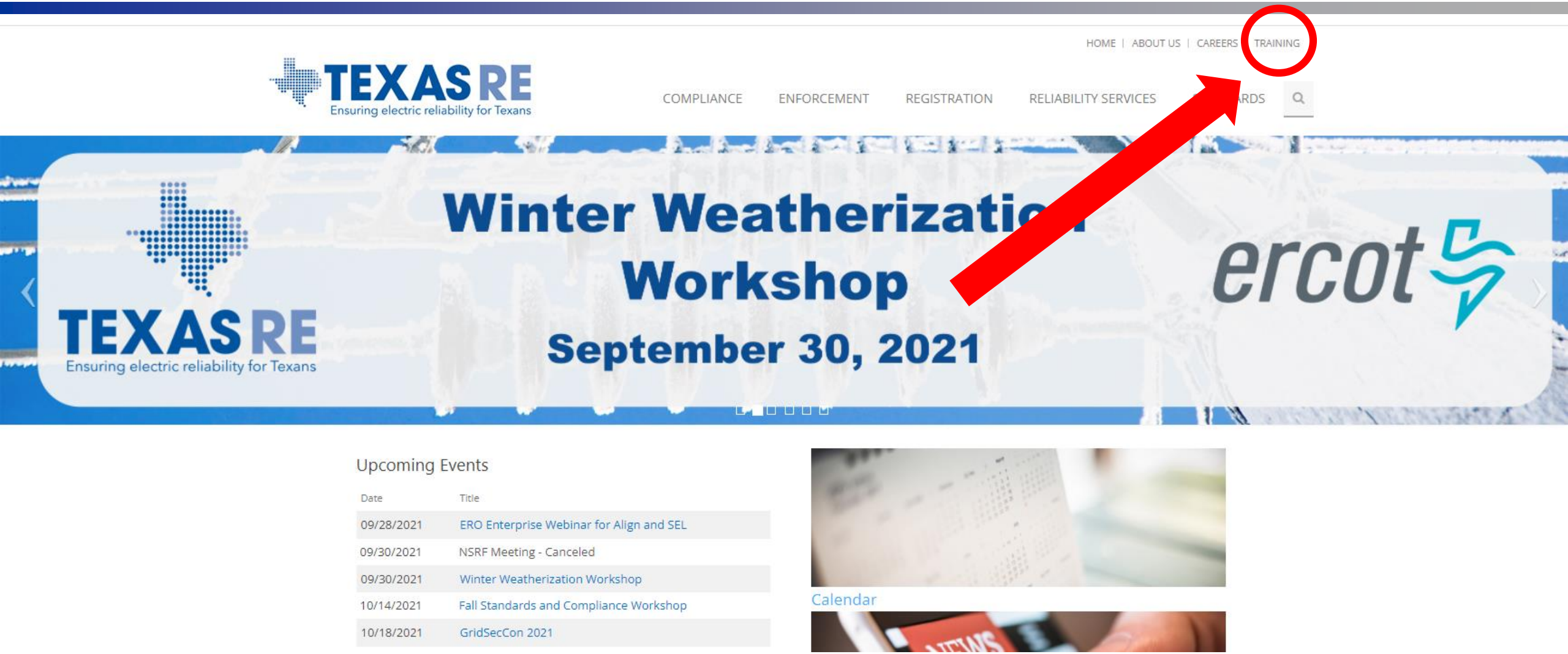
Feedback



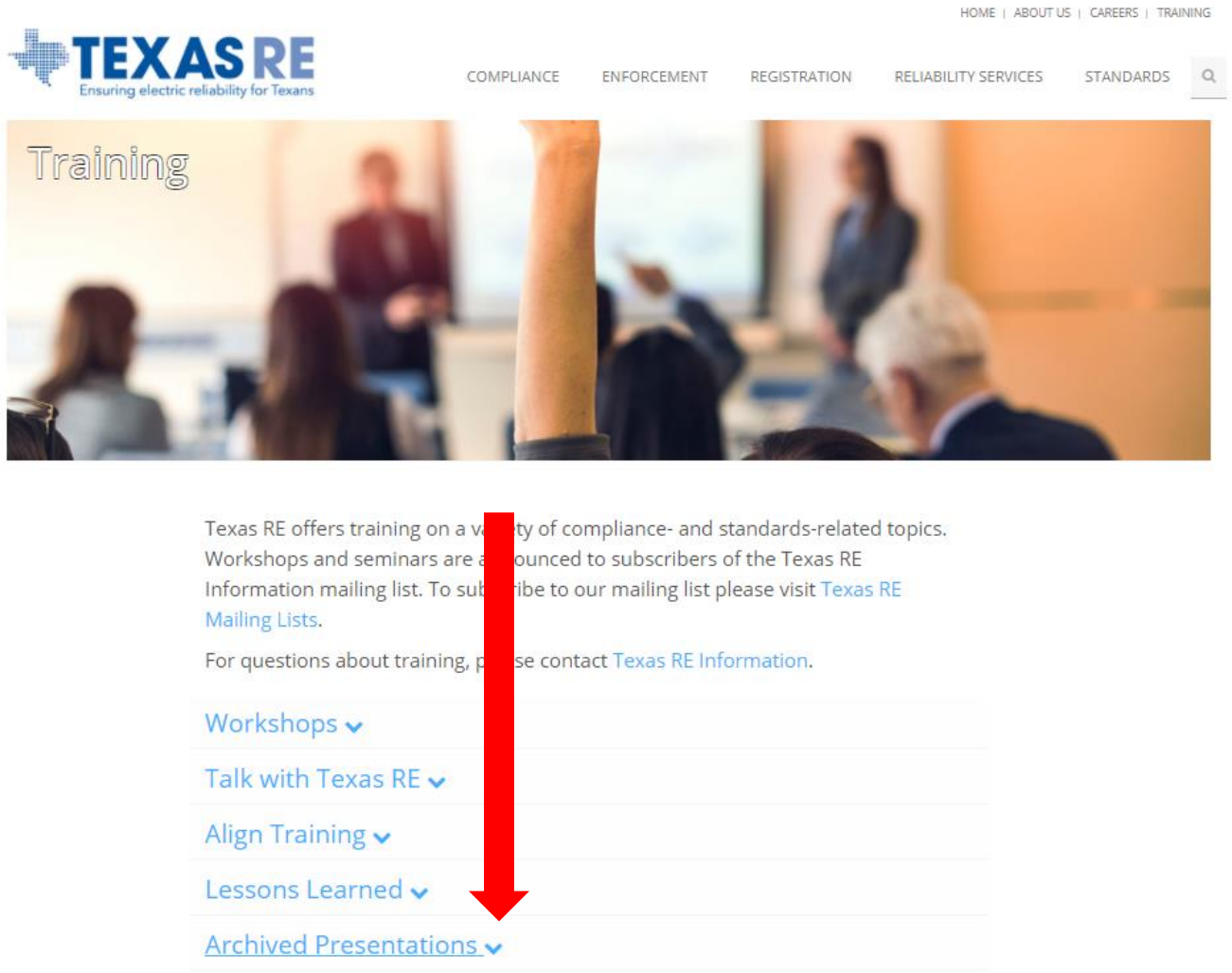
SurveyMonkey

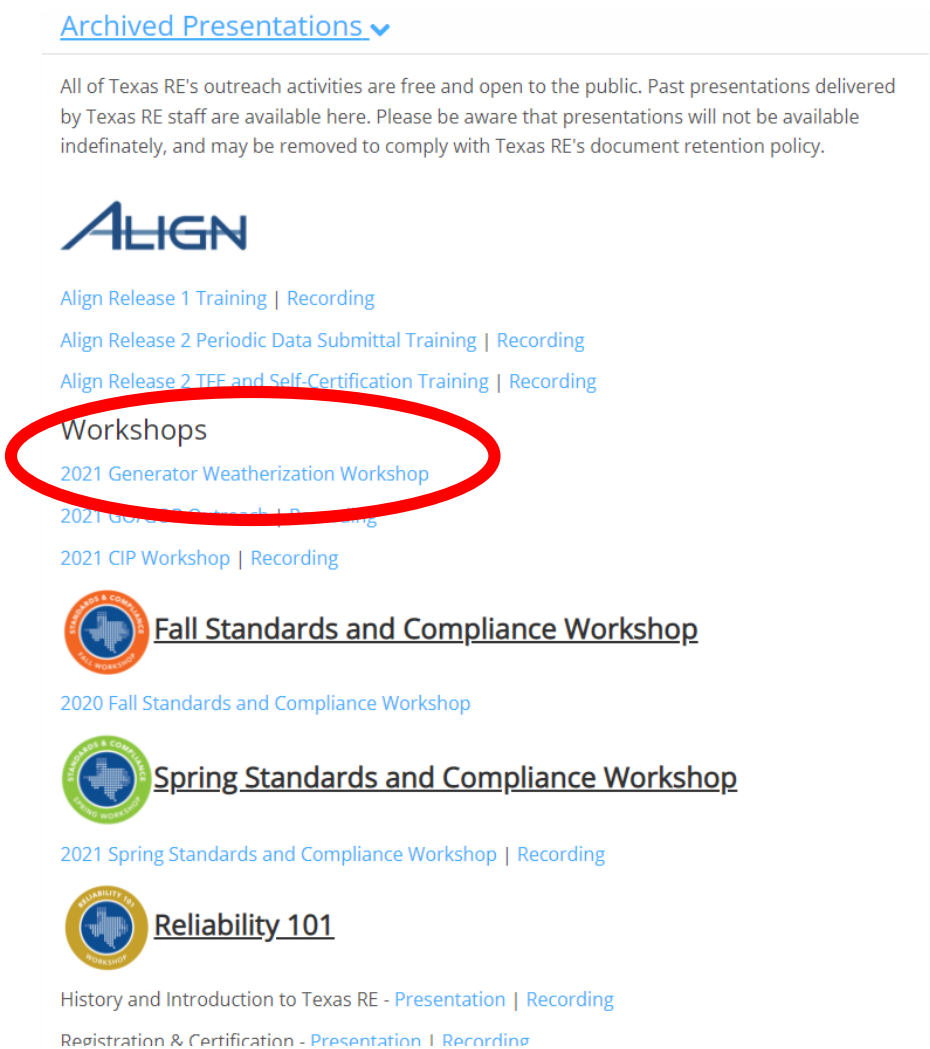


Workshop Materials



Training Page





Continuing Education Hours

Texas RE does not offer Continuing Education Hours (CEHs) for any of its workshops or trainings. However, upon request, Texas RE will provide a Confirmation of Attendance Letter (Letter), which confirms workshop attendance and the number of training hours provided.

Attendees must request a Letter within 90 days of the workshop. Requests should be sent to information@texasre.org.
Once the requestor's attendance is verified, Texas RE will email a Letter to the requestor within five business days of receipt of the request.

Texas RE reserves the right to deny a request due to insufficient information.

Social Media

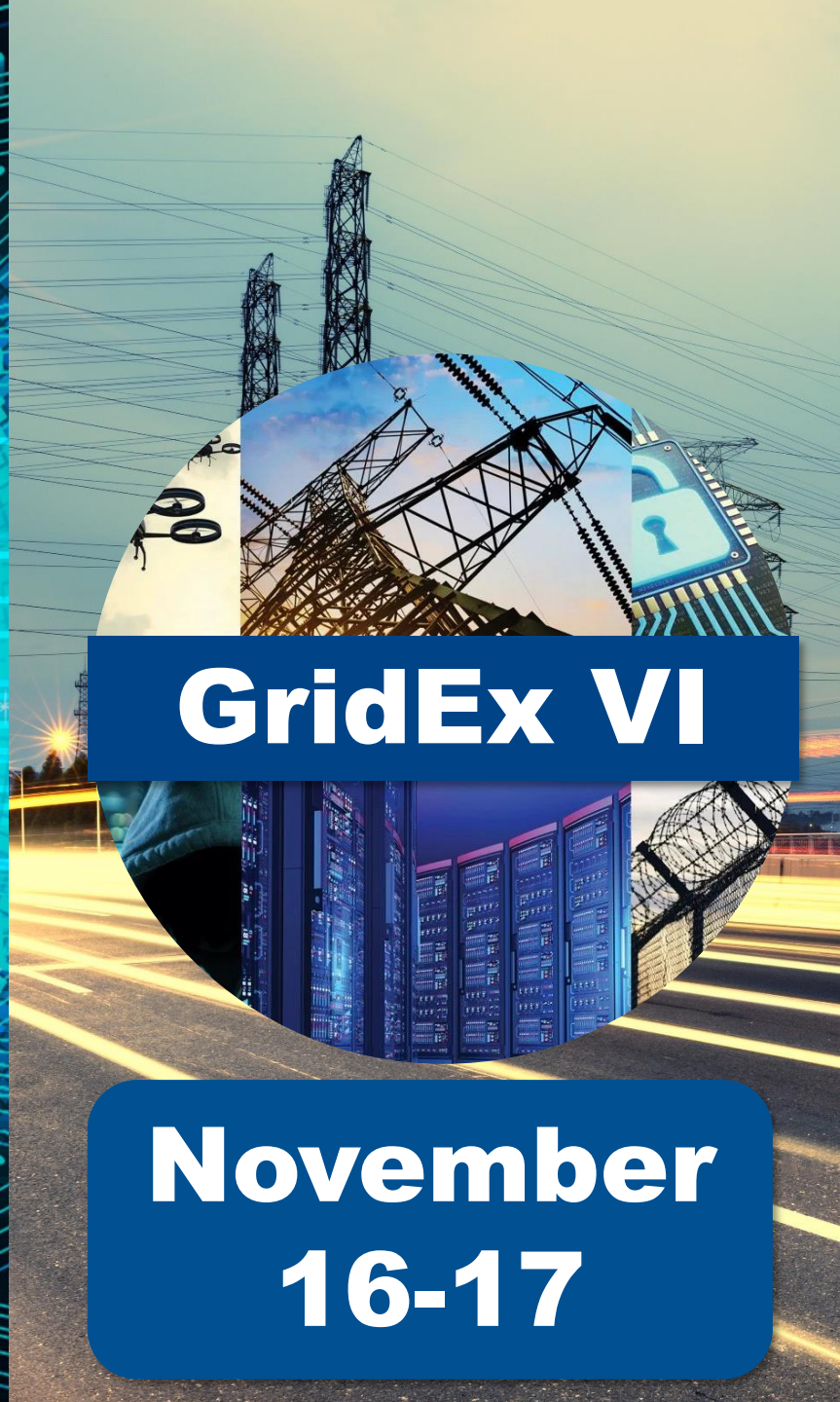
/texas-reliability-entity-inc

@Texas_RE_Inc

/TexasReliabilityEntity

October 14

October 18-20



GridEx VI

November 16-17

Questions?

TEXAS RE

Ensuring electric reliability for Texans

Executive Welcome
Jim Albright
Texas RE CEO

Agenda

- February 2021 Winter Storm Recap – Stephen Solis (ERCOT)
- NERC and Texas RE Activities – Mark Henry (Texas RE)
- Winter Weather Hardening – Mark Dittus (Black & Veatch)
- Two Severe Freeze Events, Two Different Stories – Kyle Olson (El Paso Electric)
- Winter Weather Operational Challenges, Preparations, and Update on Ferguson Power Plant Performance – Andrew Valencia (LCRA)
- 2021-22 Winter Weather Forecast and Review of Historical Winter Extremes – Chris Coleman (ERCOT)
- NRG Cedar Bayou Unit 4 2021 Winter Preparation Success and Lessons Learned – Dave Wohleber (NRG)
- ERCOT Update – Jeff Billo (ERCOT)

February 2021 Winter Storm Recap

Stephen Solis
2021-22 Winter Weatherization Workshop
September 30, 2021

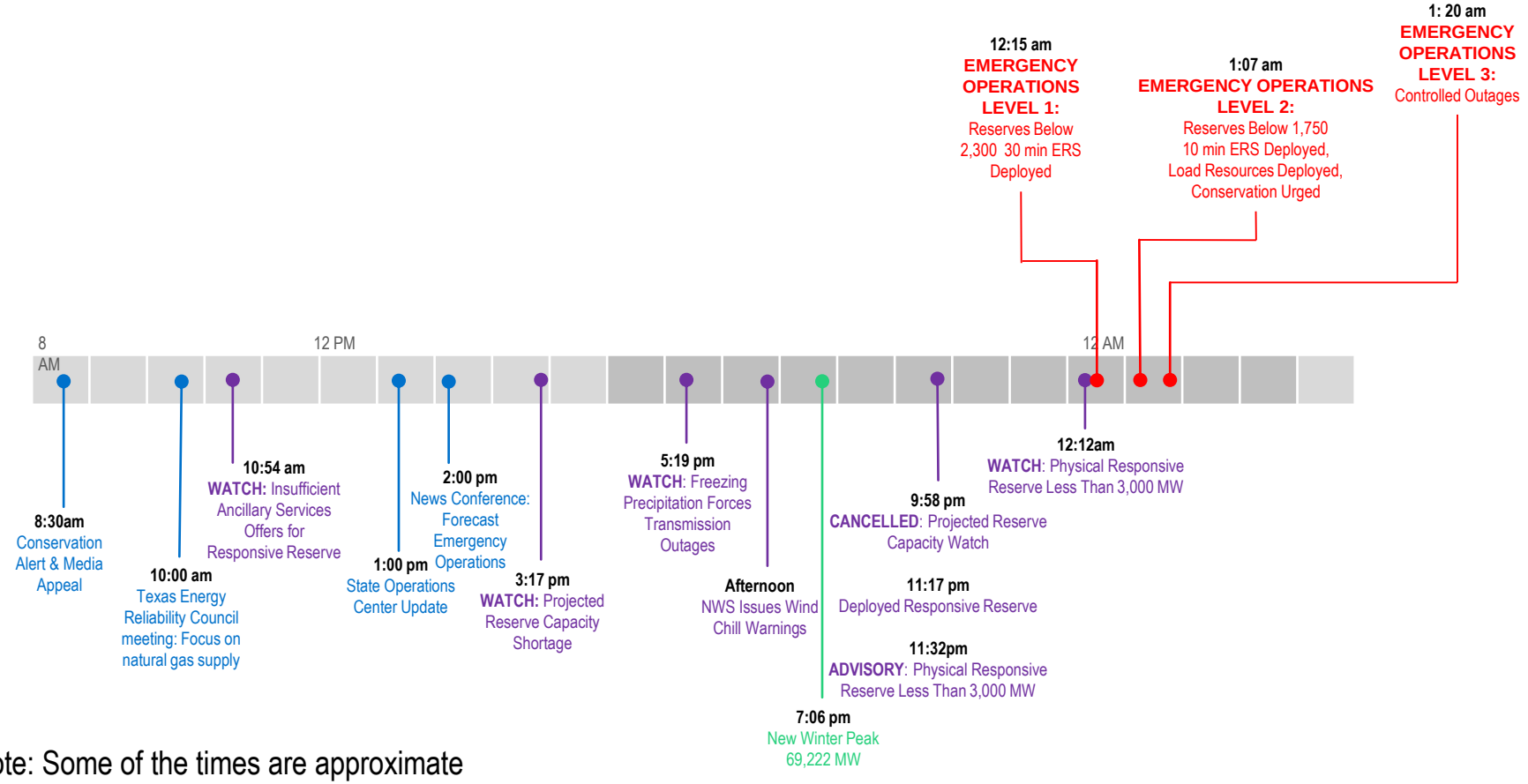
Extreme Cold Weather

- Extreme cold weather was a combination of snow, freezing precipitation, and extreme low temperatures
- Coldest since 1899 in some locations
- Extreme cold and freezing precipitation extended across multiple days
  - 2/9 – 2/14 Icing/Snow
  - 2/15 – 2/18 Extreme Cold temperatures

COLDEST 3-DAY STRETCH | DFW AREA	
AVERAGE TEMPERATURE	
FEB. 14-16, 2021	10.8°
DEC. 22-24, 1983	11.7°
DEC. 23-25, 1983 FEB. 11-13, 1899	12.3°

	DFW	Austin	Houston
Consecutive Hours at or below freezing	140	162	44
Total Hours at or below freezing	245	184	67

Sunday, February 14 – Monday, February 15

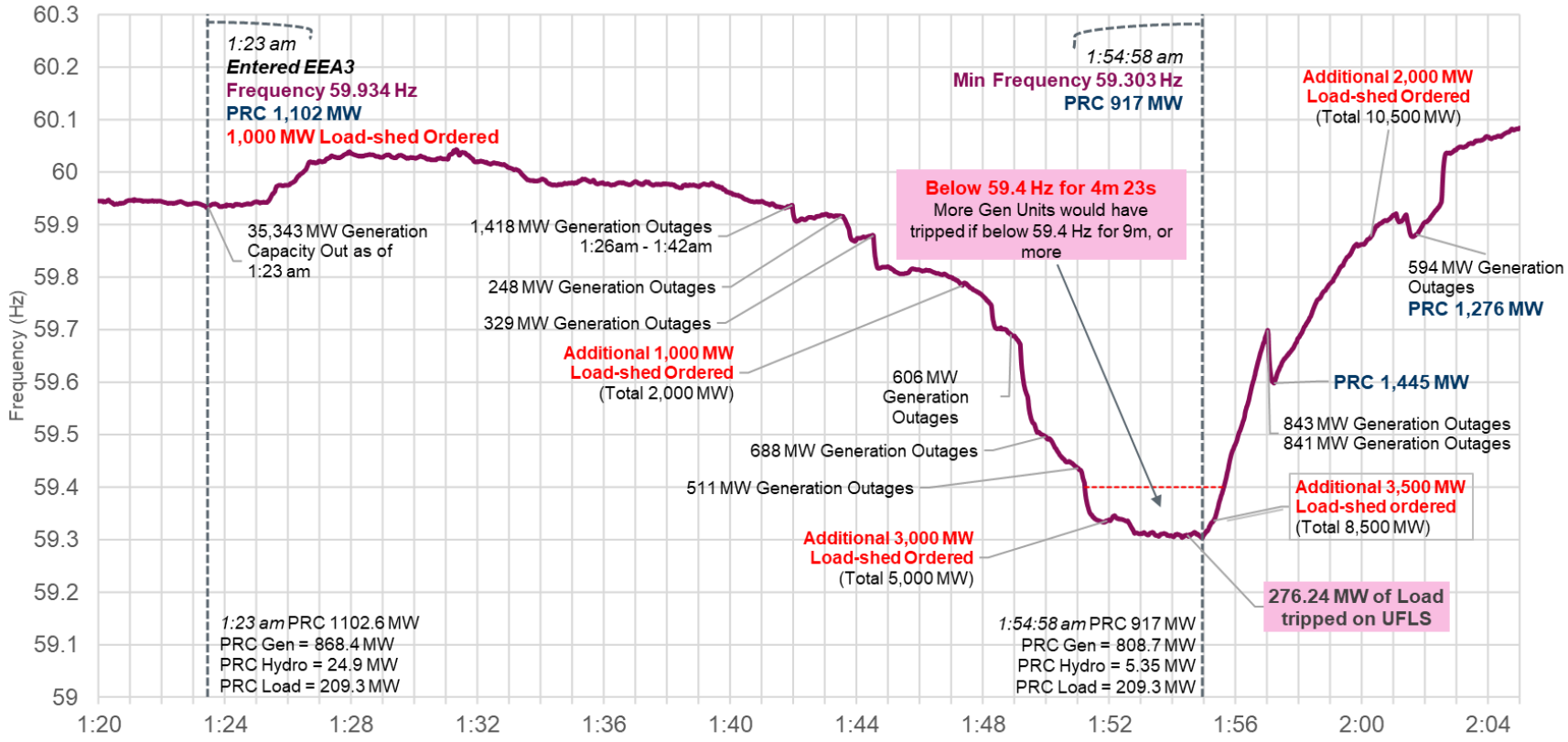


Note: Some of the times are approximate

PUBLIC

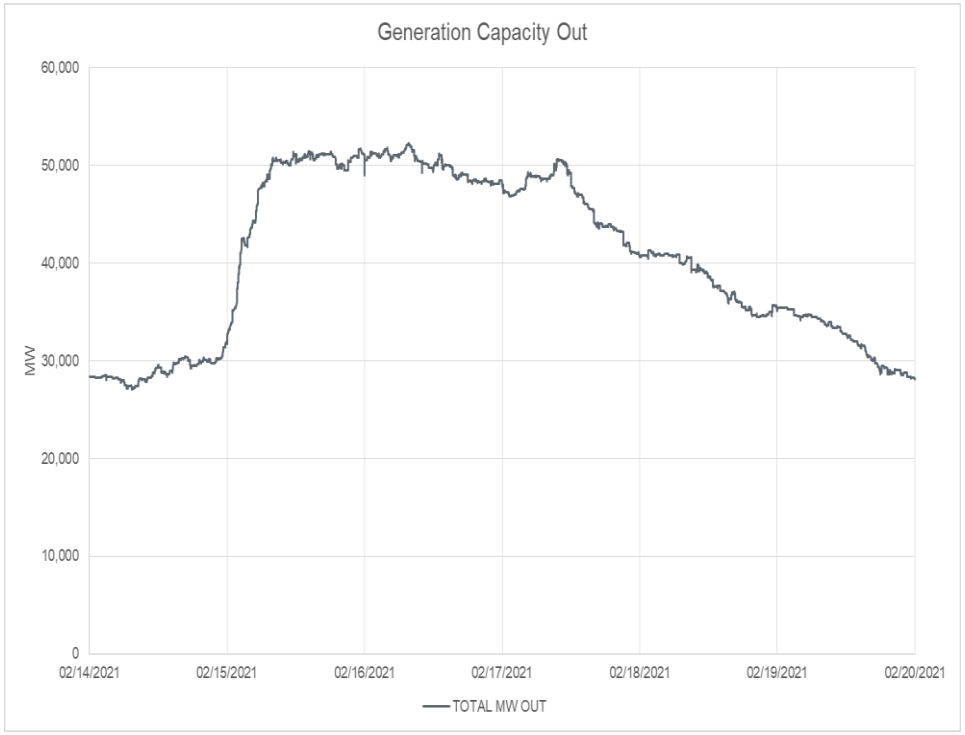
Large Frequency Deviation

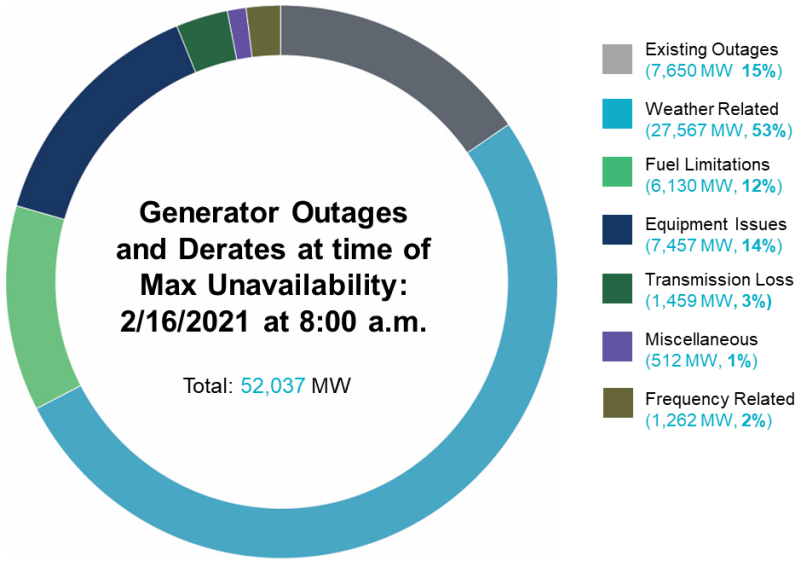
- ERCOT experienced a large frequency deviation from ~01:40 – 02:03 on 2/15
- ERCOT lost approximately 4,000 MW from ~01:40 to 01:50
- ERCOT remained below 59.4 Hz for 4 minutes and 23 seconds
- ERCOT had to instruct 9,500 MW of firm load shed in a 20-minute period to return the system to 60Hz



Generation Outages

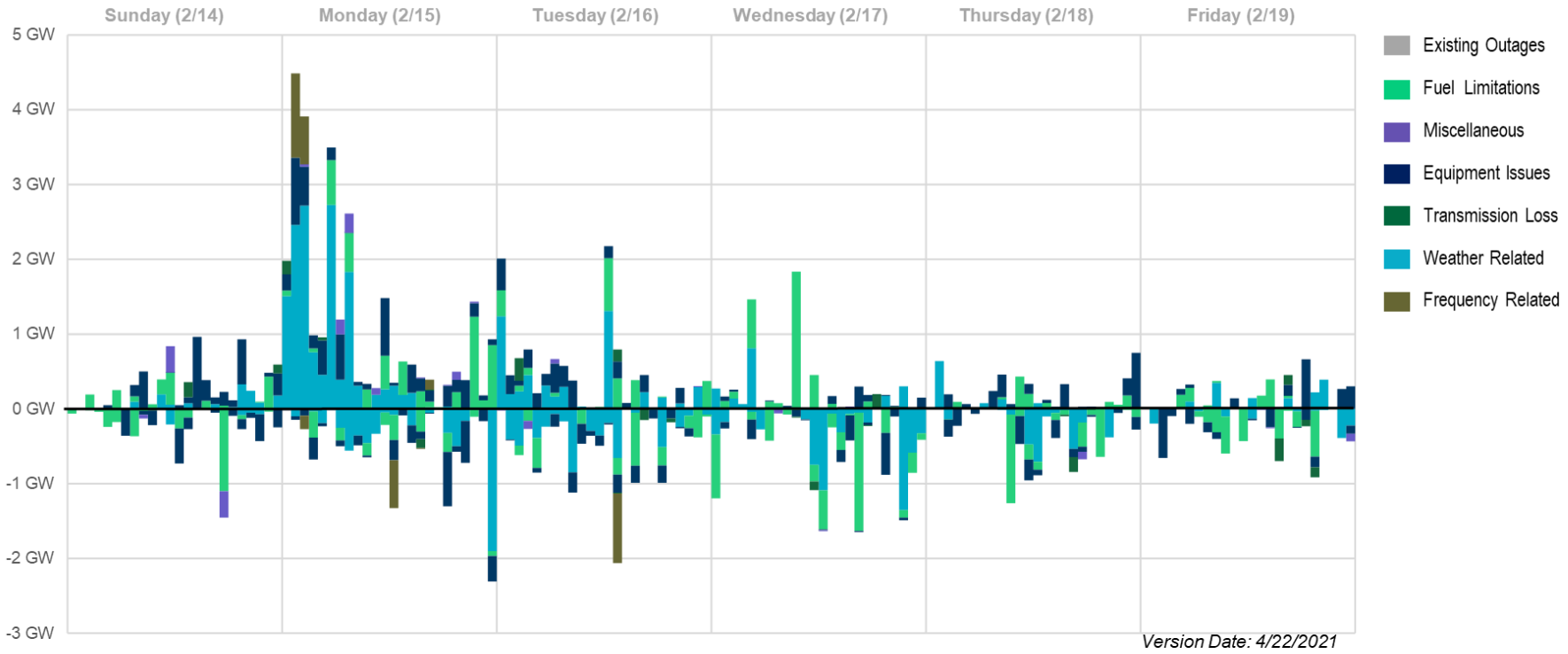
- ERCOT experienced a max 52,037 MW of unavailable generation capacity
- Snow and icing were predominant causes of outages and derates from 2/10 to 2/14
- Cold weather, fuel supply issues, and equipment outages were predominant causes of outages and derates from 2/15 to 2/18





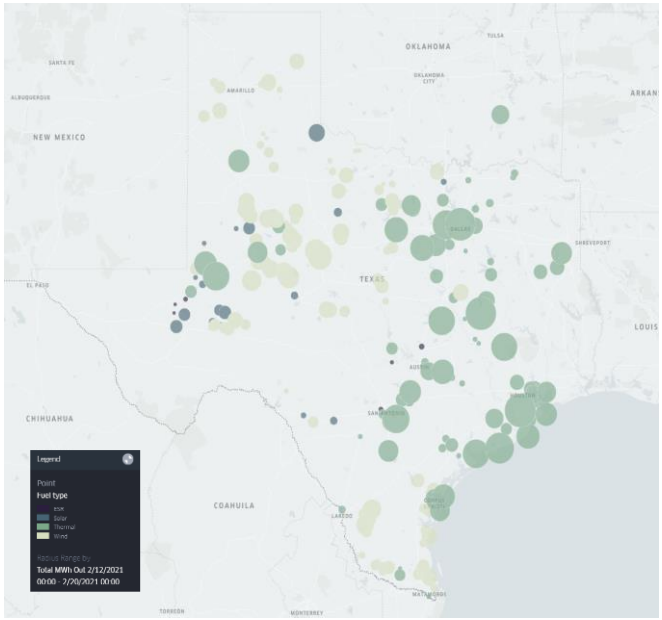
Incremental Generator Outage and Derates by Hour

- The previous slide showing the net level of outages doesn't capture the volatility of generation availability that increased dramatically on 2/15 and continued throughout the week, with generators continuing to go out of service and come into service throughout the duration of the event.

