Agenda for the Fifth Annual ERCOT and Texas RE

Generator Weatherization Workshop

For winter 2017/2018

September 7, 2017

Beginning Time	End Time	Description	Presenter
08:00	08:15	Introductory Remarks	Woody Rickerson, Vice President, Grid Planning & Operations, ERCOT
08:15	08:30	Update on the NERC Reliability Guideline: Generating Unit Winter Weather Readiness – Current Industry Practices.	Texas RE – Mark Henry Mark.Henry@TEXASRE.org
08:30	09:00	Improvements to ensure reliability during extreme cold weather.	Channelview Co-Gen – Mike Moyer and Conyers Horton mmoyer@ppmsllc.com conyers.horton@worleyparsons.com
09:00	09:15	Break	
09:15	09:45	Lessons learned and improvements to protect instrumentation from freezing.	Todd Bading – Plant engineer, Tenaska Frontier Plant tbading@tenaska.com
09:45	10:15	Overview of CPS Energy on improvements to their fleet for winter preparations.	James E. Richardson, CPS Energy Richardson, James E. jerichardson@cpsenergy.com
10:15	10:30	Break	
10:30	11:00	Lessons learned and how generators have progressed with weatherization.	Alan H. Allgower, ERCOT alan.allgower@ercot.com
11:00	11:45	Preliminary winter outlook 2017-2018.	Chris Coleman, ERCOT chris.coleman@ercot.com
11:45	12:00	Closing comments	Alan Allgower, ERCOT

TEXAS RE
Ensuring electric reliability for Texans

NERC and Texas RE Update

Mark Henry
Reliability Services, Texas Reliability Entity

ERCOT/Texas RE Generator Winter Weatherization Workshop

September 7, 2017

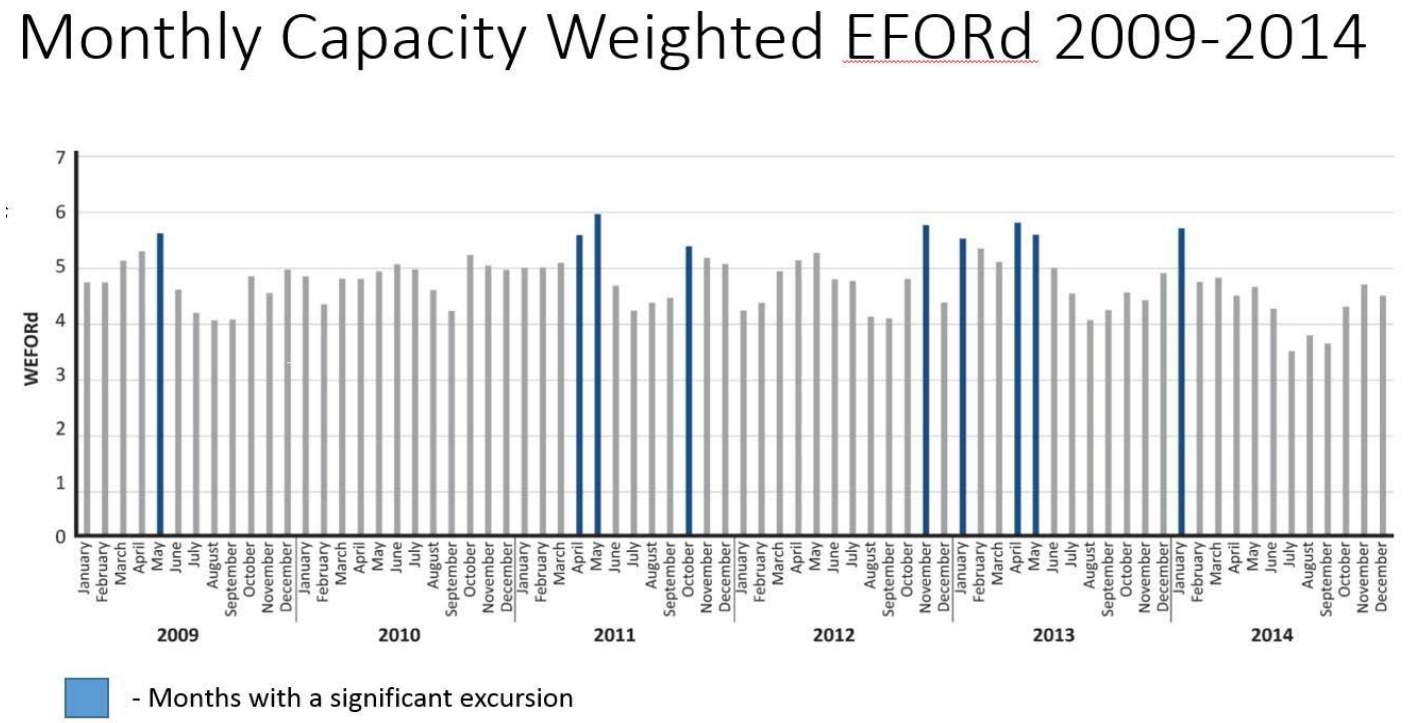
NERC Reliability Metric 6 – Reduced Risks in Targeted Areas

Measure of Success

Item a: Events caused by generating unit forced outages due to cold weather

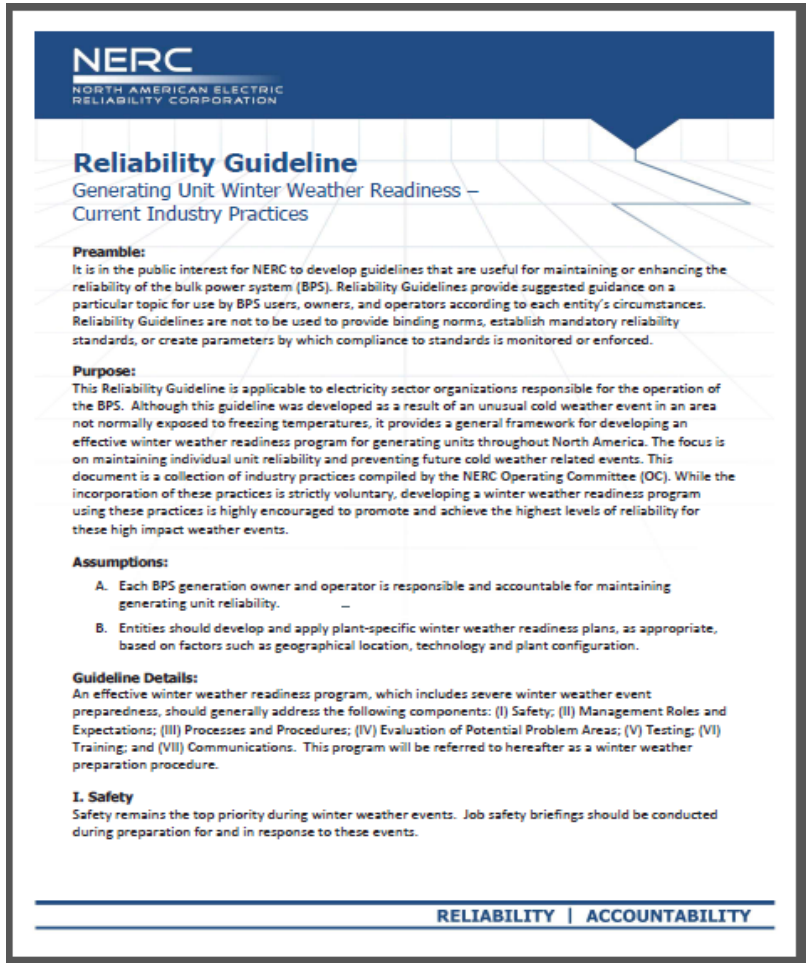
Threshold - No firm load shed occurs from generating unit forced outages caused by cold weather.

Target - Using most extreme cold winter months, the Effective Forced Outage Rate (EFOR) decreases compared to a rolling previous five year benchmark average for each Regional Entity.



NERC Winter Weather Readiness Guideline

- Approved by the Operating Committee on March 5, 2013
- 5 year review by team from industry, NERC, and Regional Entities
- Posted for comments, final review for Operating Committee approval in September 2017



NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Reliability Guideline

Generating Unit Winter Weather Readiness – Current Industry Practices

Preamble:
It is in the public interest for NERC to develop guidelines that are useful for maintaining or enhancing the reliability of the bulk power system (BPS). Reliability Guidelines provide suggested guidance on a particular topic for use by BPS users, owners, and operators according to each entity's circumstances. Reliability Guidelines are not to be used to provide binding norms, establish mandatory reliability standards, or create parameters by which compliance to standards is monitored or enforced.