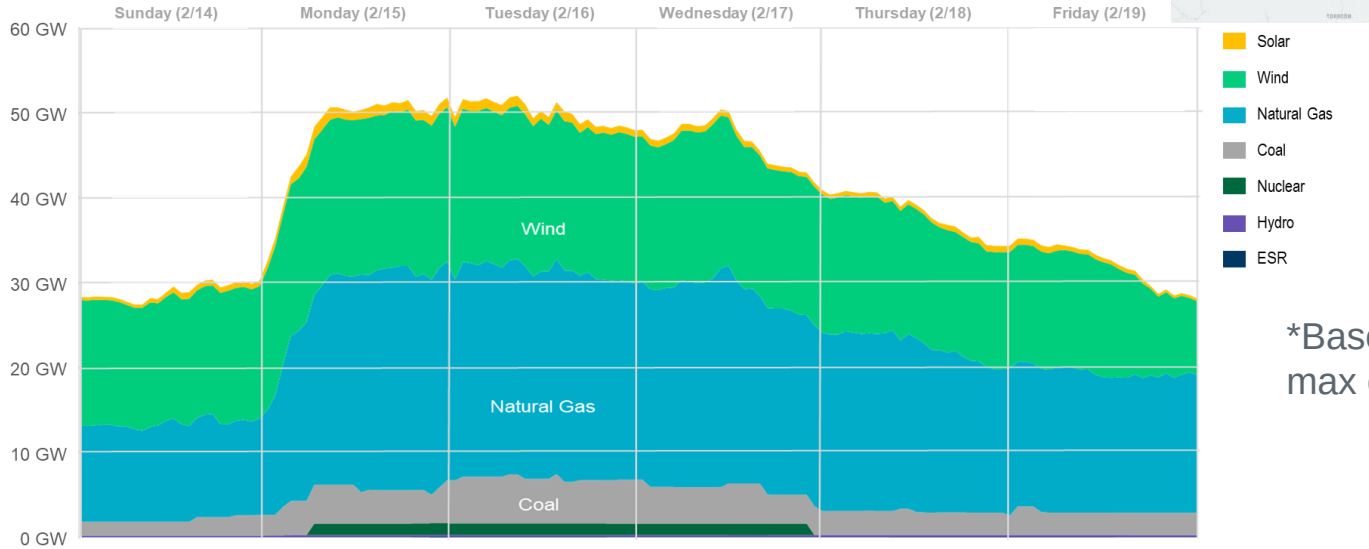


Generation losses across the entire fleet

- Generation losses were experienced throughout the state and across all fuel types



Net Generator Outages and Derates by Fuel Type*

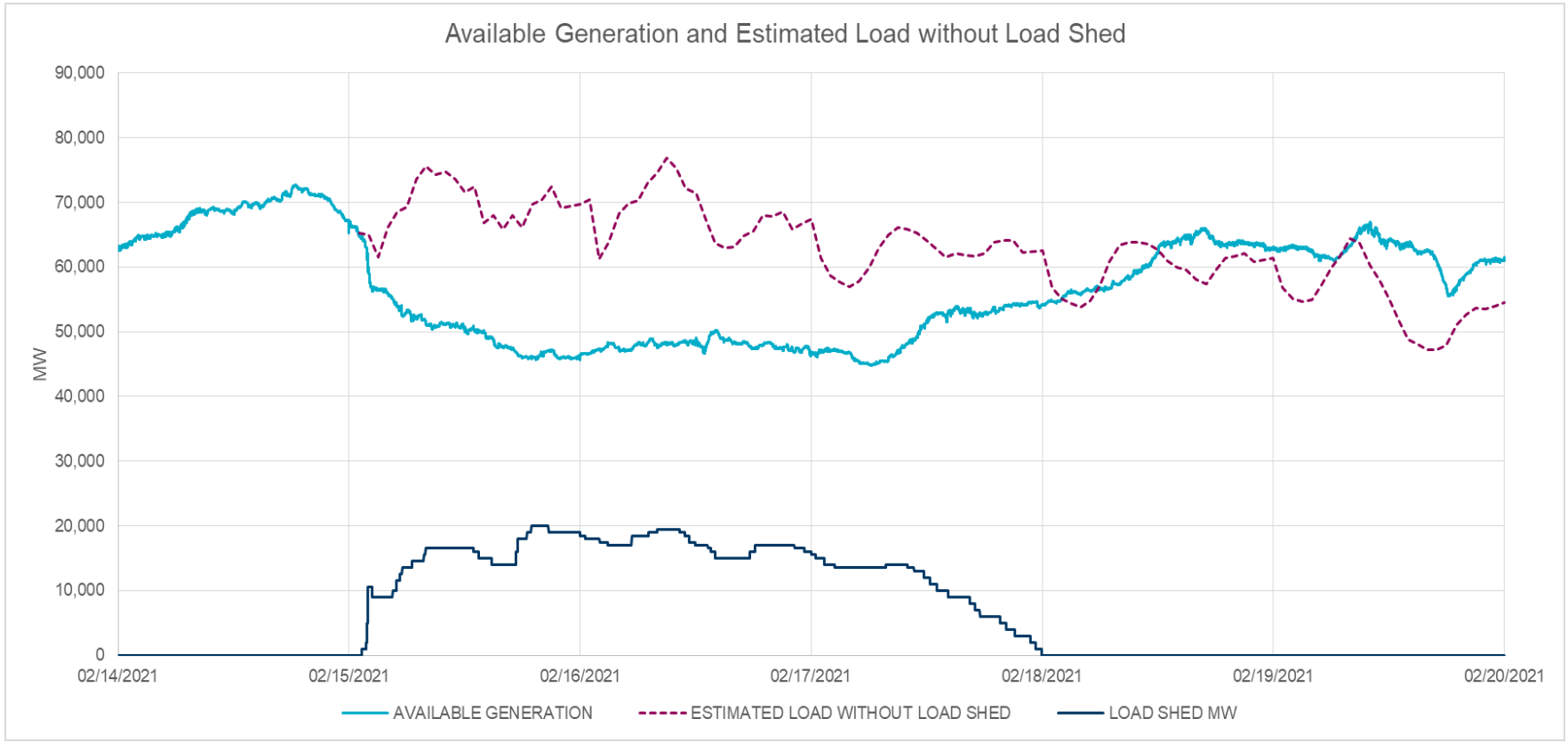


*Based on wind and solar max capacity

Version Date: 4/22/2021

Load shedding

- ERCOT directed as much as 20,000 MW of load shed during the event
- There was very little firm load left to rotate as most remaining was on UFLS or critical load circuits
- Firm load shed instructions remained in effect from 2/15 to 2/18 to be able to balance load with the available generation



System Recovery (Wednesday, February 17 – Friday, February 19)

Wednesday, February 17

- Moderating temperatures allowed reduction in controlled outages and a small net gain in generation
- Additional generation enabled reduction of load shed directives through the evening of February 17
- Load Forecasts for Thursday and Friday morning peaks raised concerns for the risk for the necessity of additional load shed directives
- Communication to coordinate restoration of load with Transmission Distribution Service Providers (TDSPs) and assess risks associated with residential and industrial load return to service
- 11:55 PM ERCOT issued instructions to TDSPs – load shed at 0 MW for first time since Monday, Feb. 15

Thursday, February 18

- Continued gain in generation
- Some outages remained due to ice storm damage; need for manual restoration and return of large industrial facilities
  - 12:42 a.m. Directed TDSPs to restore any remaining shed load

Friday, February 19 (all times approximate)

- 9 a.m. – Returned to emergency operations level 2
- 10 a.m. – Returned to emergency operations level 1
- 10:35 a.m. – Returned to normal operations

Questions?

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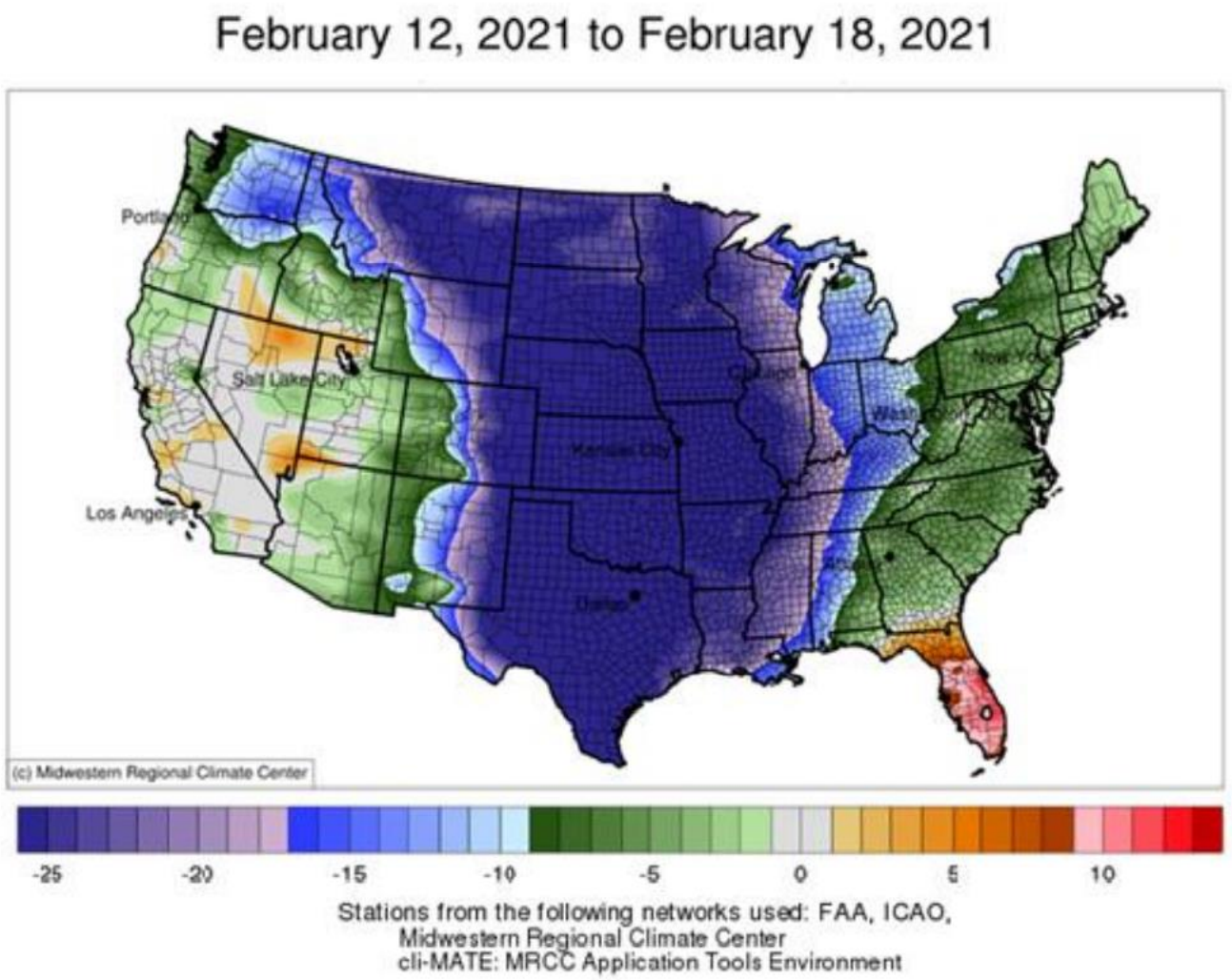
Ensuring electric reliability for Texans

NERC and Texas RE Activities

2021 Winter Weatherization Workshop

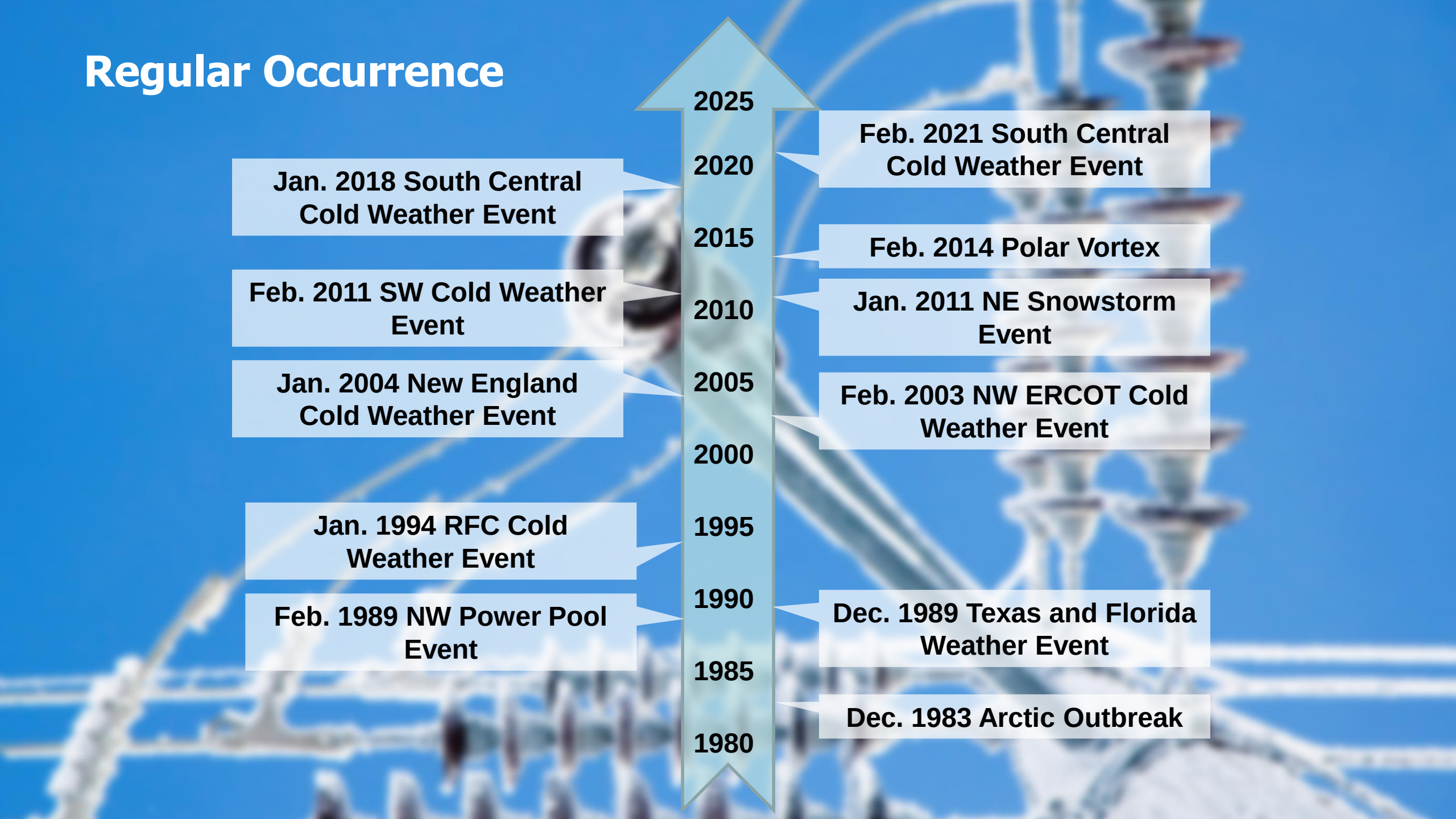
Mark Henry
Texas RE Reliability Services
September 30, 2021

Extreme Winter Conditions Across the South Central US



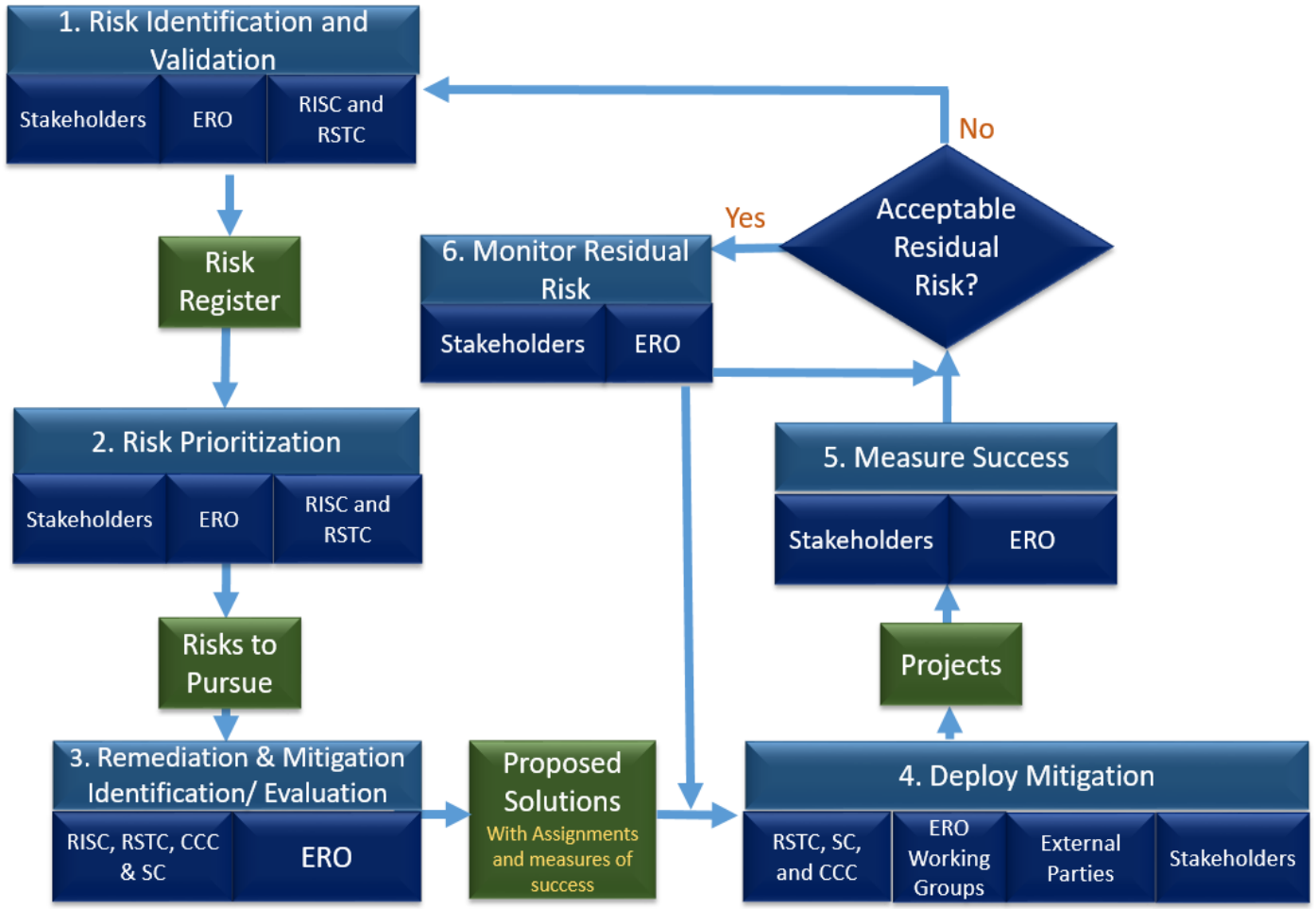
- Extreme demand
- Widespread generation outages
- Natural gas supply issues
- Huge Eastern Interconnection import power flows
- Firm load shed for transmission security and capacity adequacy

Regular Occurrence



NERC's Approach

- ERO concerned with cold weather risks for some time – use guidelines initially
- 2018 cold weather event spurs action for mandatory standards
- 2021 events and ERO/FERC Joint Inquiry providing valuable information
- Enhancements to Reliability Standards approved by FERC, but implementation periods will take up to 18 months



Electric Reliability Organization: Reliability Risk Mitigation Toolkit

Reliability Guideline

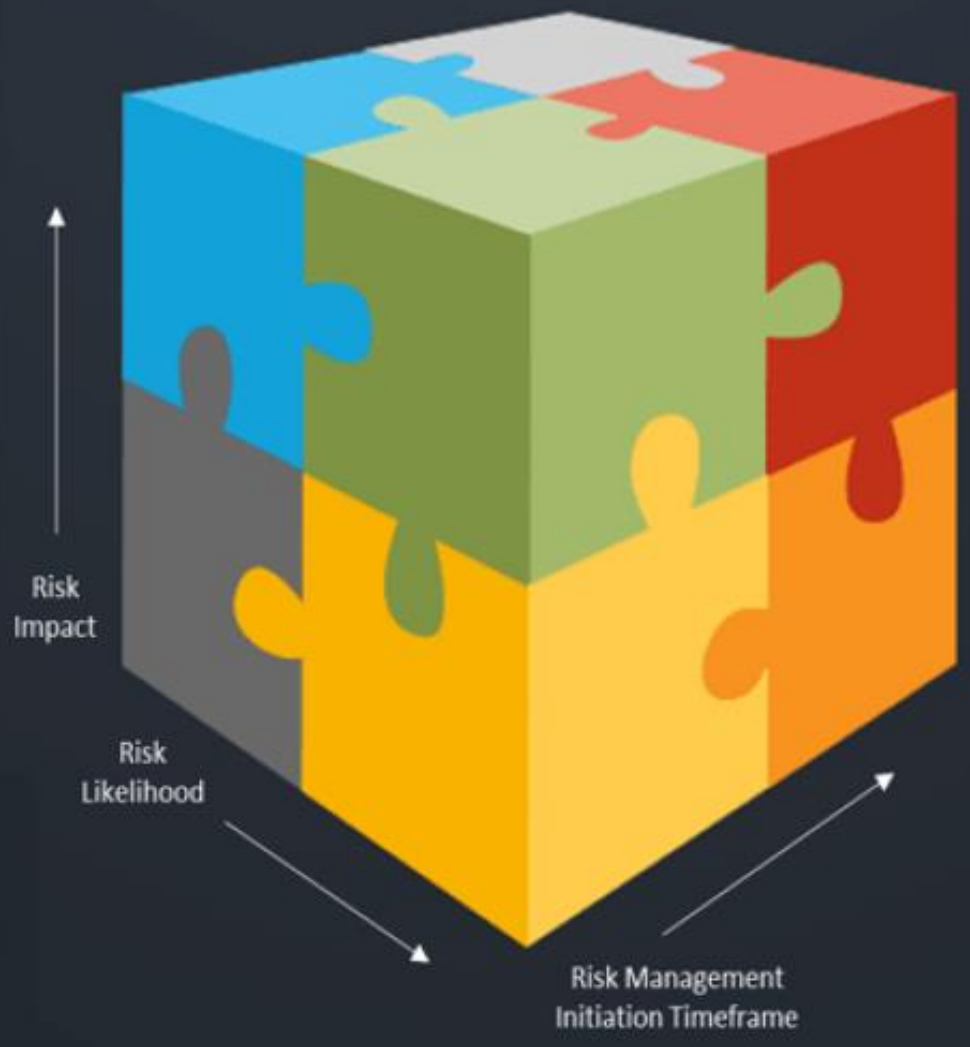
Suggested approaches or behavior in a given technical area for the purpose of improving reliability. Guidelines are not enforceable, but may be adopted by a responsible entity in accordance with its own policies, practices, and conditions.

NERC Alert: Level 2-3

NERC alerts are divided into three distinct levels, 1) Industry Advisory, 2) Recommendation to Industry, and 3) Essential Action, which identifies actions to be taken and require the industry to respond to the ERO.

Technical Engagement

Technical Engagement is a catch-all for a variety of technical activity that is conducted between the ERO and entities. This includes, technical committee activities, technical reference documents, workshops and conferences, assist visits, joint and special studies, etc.



Reliability Standards

NERC Reliability Standards define the mandatory reliability requirements for planning and operating the North American BPS and are developed using a results-based approach focusing on performance, risk management, and entity capabilities.

Reliability Assessment

NERC independently assesses and reports on the overall reliability, adequacy, and associated risks that could impact BPS reliability. Long-term assessments identify emerging reliability issues that support public policy input, improved planning and operations, and general public awareness.

NERC Alert: Level 1

NERC Alerts are divided into three distinct levels, 1) Industry Advisory, 2) Recommendation to Industry, and 3) Essential Action, which identifies actions to be taken and require the industry to respond to the ERO.

ERO FERC Joint Inquiry

On 2/16/2021, FERC and NERC announced a joint inquiry into the operations of the Bulk-Power System during the extreme winter weather conditions experienced by the Midwest and Southern Central states

Nearly 50 subject matter experts from FERC, NERC, and all six Regional Entities

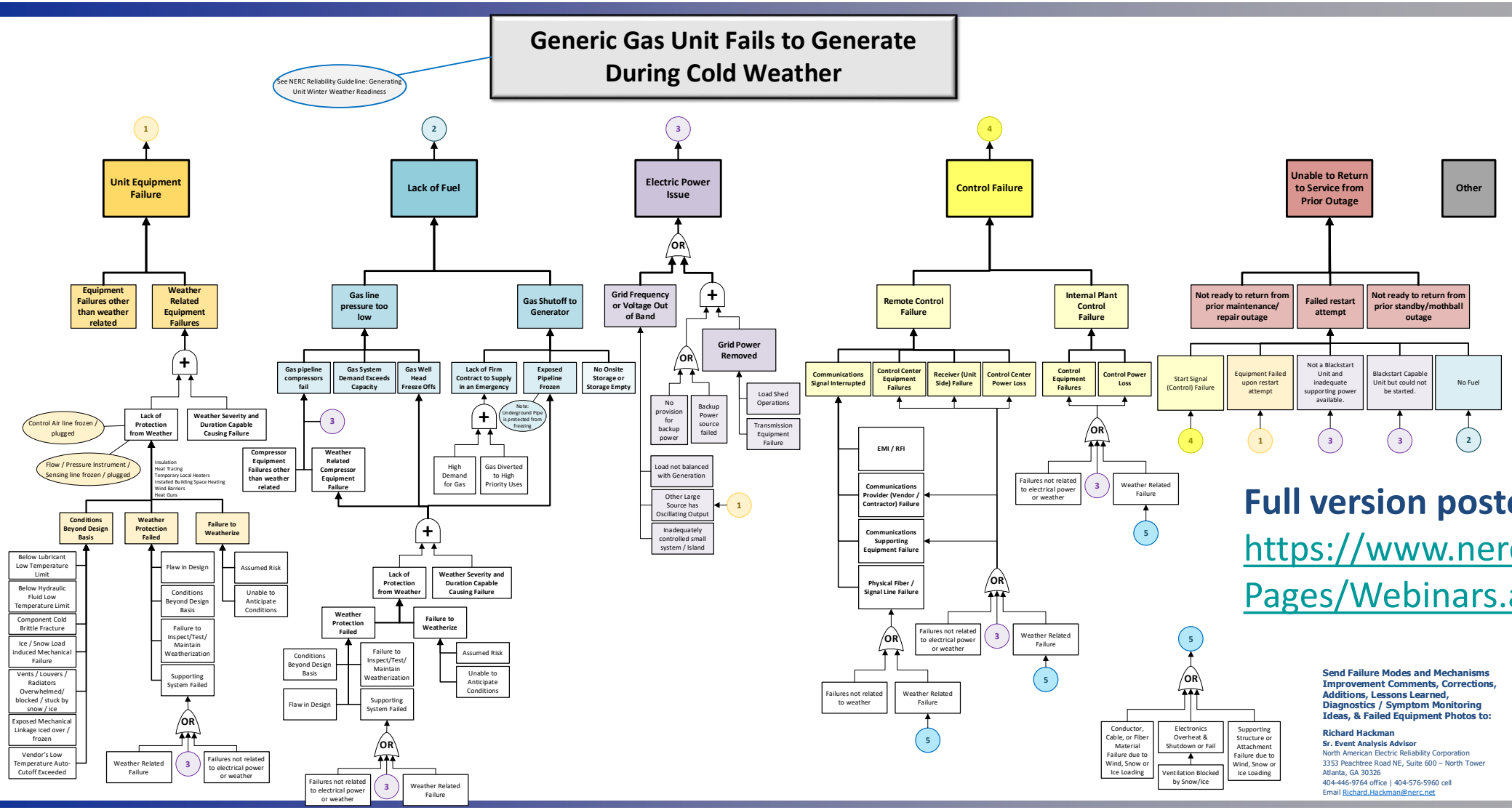
Data requests issued to RTO/ISOs and entities in southern parts of SPP and MISO as well as ERCOT entities and natural gas producers, processors, and pipelines

Preliminary Findings and Recommendations released at FERC Open Meeting on September 23rd

Final report anticipated late November 2021

Failure Modes and Mechanisms for Conventional Generation

Technical Engagement



Full version posted at:
https://www.nerc.com/pa/rrm/Pages/Webinars.aspx

Send Failure Modes and Mechanisms Improvement Comments, Corrections, Additions, Lessons Learned, Diagnostics / Symptom Monitoring Ideas, & Failed Equipment Photos to:

Richard Hackman
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North American Electric Reliability Corporation
3353 Peachtree Road NE, Suite 600 – North Tower
Atlanta, GA 30326
404-446-9764 office | 404-576-5960 cell
Email Richard.Hackman@nerc.net

Past Event Analysis and Lessons Learned

Technical Engagement

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

NERC Information Resources on Cold Weather Preparation and BPS Impacts

(as of 2/11/2021)

NERC has been collecting and sharing information on cold weather preparation and BPS impacts for years via Webinars, Special Reports, Lessons Learned, Failure Modes & Mechanisms, and other resources.

Version 3 of the Generating Unit Winter Weather Readiness Reliability Guideline was approved by the RSTC at the end of 2020. The changes between versions 2 and 3 were discussed in the 2020 Winter Weather Webinar.

Here are links to some cold weather resources:

Reports on major BPS-impacting Cold Weather events

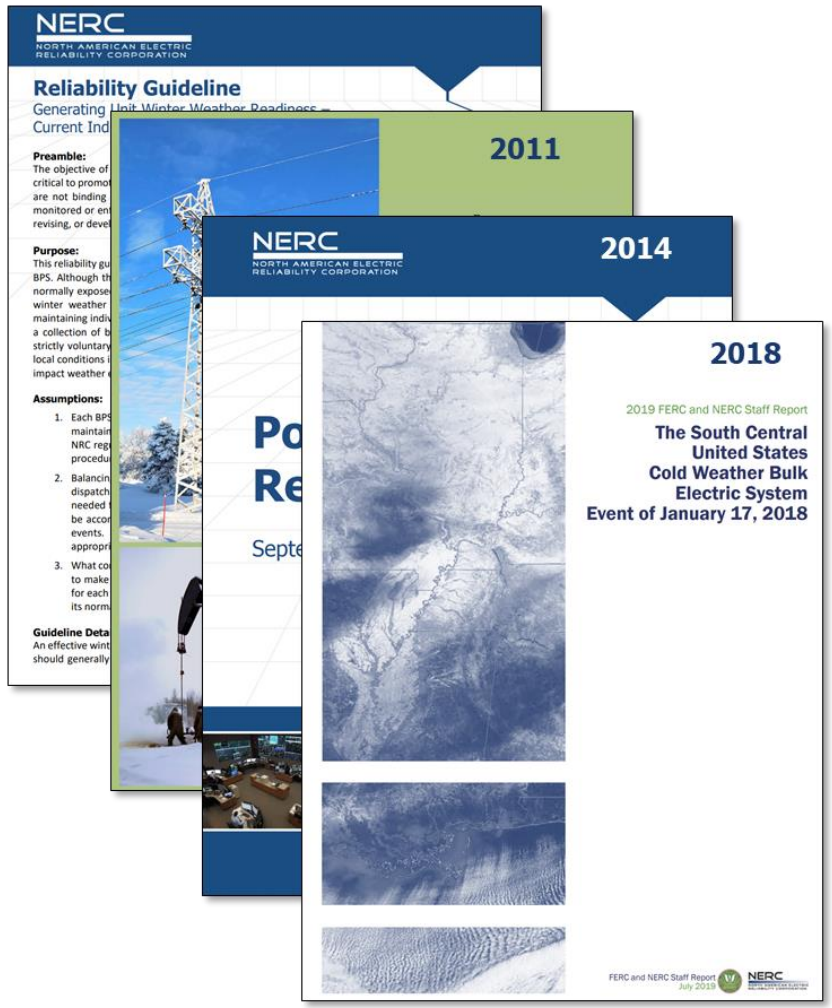
- Outages and Curtailments during the Southwest Cold Weather Event of February 1-5, 2011
- Winter Weather Readiness for Texas Generators, (2011)
- January 2014 Polar Vortex Review
- The South Central United States Cold Weather Bulk Electric System Event of January 17, 2018 (There are a number of 'sound practices' from the industry, starting on page 100.)
- Other Cold Weather Reports and Training Materials can be found on this site.

Cold weather related Lessons Learned:

- LL20110902 Adequate Maintenance and Inspection of Generator Freeze Protection
- LL20110903 Generating Unit Temperature Design Parameters and Extreme Winter Conditions
- LL20111001 Plant Instrument & Sensing Equipment Freezing Due to Heat Trace & Insulation Failures
- LL20120101 Plant Onsite Material and Personnel Needed for a Winter Weather Event
- LL20120102 Plant Operator Training to Prepare for a Winter Weather Event
- LL20120103 Transmission Facilities and Winter Weather Operations
- LL20120901 Wind Farm Winter Storm Issues
- LL20120902 Transformer Oil Level Issues During Cold Weather
- LL20120903 Winter Storm Inlet Air Duct Icing
- LL20120904 Capacity Awareness During an Energy Emergency Event
- LL20120905 Gas and Electricity Interdependency
- LL20180702 Preparing Circuit Breakers for Operation in Cold Weather (also 2018 Webinar w/FMM)
- LL20200601 Unanticipated Wind Generation Cutoffs during a Cold Weather Event
- LL20201101 Cold Weather Operation of SF6 Circuit Breakers

Winter Weather Webinars from 2012 – 2020 can be found on this site.

Annual Winter Reliability Assessments 2003/2004 thru 2019/2020 can be found on this site.



NERC Energy Assurance Reliability Guidelines

	RG-ENA-0320-1	Reliability Guideline: Fuel Assurance and Fuel-Related Reliability Risk Analysis	3/12/2020
	RG-ENA-0621-2	Reliability Guideline: Gas and Electrical Operational Coordination Considerations	6/8/2021
	RG-ENA-1212-3	Reliability Guideline: Generating Unit Winter Weather Readiness	12/15/2020

Latest Update to Gas and Electrical Operational Coordination Considerations:

Establish Gas and Electric Industry Coordination Mechanisms	**Preparation, Supply Rights, Training, and Testing**	**Establish and Maintain Communication Channels**	**Gathering, Sharing Information and Situational Awareness**

Finding NERC Reliability Guidelines

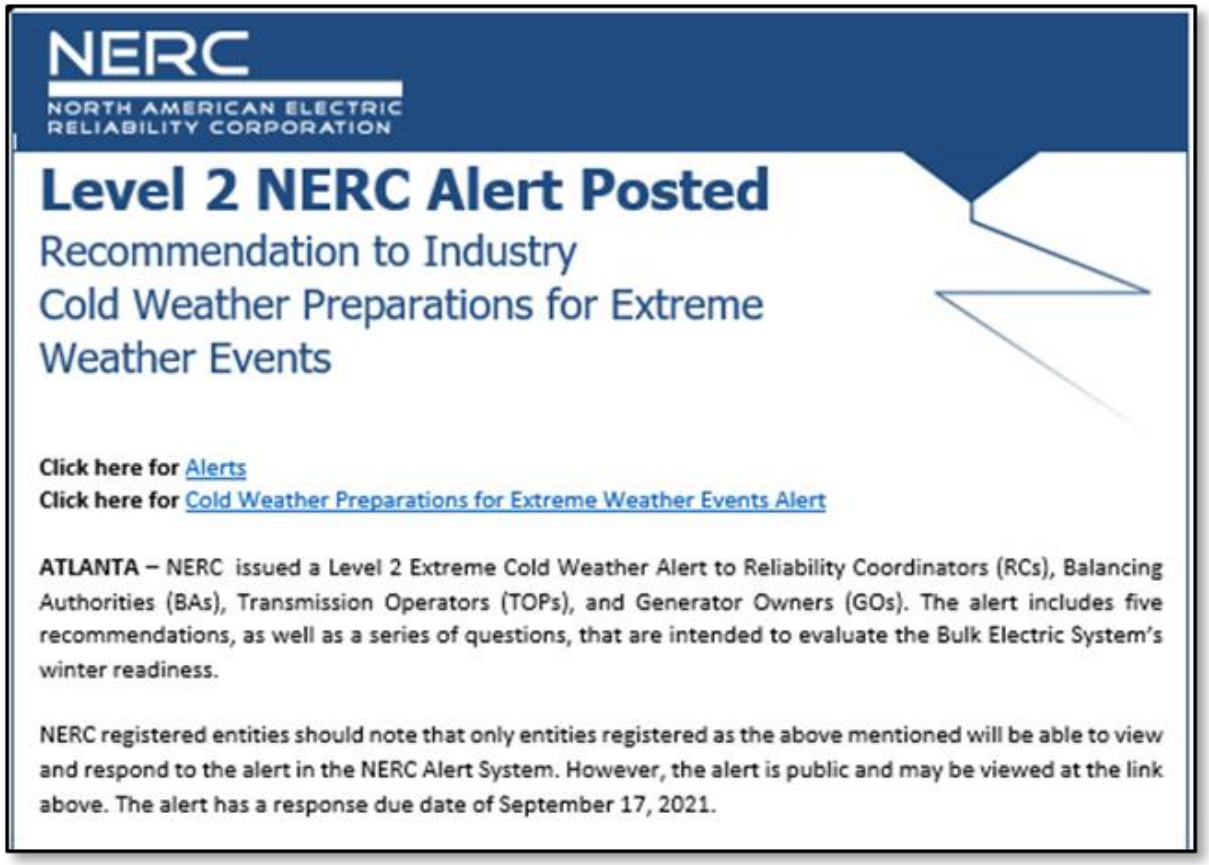
- The NERC stakeholder Reliability and Security Technical Committee (RSTC) web page has links to this and other Reliability Guidelines

- Reliability and Security Guidelines and Technical Reference Documents

- https://www.nerc.com/comm/Pages/Reliability-and-Security-Guidelines.aspx
- Over 30 Reliability Guidelines on Balancing, Energy Assurance, Operations, Protection and Control, Resource Performance, Transmission Planning, and Security

NERC Alert on Cold Weather Preparedness

NERC Alert: Level 2-3



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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Level 2 NERC Alert Posted

Recommendation to Industry
Cold Weather Preparations for Extreme Weather Events

Click here for Alerts
Click here for Cold Weather Preparations for Extreme Weather Events Alert

ATLANTA – NERC issued a Level 2 Extreme Cold Weather Alert to Reliability Coordinators (RCs), Balancing Authorities (BAs), Transmission Operators (TOPs), and Generator Owners (GOs). The alert includes five recommendations, as well as a series of questions, that are intended to evaluate the Bulk Electric System's winter readiness.

NERC registered entities should note that only entities registered as the above mentioned will be able to view and respond to the alert in the NERC Alert System. However, the alert is public and may be viewed at the link above. The alert has a response due date of September 17, 2021.

Questions included in the alert for RC, BA, TOP, and GO functions.

Five recommendations to industry to better prepare for possible extreme cold

"The recent extreme cold weather events across large portions of North America have highlighted the need to assess current operating practices and identify some recommended improvements, so that system operations personnel are better prepared to address these challenges. "

NERC Alert – Generator Owner Recommendation #2

NERC Alert: Level 2-3

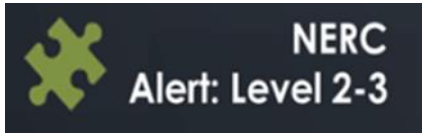
Review RC/BA/TOP winter seasonal operating plans to ensure they contain the current generator availability, fuel supplies, and other related assumptions.

Act as appropriate based on weather forecasts, resulting capacity, and energy analyses to facilitate readiness.

Allow for adjustments to maximize resource availability, including replenishment of fuel, supplies, labor, and equipment.

Maintain communications with fuel suppliers and be prepared for fuel switching if capable.

NERC Alert – Generator Owner Recommendation #3

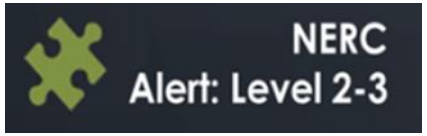


Communicate to their RCs, BAs, and TOPs, forecast and actual unit de-rates during extreme cold weather events and conditions considering

- Unavailability due to weather
- Fuel constraints (gas restrictions)
- De-rates for alternate fuels
- Potential concerns with increased outages or delayed starts based on unit ambient ratings and historical performance

Part of seasonal, outage coordination, day-ahead, and real-time energy assessments

NERC Alert – Generator Owner Recommendation #5



Conduct dual fuel assessments to ensure resources can switch to the alternate fuel and monitor how much alternate fuel is on site

Assess generating unit weatherization plans, the implementation of freeze protection measures and factors that could impact availability including

- Minimum operating temperature
- Application of heat tracing equipment
- Wind breaks

Inspect and maintain generation facility weatherization measures

- Ahead of the upcoming winter season
- Before the onset of extreme cold weather conditions
- During such conditions

NERC Winter Reliability Assessment (WRA)

Reliability Assessment

Examines potential regional resource deficiencies and operating reliability concerns

Developed with subject matter experts from each assessment area and reviewed by stakeholders

Deterministic scenario analysis

- Expected (average) conditions
- Extreme conditions based on a scenario event (e.g., polar vortex scenario)
- Identify high-risk period—not necessarily peak demand hour

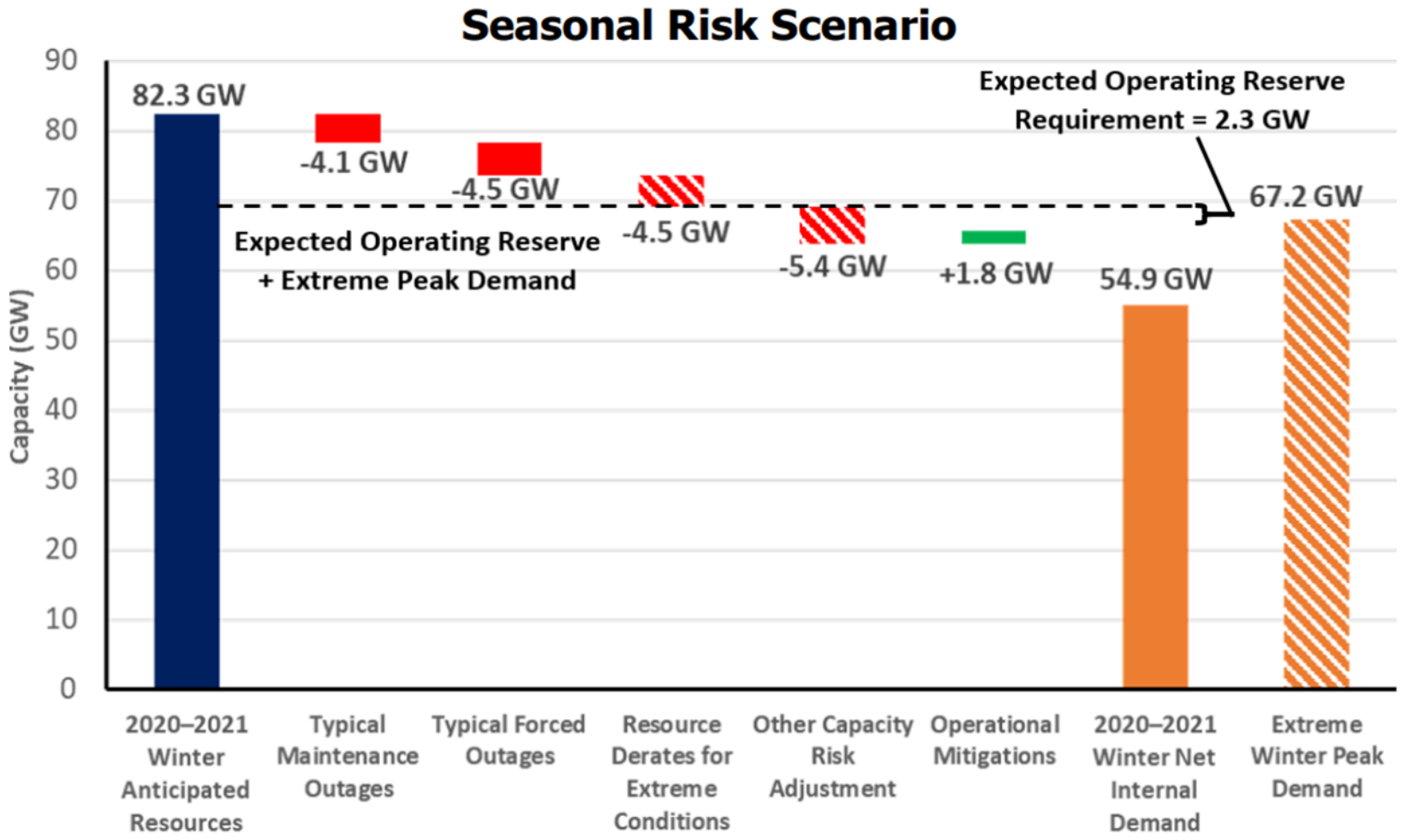
Probability-based risk analysis

- Probabilistic measures could include expected unserved energy or load-loss hours

Insights from NERC Level 2 Alert

2020-21 NERC WRA - ERCOT/Texas RE Waterfall Chart

Reliability Assessment



Source: NERC

NERC Cold Weather Reliability Standard

Current (FERC-approved)

EOP-011-2

TOP and BA emergency plans – add cold weather conditions impacts

GO cold weather preparation plans

- Appropriate freeze protection measures (self determined)
- Annual inspection
- Know operating limits
- Awareness training on plans

IRO-010-4 and TOP-003-5

RC and TOP data specifications to include requesting operating limits

Future direction:

- Implement recommended actions from FERC/NERC inquiry
- Standard for RC and/or BA seasonal emergency energy management plans
- RC standard for rolling three week emergency energy management plan

New EOP-011-2 Requirement R7

Reliability Standards

R7. Each Generator Owner shall implement and maintain one or more cold weather preparedness plan(s) for its generating units. The cold weather preparedness plan(s) shall include the following, at a minimum: [Violation Risk Factor: High] [Time Horizon: Operations Planning and Real-Time Operations]

- 7.1. Generating unit(s) freeze protection measures based on geographical location and plant configuration;
- 7.2. Annual inspection and maintenance of generating unit(s) freeze protection measures;
- 7.3. Generating unit(s) cold weather data, to include:
  - 7.3.1. Generating unit(s) operating limitations in cold weather to include:
    - 7.3.1.1. capability and availability;
    - 7.3.1.2. fuel supply and inventory concerns;
    - 7.3.1.3. fuel switching capabilities; and
    - 7.3.1.4. environmental constraints.
  - 7.3.2. Generating unit(s) minimum:
    - 7.3.2.1. design temperature; or
    - 7.3.2.2. historical operating temperature; or
    - 7.3.1.3. current cold weather performance temperature determined by an engineering analysis.

M7. Each Generator Owner will have evidence documenting that its cold weather preparedness plan(s) was implemented and maintained in accordance with Requirement R7.

New EOP-011-2 Requirement R8

R8. Each Generator Owner in conjunction with its Generator Operator shall identify the entity responsible for providing the generating unit-specific training, and that identified entity shall provide the training to its maintenance or operations personnel responsible for implementing cold weather preparedness plan(s) developed pursuant to Requirement R7. [Violation Risk Factor: Medium] [Time Horizon: Long-term Planning, Operations Planning]

M8. Each Generator Operator or Generator Owner will have documented evidence that the applicable personnel completed training of the Generator Owner's cold weather preparedness plan(s). This evidence may include, but is not limited to, documents such as personnel training records, training materials, date of training, agendas or learning objectives, attendance at pre-work briefings, review of work order tasks, tailboards, attendance logs for classroom training, and completion records for computer-based training in fulfillment of Requirement R8.

Texas RE Winterization Activities

Outreach Activities

- Overview of the Cold Weather standards held on July 8, 2021
- Targeted outreach with Generation Owners to discuss weatherization preparations on August 23, 2021
- Annual Winter Weatherization Workshop
- Future outreach regarding Joint Inquiry findings, lessons learned, and best practices identified
- Targeted outreach with key stakeholders to discuss ongoing preparations, key focus areas, and implementation challenges (including site visits)

Support development of possible enhancements to the NERC Cold Weather Standards based on FERC directives or recommendations

Support for NERC and industry's efforts to develop Compliance Guidance to implement the Cold Weather Standards. (Preliminary information: Common Engagement Questions)

Compliance and Enforcement activities as appropriate

Questions?

BUILDING A WORLD OF DIFFERENCE

30 September 2021

WINTER WEATHER HARDENING

An Overview of Freeze Protection Evaluation and Discussion on Potential Hardening Opportunities for Generation Facilities

Mark Dittus
Technology Manager
DittusM@bv.com
913-458-7133

BLACK & VEATCH
Building a world of difference.®

GOAL OF WINTERIZATION HARDENING

Where We Need to Be – Updated Design Criteria

- System improvement projects
- Maintenance projects to restore freeze protection
- O&M Improvements

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WHERE ARE WE NOW / WHERE DO WE WANT TO BE

- **Understand the original design criteria**
- **Determine revised freeze protection criteria**
  - Recommended design low temperature
  - Time duration of freeze event
  - Coincident wind speed
- **Identify areas of concern**
- **Confirm installation**
- **Determine what is needed**

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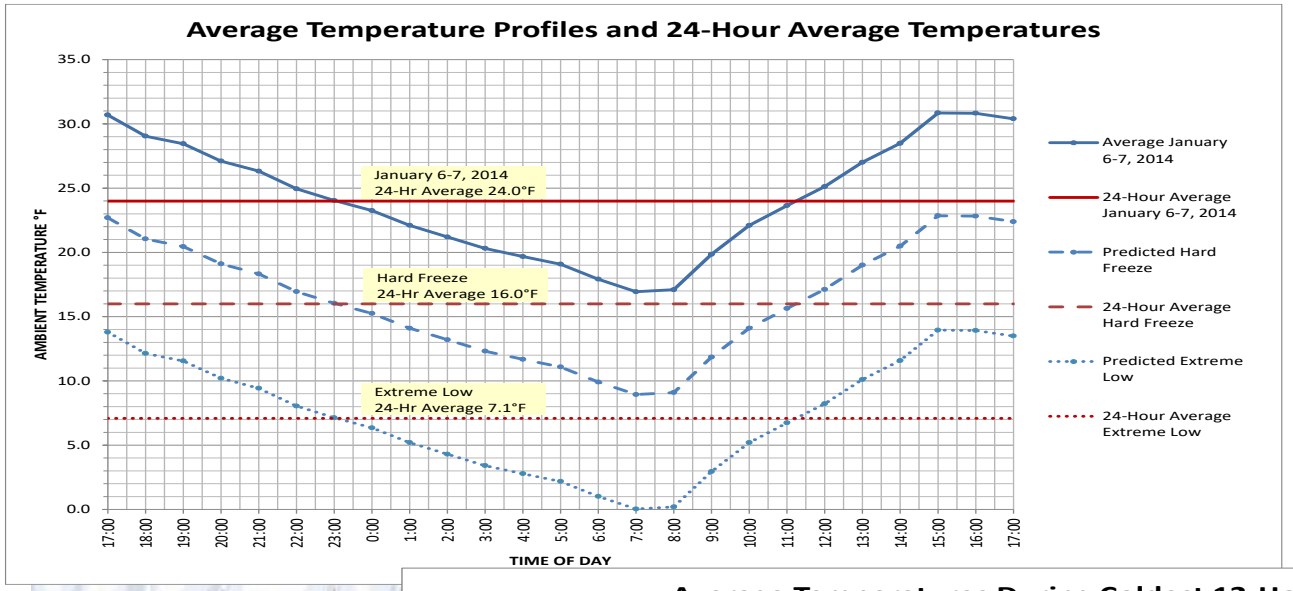
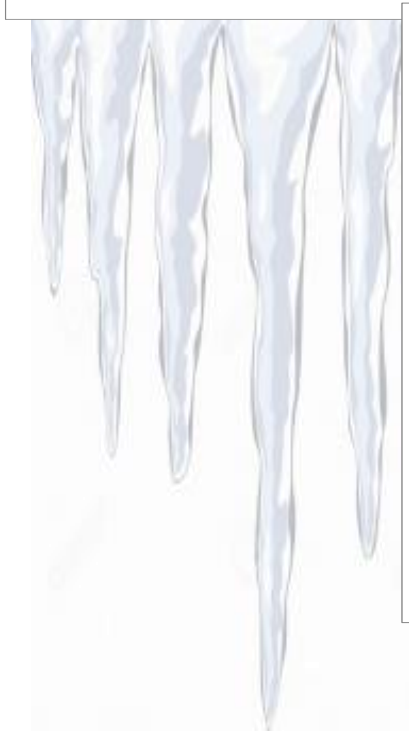
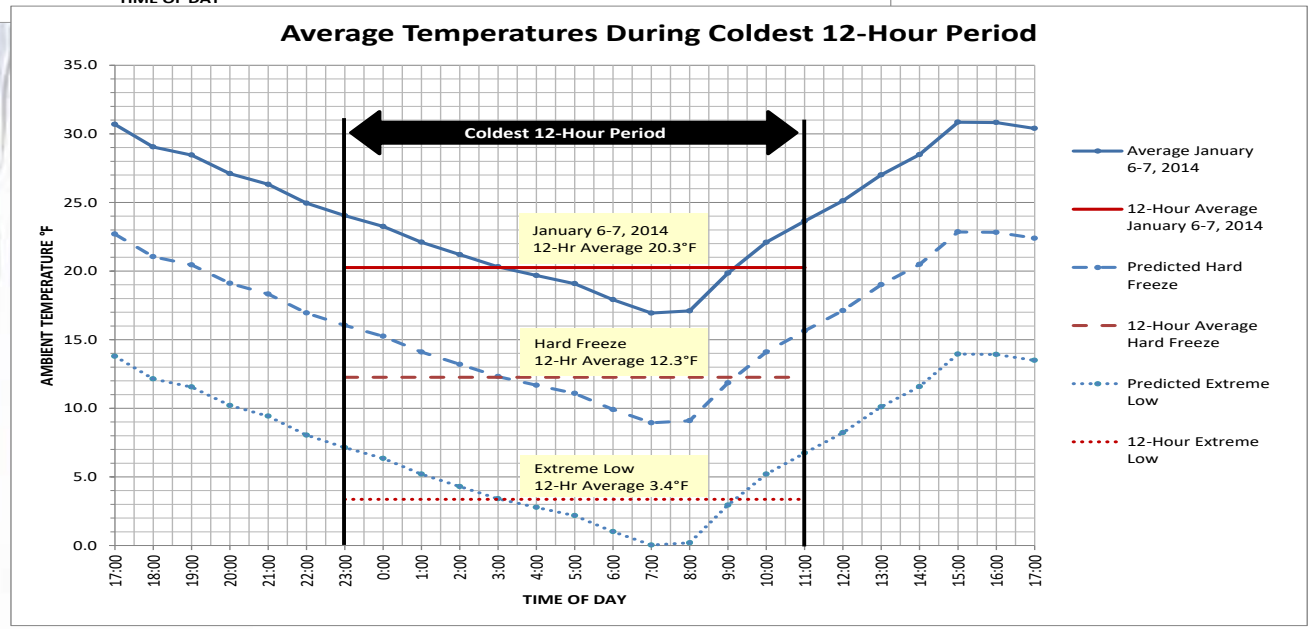


Predicted curves for the Hard Freeze and Extreme Low Temperature Event are based on the historical low trend shifted (offset) downward to yield 16^F for 24-hour average and 0^F peak low.