Purpose:
This Reliability Guideline is applicable to electricity sector organizations responsible for the operation of the BPS. Although this guideline was developed as a result of an unusual cold weather event in an area not normally exposed to freezing temperatures, it provides a general framework for developing an effective winter weather readiness program for generating units throughout North America. The focus is on maintaining individual unit reliability and preventing future cold weather related events. This document is a collection of industry practices compiled by the NERC Operating Committee (OC). While the incorporation of these practices is strictly voluntary, developing a winter weather readiness program using these practices is highly encouraged to promote and achieve the highest levels of reliability for these high impact weather events.

Assumptions:

A. Each BPS generation owner and operator is responsible and accountable for maintaining generating unit reliability.

B. Entities should develop and apply plant-specific winter weather readiness plans, as appropriate, based on factors such as geographical location, technology and plant configuration.

Guideline Details:
An effective winter weather readiness program, which includes severe winter weather event preparedness, should generally address the following components: (I) Safety; (II) Management Roles and Expectations; (III) Processes and Procedures; (IV) Evaluation of Potential Problem Areas; (V) Testing; (VI) Training; and (VII) Communications. This program will be referred to hereafter as a winter weather preparation procedure.

I. Safety
Safety remains the top priority during winter weather events. Job safety briefings should be conducted during preparation for and in response to these events.

RELIABILITY | ACCOUNTABILITY

NERC Winter Weather Readiness Guideline Update – Details

Assumptions Section Addition

Item b : Balancing Authorities and Market Operators should consider strategies to start-up and dispatch to minimum load early and anticipate severe cold weather units that are forecasted to be needed for the surge in demand, since keeping units running through exceptional cold snaps can be accomplished much more reliably than attempting start-up in the teeth of such event.

Photo: Erik Pederson/Kelly Aerospace

NERC Winter Weather Readiness Guideline Update – Details

Section 1, Safety:

Typically, robust safety programs to reduce risk to personnel include identifying hazards involving cold weather such as personnel exposure risk, travel conditions, and slip/fall issues due to icing. **A Job Safety Analysis (JSA) should be completed to address the exposure risk, travel conditions and slip/falls related to icing conditions. Winter weather Alerts should be communicated to all impacted entities. A Business Continuity and Emergency Response Plan should also be available and communicated in the event of severe winter weather event.**

Guideline Update Details – Continued

Section IV, Evaluation of Potential Problem Areas:

- **Subsection 1 and 2 – Add the word “critical” in several places related to instrumentation, equipment and components**

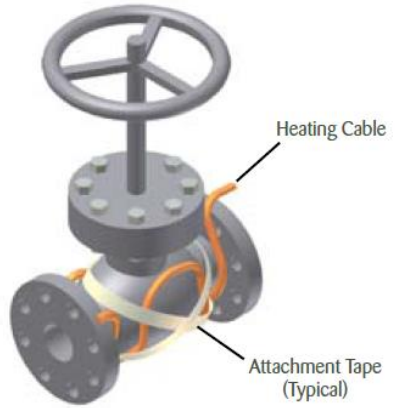
- **New Subsection 2d on Instrument Air System, to assure:**
  - Automatic blow downs, traps, dew point monitoring and instrument air dryers are functioning correctly
  - Low points in lines are periodically drained by operators to remove moisture during extreme cold

Photo: iStock

Guideline Update Details – Continued

Attachment 1, Section 3B, Heat Trace – additions

- Inspection of heat tracing installations covered by insulation
  - Extra cable length specified by the designer meant to be bunched at valves and supports, not applied as a constant-pitch spiral over the length of the line.



Heating Cable Serpentined on Valve

- Require heat tracing calculations from the ***contractor***
  - Reference to heat tracing calculations IEEE Standard-515
  - Valve bonnets, actuators and pipe supports should reflect actual insulation conditions; they may not be fully encapsulated with insulation, which could lead to mismatch.


Circuit Layout on Valve

Guideline Update Details – Continued

Attachment #1, updates to Item 4, Supplemental Materials List

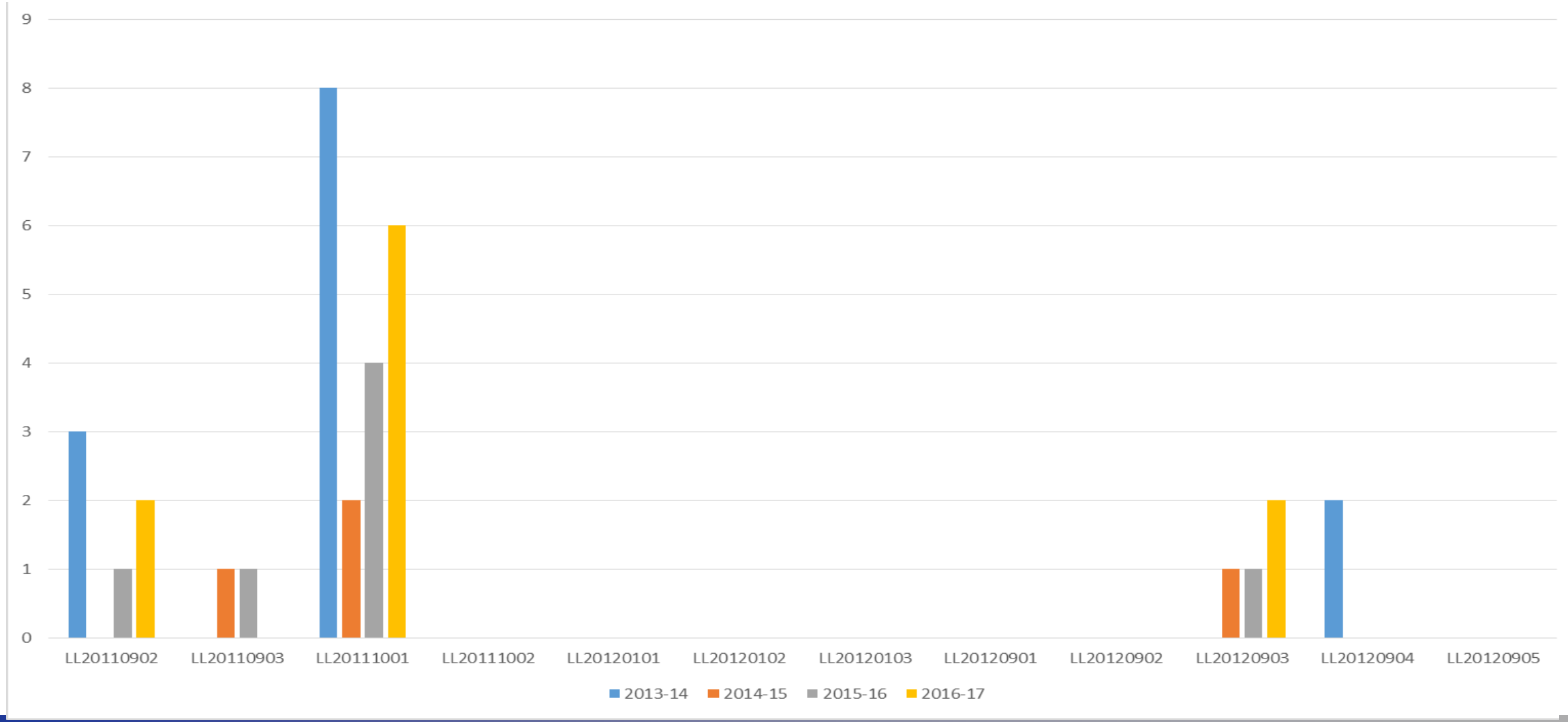
- **Item p**: Cold weather Personal Protective Equipment (PPE) has been inspected and is available to personnel as appropriate**.**

- **Item q:** Service vehicles to ensure they are properly winterized and that the 4WD is functioning.

12 Winter Weather-Related Lessons Learned

- LL20110902 Adequate Maintenance and Inspection of Generation Freeze Protection
- LL20110903 Generating Unit Temperature Design Parameters and Extreme Winter Conditions
- LL20111001 Plant Instrument and Sensing Equipment Freezing Due to Heat Trace and Insulation Failures
- LL20111002 Plant Fuel Switching and Cold Weather
- LL20120101 Plant Onsite Material and Personnel Needed for a Winter Weather Event
- LL20120102 Plant Operator Training to Prepare for a Winter Event
- LL20120103 Transmission Facilities and Winter 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

Observed Issues by Texas RE Since Lessons Learned Published



Questions?

Thanks to Bob Collins for support.

Contacts for further information:
Bob Collins (512-583-4986)
Mark Henry (512-583-4988)

Email:
rapa@texasre.org

Photo: iStock

Channelview Cogeneration

Winter Weatherization Review

EIF Channelview Cogeneration, LLC

Presented by Conyers Horton & Mike Moyer

Channelview Cogeneration

Presentation Overview

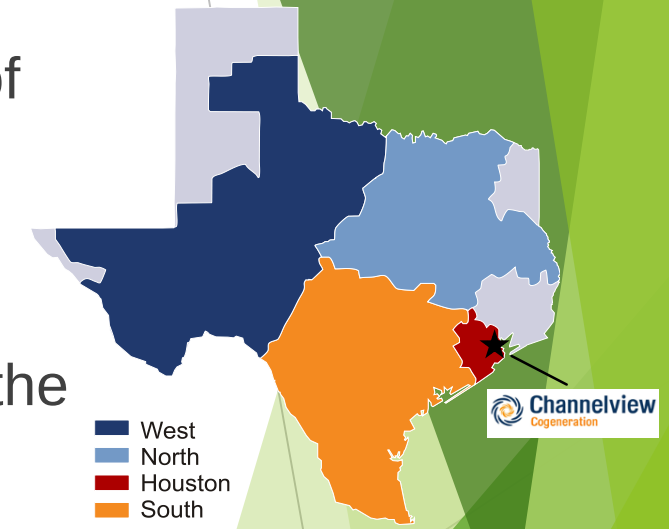
- Description of the Facility
- Results from the 2015 ERCOT Winter Weatherization Spot Check
- Areas of Improvement

- Plant Winter Weatherization Procedure

Channelview Cogeneration

EIF Channelview Cogeneration, LLC

- Located in Channelview, TX
- The site is a Combined-Cycle Cogeneration plant consisting of four Siemens 501FD2 Combustion Turbine/ Nooter-Eriksen HRSG trains that feed an Alstom Steam Turbine Generator
- Total plant output is 830 MW's
- The site is electrically interconnected to the Houston Zone of the ERCOT Wholesale Electric Market via 345kV and 138kV connections.
- The plant is a QF facility to a neighboring chemical plant meeting their steam and electrical requirements



Channelview Cogeneration

EIF Channelview Cogeneration, LLC

- Commercial Operation Date
  - Unit 4 – August 2001
  - Units 1,2,3,5 – June 2002
- Plant Construction
  - HB Zachary
  - Construction began end of 1999

Channelview Cogeneration

Results from the 2015 ERCOT Winter Weatherization Spot Check

- Wrong type of Tarps & Blankets
- Heat Trace panel screens were unreadable
- Heat Trace not functioning properly (open circuits)
- Exposed Heat Trace cables (uninsulated)
- Gaps in insulation
- Plant Procedure needed work

Channelview
Cogeneration

Channelview Cogeneration

Plant Winter Weatherization Procedure

- The Winter Weather Procedure OP 11.00 covers:
- Freeze Alert Level One – which starts when the temperature drops below 45 degrees F and the forecast indicates the temperature will remain below 32 degrees F for 2 to 3 hours but will rise significantly above 32 degrees F the following day.
- Freeze Alert Level Two – which starts when the temperature is below 28 degrees F for 4 to 12 hours.
- Annual Training

Channelview
Cogeneration

Channelview Cogeneration

Annual Training

- Review the Plant Procedure (OP 11.00)
- Discuss what to look for during Plant rounds
- Review Checklists
- Review past winter incidents
- Documented with a sign off sheet

Channelview
Cogeneration

Channelview Cogeneration

Plant Winter Weather Procedure

- Responsibilities
  - The Operations Manager and the Maintenance Manager are responsible for designating personnel for freeze protection duty
  - It is the responsibility of all personnel to exercise good judgement in the performance of this procedure
  - Channelview Operations and the Steam Host will communicate with each other when unusual conditions exist that may affect the operation of either facility

Channelview
Cogeneration

Channelview Cogeneration

Attachments to the Winter Weatherization Procedure (OP 11.00)

- Heat Trace Circuit Inspection Sheet
- Critical Instrument List
- Cold Weather Preparedness List
- Winter Weather Insulation List
- Main Power Transformer Oil Level Record Sheet
- Cabinet Temperature Round Sheet

Channelview Cogeneration

Attachment 1 – Heat Trace Circuit Inspection Sheet

CKT. #	DWG. #	FP #	PANEL #	AMPS	COMMENTS
M1C01	WILRE355	1FP013	U1H1-P1	5.5	
M1C01	WILRE377	NOT USED			
M1C01	WILRE390	1FP041	U1H1-P1	0.6	
M1C01	WILRE396	1FP068	U1H1-P1	0.6	
M1C03	WILRE352	1FP004	U1H1-P1	2.4	
M1C03	WILRE355	1FP007	U1H1-P1	1.5	
M1C03	WILRE385	1FP054	U1H1-P1	4.4	
M1C03	WILRE390	1FP061	U1H1-P1	2.2	
M1C03	WILRE414	1FP117	U1H1-P1	1.7	
M1C04	WILRE433	1FP019	U1H1-P1	3.5	

Channelview Cogeneration

Attachment 2 – Critical Instrument List

sl_tag_number	description	primary_drawing_number	Insulated	Heat Traced	Wind Break
0FT-CD202	COND PMP DSCH HDR FLOW	M-104-1	X	X	
0FT-LW203A	LP STM TO EQ FLOW A	M-102-2	X	X	
0FT-LW203B	LP STM TO EQ FLOW B	M-102-2	X	X	
0FT-MS207A	HP STM TO EQ FLOW A	M-102-1	X	X	
0FT-MS207B	HP STM TO EQ FLOW B	M-102-1	X	X	
0FT-MU211A	LPFP A DISCH FLOW	M-107-1	X	X	
0FT-MU211B	LPFP B DISCH FLOW	M-107-1	X	X	
0FT-MU211C	LPFP C DISCH FLOW		X	X	
0LT-CD211A	CNSR HW LVL A	M-104-1	X	X	
0LT-CD211B	CNSR HW LVL B	M-104-1	X	X	
0LT-CD211C	CNSR HW LVL C	M-104-1	X	X	
0LT-MU204A	COND STOR TK LVL A	M-107-1	X	X	
0LT-MU204B	COND STOR TK LVL B	M-107-1	X	X	
0LT-MU204C	COND STOR TK LVL C	M-107-1	X	X	
0LT-MU209A	COND RTRN TK LVL A	M-107-1	X	X	
0LT-MU209B	COND RTRN TK LVL B	M-107-1	X	X	
0LT-MU209C	COND RTRN TK LVL C	M-107-1	X	X	
0PIT-WC201A	AUX WTR PMP A DSCH PRESS	M-105-1	X	X	
0PIT-WC201B	AUX WTR PMP B DSCH PRESS	M-105-1	X	X	
0PT-AD201A	AD STM PRESS A	M-102-2	X	X	
0PT-AD201B	AD STM PRESS B	M-102-2	X	X	

Channelview Cogeneration

Cold Weather Preparedness List

- Tarps
- Portable Heaters & Heat Lamps
- Propane
- Temporary Insulation
- Portable Lighting
- Instrumentation Tubing
- Temporary Heat Trace
- Extension Cords
- Hand Warmers

Channelview Cogeneration

Attachment 3 – Cold Weather Preparedness List

	Units	Qty Required	Qty On Hand	Inventoried By:
Tarps	Each	20		
Portable heaters				
480VAC	Each	2		
110VAC	Each	3		
Propane	Each	3		
Heat lamps	Each	18		
Drop Lights	Each	12		
Extension cords				
480VAC	Each	4		
110VAC	Each	18		
Propane				
Cylinders	Each	6		
Bottles	Each	20		
Temporary insulation	Boxes	2		
Plastic rolls	Each	1		
Portable lighting	Each	10		
Instrumentation tubing				
1/4"	Feet	90		
3/8"		60		
1/2"	Feet	60		
Handheld welding torches	Each	6		
Diesel	Barrels	4		
Temporary Heat Trace	Each	8		
Ear protection	Each	30		
Hand Warmers	Each	50		