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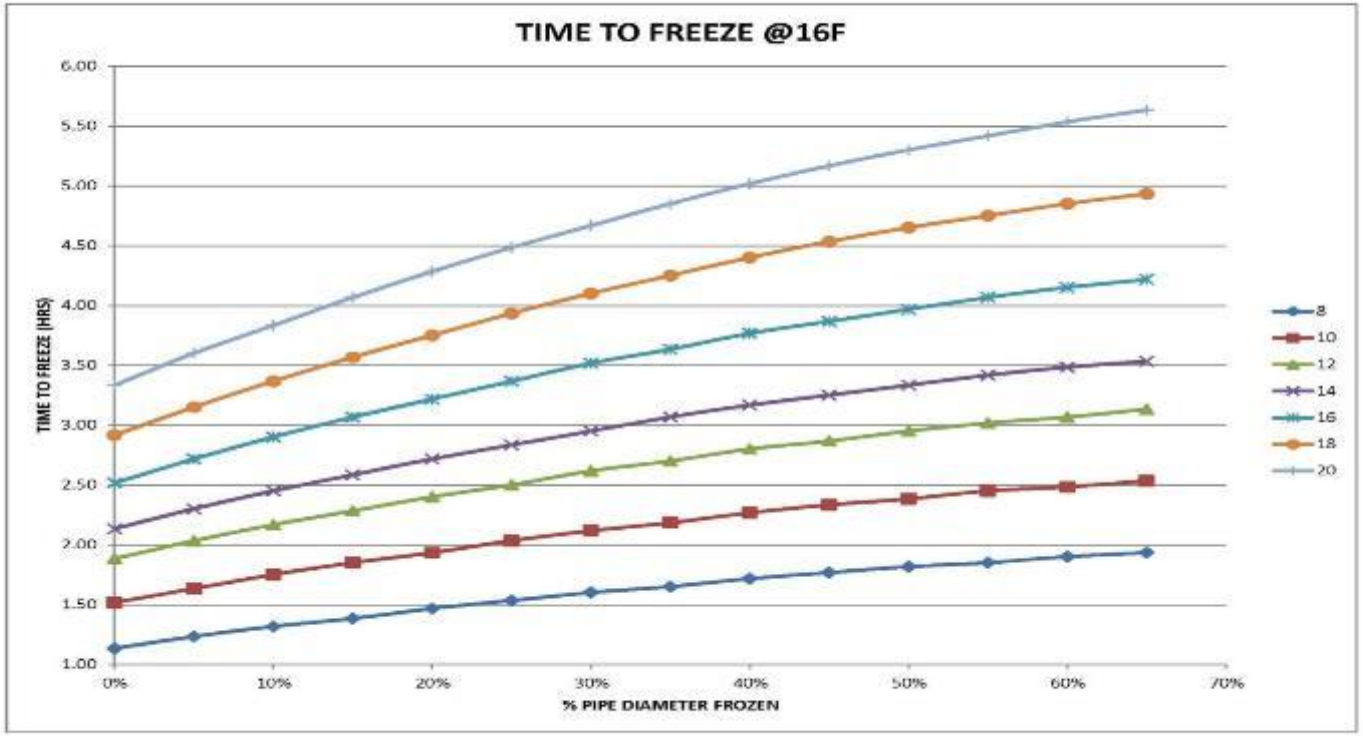
TIME TO FREEZE CALCULATIONS



Initial Freeze Times with Increase Fluid Start Temperatures

At 16F with 10 mph wind	Hrs to 10% Freeze						
Nominal Pipe Diameter, inches	40F	50F	60F	70F	80F	90F	100F
8	1.3	2.3	3.0	3.6	4.0	4.4	4.7
10	1.8	3.0	4.0	4.7	5.3	5.9	6.3
12	2.2	3.8	5.0	5.9	6.6	7.3	7.8
14	2.5	4.3	5.6	6.6	7.5	8.2	8.8
16	2.9	5.1	6.6	7.9	8.9	9.7	10.5
18	3.4	5.9	7.7	9.1	10.3	11.3	12.1
20	3.8	6.7	8.8	10.4	11.7	12.9	13.9

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EXAMPLE DESIGN CRITERIA MATRIX

Uninsulated Pipe								
Critical Sensing	Pipe Diameter (Inches)							
	<1.0	1.0	1.5	2.0	2.5	3.0	4.0	6.0-20.0*
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x

1.5-Inch Insulation								
Critical Sensing	Pipe Diameter (Inches)							
	<1.0	1.0	1.5	2.0	2.5	3.0	4.0	6.0-20.0*
HT	HT	HT	HT	HT	HT	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	HT	✓	✓	✓	✓	✓
HT	HT	HT	HT	✓	✓	✓	✓	✓
HT	HT	HT	HT	HT	HT	✓	✓	✓
HT	✓	✓	✓	✓	✓	✓	✓	✓
HT	HT	HT	HT	✓	✓	✓	✓	✓
HT	HT	HT	HT	HT	✓	✓	✓	✓
HT	HT	HT	HT	✓	✓	✓	✓	✓

2.0-Inch Insulation								
Critical Sensing	Pipe Diameter (Inches)							
	<1.0	1.0	1.5	2.0	2.5	3.0	4.0	6.0-20.0*
HT	HT	HT	HT	HT	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	HT	HT	✓	✓	✓	✓
HT	✓	✓	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	HT	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓

3.0-Inch Insulation								
Critical Sensing	Pipe Diameter (Inches)							
	<1.0	1.0	1.5	2.0	2.5	3.0	4.0	6.0-20.0*
HT	HT	HT	HT	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	HT	✓	✓	✓	✓	✓
HT	✓	✓	✓	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓
HT	HT	HT	HT	✓	✓	✓	✓	✓
HT	HT	HT	✓	✓	✓	✓	✓	✓

Symbology	
x	Pipe diameter fails the freeze assessment
HT	Heat trace required under all pipe insulation thickness scenarios for the given pipe diameter.
HT	Heat trace required for the given pipe diameter under the insulation thickness scenario.
✓	Pipe diameter passes the freezing analysis under all insulation thickness scenarios.
✓	Pipe diameter passes the freezing analysis at given insulation thickness after not passing in thinner insulation thickness scenario(s).

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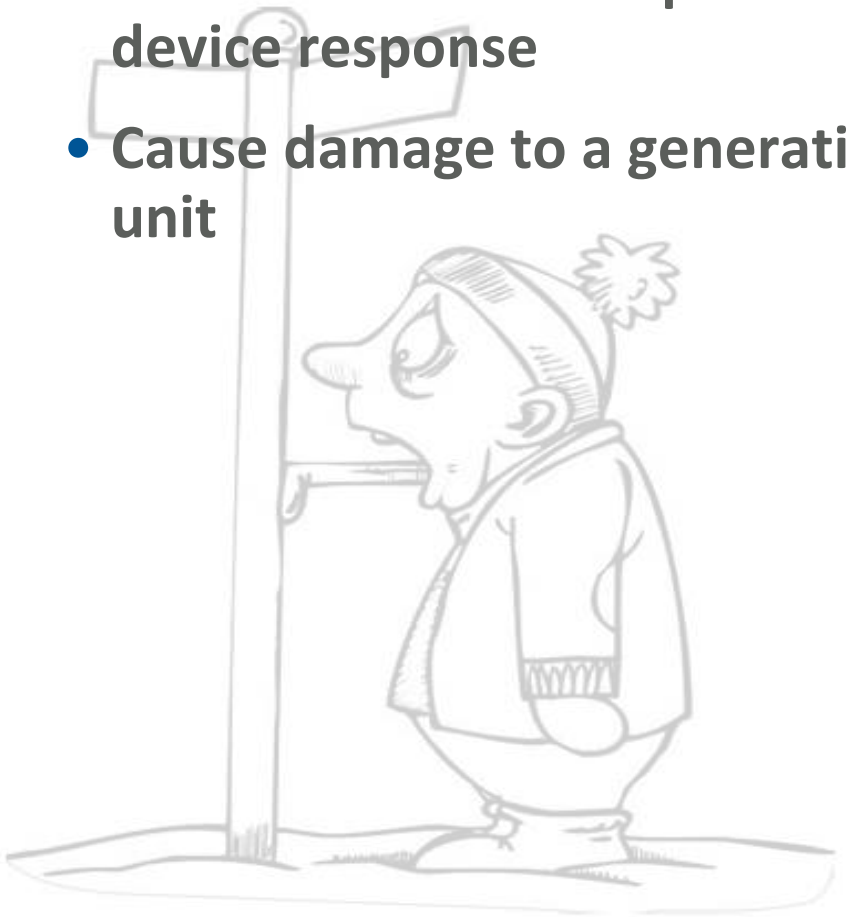
CRITICAL SYSTEM FUNCTIONS – POTENTIAL OPERATIONAL CONCERNS

- Create a weather-related safety hazard
- Cause unit trip
- Impact unit start-up
- Cause unit runback schemes and/or partial outages
- Adversely affect environmental controls
- Cause a slower or impaired device response
- Cause damage to a generating unit



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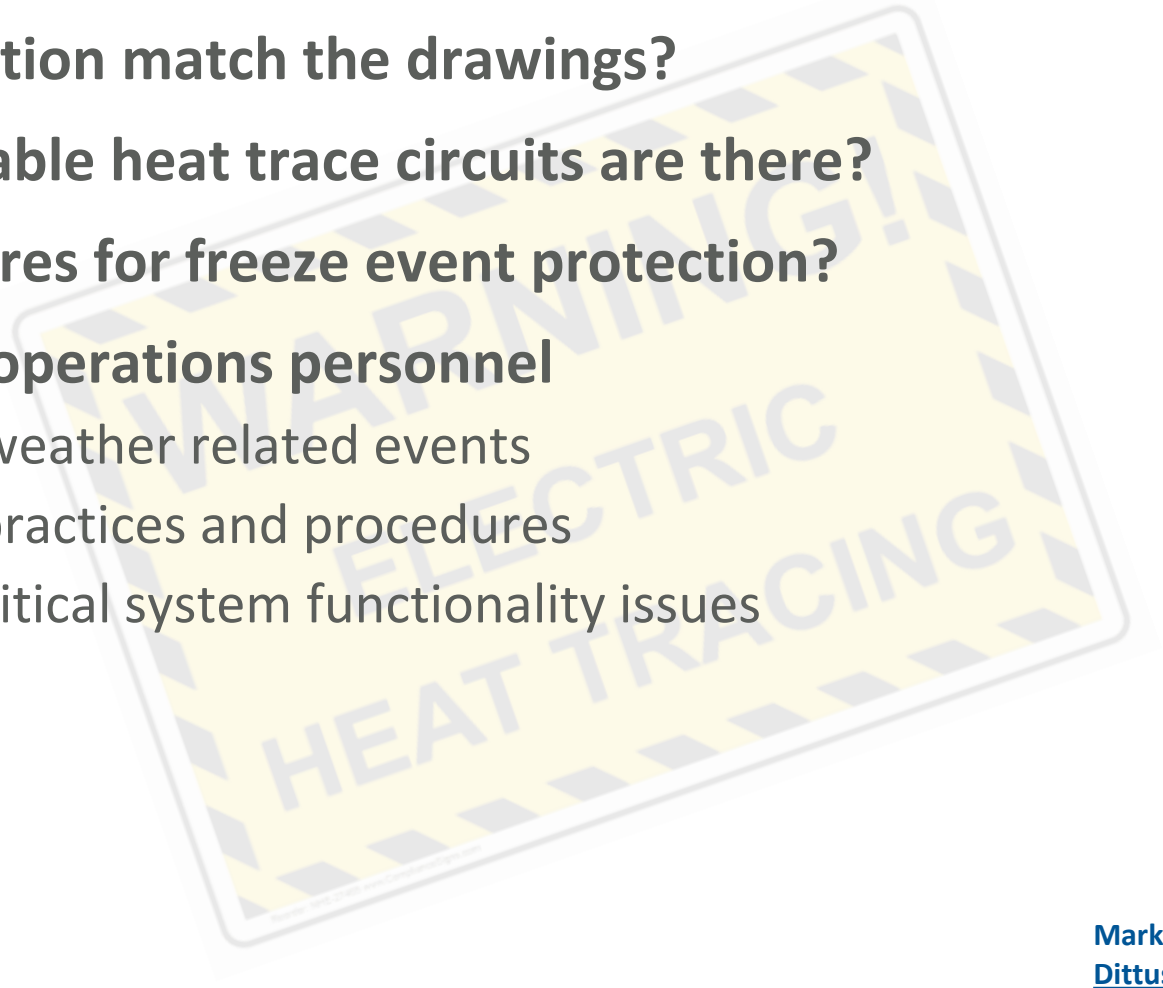
ITEMS OBSERVED DURING SITE VISITS

- Condition of existing heat tracing and insulation
- Does the installation match the drawings?
- How many available heat trace circuits are there?
- Written procedures for freeze event protection?
- Interviews with operations personnel
  - Recent winter weather related events
  - General O&M practices and procedures
  - Discussion of critical system functionality issues



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OPPORTUNITIES FOR IMPROVEMENT

WINTER WEATHER HARDENING

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REVIEW MATRIX SAMPLE

SITE OBSERVATION						OBSERVATION CATEGORY (Check one)				
NO.	OBSERVATION	SYSTEM	SERVICE	MEETS PLANT FREEZE PROTECTION CRITERIA? (Y/N)	SOURCE OF DATA (V=Visual, C=Calculated, D=Drawing, R=Reported by PowerSouth)	HEAT TRACING OF PIPING SYSTEMS	HEAT TRACING OF INSTRUMENTS	INSULATION & LAGGING	HEAT TRACING CONTROLS / MONITORING	OTHER COLD WEATHER REPORTED AND OBSERVED PROBLEMS
1	Turbine basement has no space heating. Several exterior doors need repairs to ensure proper shut. Exterior wall louvers are nonoperational and need freeing. Siding in general is in good condition; however, several through wall exterior penetrations need to be addressed. (See photos LOWMAN1, LOWMAN2)	Building Enclosure	Turbine Basement	N	V					X

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REVIEW MATRIX SAMPLE

	ACTION ITEM CATEGORY (Check one)						
RECOMMENDED ACTION ITEMS	**CRITICAL**			**NON-CRITICAL**		**PROJECT ESTIMATED COST & SCHEDULE**	
(INCLUDES REPAIRS TO EXISTING FREEZE PROTECTION SYSTEMS, RECOMMENDED NEW ADDITIONS, AND CHANGES / ADDITIONS TO PLANT OPERATING AND PREVENTATIVE MAINTENANCE PROCEDURES)	**RESTORATION / REPAIR OF EXISTING NON-FUNCTIONAL FREEZE PROTECTION SYSTEM**	**NEW FREEZE PROTECTION SYSTEMS TO BE ADDED (CRITICAL)**	**OPERATING OR PM PROCEDURAL CHANGES AND ADDITIONS**	**NEW FREEZE PROTECTION SYSTEMS TO BE ADDED (NON-CRITICAL)**	**OPTIONAL UPGRADE PROJECTS**	**ESTIMATED COST**	**ESTIMATED SCHEDULE DURATION (MONTHS)**
Doors and wall louvers need to be repaired. The exterior wall penetrations should be addressed with well fitted panels.	X					O&M	--

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PATH FORWARD

- Use Review Matrix to prioritize repairs and new installations
- Use temporary procedures until permanent solutions can be implemented (portable heaters, draining of lines)
- Continued emphasis to improve the operating, maintenance, and PM procedures for reliability and longevity

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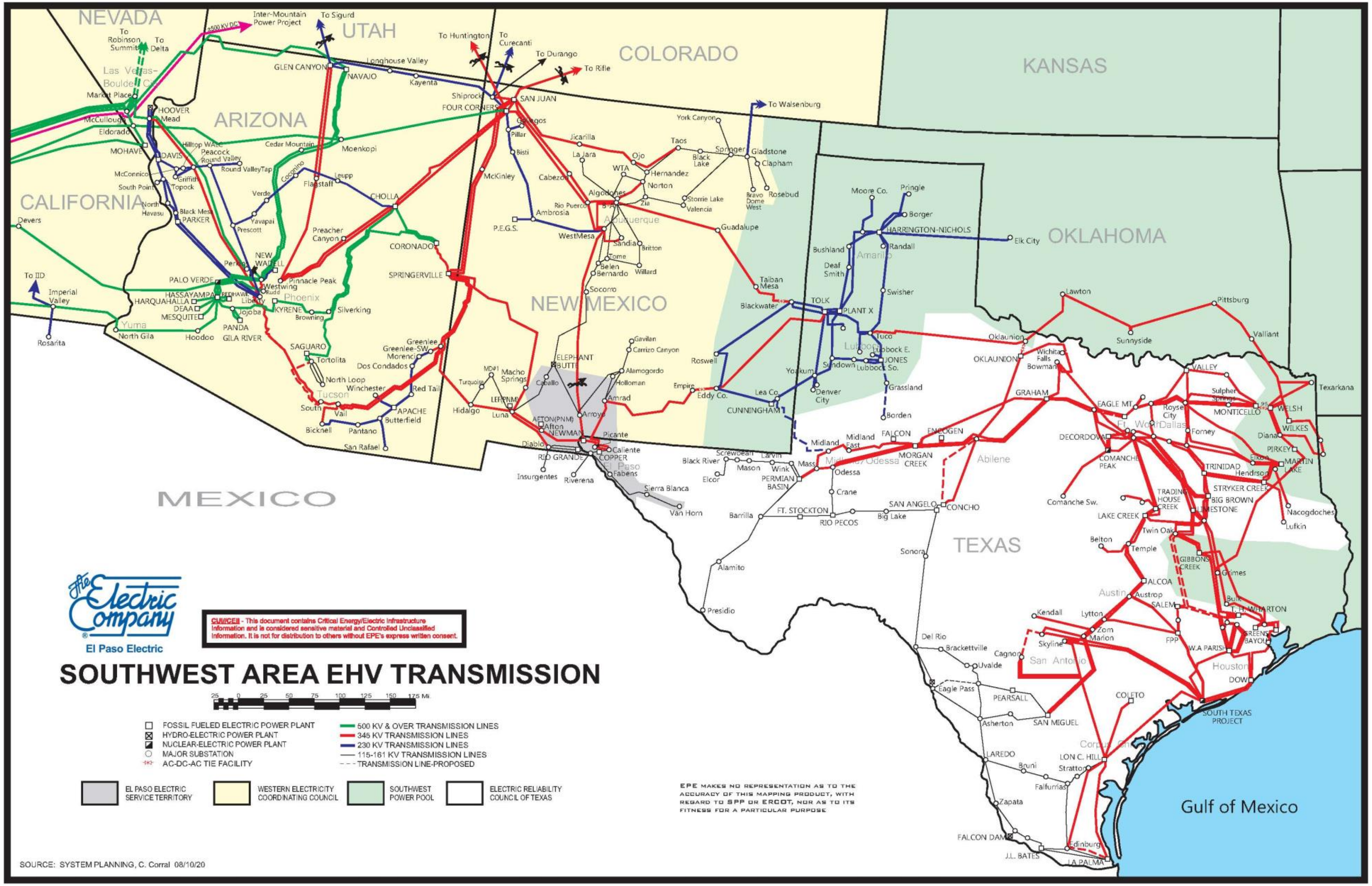
El Paso Electric

Two Severe Freeze Events

Two Different Stories


SOUTHWEST AREA EHV TRANSMISSION
El Paso Electric
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FOSSIL FUELED ELECTRIC POWER PLANT
HYDRO-ELECTRIC POWER PLANT
NUCLEAR-ELECTRIC POWER PLANT
MAJOR SUBSTATION
AC-DC-AC TIE FACILITY
500 KV & OVER TRANSMISSION LINES
345 KV TRANSMISSION LINES
230 KV TRANSMISSION LINES
115-161 KV TRANSMISSION LINES
TRANSMISSION LINE-PROPOSED
EL PASO ELECTRIC SERVICE TERRITORY
WESTERN ELECTRICITY COORDINATING COUNCIL
SOUTHWEST POWER POOL
ELECTRIC RELIABILITY COUNCIL OF TEXAS
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Gulf of Mexico
Inter-Mountain Power Project
To Sigurd
To Huntington
To Curecanti
To Durango
To Rifle
To Walsenburg
GLEN CANYON
NAVAJO
FOUR CORNERS
SAN JUAN
PALO VERDE
HOOVER
CHOLLA
CORONADO
SPRINGERVILLE
Phoenix
Tucson
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LAREDO

HEADLINE FEBRUARY 3, 2011

El Paso Times

elpasotimes.com

THURSDAY, FEB. 3, 2011

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75 CENTS

Railroad Drive at Fred Wilson Avenue was covered with snow and ice Wednesday afternoon.

RUDY GUTIERREZ / EL PASO TIMES

KNOCKED OUT

Power problems bring city to standstill

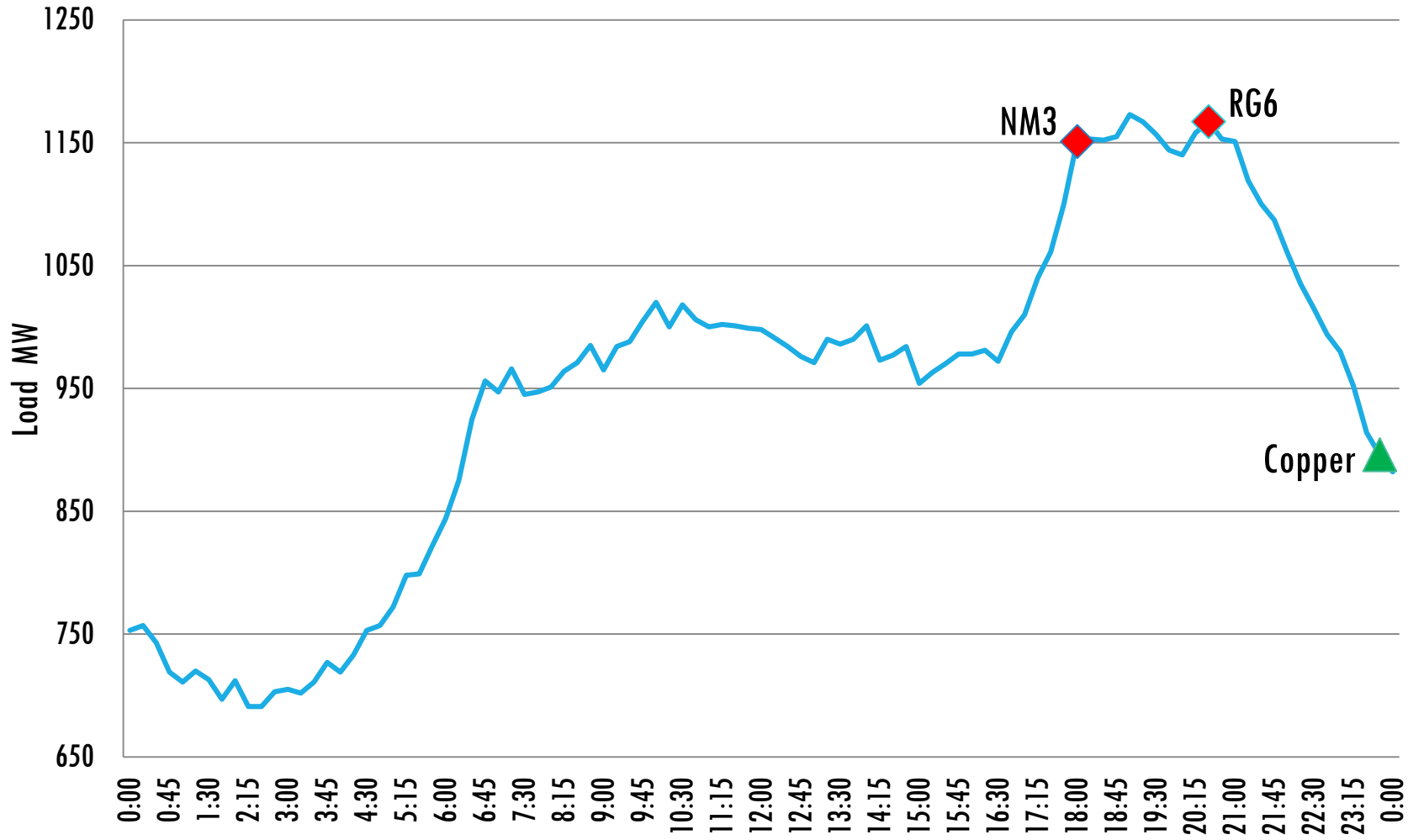
City offices, schools close a second day

INSIDE THE TIMES

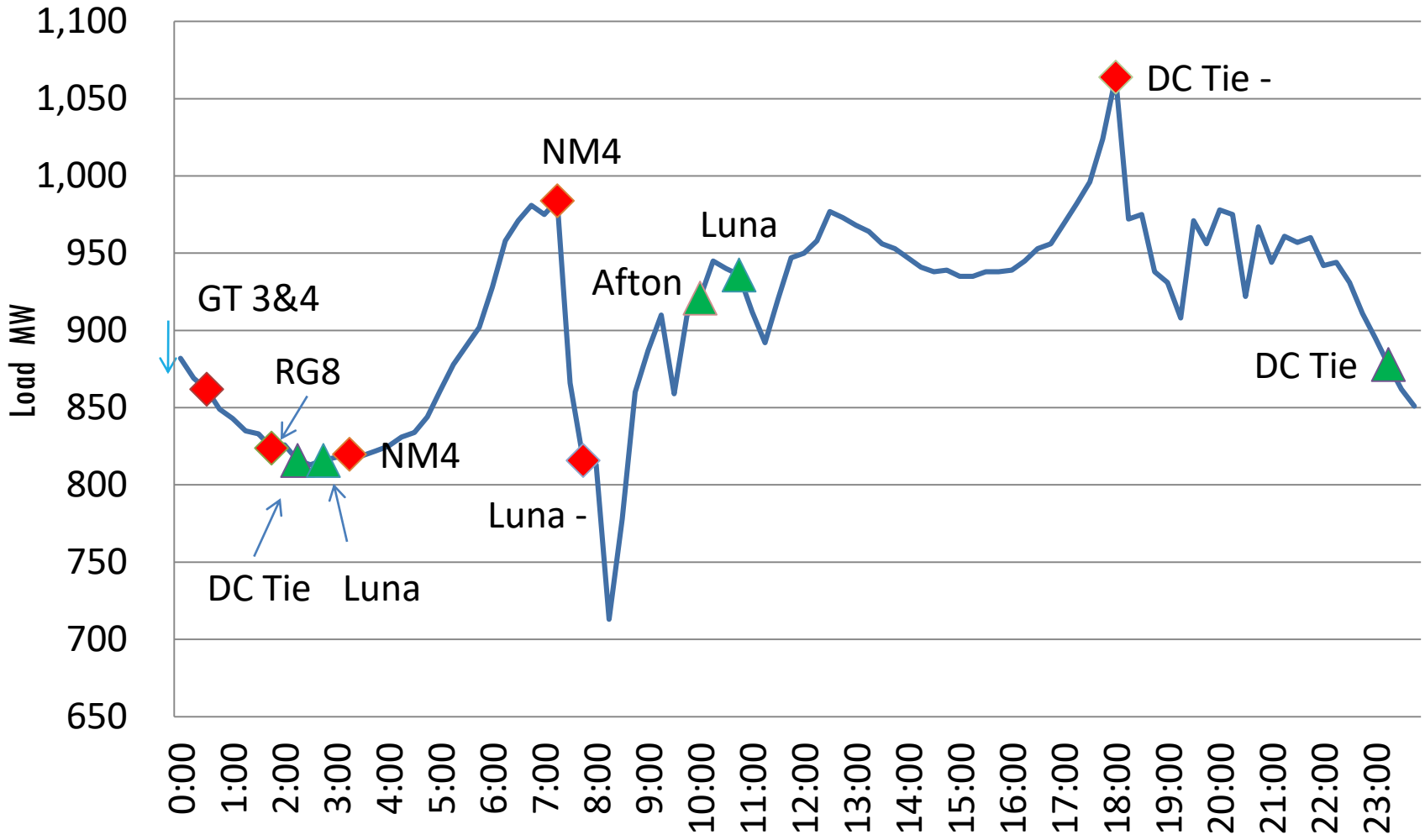
NEWMAN POWER PLANT 2011

NEWMAN POWER PLANT 2011

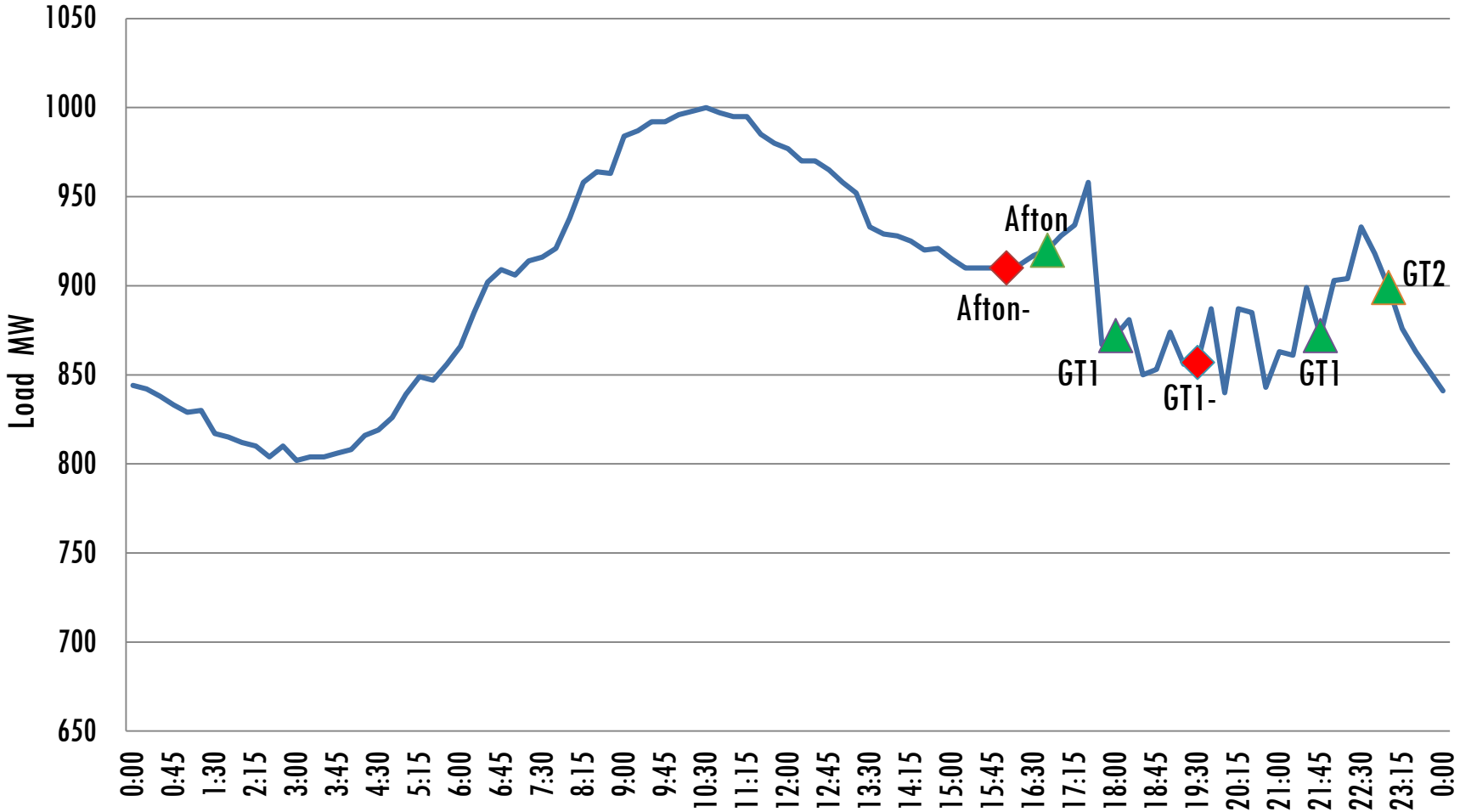
LOAD AND GENERATION FEB. 1, 2011



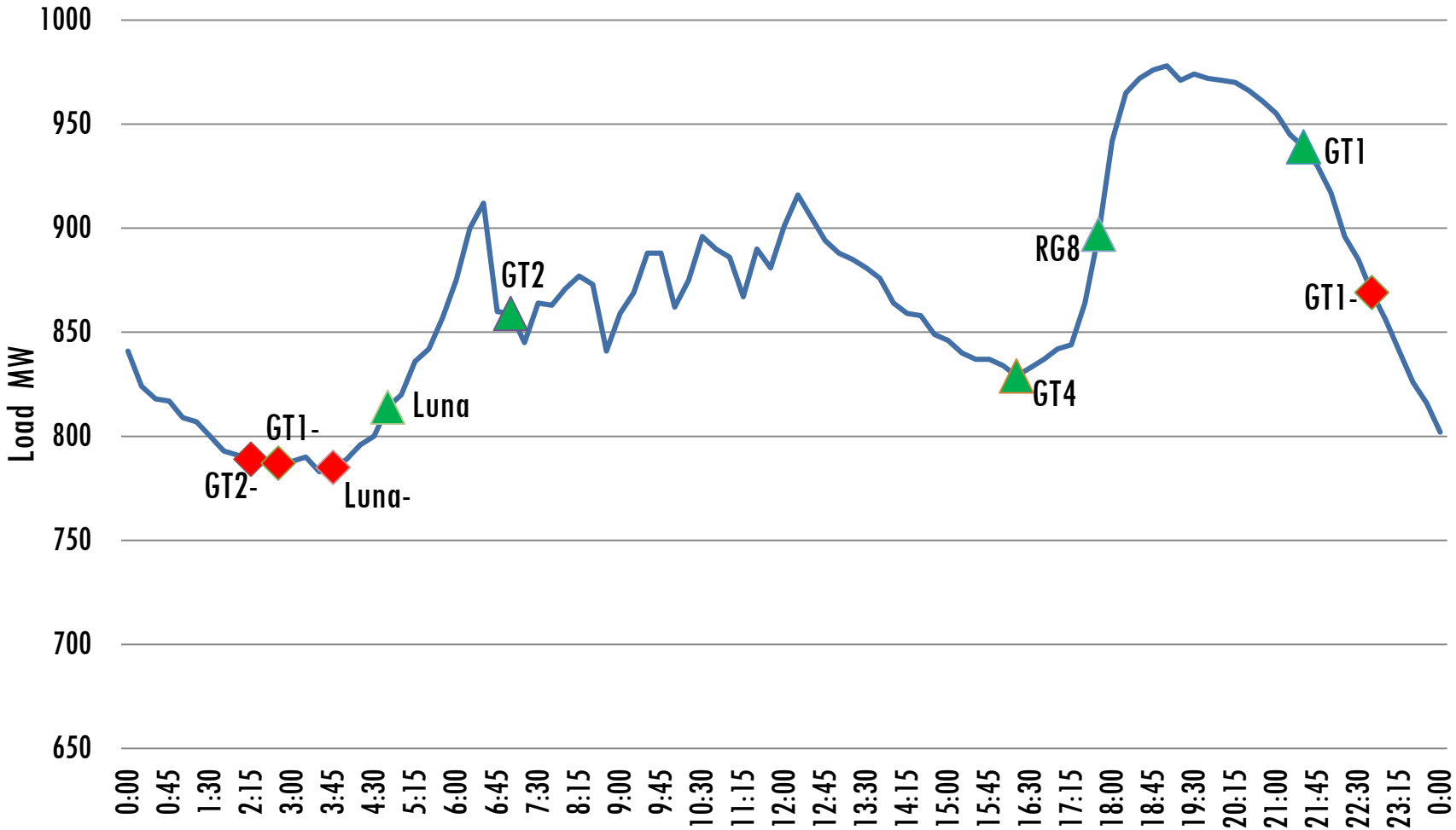
LOAD AND GENERATION FEB. 2, 2011



LOAD AND GENERATION FEB. 3, 2011



LOAD AND GENERATION FEB. 4, 2011



2011 LESSONS LEARNED & INITIATIVES

Freeze Protection Improvements

- Black & Veatch hired to review systems and provide recommendations
- $4.5 MM invested in freeze protection systems to mitigate against future failures
  - Improved heat tracing, insulation, and other winterization tools to a design criterion of minus 10 degrees Fahrenheit (two degrees lower than the record low temperature in the El Paso area), and the design coincident wind velocity of 25 mph.
  - Improved, both hot and cold, weatherization checklists, procedures, and preventative maintenance.