Channelview Cogeneration

Attachment 4 – Winter Weather Insulation List

Insulation Satisfactory (Y/N	sl_tag_number	description	drawing_number
	0FT-CD202	COND PMP DSCH HDR FLOW	M-104-1
	0FT-LW203A	LP STM TO EQ FLOW A	M-102-2
	0FT-LW203B	LP STM TO EQ FLOW B	M-102-2
	0FT-MS207A	HP STM TO EQ FLOW A	M-102-1
	0FT-MS207B	HP STM TO EQ FLOW B	M-102-1
	0FT-MU211A	LPFP A DISCH FLOW	M-107-1
	0FT-MU211B	LPFP B DISCH FLOW	M-107-1
	0FT-MU211C	LPFP C DISCH FLOW	
	0LT-CD211A	CNSR HW LVL A	M-104-1
	0LT-CD211B	CNSR HW LVL B	M-104-1
	0LT-CD211C	CNSR HW LVL C	M-104-1
	0LT-MU204A	COND STOR TK LVL A	M-107-1
	0LT-MU204B	COND STOR TK LVL B	M-107-1
	0LT-MU204C	COND STOR TK LVL C	M-107-1

Channelview Cogeneration

Attachment 5 – Main Power Transformer Oil Level Record Sheet

Transformer	Oil Temperature	Oil Level	Level Satisfactory (Y/N)
MPT 1			
MPT 2			
MPT 3			
MPT 4			

Inspector:	
Date:	

Channelview Cogeneration

Attachment 6 – Cabinet Temperature Round Sheet

UNIT	CABINET	LEVEL	LOCATION	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP
				6:00	9:00	12:00	15:00	18:00	21:00	0:00	3:00
STEAMER	0ST1	GROUND	EAST OF UNIT BY CONDENSATE PUMPS								
STEAMER	0ST2	GROUND	EAST OF UNIT BY CONDENSATE PUMPS								
STEAMER	0ST3	GROUND	SOUTH OF UNIT								
STEAMER	0ST4	GROUND	SOUTH OF UNIT								
STEAMER	0ST5	GROUND	SOUTH OF UNIT								
UNIT 1	1FW1	GROUND	NORTH OF UNIT BY BFW PUMP 1B								
UNIT 1	1FW2	GROUND	NORTH OF UNIT BY BFW PUMP 1B								
UNIT 1	1FW3	GROUND	NORTH OF UNIT BY BFW PUMP 1B								
UNIT 1	1FW4	GROUND	BY BLOWDOWN TNK								
UNIT 1	1FW5	GROUND	NORTH OF UNIT BY BFW PUMP 1A								
UNIT 1	1FW6	GROUND	NORTH OF UNIT BY BFW PUMP 1B								

Channelview Cogeneration

Summary

- Over $173,000 in improvements
- Updated Winter Weatherization Plant Procedure
- Improvements to the Heat Trace System
- New silver tarps, blankets and insulation
- Revised Annual Training

TENASKA® FRONTIER GENERATING STATION

Weatherization Program

Todd A. Bading, P.E., Plant Engineer

ERCOT Workshop, Fall 2017

September 7, 2017

About Tenaska

- Develops, constructs, owns and operates electric generating plants
  - Developed approximately 9,000 megawatts (MW) in 16 domestic and international projects (capable of serving about 9 million homes)
- Markets natural gas, electric power and biofuels
- Manages private equity investments
- Engages in natural gas exploration and production
- Headquarters in Omaha, Nebraska
  - Regional offices in Dallas, Denver, Pittsburgh
  - Calgary and Vancouver, Canada
- Approximately 700 employees
- Private Company / Employee owned

Tenaska Frontier Overview

- 830 MWs (~ 650,000 Texas homes); Peak over 900 MWs
- COD in Fall 2000 (17 years)
- Zero lost-time injuries since the start of commercial operation; over 1 million hours
- Filed for OSHA VPP Star status; 28 employees

Generating Equipment

- 3 X 1 Combined Cycle Power Plant
- 3 GE Model 7FA dual fuel combustion turbine-generator sets (rated at 164 MW each)
- 1 GE Model D11 steam turbine-generator set (rated at 391 MW)

Electric Power Delivery

Dual-grid capability

- Electric Reliability Council of Texas (ERCOT)
- SERC Reliability Corporation (SERC)

QSE: Constellation, An Exelon Company

Reliability: 97% in 2016 contract year

TENASKA FRONTIER GENERATING STATION

1. Two 345 kV transmission lines pass through the site to carry electricity to customers.
   a. Carries power to ERCOT
   b. Carries power to the Eastern Interconnect

2. Three natural gas-fired turbines drive three electric generators. The heat produced by the turbines passes over tubes to make steam in the Heat Recovery Steam Generator.
   a. Gas turbine generator
   b. Heat Recovery Steam Generator

3. The steam-powered electric generator increases power output.

4. Water from Huntsville is used to cool the facility and operate a steam-powered electric generator. Circulating water is evaporated and cooled in a cooling tower and recycled several times before being replaced in the cooling cycle.

5. Office/Control Building

6. Fresh water pumped to the site is stored. Purified water is used in the steam generation process and stored separately. The water treatment building houses purifying equipment.
   a. Purified water
   b. Fresh water storage
   c. Water treatment building

7. Back-up fuel oil is stored should natural gas delivery be interrupted.
   a. Fuel oil tank
   b. Fuel oil off-loading station

January 7th, 2017 Cold Weather Event:

Around 07:00 am, ambient was 17 DegF

Plant Load was 885 MWs

Freezing temperatures for 33 consecutive hours

Frontier Plant stayed on-line / did not trip.

Failed Transmitters from January 7th, 2017 Cold Weather Event

Heat Recovery Steam Generator (HRSG) / Steam Systems

- Low Pressure (LP) Drum
  - Level Transmitter (LT) ‘C’
- LP Super Heater (SH) outlet
  - Pressure Transmitter (PT)
- Intermediate Pressure (IP)
  - Boiler Feed Water (BFW) PT
- IP SH outlet Flow Transmitter (FT)
- IP BFW FT to drum
- HP drum LT ‘C’
- HP drum PT ‘C’
- Condensate to LP Economizer FTs

Cause & Remediation of Failed Transmitters:

- IP BFW PT - Original cloth tape & plaster on the sensing lines needs newer insulation to be tightened up. Add layer of new insulation & weak solution of antifreeze to sensing lines. Complete.

- HP drum LT ‘C’ - Insulation is not made up in 2 places along sensing line at transmitter allowing cold air to enter. Recommend sensing line & transmitter with weak solution of antifreeze. Long term replace tubing with larger pipe.

- LP SH outlet PT- Pipe is plugged & needs replacement. Add new heat trace, insulation & diluted antifreeze solution after replacement. Complete.