2011 LESSONS LEARNED & INITIATIVES

Freeze Protection Improvements

- Black & Veatch provided heat tracing recommendations based on Priority
  - **Priority 1.** This category includes those items which caused a unit to trip or prevented a restart.
    - IE Critical Instrumentation, Major Control Valves, Flue Gas Recirculation Systems, etc.
  - **Priority 2.** Includes those items which proved vulnerable to freezing and may not have directly resulted in a unit trip or prevented a unit restart, but which are considered a potential contributor to unit unavailability.
    - IE Steam and Water Lines Exposed to Freezing, Other Non-critical Instrumentation, etc.
  - **Priority 3.** This category includes those items which proved vulnerable to freezing, but were not, in themselves, primary contributors to a unit trip or failure to restart.
    - IE Cooling Towers, Non-Critical Water Lines

2011 LESSONS LEARNED & INITIATIVES

Freeze Protection Improvements

- Sample Priority 1 Recommendations:

FD fan inlet guide vane operating mechanisms and flue gas recirculation system	--Provide protective shield to prevent condensation from falling onto the mechanism. --Replace isolation damper with tight shutoff damper to allow operation without flue gas recirculation under extreme cold conditions.
Drum level instrumentation	Upgrade insulation and heat tracing to withstand -10° F. Add electric strip heater to existing instrument enclosure. Relocate closer to point of connection, if possible.
Deaerator level instrumentation and sight glass	Upgrade insulation and heat tracing to withstand -10° F. Add heated enclosure for instruments. Relocate closer to point of connection, if possible.
Feedwater regulator actuator	Install removable insulation blanket.
Economizer sight glass	Provide heated enclosure.
HP drum pressure gauge	Provide heated enclosure or heat tracing.

2011 LESSONS LEARNED & INITIATIVES

Freeze Protection Improvements

- Sample Priority 2 Recommendations:

Unit 3 emergency steam	For piping exposed to freezing temperatures, upgrade insulation for all pipe sizes and upgrade insulate and heat tracing for 4" and smaller piping to withstand -10° F.
Unit 3 boiler blow down system	For piping exposed to freezing temperatures, upgrade insulation for all pipe sizes and upgrade insulate and heat tracing for 4" and smaller piping to withstand -10° F.
Sample tubing	Upgrade insulation and heat tracing to withstand -10° F.
Exposed service water piping	Upgrade insulation and heat tracing to withstand -10° F.
Compressed air systems	If not already so configured, provide connection to compressed air system downstream of dryers for emergency supply to outdoor service air during extreme cold weather operation.

2011 LESSONS LEARNED & INITIATIVES

Freeze Protection Improvements

- Sample Priority 3 Recommendations:

Cooling tower	--Consider adding bypass for cold weather startup. --Consider replacing single speed fans with two-speed fans or variable frequency drive for increased operational flexibility.
Various piping systems located indoors adjacent to louvers, doors, and other building openings.	Consider upgrading or adding insulation and heat tracing to withstand -10° F.
Building heating	Consider adding unit heaters at indoor areas near louvers, large doors, or other building openings to provide supplementary heating to help prevent freezing of piping and equipment in the vicinity under extreme cold conditions.

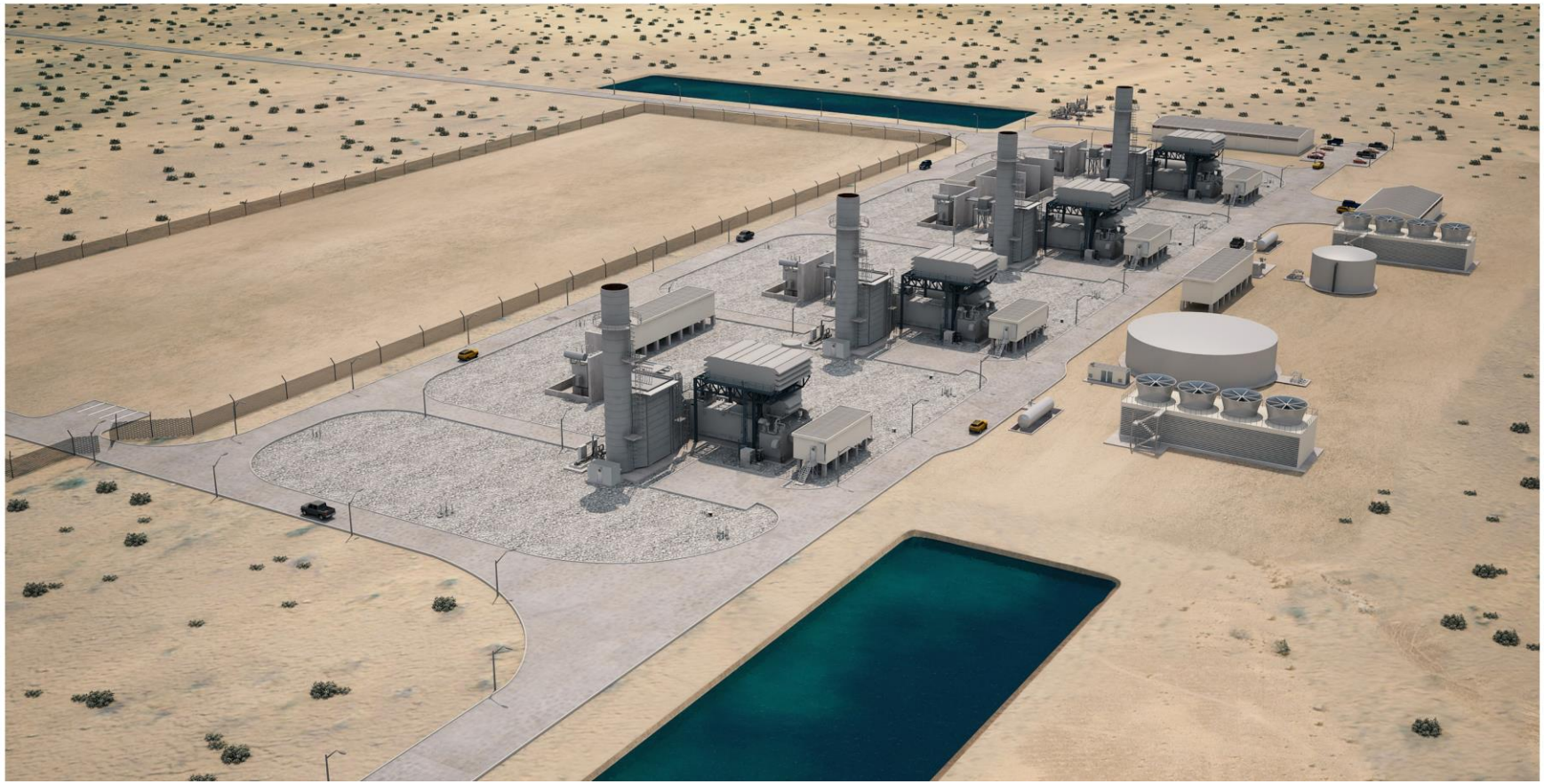
2011 LESSONS LEARNED & INITIATIVES

Revised Future System Additions

- Construction of new gas turbine generation designed to -10 F
- Opted for Simple Cycle Combustion Turbines vs. Combined Cycle Units
- Installed dual fuel capability on new additions
- Added a second natural gas interconnection to MPS

2011 LESSONS LEARNED & INITIATIVES

Montana Power Station – 4 Simple Cycle LMS100 Gas Turbines with Dual Fuel Capabilities

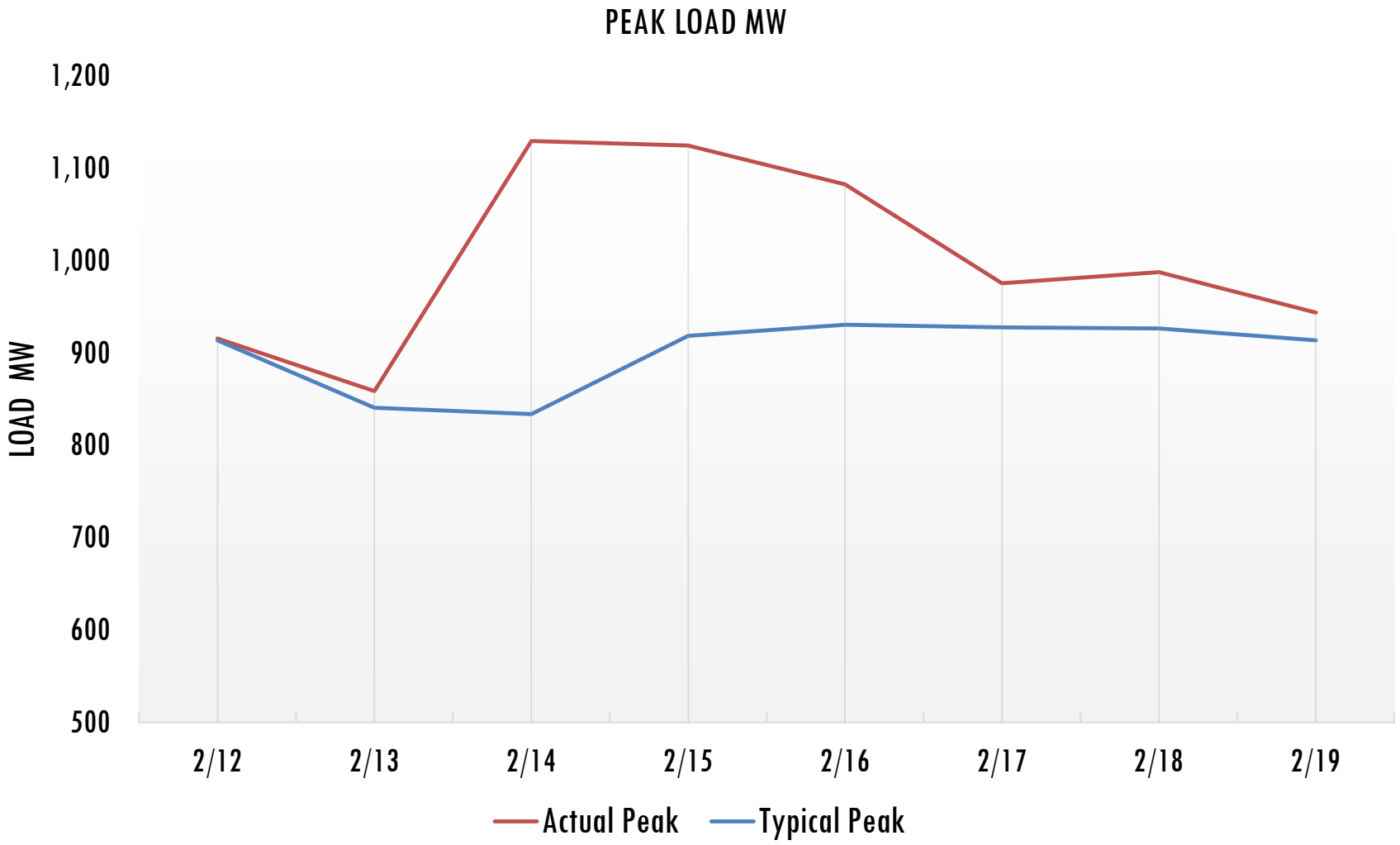


2021 FREEZE

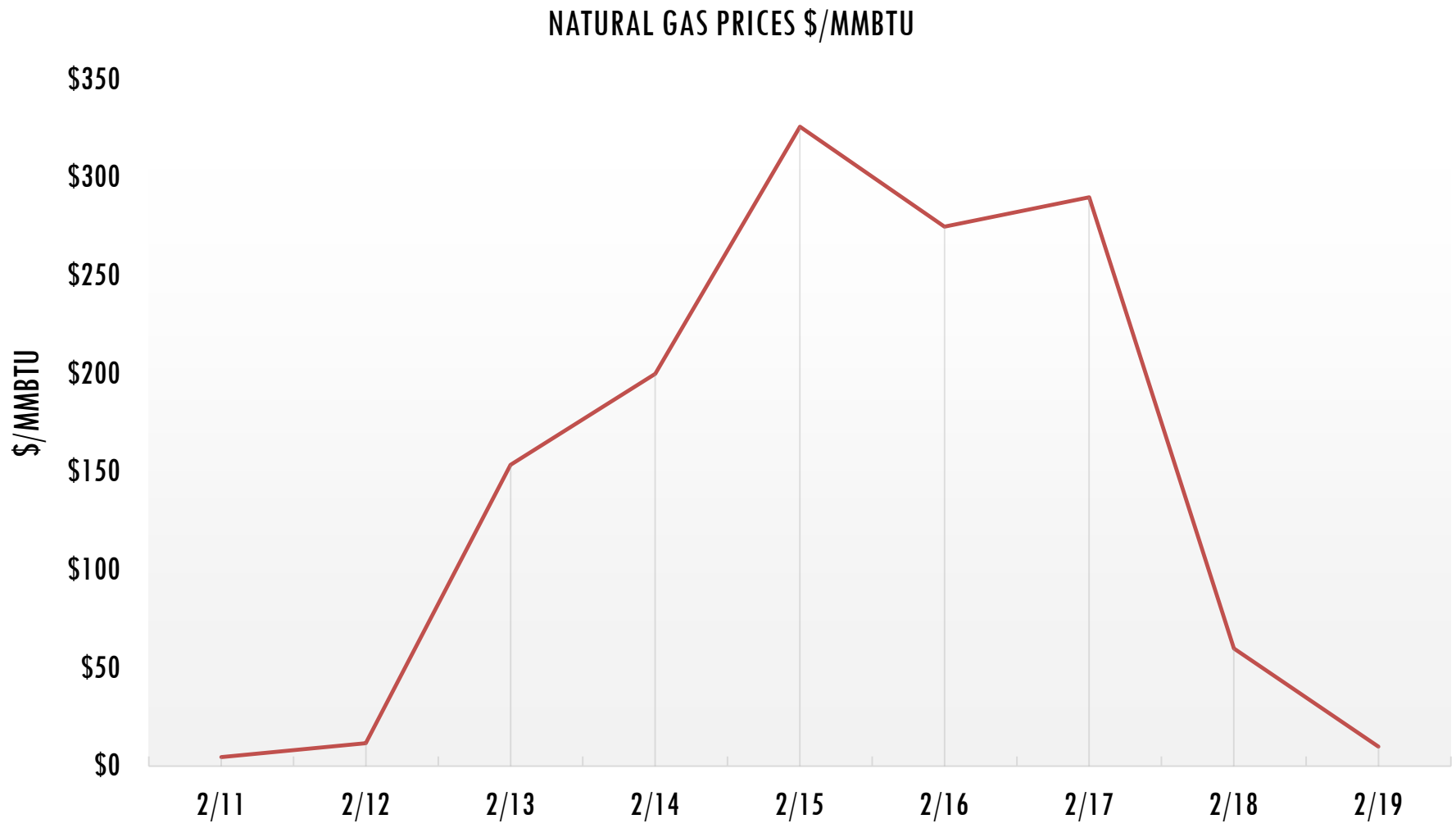
Challenges

- Temperatures dropped to 14 degrees
- Much higher loads than forecasted
- Some older units tripped
- Gas curtailments began; averaging 33% for the week
- Daily and spot gas prices increased by over 16,000%
- Solar Output collapsed to under 11%
- Fuel oil supply limited
- Outside crews dealing with extreme temperatures

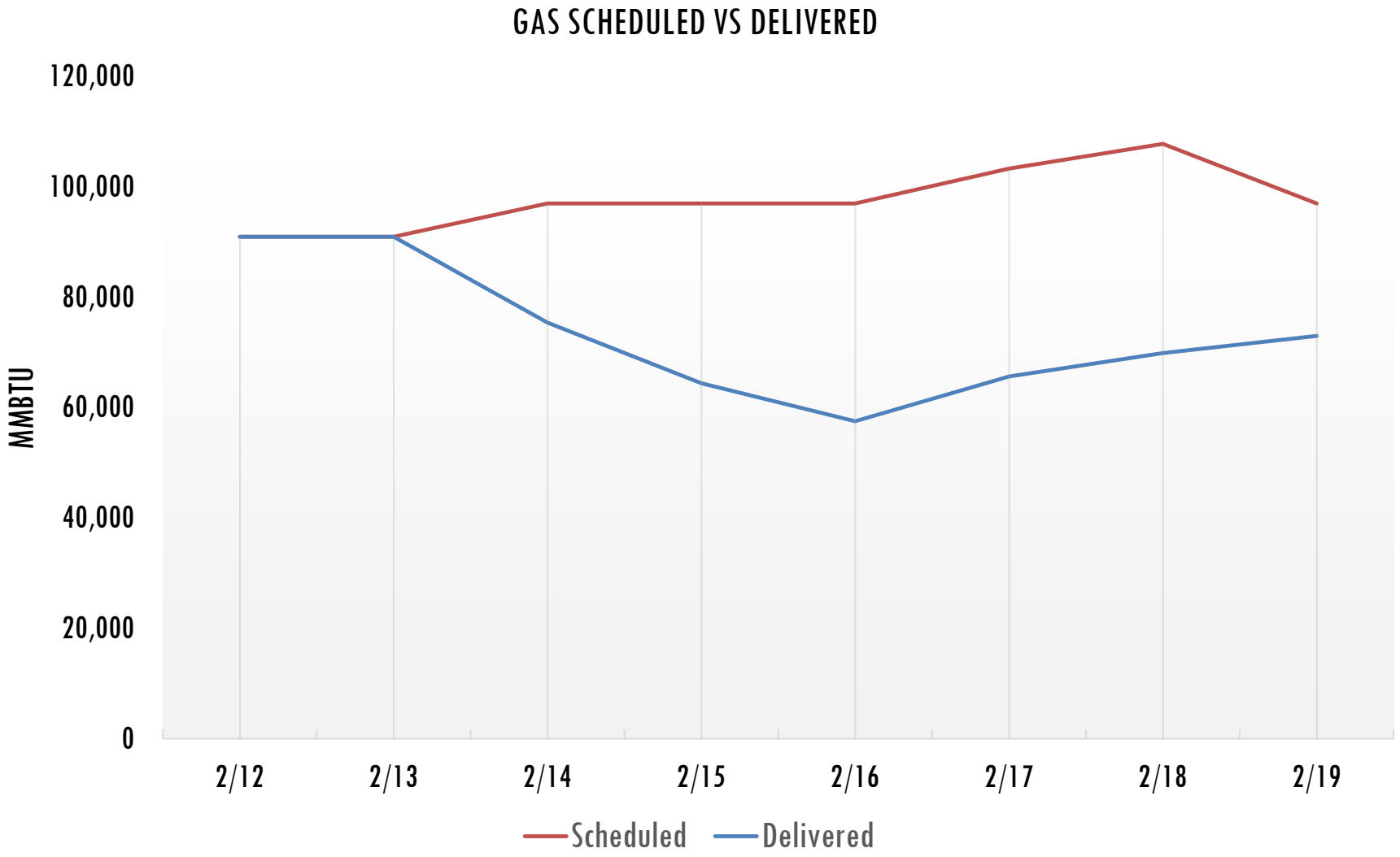
2021 Peak Load



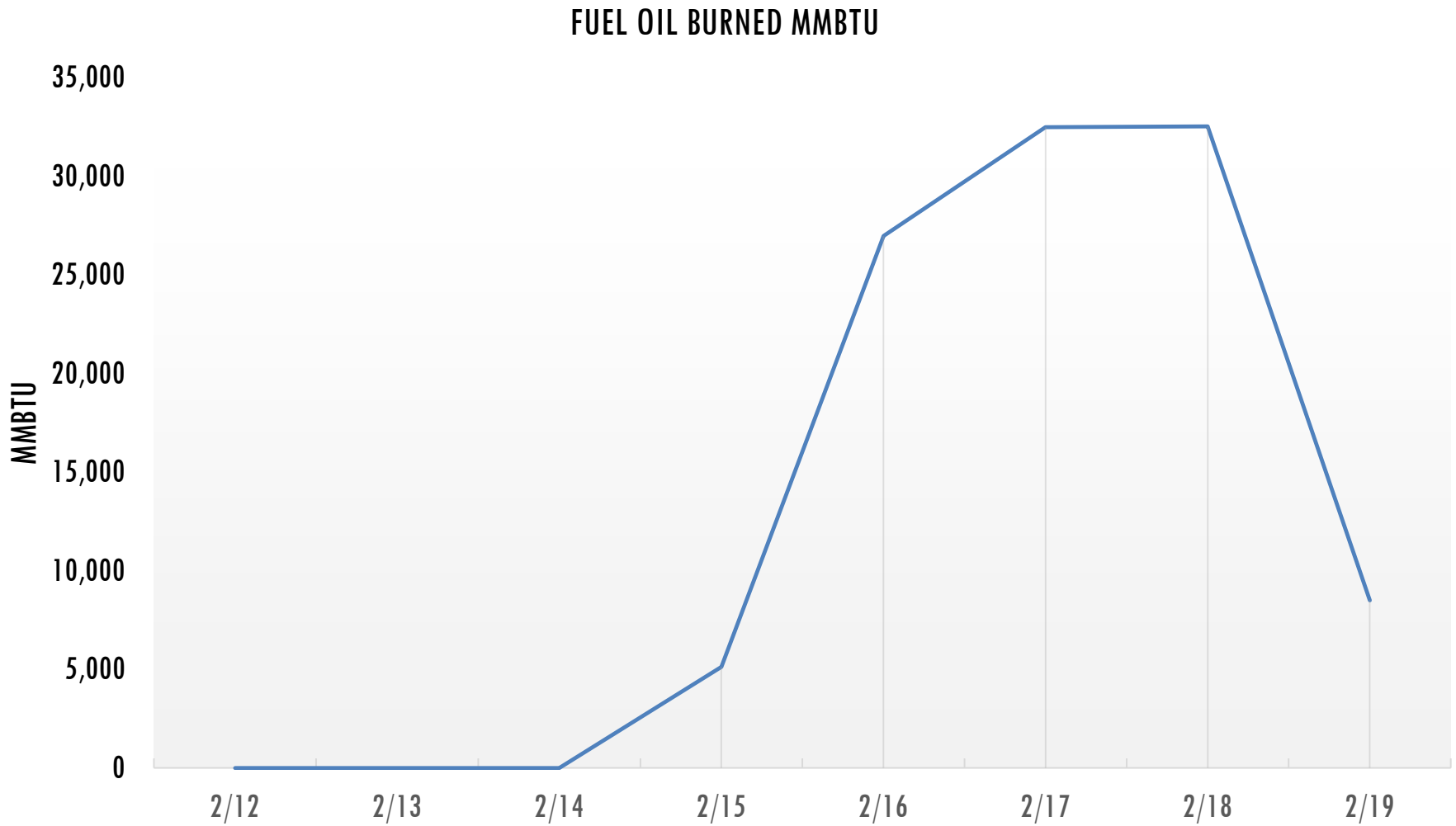
Natural Gas Prices – Freeze 2021



Natural Gas Curtailments – Freeze 2021



Benefits of Fuel Diversity – Freeze 2021



The El Paso Electric Response

- EPE maintains operation of local units despite challenges
- Use of fuel oil made up for gas curtailments (estimated savings over $19 MM)
- Investment in transmission and distribution paid off with grid stability
- Limited customer outages
- Palo Verde was essential to meet customer's needs – provided 65% of energy without fuel price spikes

Lessons Learned

Looking to the Future

- It is critical to replace/upgrade older infrastructure
- Design for extremes
- Fuel/supply diversity is critical
  - Supply contracts should be periodically reviewed
- Training is essential
  - New generation of employees may not be aware of what effective freeze protection looks like

Winter Weather Operational Challenges, Preparations and Update on Ferguson Performance

Andrew Valencia, PE

Senior Vice President of Generation

LCRA
ENERGY • WATER • COMMUNITY SERVICES

Agenda

- Discuss plant cold weather design and operational challenges
- Review LCRA's cold weather preparation and after-action process
- Review Thomas C. Ferguson Power Plant performance during the February 2021 event

Cold Weather Design and Operational Challenges

Plant Subsystems and Major Equipment Design

- **Subsystems and major equipment typically designed for specific minimum temperature**
- **May or may not be consistent among different subsystems and equipment**
- **Highest temperature rating sets rating for entire plant**

A plant is only as good as its weakest link

Overall Plant Design

- **Some plants have overall design minimum temperature**
  - Typically highest of subsystem ratings
- **Some plants do not have overall design minimum temperature**
  - Determine by adding safety margin to highest subsystem rating

Cold Weather Procedures

- **Most plants have procedures to prevent cold weather issues**
  - Usually for temperatures at or slightly above freezing
  - Well before temperature is close to plant rating
- **Based on operating history, lessons learned**
- **Response activated based on:**
  - Forecast lows
  - Wind
  - Forecast precipitation
  - Expected event duration

Putting Procedures Into Effect

- **Hundreds of procedure provisions may be required to maintain operation**

- **Steps include:**
  - Activating temporary heat sources
  - More frequent equipment surveillance
  - Adding additional staff

Operating

- **Even if a plant has overall design temperature, there typically is no specified duration**
- **Many factors increase likelihood of a problem:**
  - Colder temperatures
  - Higher winds
  - More precipitation
  - Longer duration

Operating at or near plant rating is not normal

Other Challenges

Startup	Testing	Heat
Most plants not able to start up at temperatures approaching design rating	Can’t functionally test weather protection	Things you do to protect plant from extreme cold hurt plant in extreme heat

LCRA Cold Weather Preparation Process

Preparation Meeting – Early November

- **Includes staff from generation, plant management, qualified scheduling entity operations, meteorology**
- **Discuss:**
  - Expected weather patterns
  - Expected real-time market conditions
  - Preparation status
  - Questions, concerns, needed resources
- **Document action items**

Site Procedures, Staffing

- **Written procedure and checklists for each site**
  - Required supply inventories and equipment checks
  - Location, type of temporary measures
- **Plant directors affirm execution of site procedures**
  - By early November
  - Documentation for all checks performed
- **Senior manager tours each site to verify preparations**
- **Also follow site procedures and checklists for actions while temperatures below freezing**
- **Three staffing levels depending on forecast temperatures**

Close Coordination

- **Plant, QSE and meteorology staff hold daily calls to discuss:**
  - Plant status
  - Market/Electric Reliability Council of Texas status
  - Weather issues – severity, duration, timing
  - Offline units
  - Fuel supply needs
- **Depending on severity of event, hold additional calls with managers on duty, risk staff**
- **For severe event, may activate Generation Emergency Command Center**

After an Event

- Hold after-action reviews
- Discuss issues, challenges, lessons learned
- Update procedures