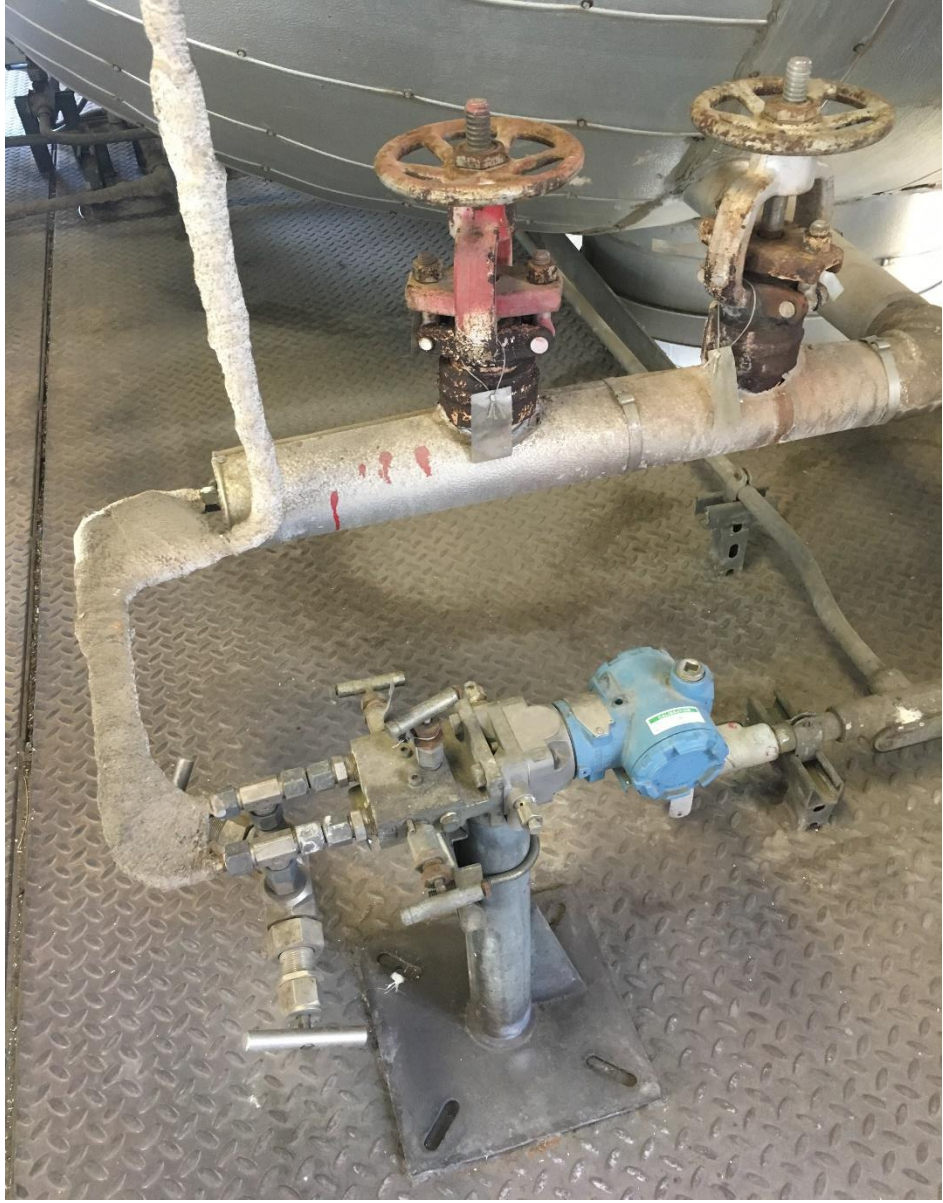
Corrections / Remediation continued.

- IP SH outlet FT- No heat trace (HT). Recommend new heat trace & insulation. Antifreeze at transmitter. Complete.

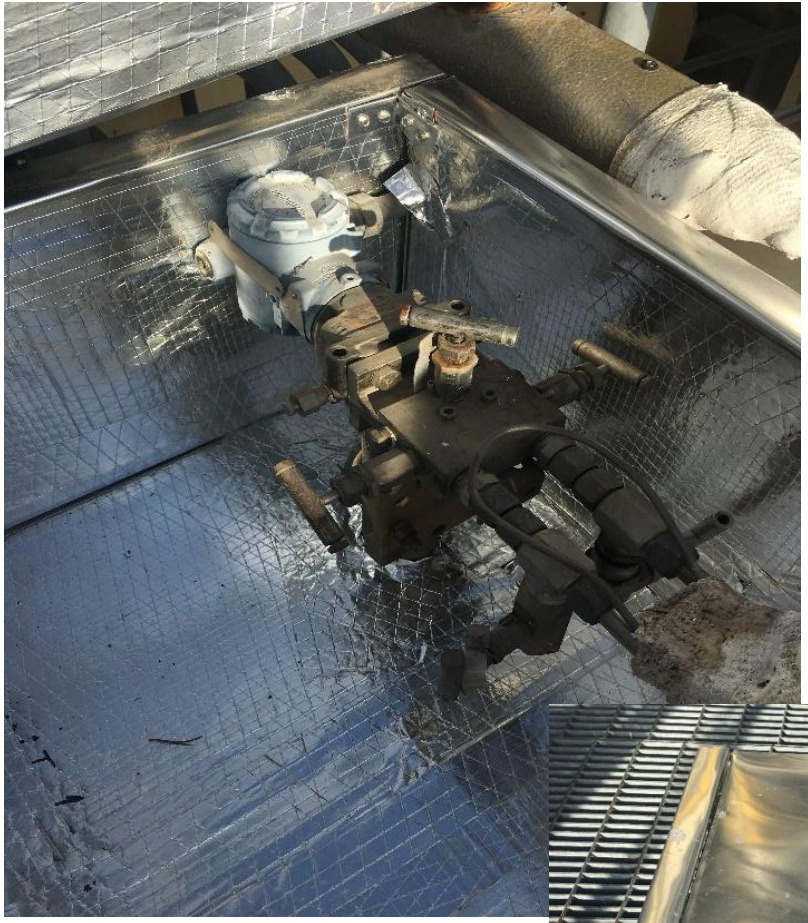
- IP BFW flow to drum - Operators have covered with tarp & installed a temporary lamp. Long term replace tape insulation with thicker new insulation. Antifreeze at transmitter. Complete.

- HP drum PT 'C' – Limited insulation. Removed to examine small steam leak. Fix leak & replace insulation. Complete.

- Condensate to LP economizer FTs – Insulation missing at bottom of mezzanine on west side. Complete.



HP, IP & LP Drum LT ‘A”&’B’



HP, IP & LP
Drum LT ‘C”

& IP BFW FT
to drum

After Jan.7th event


STEAM RELIEF VENT
LP STEAM


LP STEAM

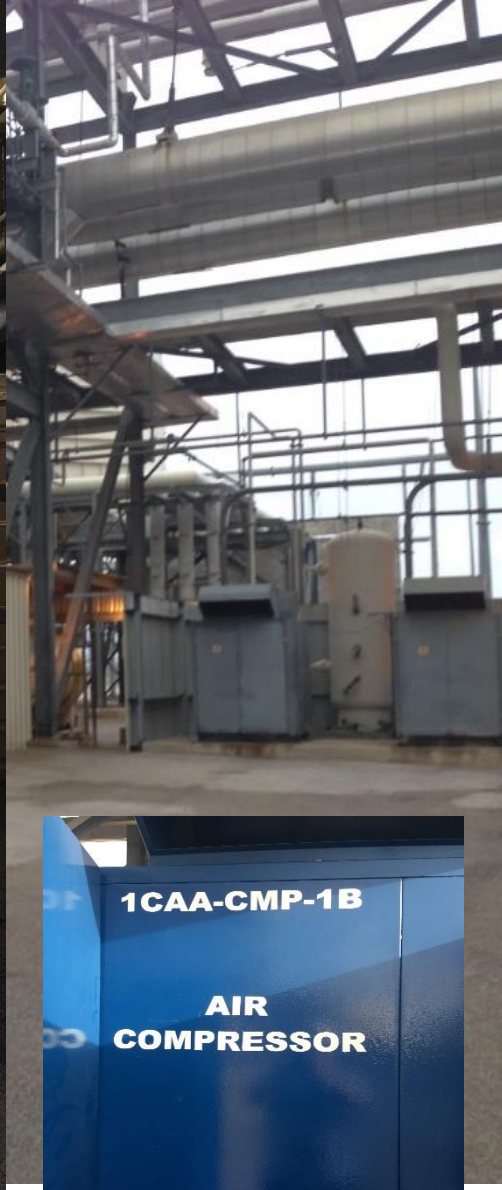
HRSG Transmitters & Heat Trace Panel

HRSG Transmitter Banks


Temporary Winter Shelters for HRSG Transmitter Banks
Permanent Shelter for Desiccant Compressed Air Dryers
Removable walls around Compressors

Temporary Winter Shelters
for HRSG Transmitter Banks

Temporary Winter Shelters for HRSG
Transmitter Banks with heat lamps inside




1CAA-CMP-1B
AIR
COMPRESSOR

ERCOT (Winter) Weatherization Spot Check Audit (late Jan. 2017)

ERCOT Recommendations:

- Per PUCT Rule 2553 Section B, a list of Critical Failure Points (Critical Equipment) within the facility should be developed.
- Under the same PUCT Rule, Alternate Fuel Testing should be considered before each Winter season or at least verification of proper operation of the critical components should be documented.
- Operating Procedure for Cold Weather Operations should be reviewed by the Plant Management, Operations and Maintenance groups.
- Weatherization of Plant Instrument Air Systems, Fuel Oil Operating Procedure and the Generator Set-Up transformer oil levels should be reviewed as well.
- During annual heat trace systems' audit, record the amperage readings to compare to previous year(s) for degradation.

Tenaska Frontier Generating Station
Tenaska Frontier Partners, Ltd.
Emergency Operations Plan Summary

Purpose:

The purpose of this summary is to provide documentation for the Public Utilities Commission of Texas (PUCT) - Project No. 34202, § 25.53 (b), (c), which in part, requires that power generation companies (PGCs), as a market entity operating in the state of Texas file a plan or summary of their plan for emergency operations. The initial filing date was May 1, 2008, and subsequent filings are required for any plan changes, no later than 30 days following the changes.

Description of Plan:

Tenaska Frontier Generating Station maintains comprehensive plans and programs that address various types of emergency operating conditions or scenarios, involving plant personnel, equipment, as well as, the potential effects to the surrounding environment and /or the neighboring community that may be caused by an emergency situation.

Types of emergencies include, but are not limited to:

- Loss of generation and recovery due to equipment failure / malfunction
- Weather related (i.e. tornados, hurricanes, freezes, etc.)
- Hazardous materials spill / Environmental release
- Fire and Explosion
- Terrorist acts or threats
- Cyber attack

Tenaska Frontier Generating Station

Document Type: OPERATING PROCEDURE	Document Number: EOP-1
	Revision Number: Rev. 3
	Unit Number: General P
Document Title: COLD WEATHER OPERATIONS	Effective Date: 29 January 2
	Expiration Date:

Revision Summary:

	Revision Date:
D1. DRAFT 1 submitted for review and comments	18 September 20
R1. Modified Sec.1-F: permanent structures installed	12 November 201
R2. Modified Sec. 1-G-1: modified wording	19 December 201
Modified Sec. 1-H-1: modified wording	
R3. Modified Checklist EOP1-1	29 January 2015

Reviewed By: Frank Hernandez Date: 1-29-2015

Approved By: Ross Billingsley Date: 1-29-2015

TABLE OF CONTENTS

COLD WEATHER OPERATIONS .....
A. FREEZING WEATHER PREPARATION - DAY BEFORE..
B. OPERATIONS COLD WEATHER ROUNDS .....
C. VACUUM PUMP OPERATION .....
D. EVAPORATIVE COOLER OPERATION .....
E. COOLING TOWER OPERATION .....

E. COLD WEATHER PREPAREDNESS

In advance of the cold-weather season, plant personnel will perform certain activities to prepare for sub-freezing temperatures. These activities should be completed prior to forecasted freezing conditions. It is the responsibility of the Operations Manager to ensure that these pre-cold weather activities are completed in a timely manner.

F. ERECT TEMPORARY WEATHER SHELTERS

1. Operations will submit a work request to have a temporary weather shelter erected around HRSG 101 transmitters located on ground level.
2. Operations will submit a work request to have a temporary weather shelter erected around HRSG 201 transmitters located on the ground level.
3. Operations will submit a work request to have a temporary weather shelter erected around HRSG 301 transmitters located on ground level.

G. HEAT TRACING CIRCUIT CHECKOUT

I&E department will check out all heat tracing circuits to ensure that they are operational. From this checkout a work list will be developed of freeze protection circuits that need to be repaired prior to the arrival of cold weather.

1. Work order will be created in order to perform an annual heat tracing audit that will be used develop a work list of all known deficiencies in the freeze protection system.
2. Operations and Maintenance will inspect all pieces of equipment to ensure that proper insulation has been installed. If deficiencies are found, a work list will be generated and attached to an EAM work list.
3. Review work list generated from heat tracing audit and insulation inspection. Add any additional known deficiencies and submit in EAM so that repairs can

TENASKA FRONTIER GENERATION STATION

Date: 11/15/2016

Subject: Frontier **2016** Winterization Preparation Management Review

Participants: Ross Billingsley – Plant Manager
Frank Hernandez – Operations Manager
Todd Bading – Plant Engineer
John Schretlen-Maintenance Manager
Noe Juarez-Senior Plant Operator

Review Items:

1. Status of temporary winterization enclosures for specific equipment: **In Progress**. Regarding enclosures on the cold weather operations procedure.
2. Status of winterization consumable items: **In Progress.** Inventory confirmed and requisition to purchasing for items needed.
3. Status of electrical heat trace & insulation audit: **Complete.**
4. Status of electrical heat trace and insulation repairs: **Electrical work complete. Insulation in progress**. Substantial completion by Nov. 23rd.
5. Status of final insulation winterization punchlist: **In-progress**. Final insulation punchlist is due to be completed on Nov. 23rd.
6. Review of Cold Weather Operating Procedure: **Complete.** The procedure was reviewed and discussed.

TAB

RATION STATION

Date: 12/5/2016

ion Preparation Management Review Follow-up

er
Manager

Manager

closures for specific equipment: **Complete.**
ather operations procedure.

ems: **Received; complete.** Inventory confirmed. .

ation audit: **Complete.**

ulation repairs: **Electrical work complete.**

punchlist: **Complete.**

ocedure: **Complete.**

TAB

EOP-1-2 - Cold Weather Operations				Inventory CK
Exhibit 1-2 - Cold Weather Supplies Box Inventory				11-02-2016
Item #	Description	Quantity Needed	Quantity On Hand	Amount to order
1	8' x 10' Poly Tarps	12	4	8
2	20' x 20' Poly Tarps	1	0	1
3	12' x 20' Poly Tarps	1	0	1
4	6' x 8' Poly Tarps	24	15	9
5	Heat Guns, Electric			
6	120 Volt Electric Heaters			
7	Pipe heating cable (6')			
8	Pipe heating cable (12')			
9	Pipe heating cable (24')			
10	Pipe heating cable (18')			
11	100' Extension Cord			
12	50' Extension Cord			
13	25' Extension Cord			
14	Roll of Tie Wire			
15	Roll of Duct Tape			
16	Strikers	8	3-manual	5
17	Self striking nozzles	10	4	6
18	Propane Bottles	50	35	15
19	Wire Ties (Tie Wraps)	100 ties	0	2x100 (heavy duty 11") 4x100(7.5" medium duty)
20	Pipe Insulation (fiberglass wrap) 35 ' Roll	5	2	3
21	Foam Pipe Wrap 8' pieces of foam	8 pieces	2	6
22	Halogen lights mounted on stands	6	4	2
23	Portable halogen lights	12	10	2
24	Spare halogen light bulbs	25	2	23
25	>70,000 BTU kerosene heater	3	*3 rough shape	0
26	35,000 BTU kerosene heater	3	5	2

Title: **Severe Cold Weather (Reviewed as drill)**

Date(s):
12-03-16 (simulated table top drill with "A" crew)
12-20-16 (tabletop discussion with plant personnel and a live first aid and emergency response drill with "D" crew)
DEC. 2016 drill photos

Location: Plant wide

Objective: Review of Severe Cold Weather Precautions and Activities

Active Participants:
Operations- Noe Juarez, Loran Grassl, Mike Curry
CRO: Noe Juarez
Manager: All managers off sight.
All managers were successfully notified during the call portion of drill held on 12-3-16

Overview of events/ scenario:

Scenario: Hard freeze conditions could easily cripple the plant if we are not prepared. This drill will attempt to reveal some potential vulnerabilities not all are likely and assumes some negligence for the sake of the drill—st interested:

By now ERCOT and MISO have issued severe cold weather alerts and hav confirmed that all of Frontiers units are available. Decision is made to not provide maintenance staff support overnight. Operations assigns an additional operator to each night shift....*(Decisions would be made as accurately as possible based on weather forecasts)*

0130:2nd start attempt successful, purge underway, "C" LP drum level and psi transmitter issues from GT2 and GT3. Decision made to not pursue getting those back into service. Stairways are covered in ice.
Which transmitters are not critical? Discussed how and when to select desired transmitters as needed.
Operations discretion, for this scenario the "C" drum level transmitters are accurately identified as not being a priority given the weather conditions. All staff members are encourage to write up any freeze protection concerns. We have provided a list of some that were identified during this drills time period.