Ferguson Plant Performance – February 2021

Thomas C. Ferguson Power Plant

Combined cycle

Broke ground 2012

Designed after February 2011 event

Began commercial operations October 2014

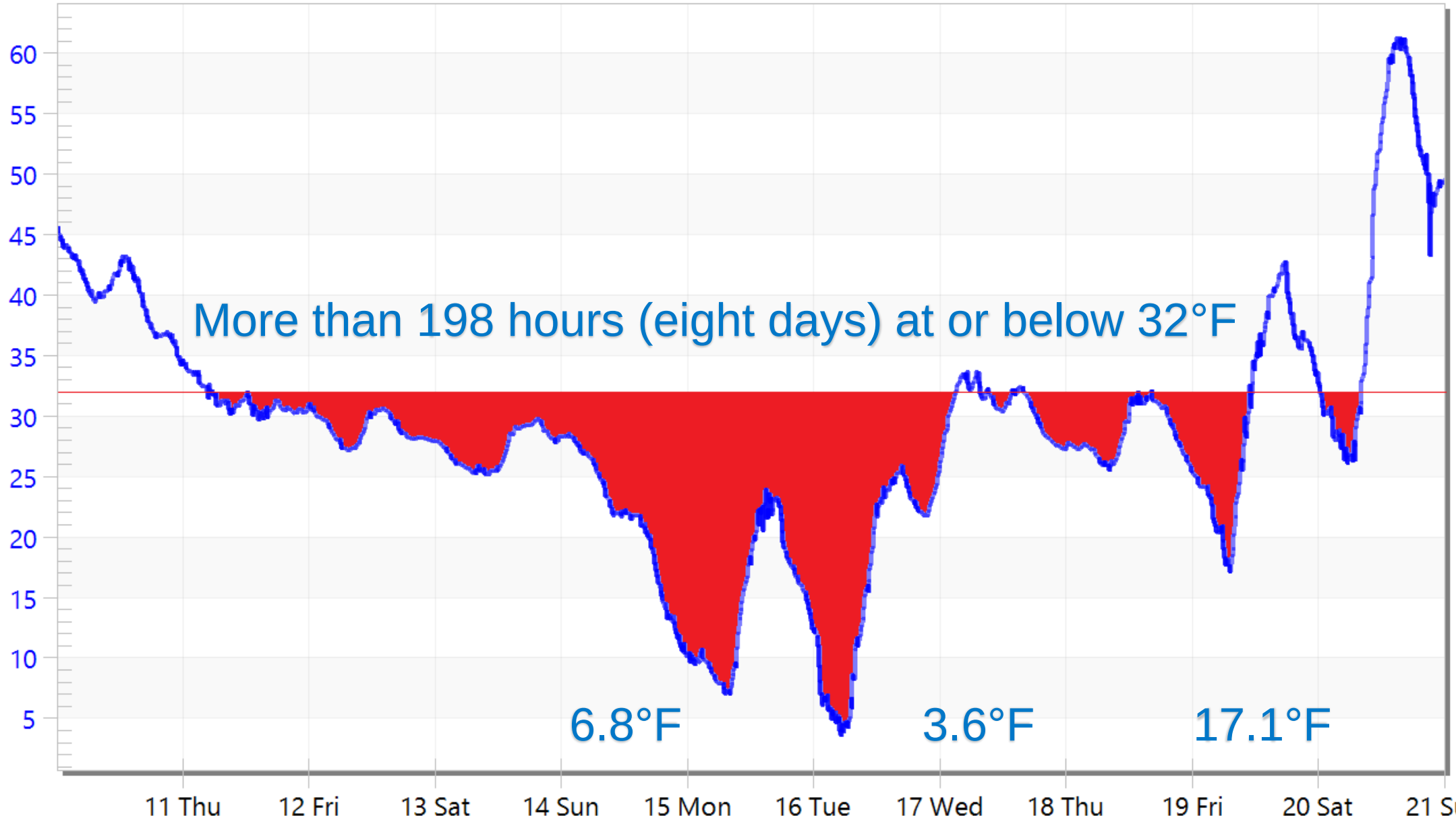
Designed for 0º F with 40 mph wind

Event Preparation, Staffing

Feb. 5	Started preparing for the event
Feb. 12	Began level 3 staffing
Feb. 21	Resumed normal staffing

Added 12 additional LCRA or contract workers

Temperatures



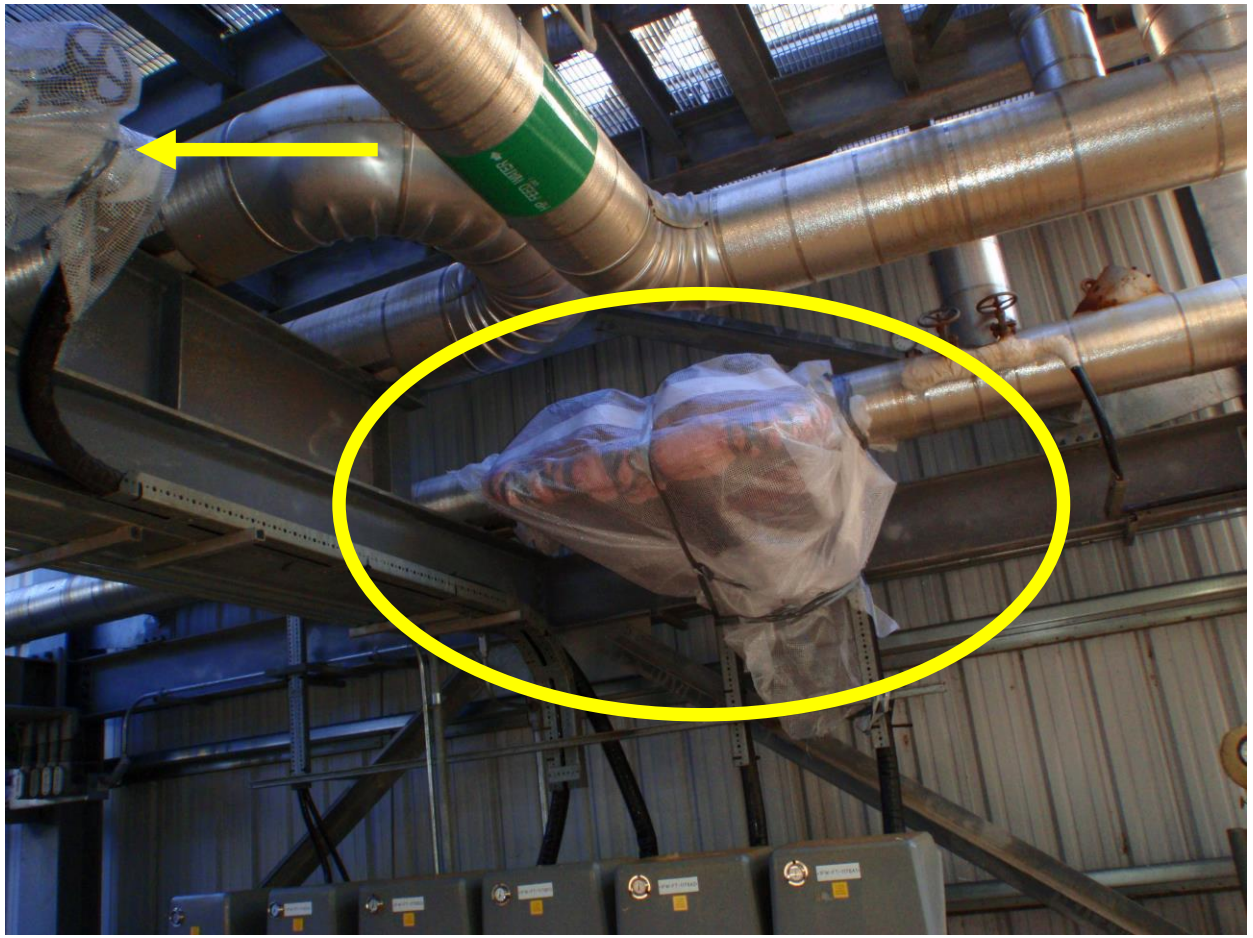
Challenges

- **80 events required a field response**

- **Problematic areas:**
  - Sensing lines with exposed root valves
  - Chemical totes
  - Drain valves
  - Ice buildup
  - Fuel gas compressor nitrogen generators

Temporary Measures

- Installed from previous lessons learned or due to new issues encountered during event



Permanent Solutions Installed

Wind wall

Custom cover

Shielding

Plant Performance

- **Plant performed well during event**
- **Steam turbine tripped Feb. 16**
  - Not freeze-related
  - Able to restart
- **Both gas turbines remained online**
  - 100% steam bypass capacity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ENERGY • WATER • COMMUNITY SERVICES

2021-22 Preliminary Winter Weather Outlook and Review of Historical Winter Extremes

Chris Coleman
ERCOT Sr. Meteorologist

Winter Weatherization Workshop
September 30, 2021

Agenda

- Review of last winter
- Expectations for the upcoming winter 2021-22
- Analysis of historical cold extremes

Last Winter's Forecast (as presented at the Generator Weatherization Workshop)

- Unlikely to see a winter that ranks among the top third coldest of all-time (2013-14 is the most recent winter that ranked that cold – but it is an outlier historical analog)
- January and February have very warm potential (more so than December)
- February has very cold potential to parts of the North Central and Northwestern U.S. (meaning, some risk of a colder outbreak briefly impacting Texas)
- Need to analyze more if the expected dry winter could impact temperatures colder at times
- **Mild winters can – and oftentimes do – have very cold periods!**

- **This is preliminary. The winter forecast will be finalized by early-November and will be available on the ERCOT website**
- **The 2020-21 winter is most likely to either rank in the warmest third or middle third of winter rankings. Least likely is the coldest third**
- **A drier winter has historically allowed for colder outbreaks (polar vortex) to impact Texas a time or two. Late-winter has some signals that could encourage this to happen**

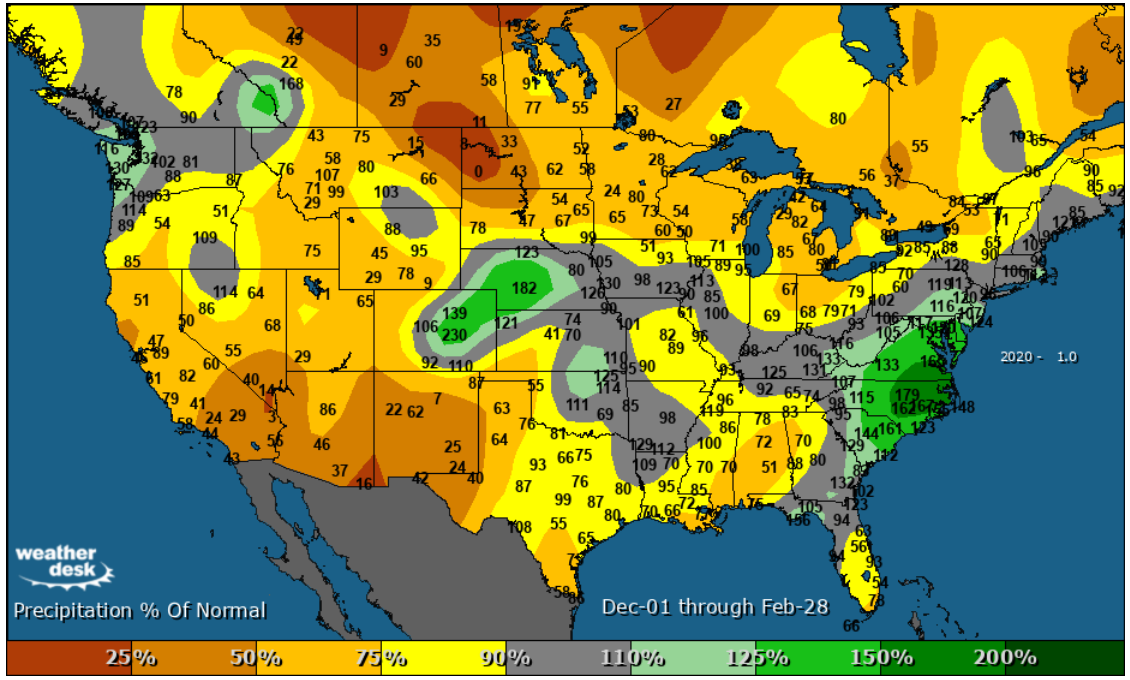
Last winter ranked 15th warmest; this winter could be similar – although **there may be more opportunities for a strongly cold period or two than experienced the past two winters**

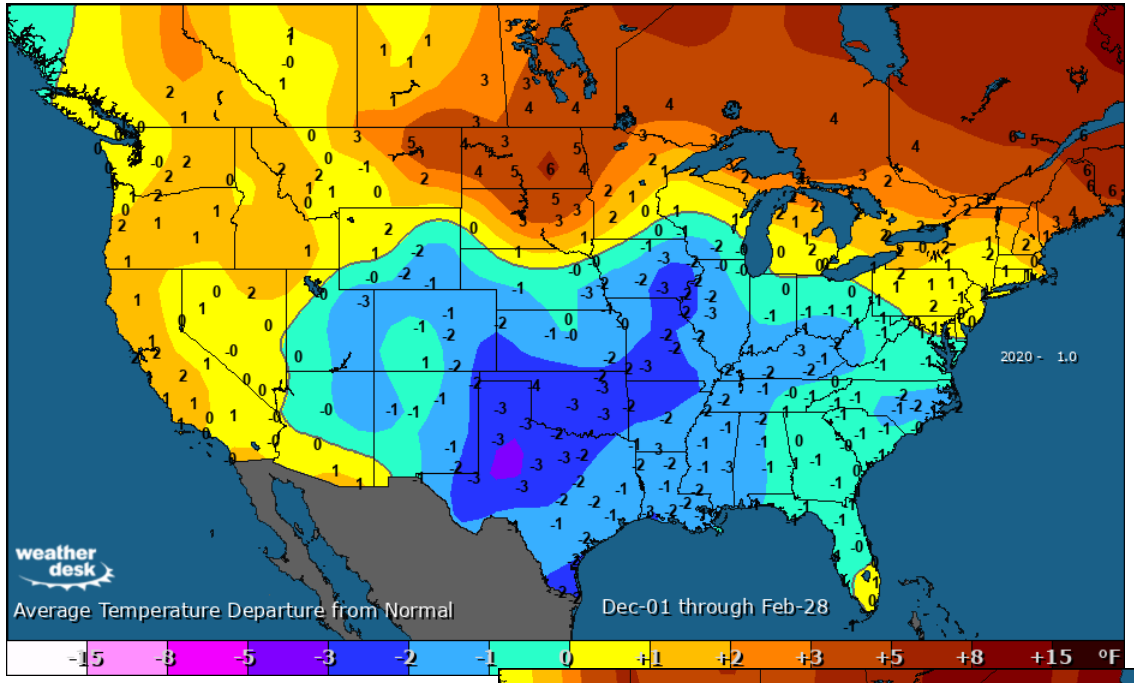
Posted to the website for the final winter forecast:

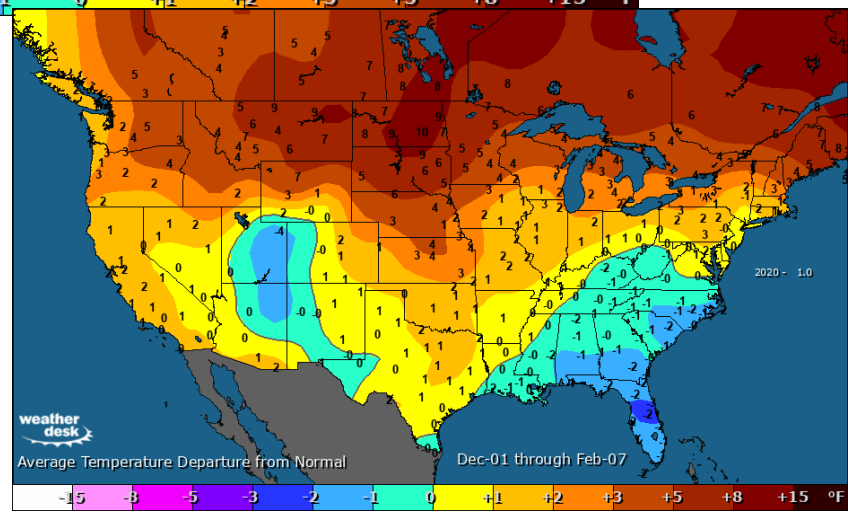
14 of the 15 historical matching winters (analogs) had at least one period colder than last winter. Five of those winters (including three of the top four matches) had periods of extreme cold (Dallas <=15°, Houston <=25°, Austin and San Antonio <=22°). The odds are very good that this winter will have at least one period colder than any experienced last winter. And there's enough of a chance for a period of extreme cold that the possibility cannot be discounted – even in what may otherwise be a mild winter.

PUBLIC

Winter 2020-21







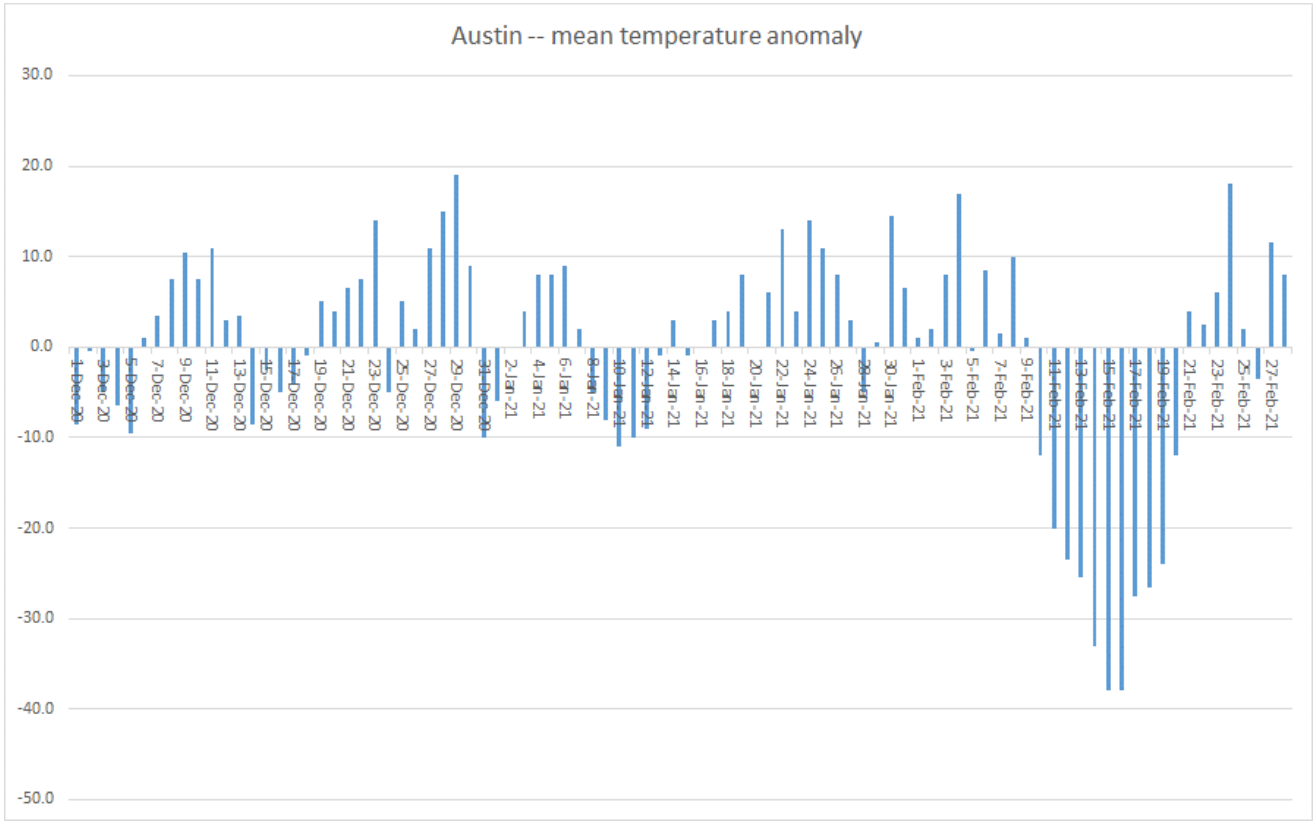
Last winter ranked 42nd coldest for the state of Texas (1895-2021)
However, it was 95th coldest for Dec-Jan (a mild winter)
But February was the 9th coldest on record

Winter 2020-21

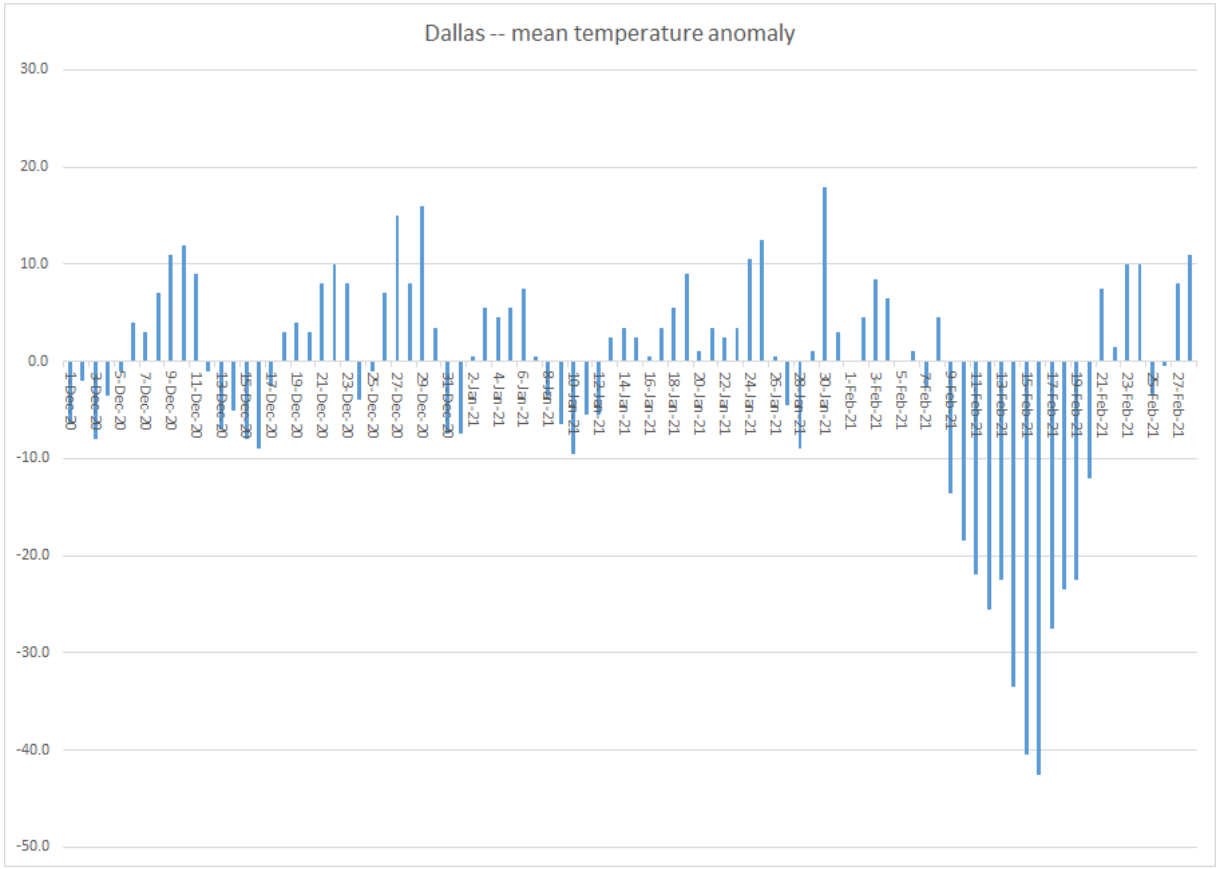
The message: even otherwise mild winters can have a period of extreme cold

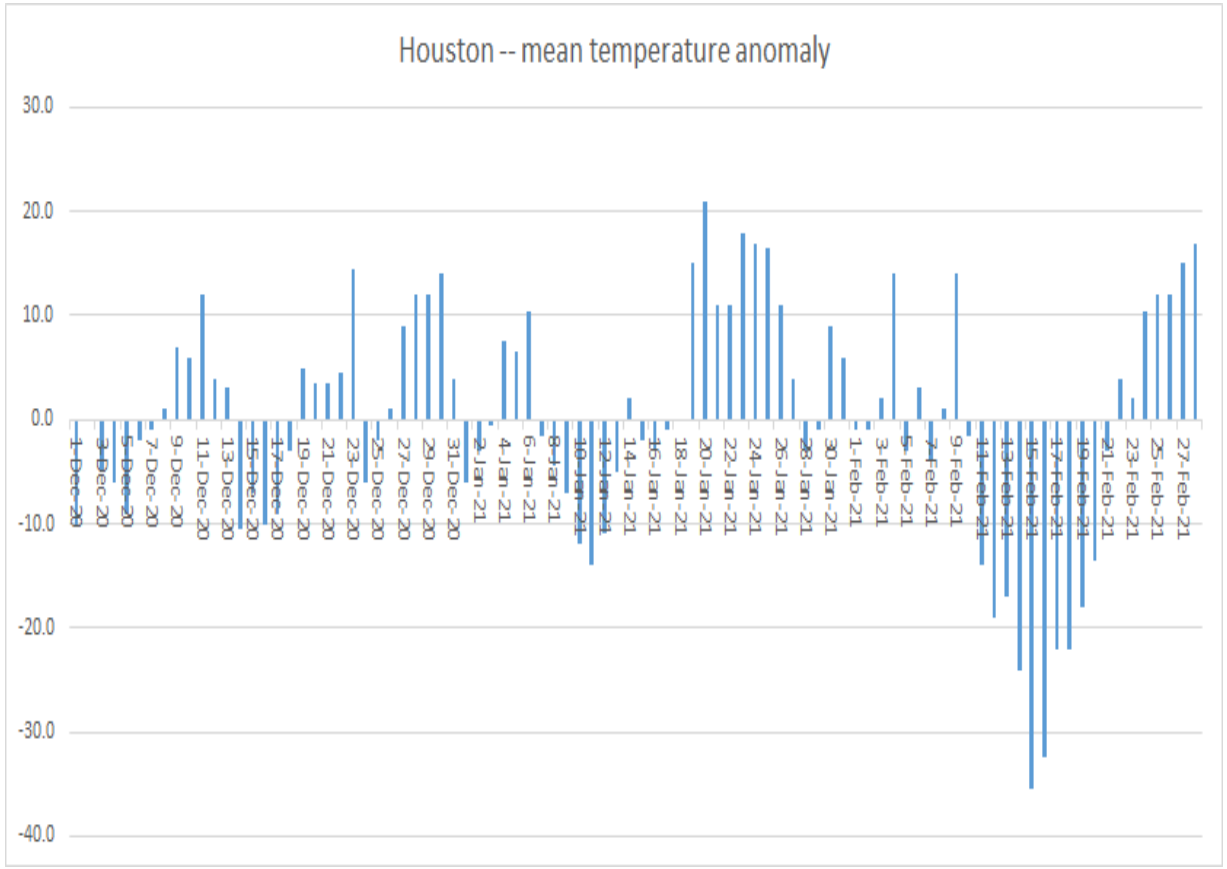
	anomalies				actual temperatures	
Austin	mean tmp	max tmp	min tmp		max tmp	min tmp
10-Feb-21	-12	-18	-7		46	37
11-Feb-21	-20	-27	-13		37	31
12-Feb-21	-23.5	-32	-15		33	29
13-Feb-21	-25.5	-34	-18		31	26
14-Feb-21	-33	-35	-32		30	13
15-Feb-21	-38	-40	-37		25	8
16-Feb-21	-38	-39	-38		26	7
17-Feb-21	-27.5	-34	-21		32	24
18-Feb-21	-26.5	-33	-21		33	24
19-Feb-21	-24	-23	-25		43	21
20-Feb-21	-12	-4	-20		62	26

Austin	
-0.3	entire winter
3.2	winter with exception to Feb 10-20
2.8	Dec 1 - Feb 9
-25.5	Feb 10-20
11 of 90 days turned Austin from +3.2 to -0.3	



Winter 2020-21





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But February was the 9th coldest on record

Austin Freezes

Camp Mabry Dec - Feb	total # of freezes	total # below 40	coldest temp
2020-21	16	38	7
2019-20	3	24	30
2018-19	5	27	32
2017-18	15	36	18
2016-17	5	16	19
2015-16	4	29	31
2014-15	11	41	23
2013-14	22	48	22
2012-13	11	33	27
2011-12	7	23	27
2010-11	19	46	17
2009-10	23	51	17
2008-09	11	42	28
2007-08	14	41	25
2006-07	13	43	24
2005-06	8	35	23
2004-05	13	26	24
2003-04	6	36	28
2002-03	9	41	24
2001-02	11	44	25
2000-01	16	50	27
Averages:	11.5	36.7	23.7

This past winter's # of freezes and days below 40° were similar to the 2017-18 winter – and not as many as the polar vortex winter of 2013-14.

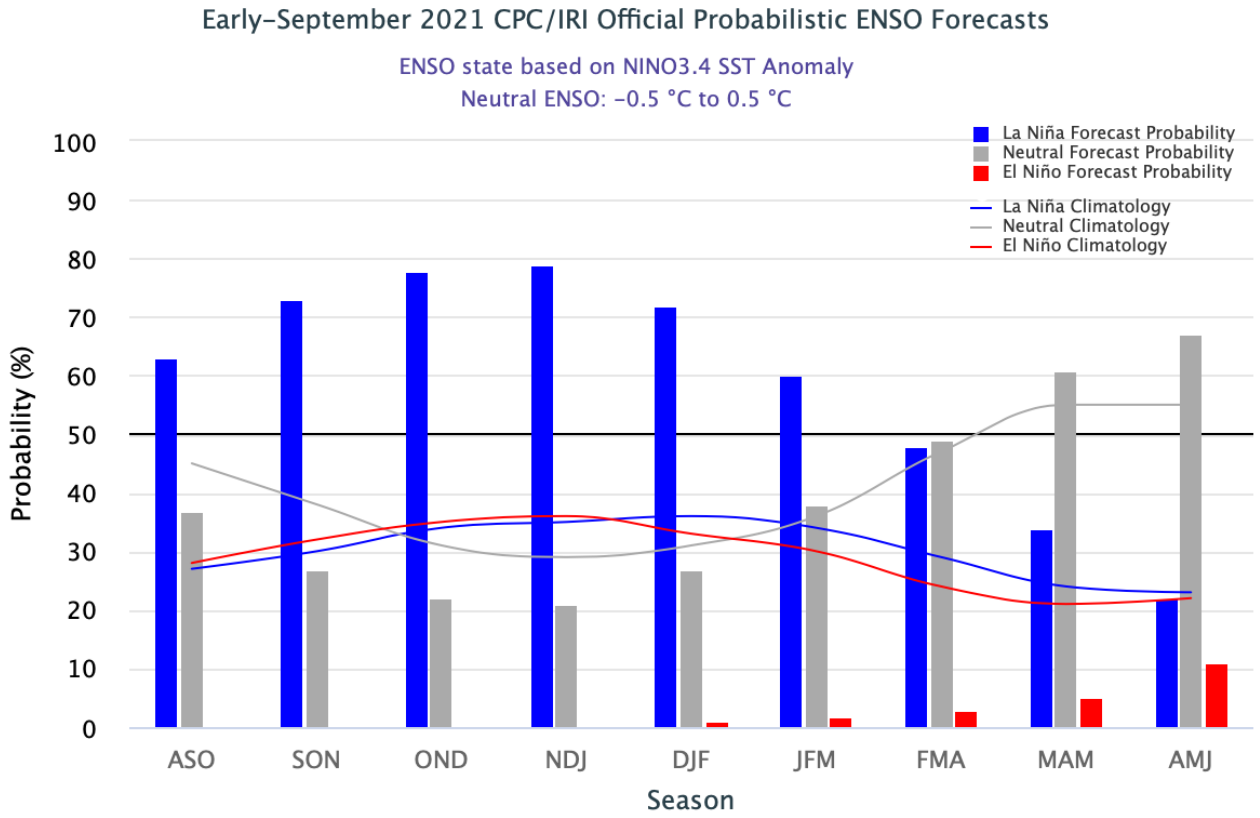
Last winter's extreme was the coldest since 1989 (4° at Austin Camp Mabry)

Dallas recorded -2° on 2/16/21 – tied for second coldest all-time with January 1949. Coldest was 2/12/1899 at -8°

La Niña

- Increasingly likelihood for a second consecutive La Niña
- Current projections suggest this winter's La Niña may not be as strong as last winter's – but low forecast confidence on intensity at this point

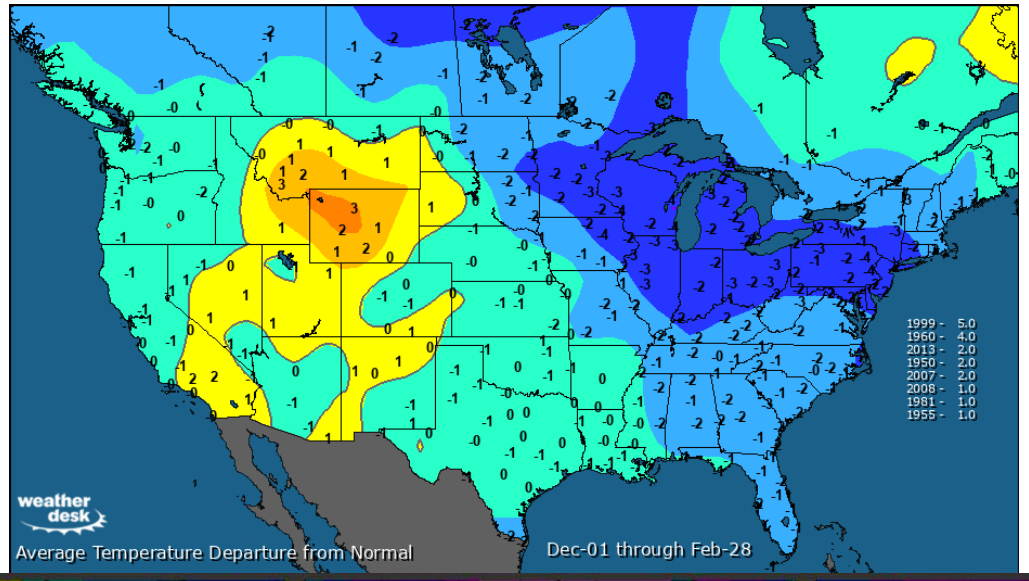
2nd year La Nina	
2017-18	49th warmest
2011-12	26th
2008-09	14th
1999-00	3rd
1984-85	90th
1974-75	66th
1971-72	26th
1955-56	54th
1950-51	64th



2021-22 Winter Historical Matches (Analogs)

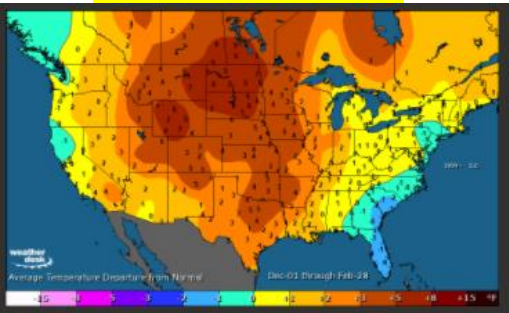
OVERALL (as of 9/15/21)

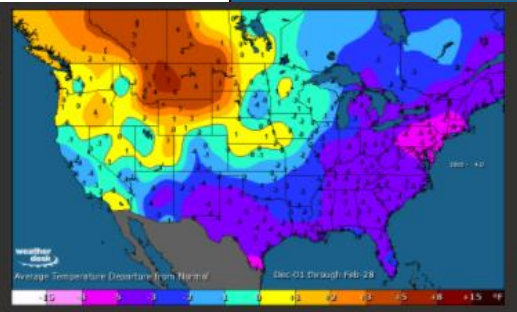
1. 1999-2000
2. 1960-61
3. 2013-14
4. 1950-51
5. 2007-08
6. 2008-09
7. 1981-82
8. 1955-56

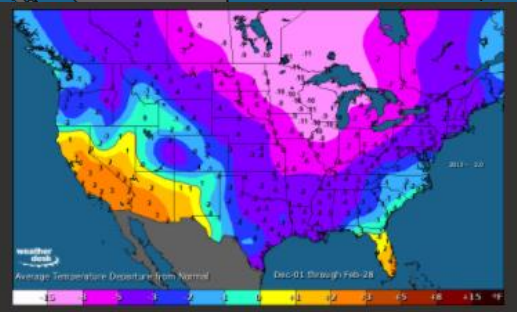


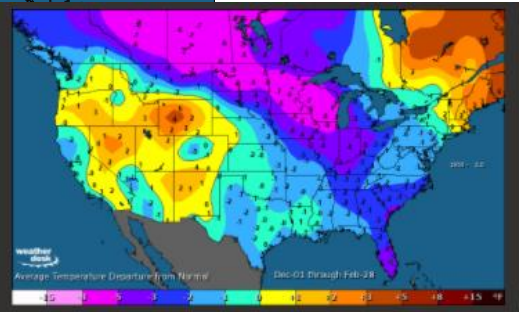
What was the coldest temperature in each of those winters?

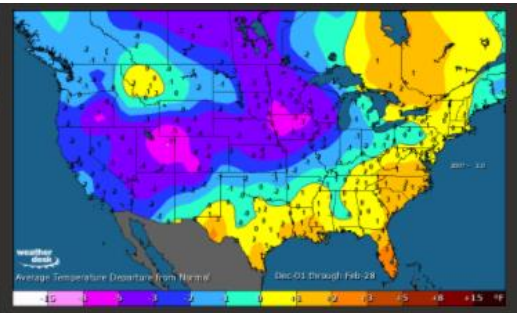
- 1999-00: DFW 23° (Jan)
- 1960-61: DFW 11° (Jan)
- 2013-14: DFW 15° (Jan)
- 1950-51: DFW 6° (Feb)
- 2007-08: DFW 23° (Jan)
- 2008-09: DFW 20° (Jan)
- 1981-82: DFW 7° (Jan)
- 1955-56: DFW 14° (Jan)

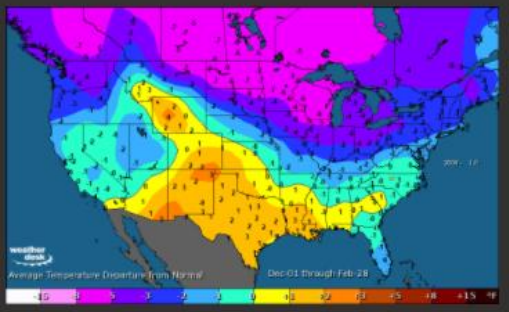


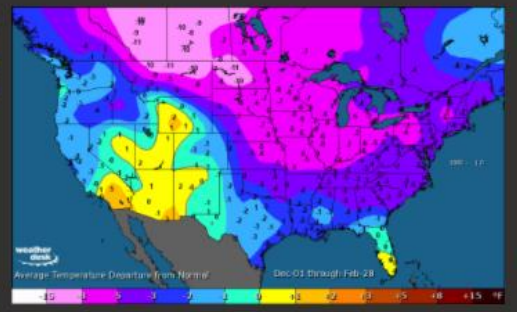


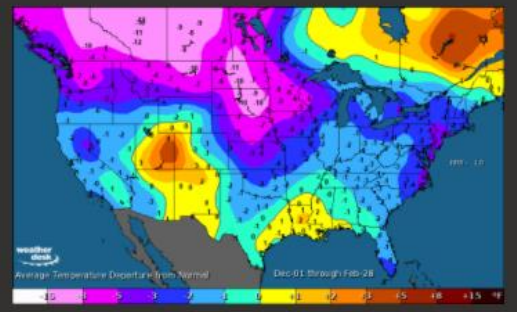












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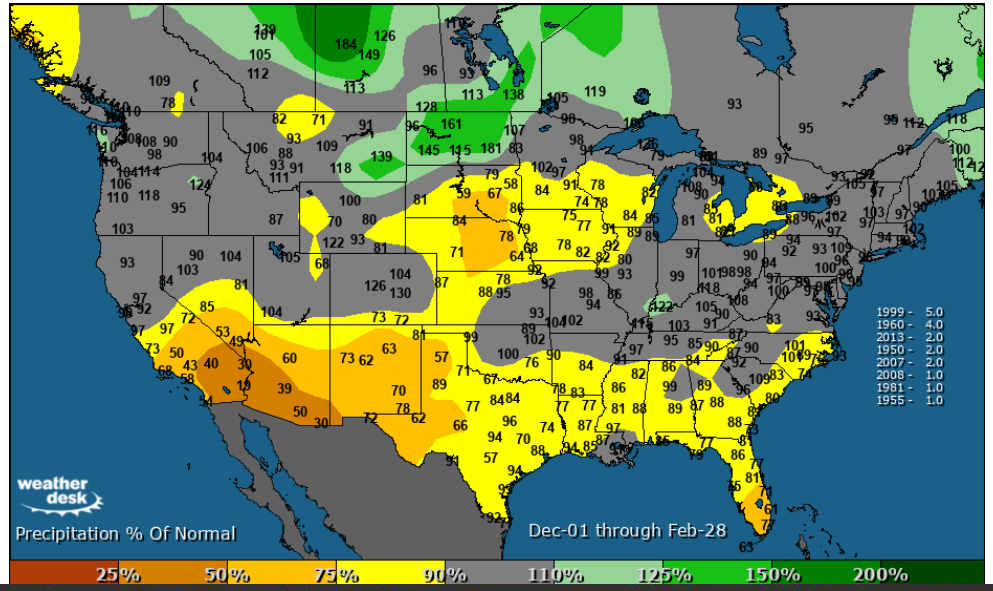
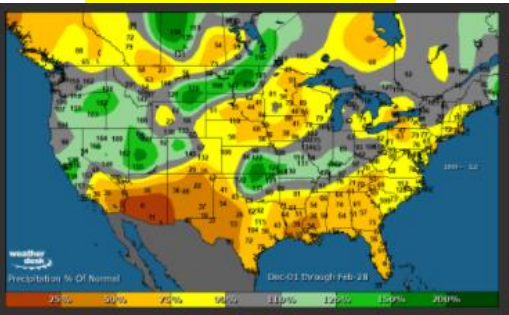
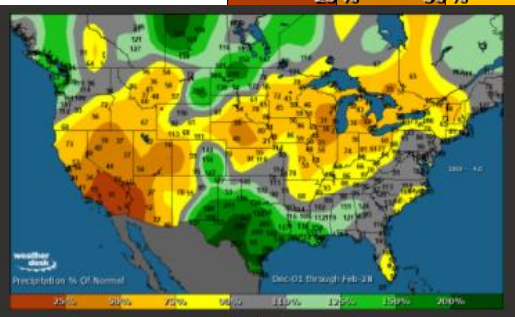
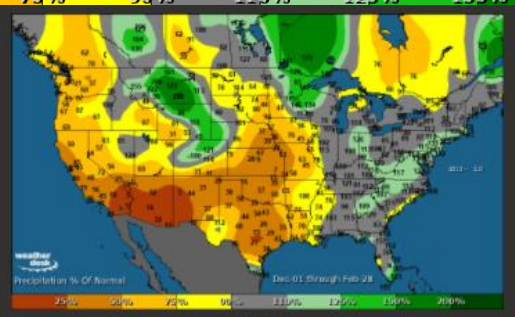
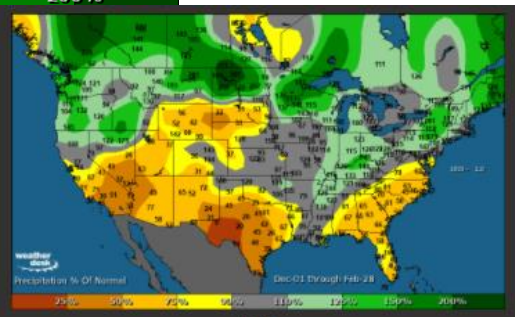
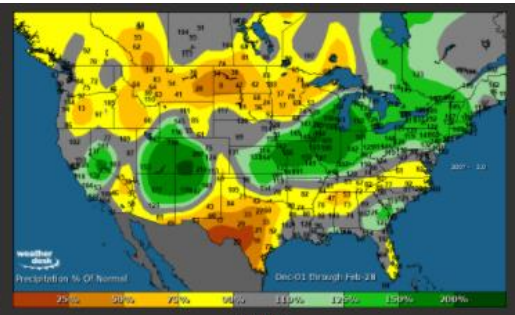


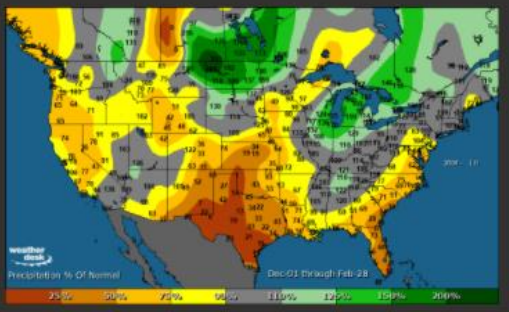

1999

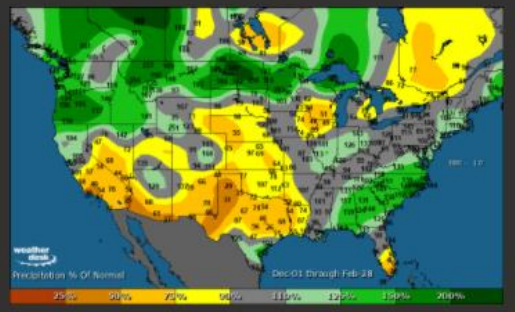

1960

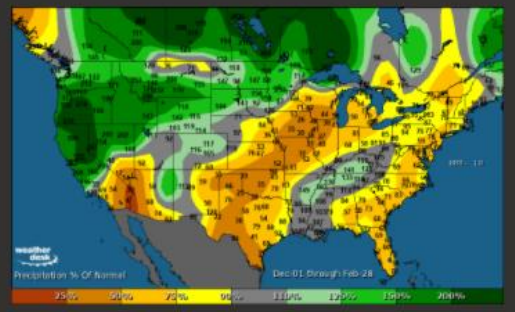

2013


1950

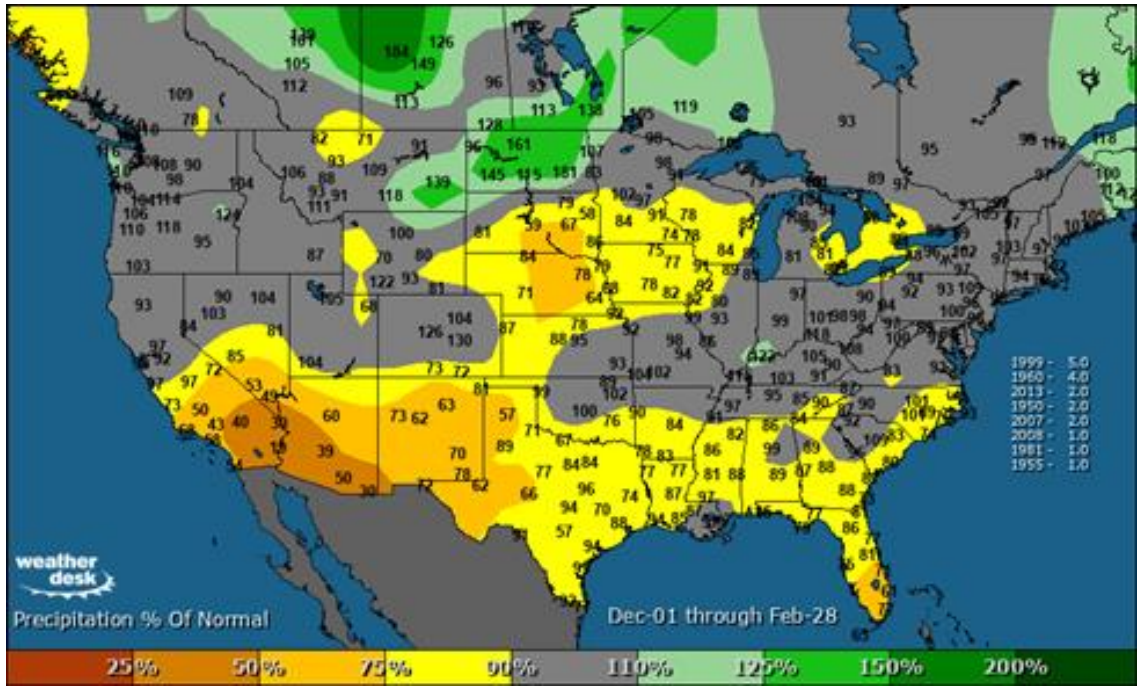

2007


2008

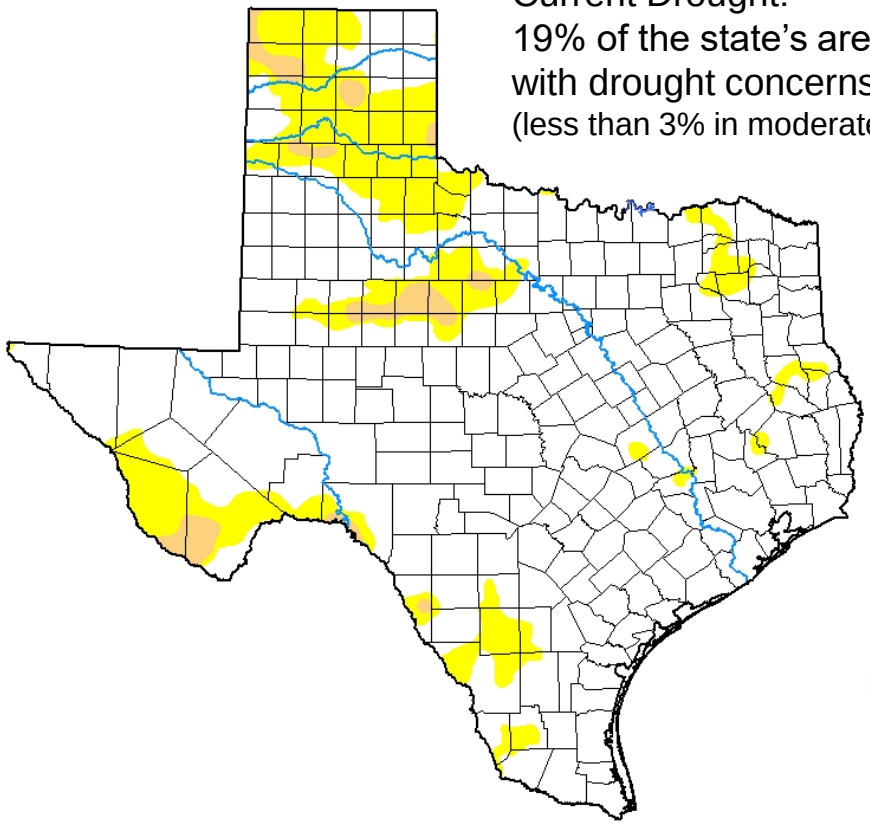

1981

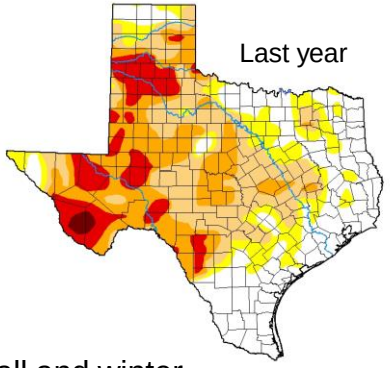

1955

Winter 2020-21 Precipitation Outlook vs Drought



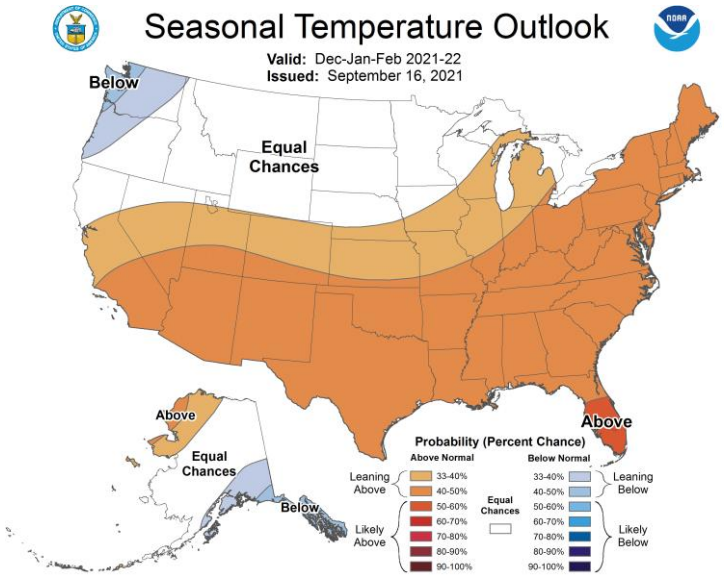
Current Drought:
19% of the state's area
with drought concerns
(less than 3% in moderate drought)

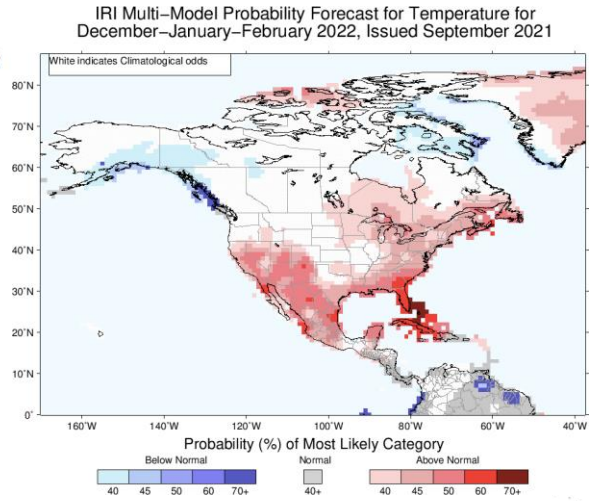


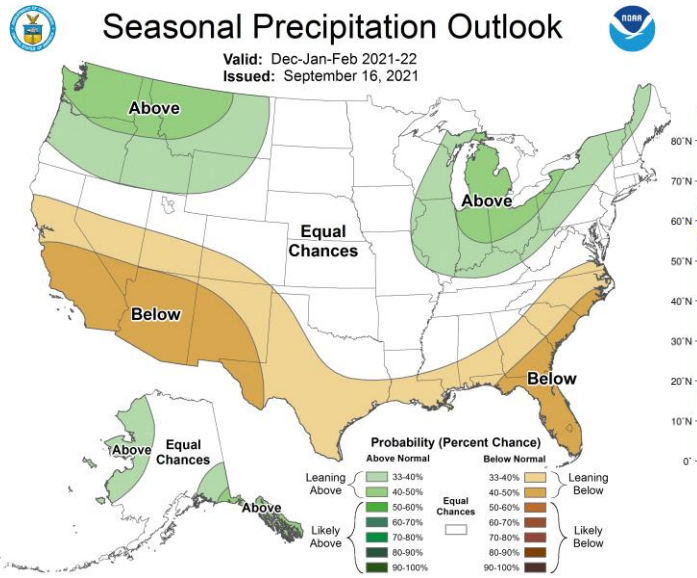


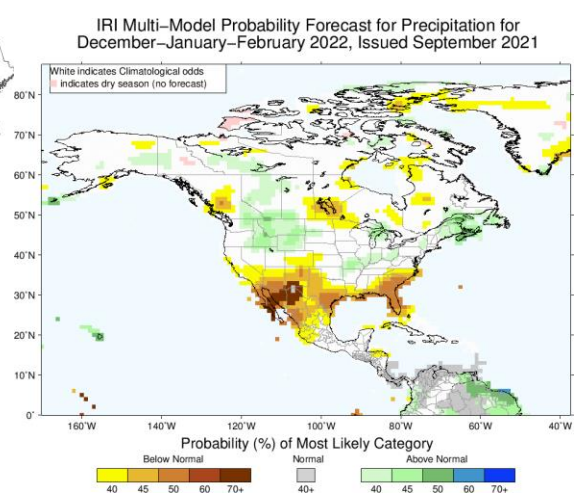
While not at the same level as last year at this time, both the fall and winter forecasts are indicating increasing potential for drier weather. This could also increase drought concerns as the winter progresses – although unlikely to last winter's levels

This Year's Winter Outlooks

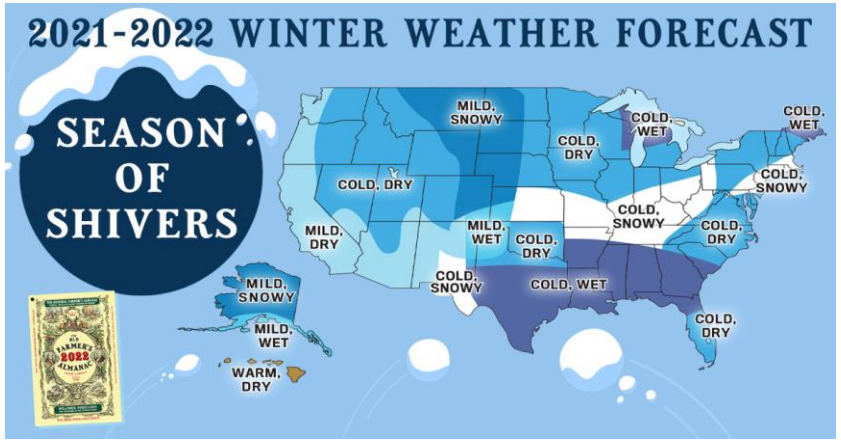








(All based on 30-year normal)



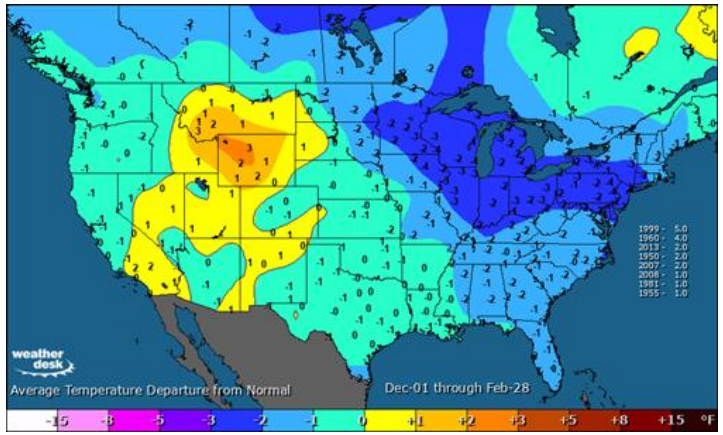
"This coming winter could well be one of the longest and coldest that we've seen in years," says Janice Stillman, editor of *The Old Farmer's Almanac*.

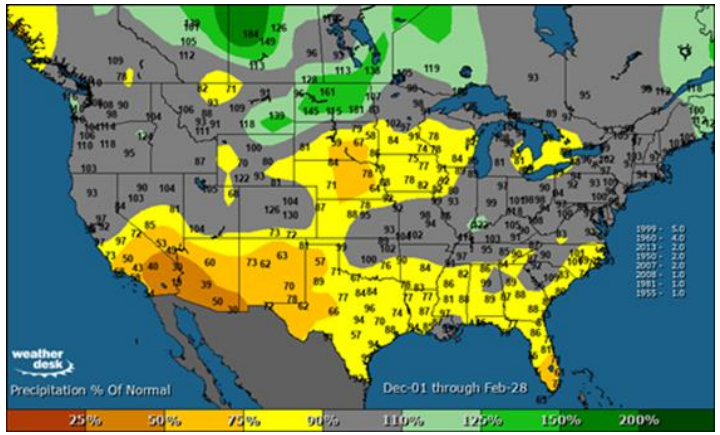
PUBLIC

Winter Weather Outlook Summary

- This is preliminary. The winter forecast will be finalized by early-November and will be available on the ERCOT website
- Current analog winters suggest greater-than-average potential for an active polar vortex
- This suggests elevated potential for cold outbreaks that could impact ERCOT
- A bit more of a forecast lean for the strongest pushes of cold air to be over the Eastern U.S. – but not necessarily missing Texas in all cases
- Conflicting analog with 1999-00, which was a very mild winter – ideally will reduce the conflict with the final forecast release

- Increasing potential for a second consecutive dry winter; however, less drought going into the winter than last year
- **Even mild/warm winters are capable of producing a period of extreme to record breaking cold**. Winter is a much more volatile weather pattern than the summer season. Extreme cold can only be forecast in the shorter-term – not long-range, several months out forecasts





Historical Extreme Cold Periods

Dallas: 14 winters (dating back to 1899) recorded a low of 5° or colder:

(parentheses show rank of TX winter with #1 being coldest)

2021 (40)	1933 (43)
1989 (71)	1930 (40)
1983 (7)	1918 (11)
1964 (5)	1912 (6)
1949 (52)	1911 (119)
1947 (31)	1905 (2)
1943 (95)	1899 (1)

Houston: 14 winters (dating back to 1895) recorded a low of 15° or colder:

2021 (40)	1933 (43)
1989 (71)	1930 (40)
1983 (7)	1918 (11)
1982 (54)	1912 (6)
1951 (62)	1905 (2)
1949 (52)	1899 (1)
1940 (21)	1895 (?)