0220: CRO decides to start rotating auxiliary pumps more frequently to prevent freeze related problems discovers that the standby CCCW pump is making lots of cavitation like noise when started, decision made to use a portable heater in this area, tarp erected in front of the pump area to block North wind. Same type of issue found with the standby vacuum pump.
Better to start the rotations earlier to avoid this or leaving both pumps in service altogether.

0355: GT2 ramped on ERCOT.

0430: Additional maintenance personnel and manager arrive to assist operations.

This drill will also be recorded as an emergency/first aid deployment drill.

Operators have identified these areas currently in need of insulation: The first three were corrected during this drill time period.

~~1: Steam Turbine seal drain valve.~~
~~2: Main steam valve thermocouples~~
~~3: Valve 2017: CRH drain IBD~~
4: IP FW x-mitter SGA-FT-A/B
5: "C" Drum level transmitters

Discuss MVAR alarms and CT/ Stmr capability with operations.
Note: A set of guidelines will be provided soon to address this.

2016 Heat Trace Audit Work Scope
AREA
Unit#3 PNL#301
Unit#2 PNL#201
Unit#1 PNL#101
Demin Water Area (PNL201)
Demin Water Building
Chem Bldg & Acid Area
Cooling Tower
Steam Turbine PNL-STG

HEAT TRACE CONTROL PNL (HTP 301) HTR#	SECTION	SYSTEM	SYSTEM DESC	UNIT	HT / LENGTH / TYPE	EQUIP ID	HEAT TRACE CONTROL PNL (HTP 301) BRK#	DESIGN VOLTS	CONNECTION AMPS 2014 AUDIT	CONNECTION AMPS 2016 AUDIT
10-A	PIPE RACK	IP	IP FEED WATER	3 (MEZZ)	MIQ / (NO TAG)	N/A	10	120	7.66	7.2
11-A	PIPE RACK	N/A	N/A	3 (MEZZ)	INSIDE A ENCLOSED TUBE BUNDLE TRAY	N/A	11	120	9.5	8.9
11-B	PIPE RACK	N/A	N/A	3 (MEZZ)	INSIDE A ENCLOSED TUBE BUNDLE TRAY	N/A	11	120	9.42	9
12-A	PIPE RACK	N/A	N/A	3 (MEZZ)	N/A	N/A	12	120	0.3	0.3
12-B	EAST SIDE BY PNL#301B	PT	PRESSURE TRANSMITER	3 (BOTTOM)	MIQ / 70' / 120 VOLT DESIGN-RMI-070-04-120	1SGJ-PT-301B	12	120	2.2	1.8
12-C	EAST SIDE BY PNL#301A	PT	PRESSURE TRANSMITER	3 (BOTTOM)	MIQ / 90' / 120 VOLT DESIGN-RMI-070-04-120	1SGJ-PT-301A	12	120	2.2	2.4

Questions?

Standardized Winter Readiness Preparation at CPS Energy

PRESENTED BY : James Richardson

September 7, 2017

ERCOT and Texas RE Generator Weatherization Workshop

SUMMARY

- About CPS Energy
- About Power Generation
- Winter Preparations in the CPS Energy Power Generation Fleet

ABOUT CPS ENERGY

ABOUT CPS ENERGY

- **Nation's largest municipally owned energy company providing both**
  - Electricity
  - Natural gas
- **Vertically-integrated utility with over 8,084 MW of generation capacity serving**
  - 804,675 electric customers
  - 343,754 natural gas customers
  - Over 1,500-square-mile service area
- **$2.5 billion in revenue; $10.9 billion in total assets**
- **Approximately 3,100 employees**

System Statistics

CPS Energy Electrical System
- Overhead lines = 7,866 miles
- Underground lines = 5,476 miles
- Transmission lines = 1,530 miles

CPS Energy Gas System
- Distribution mains = 5,415 miles
- Transmission mains = 89 miles

AFFORDABLE | RELIABLE | INNOVATIVE cps

ABOUT CPS ENERGY POWER GENERATION

- Four Coal Plants – 2185 MW
- Five Gas/Oil Plants – 1689 MW
- One 2X1 CC Plant – 466 MW
- One 3X1 CC Plant – 785 MW
- Eight Simple Cycle CT – 373 MW

WINTER DEFINITION

CPS Energy and ERCOT define Winter as December 1st through February 28th

WINTER READINESS BOOK TABLE OF CONTENTS

1. 2016 Winter Readiness Communications	11. Winter Readiness Examples
2. Power Generation Declaration of Completion	12. Work Orders
3. 2015 – 2016 Winter Lessons Learned	13. Critical Components List
4. Power Generation Seasonal Readiness Procedures	14. Winter Readiness Training Sign Off
5. Rio Nogales Severe Weather Procedure	15. Operations Round Sheets
6. Power Generation Mock Winter Readiness Drill	16. Frozen Drum Level Transmitter Corrective Actions
7. Energy Supply & Market Operations Severe Weather Procedure GOP-GP-250	17. ERCOT Winterization Workshop
8. Energy Supply & Market Operations Off Normal Procedure GOP-GP-251	18. NERC Reliability Guidelines
9. Freeze Protection Criteria	19. Current Freeze Protection Improvements
10. Electric Heat Trace	20. Future Freeze Protection Projects

POWER GENERATION WINTER READINESS PROCESS

- The Generation Duty Office (GDO) initiates the Seasonal Readiness process in early September

- GDO conducts routine process review meetings with each Winter Readiness Coordinator and Plant Management to track progress and identify critical issues

POWER GENERATION WINTER READINESS PROCESS

In September, October, and early November

- Winter Readiness Coordinators identify and begin system reviews using plant specific System Readiness Review documents

- Winter Readiness Coordinators review and update plant freeze protection checklists

POWER GENERATION WINTER READINESS PROCESS

- Winter Readiness Coordinators review processes and schedules required winter tests

- Winter Readiness Coordinators ensure lessons learned from previous winters are incorporated into plant readiness plans

POWER GENERATION WINTER READINESS PROCESS

- On or before November 15th, all work orders, procedures, and checklists for winter readiness are completed

- Winter readiness training is held with operations and maintenance personnel

POWER GENERATION WINTER READINESS PROCESS

- Compliance Department holds mock audits of each PG facility to validate that winter preparations are completed

- At the beginning of the winter season, GDO coordinates mock winter readiness drills when the temperature approaches freezing but does not fall low enough to trigger an actual winter readiness alert

POWER GENERATION WINTER READINESS PROCESS

- During the winter season, GDO coordinates unit status update meetings to discuss any open action items and/or new issues

- At the end of the winter, the GDO conducts a Winter Readiness critique meeting to document performance during the season and identify any lessons learned

COAGULANT AID BUILDING WINTERIZATION

DRUM LEVEL TRANSMITTERS

DRUM LEVEL TRANSMITTERS

STEAM TURBINE VACUUM PUMP AREA

FLOW TRANSMITTER AT CITY WATER TANK

COOLING TOWER MAKEUP WATER STATION

PLANT AIR COMPRESSOR SKID

PLANT AIR DRYER SKID

CLOSED CYCLE COOLING WATER HEAD TANK

WINTERIZED WATER TREATMENT AREA

WATER TREATMENT AREA

HRSG FLOW AND PRESSURE TRANSMITTERS

FREEZE PROTECTION JOBOX

FREEZE PROTECTION JOBOX

FUTURE FREEZE PROTECTION PROGRAMS

- CPS Energy has made a significant investment in the upgrade and repair of freeze protection equipment throughout the fleet since 2011

- More capital investments are planned this year and in future years to upgrade freeze protection systems fleet wide to improve plant winter reliability

- CPS Energy continues to improve its Winter Readiness Program as new best practices are developed and implemented

EVOLUTION OF WINTER READINESS SINCE 2011

1. Standardized the Seasonal Readiness Procedure – everyone has a responsibility	**6. Memorialize winter readiness preparations in the Winter Readiness Book**
2. Improved communications tracking related to winter readiness	**7. Training of Operations and Maintenance in winter readiness**
3. Conducts mock winter readiness drills	**8. Compliance Department does mock audits of each facility**
4. Energy Supply & Market Operations utilizes the Severe Weather Procedure to call cold weather alerts	**9. Freeze protection upgrades with emphasis on heat trace, insulation, wind breaks, and heaters**
5. Developed critical components list	**10. Annual lessons learned shared with all Power Generation facilities**