Both cities:

1989	1918
1983	1912
1949	1905
1933	1899
1930	

Most Extreme Winter Periods

These winters all had Dallas at 5° or colder and Houston at 15° or colder:

2021
1989
1983
1949
1933
1930
1918
1912
1905
1899

Five most extreme winter periods on record for Texas:

Combination of extreme cold, prolonged cold, and area impacted

2021, 1989, 1983, 1930**,** and **1899**

Austin has recorded 13 winters with a temperature of 12° or colder, among the above list: 2021, 1989, 1983, 1949, 1933, 1930, 1918, 1899

Abilene has recorded 14 winters with a temperature of 2° or colder, among the above: 2021, 1989, 1983, 1933, 1930, 1918, 1899

Brownsville has recorded 11 winters with a temperature of 23° or colder, among the above: **2021, 1989, 1983, 1899** ← those are the only four winters that impacted all cities listed with the given criteria (**1930** just missed with Brownsville at 24°)

(temperature thresholds were determined to get between 10 and 15 years in sample)

Historical Extreme Cold Periods – and the following winter

Both cities	1989 (D)	1918 (J)
(5 deg DFW,	1983 (D)	1912 (J)
15 deg HOU):	1949 (J)	1905 (J)
	1933 (F)	1899 (F)
	1930 (J)	

Less extreme reference:
Feb 2, 2011:
DFW 13
HOU 21

Winters following a winter with extreme cold:

1990-91: 58th coldest for Texas
DFW, December 21-24, 1990: 16/45, 13/16 (0.2” snow), **10**/26, 12/40
Houston, Dec 22-25, 1990: 24/33, 22/31, **19**/41, 26/44

1984-85: 35th coldest for Texas
DFW, Jan 20-22, 1985: **10**/22, 17/38, 22/42
DFW, Jan 31-Feb 3, 1985: 13/28 (1.2” snow), 13/17 (1.7” snow), **7**/25, 14/30
Houston, Jan 20-22, 1985: 20/55, **16**/40, 22/45
Houston, Jan 31-Feb 3, 1985: 23/64, 22/28 (0.3” snow), **20**/40, 25/38

1949-50: 121st coldest for Texas
DFW, Jan 4-6, 1950: 15/27 (1.0” snow), 17/27, 25/39
Houston, no temperatures below 32

1933-34: 111th coldest for Texas
DFW, no temperatures below 20; Houston, Feb 26, 1934: 29/46

Historical Extreme Cold Periods – and the following winter

Both cities (5 deg DFW, 15 deg HOU):		
	1989 (D)	1918 (J)
	1983 (D)	1912 (J)
	1949 (J)	1905 (J)
	1933 (F)	1899 (F)
	1930 (J)	

Less extreme reference:
Feb 2, 2011:
DFW 13
HOU 21

Winters following a winter with extreme cold:

1930-31: 53rd coldest for Texas
DFW, no temperatures below 20; Houston, no temperatures below 32
1918-19: 28h coldest for Texas
DFW, Jan 1-4, 1919: 22/31, 18/34, **16**/33, 18/50
Houston, Jan 1-4, 1919: 29/56, 27/32, 24/40, 24/49
1912-13: 14th coldest for Texas
DFW, Jan 6-8, 1913: 17/32, **13**/27, 14/40
Houston, Jan 7-9, 1913: 24/33, 24/36, 31/44
1905-06: 18th coldest for Texas
DFW, Feb 5-8, 1906: **13**/33, 23/31, 23/45, 20/55
Houston, no data available
1899-1900: 40th coldest for Texas
DFW, Jan 28-29, 1900: 19/40, **12**/42. Feb 16-18: 18/28, **13**/29, **13**/60
Houston, Jan 29-30, 1900: 25/45, 25/45. Feb 17-19: 22/40, **19**/37, 20/49

Both the 1983 and 1989 (Dec) cold extreme periods had a second consecutive winter with extreme cold (1984-85 especially)

1899, 1905, and 1912 winters also had cold extremes the following winter – just not quite to the 1980s periods. In other words, **5 of the 9 historical winters with extreme cold were Followed by another winter with extreme cold**

Dec 1990, Jan 1985, and Feb 1900 were all second consecutive winters with cold at least as extreme as February 2, 2011

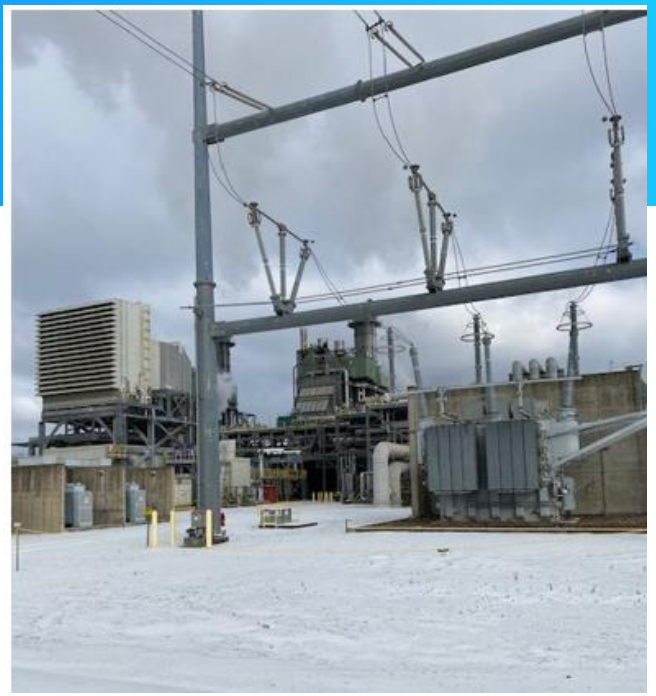
Conclusion:
A winter with a cold extreme (like February 2021) can be followed by another winter with an extreme cold period, but historically has never been quite as cold as the winter prior

NRG Cedar Bayou Unit 4
2021 Winter Preparation Success and Lessons Learned

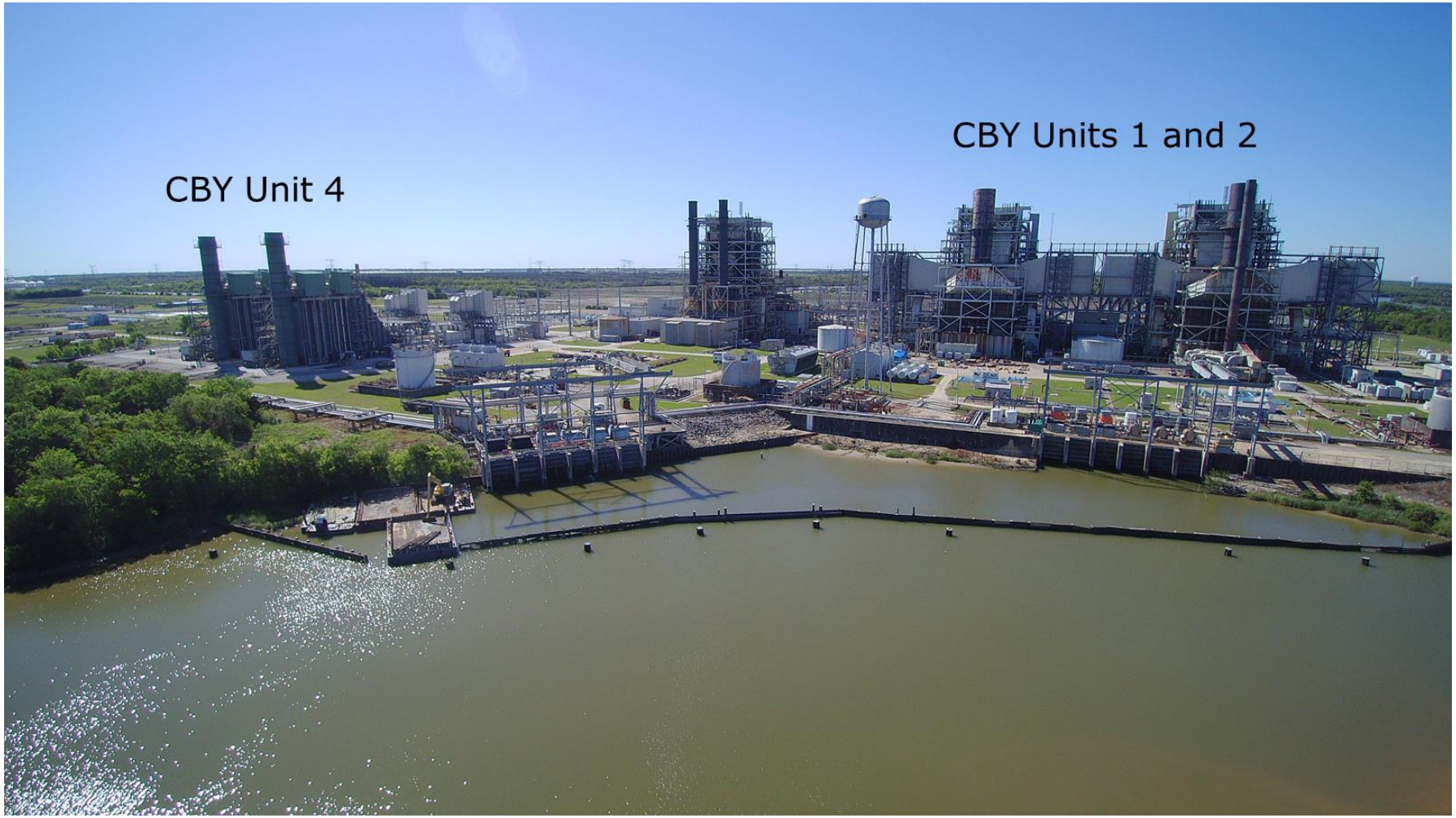
Presenter: Dave Wohleber, Operations and Maintenance Manager

September 30, 2021

- Location : Baytown, Texas (Houston)
- 600 MW 2x1 Combined Cycle Facility
  - 2 Siemens W501FD2 Gas Turbines
  - 1 Siemens KN Steam Turbine
- Commercial Date : June 2009



Cedar Bayou Site



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Safe Harbor

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Winter Storm Uri In Review

Winter Readiness Preparation

- Regional Process and Procedure review
- Personnel Training
- Plant Operational Readiness

What Went Well

- Unit Performance and Reliable generation during Winter Storm Uri
- Drum Enclosures, Heat tracing and Wind Breaks/ Inst. Cabinets, Equipment monitoring
- Right size staffing, employee accommodations, communications
- Safety – No injuries

Lessons Learned

- Improvements made prior to Winter Storm Uri
- 2021 Lessons Learned
- Long term scope

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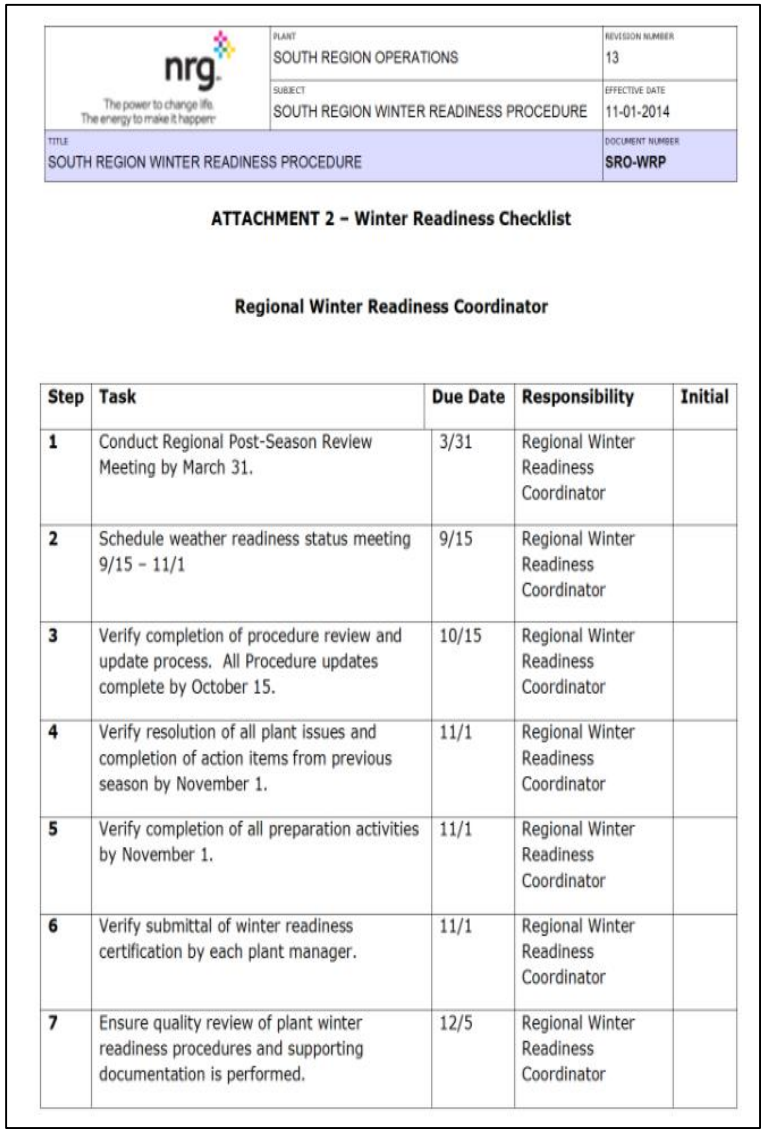
Winter Readiness Preparation

Regional Process and Procedure Review

- Winter Readiness refers to the preparation required to ensure reliable operation during winter weather emergencies
- Readiness period Nov. 1st – Mar. 31st
- Post Season Review
- Implementation of equipment or process improvements
- Winter Preparedness Matrix - Regional Coordinator
    - Review and Revision of Individual Plant Winter Readiness procedures
    - Supplies Staged, complete Heat Tracing checklists and Instrument Air Dewpoint meter calibration and daily checks recorded.
    - Winter Readiness Certification completed before the start of winter readiness (Nov. 1st)

Personnel Training

- Detailed Risk Assessment Plan (DRAP) process refresher
- Conservative Operations and Maintenance Alert (COMA) refresher
- Human Performance Reinforcement
- Employee winter weather preparations, site procedure review and safety refresher



nrg The power to change life. The energy to make it happen	PLANT: SOUTH REGION OPERATIONS	REVISION NUMBER: 13
	SUBJECT: SOUTH REGION WINTER READINESS PROCEDURE	EFFECTIVE DATE: 11-01-2014
TITLE: SOUTH REGION WINTER READINESS PROCEDURE		DOCUMENT NUMBER: SRO-WRP

ATTACHMENT 2 – Winter Readiness Checklist

Regional Winter Readiness Coordinator

Step	Task	Due Date	Responsibility	Initial
1	Conduct Regional Post-Season Review Meeting by March 31.	3/31	Regional Winter Readiness Coordinator	
2	Schedule weather readiness status meeting 9/15 – 11/1	9/15	Regional Winter Readiness Coordinator	
3	Verify completion of procedure review and update process. All Procedure updates complete by October 15.	10/15	Regional Winter Readiness Coordinator	
4	Verify resolution of all plant issues and completion of action items from previous season by November 1.	11/1	Regional Winter Readiness Coordinator	
5	Verify completion of all preparation activities by November 1.	11/1	Regional Winter Readiness Coordinator	
6	Verify submittal of winter readiness certification by each plant manager.	11/1	Regional Winter Readiness Coordinator	
7	Ensure quality review of plant winter readiness procedures and supporting documentation is performed.	12/5	Regional Winter Readiness Coordinator	

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Site Specific Winter Readiness Preparation

Plant Operational Preparedness

- Staffing Plan developed
- Equipment and System Reliability verification
  - Heat Tracing systems tested, and Freeze Protection checklists completed
  - Wind Breaks and enclosure erected
  - Portable and temporary heating staged and in-service
- Operational Procedural Affirmation
  - Environmental and System Equipment parameters and Critical Alarm responses reviewed
- Implementation of the COMA and DRAP processes
  - A detailed risk assessment shall be completed before any proposed work is performed
- Implementation of Lessons Learned from previous cold weather events
  - Steam Drum Enclosures, Heat tracing, Wind Break cabinets and Critical Equipment wind tarps (BFP, Ammonia and Aux. Cooling tower systems)

Detailed Risk Action Plan
(Complete in accordance with Section 18.5)

Plant:	Unit:	Date:	W.O.#
Issue to be Addressed:			
Risk Associated with the Issue: (include recent history of maint. activities on component(s))			
Risk Categories: (check all that apply)	□ Environmental Systems or Monitoring	□ Safety critical	
	□ Protective Relays	□ Unit trip circuits	
	□ DCS	□ Unit interlocks, and critical alarms	
	□ Generation critical system(s)	□ Vibration detection or disturbance	
	□ Failure to repair increases unit risk	□ Work adjacent to critical components or systems	
	□ Critical instruments, instruments with trip functions	□ Other	
Operational Risk of Completing Plan:			
Operational Risk of NOT completing Plan:			
Facts/Discussion: (prior DRAP issues w/ component)			
Plan of Action: (steps must be listed in checklist format)			
Job Duration:			
Challenges/Additional Resources Needed:			
Commercial Operations Discussion Completed:	Comm. Ops Discussion Required? (YES/NO)	Comm. Ops contact date:	Comm. Ops Contacted by:
	Discussion/Additional Information:		

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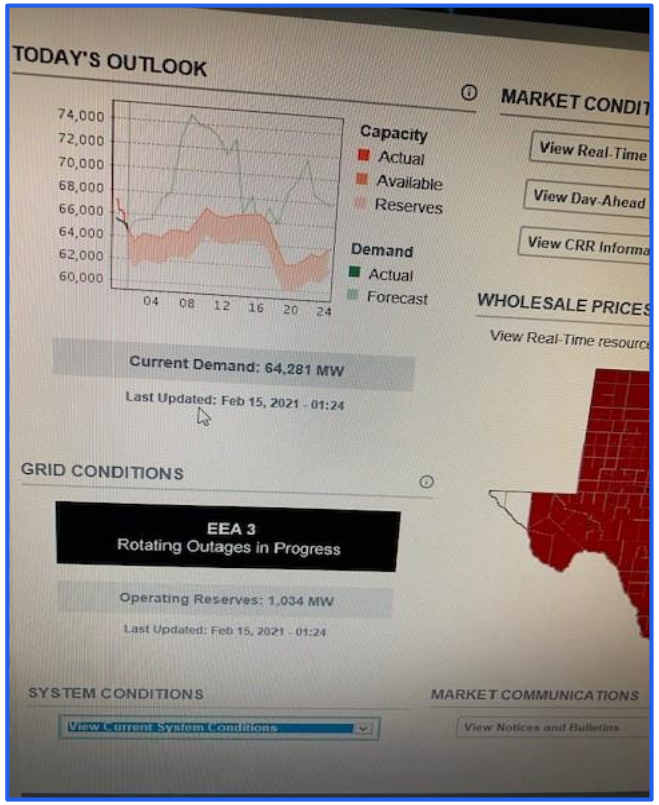
What Went Well

Notification of Pending Weather Event

- Early Implementation of Regional Weather Alert Process
- Additional Cold weather hardening initiatives due to expected duration and cold temps (Fig. #1)
- Reverification of portable heaters, Heat Tracing systems, checklist review, Wind Break and freeze protection enclosure integrity
- Early and often engagement with Supply Chain (Demin. Trailers & Chemicals)
- Early unit startup prior to temps dropping below 40^{F} and rain conditions to address Inlet IGV icing.(Fig.#2)
- Vendor and support staff identified to provide around the clock support
    - Local hotels and onsite sleeping accommodations, freezers and pantries full, individual employee preparations (family safety and well being , medications, etc.)
    - Challenges: Maintain Covid protocols throughout event
- Experienced Staff
    - Alarm Management, Detailed Shift turnover, Management in Control Room and Clear Communication, Positive and supportive Attitude
    - Increased frequency of operator rounds, and equipment checks



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What Went Well

Severe Winter Weather Alert Process

- Daily Conference calls Lead by Regional Coordinator
  - Attendees; Ops SVP, Reg. VP, Com Ops, Plant and Ops Mgr. and Support Staff
  - Safety, Environmental or Weather-Related Concerns
  - Staffing, Supplies and Freeze Protection update
  - Individual plant operational status

Fig. #1

Fig. #2

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Improvements made prior to Winter Storm Uri

HP, IP and LP Steam Drums – Site Specific Permanent Enclosures, Critical Equipment Instrumentation Heat Tracing and Installation of cabinets

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2021 Lessons Learned

Instrumentation Weatherization

- Some instrument cabinets allowed for rain to penetrate the internal cabinets which resulted in some transmitters to temporarily malfunction due to icing
    - We were able to thaw the cabinets out and install temporary heating while unit stayed online
- Currently we are weather sealing all cabinets and adding insulation to the internal surfaces in preparation for 2021 winter readiness

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2021 Lessons Learned

Instrumentation Weatherization

- Fabricate weather resistance insulation blankets for critical equipment instrumentation
  - Fuel gas yard and additional critical instrumentation such as control modules, positioners and valve actuators

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2021 Lessons Learned

Additional takeaways

- Elevated transmitter cabinets need supplemental insulation/heating
- Add roof tarps to existing Wind Breaks
- Additional freeze protection required in gas supplier flow monitoring station
- Increase consumables to support extended Freeze Events
- Stock more food in individual servings
- Exposed mechanical devices (linkages, valve stems, etc.) need to be protected from freezing precipitation buildup
- Remote plant systems that are fed by pole power (not directly from plant) may be subject to curtailment

2022 projects

- Inlet Bleed Heating to mitigate IGV icing
- Heat Tracing Temperature monitoring at DCS
    - Replace current Power Panel with a Control Panel that will allow for individual system monitoring (temps. and Amps)

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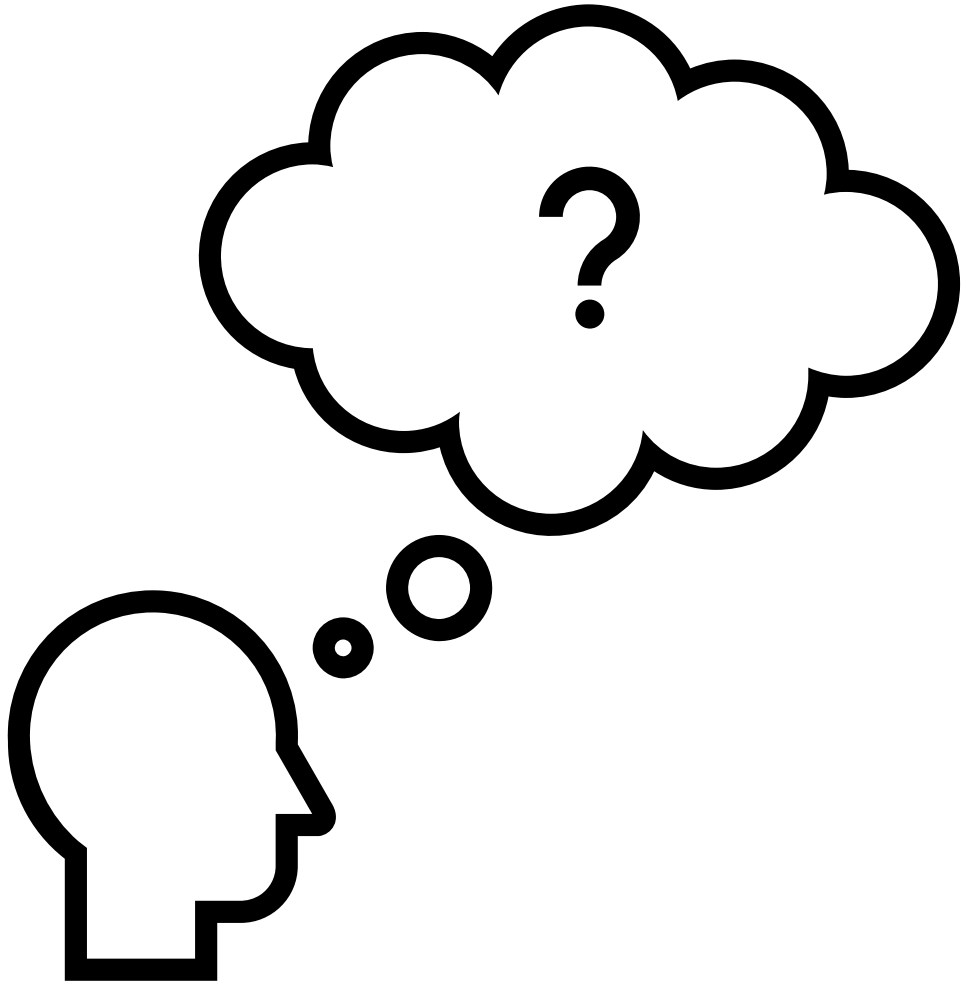
Questions?



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ERCOT Update

Jeff Billo
2021-22 Winter Weatherization Workshop
September 30, 2021

ERCOT Stakeholder Process Response to Uri

- The Technical Advisory Committee (TAC) created a 128-item list of issues to be addressed

Item #	Abbreviated Description	Status
2	Increase coordination between the Texas Energy Reliability Council and ERCOT's Gas Electric Working Group to identify critical gas facilities	Public Utility Commission (PUC) projects 51839 and 51888
5	Improve Outage Scheduler timing and information	In progress
6	Improve resource telemetry accuracy and frequency of updates	In progress
34	Review availability of blackstart units and identify potential process improvements, including fuel supply or on-site storage	In progress
35	Review communication during a natural gas supply emergency	In progress
40	Review ERCOT's emergency response plan and ERCOT's role in emergency preparedness	PUC project 51841
95	Evaluate the costs, benefits, and constraints of dual fuel and on-site fuel storage	Not started

The above is a sample from the TAC Emergency Conditions List; for the full list see: http://www.ercot.com/committee/tac

Previous Years: Winter Spot Checks

- In previous years, ERCOT performed on-site visits of generation units to help plant personnel verify winter readiness and share industry best practices.
  - ERCOT visited approximately 80 units per year
  - Spot checks occurred from approximately mid-November through the end of February
  - Winter 2020-2021 visits were held virtually due to COVID concerns

Regulatory Changes

- Earlier this year the Legislature passed Senate Bill 3 (SB3), which was signed into law on June 8, 2021
- Among other things, SB3 requires the following:
  - The Public Utility Commission (PUC) to develop mandatory weatherization reliability standards for generation and transmission facilities within six months
  - ERCOT, as the Independent Organization, to perform inspections of these facilities for compliance with these standards
  - Failure to comply with the standards can result in a fine of up to $1 million per day
- The PUC decided to split the standard development into two phases
- On August 26, the PUC posted a “Proposal for Publication” or PFP describing the Phase 1 draft weatherization rule changes
  - https://interchange.puc.texas.gov/search/documents/?controlNumber=51840&itemNumber=68

Highlights of *Draft* PUC Weatherization Rule for Phase 1

- Includes Phase 1 weatherization requirements for winter 2021-2022
  - Phase 2 requirements and timeline are TBD
- Requires all generators to:
  - Perform certain winter readiness preparations,
  - Submit a winter readiness report to the PUC and ERCOT by December 1, and
  - Submit a winter readiness attestation to the PUC and ERCOT by December 1
- Requires ERCOT to:
  - Report to the PUC on generator (and transmission service provider) compliance with December 1 deadline, and
  - Inspect generators (and transmission service providers) for compliance with preparation requirements

Draft PUC Weatherization Standard for Generation

Draft PUC Substantive Rule 25.55 (c)(1):

(1) By December 1, 2021, a generation entity must complete the following winter weather emergency preparations for each resource under its control:

(A) All preparations necessary to ensure the sustained operation of all cold weather critical components during winter weather conditions, such as chemicals, auxiliary fuels and other materials, and personnel required to operate the resource;

(B) Installation of adequate wind breaks for resources susceptible to outages or derates caused by wind; enclosure of sensors for cold weather critical components; inspection of thermal insulation for damage or degradation and repair of any damaged or degraded insulation; confirmation of the operability of instrument air moisture prevention systems; maintenance of freeze protection components for all equipment, including fuel delivery systems, the failure of which could cause an outage or derate, and establishment of a schedule for testing of such freeze protection components on an ongoing monthly basis; and the installation of monitoring systems for cold weather critical components, including circuitry providing freeze protection or preventing instrument air moisture;

(C) All actions necessary to prevent a reoccurrence of any cold weather critical component failure that occurred in the period between November 30, 2020, and March 1, 2021;

(D) Provision of training on winter weather preparations to operational personnel; and

(E) Determination of minimum design temperature, minimum operating temperature, and other operating limitations based on temperature, precipitation, humidity, wind speed, and wind direction.

Draft PUC Weatherization Attestation for Generation

Draft PUC Substantive Rule 25.55 (c)(2):

(2) By December 1, 2021, a generation entity must submit to the commission and ERCOT, on a form prescribed by ERCOT and developed in consultation with commission staff, a winter weather readiness report that:

(A) Describes all activities taken by the generation entity to complete the requirements of paragraph (1) of this subsection; and

(B) Includes, a notarized attestation sworn to by the generation entity's highest-ranking representative, official, or officer with binding authority over the generation entity, attesting to the completion of all activities described in paragraph (1) of this subsection and the accuracy and veracity of the information described in subparagraph (2)(A) of this subsection.

ERCOT 2021-2022 Winter Inspections

- ERCOT will inspect facilities on site and in accordance with the PUC rule
- ERCOT is targeting the following based on the draft PUC rule:
  - Complete all inspections between December 6-24
  - Complete any inspection follow-up in January
  - Expecting to complete approximately 250 unit inspections
    - Based on risk, including facilities that tripped during weather emergencies
    - Could include wind and solar units
- ERCOT issued a Request For Proposal to obtain contractor help with timely completion of inspections

Looking Ahead

- The PUC will finalize the Phase 1 weatherization rules in November and begin drafting Phase 2 weatherization rules shortly thereafter
- At the request of the PUC, ERCOT is conducting a weather study to identify historic weather statistics by region (weather zone)
- ERCOT is adding staff to be able to handle a larger inspection program going forward

Questions?

ercot

TEXAS RE

Ensuring electric reliability for Texans

Winter Weatherization Workshop

Wrap-up

SurveyMonkey