THANK YOU

Generator Weatherization Workshop

September 7, 2017

Alan H. Allgower
Operations Analyst, Senior
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512-348-4613 (o)

Remember……

2011 Headlines….

Extremely Cold Weather Grips Texas

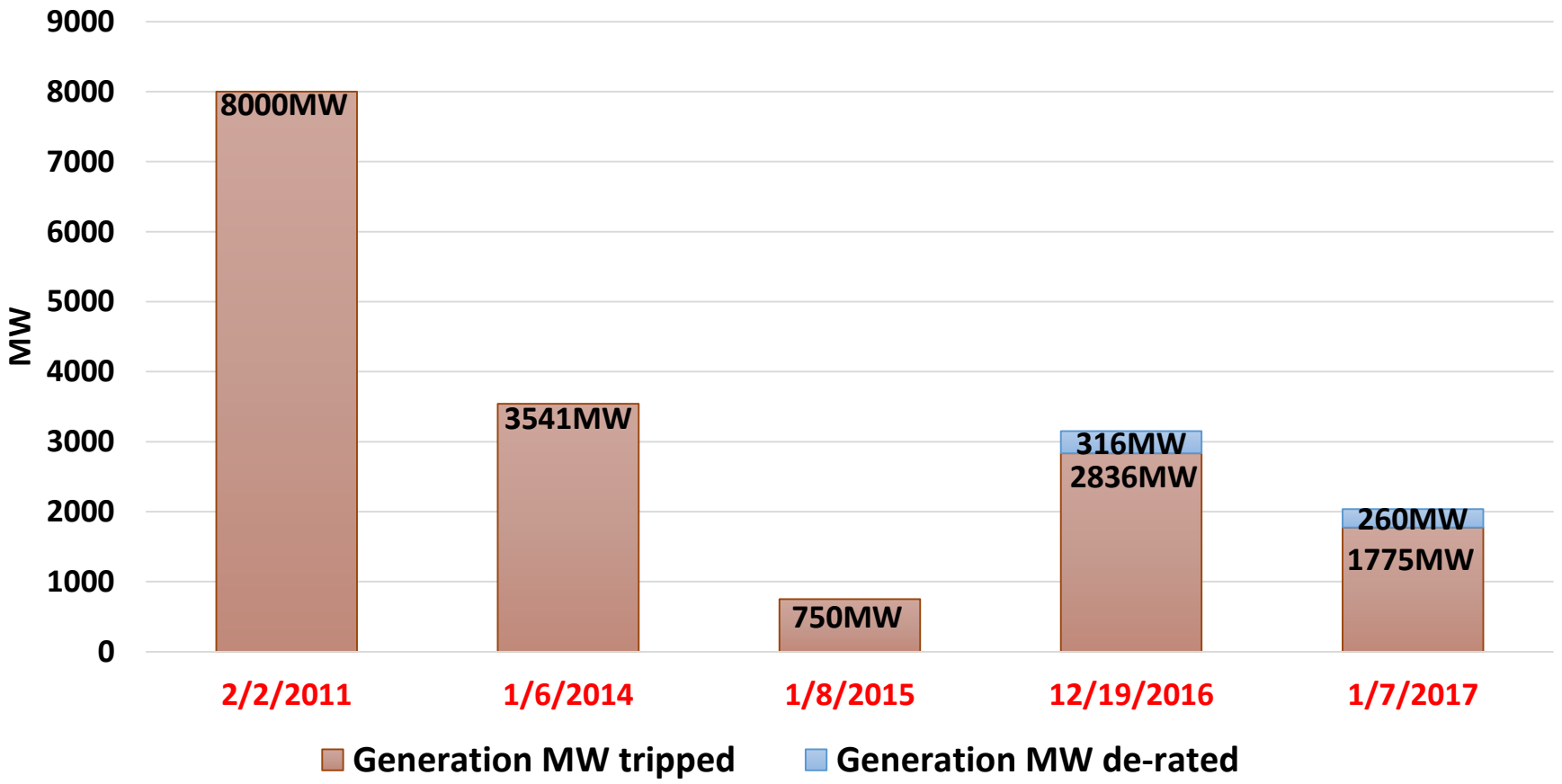
A Federal Electric Reliability Commission (FERC)'s task force looking into the causes of rolling blackouts during cold weather in February 2011 said that "grid operators and power plant operators should have better prepared for extreme winter weather."

The task force said "the Electric Reliability Council of Texas (ERCOT) region experienced a similar event in 1989 when it also shed firm load, but the lessons learned from that event were not used to prevent outages during the 2011 event."

What have we learned since February 2011?

- Identify critical components that will derate, trip or fail to start the unit if frozen and incorporate into weatherization plan.
- Detailed testing of heat trace is necessary, identifying critical circuits.
- Verify critical heat trace circuits are still functioning prior to every extreme cold weather event.
- Heat trace failure rates in Texas on average are 10-15% from previous season.
- Insulation inspections, focusing on critical components.
- Plant staff training prior to winter.
- Using wind breaks that can sustain long periods of wind and can last the winter. Avoid off the shelf tarps.
- Continuous improvements to weatherization plan.
- Review scope of contractor work and verify acceptable completion.

Tripped or de-rated capacity due to frozen elements



Comparing Jan 6, 2014 to Jan 8, 2015

3541MW of capacity tripped that was freeze related.

ERCOT declared EEA2

January 6, 2014

Dallas: 15° (9MPH wind)
Houston: 27°(16MPH wind)
San Antonio: 27° (15MPH wind)
Austin: 20° (13MPH wind)
Brownsville: 37° (17MPH wind)
Abilene: 11° (5MPH wind)
Midland: 14° (12MPH wind)

750 MW of capacity tripped that was freeze related.

Normal Operations in ERCOT

January 8, 2015

Dallas: 16° (5MPH wind)
Houston: 28°(6MPH wind)
San Antonio: 28° (8MPH wind)
Austin: 21° (7MPH wind)
Brownsville: 39° (16MPH wind)
Abilene: 16° (8MPH wind)
Midland: 20° (7MPH wind)

Weather Source: Chris Coleman, ERCOT

Comparing temperatures Feb 2, 2011 to Dec 19, 2016

8000MW of capacity tripped, failed to start or derated that was freeze related.

February 2, 2011

Dallas: 13° (20MPH wind)
Houston: 21°(16MPH wind)
San Antonio: 19° (25MPH wind)
Austin: 18° (26MPH wind)
Brownsville: 32° (26MPH wind)
Abilene: 7° (16MPH wind)
Midland: 6° (16MPH wind)

ERCOT declared EEA3 – 4000MW of firm load shed.

2836MW of capacity tripped that was freeze related. 316MW of capacity derated.

December 19, 2016

Dallas: 17° (7MPH wind)
Houston: 30°(14MPH wind)
San Antonio: 25° (13MPH wind)
Austin: 24° (12MPH wind)
Brownsville: 37° (17MPH wind)
Abilene: 15° (3MPH wind)
Midland: 21° (4MPH wind)

Normal Operations in ERCOT

Weather Source: Chris Coleman, ERCOT

Hours below freezing comparing Feb 2, 2011 to Dec 19, 2016

City	2-Feb-11	19-Dec-16
Dallas	24	12
Houston	12	8
San Antonio	24	10
Austin	24	9
Brownsville	1	0
Abilene	24	12
Midland	24	12

Weather Source: Chris Coleman, ERCOT

December 18-19, 2016 lessons learned

- Eight generators experienced outages or derates.
- ERCOT followed up with spot checks.

December 18-19, 2016 lessons learned

- Plant 1 – trip; ten critical components froze
  - GT1 performance heater froze
  - GT1 compressor bleed valve air regulators froze
  - GT2 performance heater froze
  - HRSG1 HP flow transmitter sensing line froze
  - HRSG2 HP flow transmitter sensing line froze
  - HRSG2 LP flow transmitter froze
  - HRSG3 HP attemperator HP bypass froze
  - Condensate hotwell level flow transmitter froze
  - Instrument air compressor coalescing filter froze
  - Instrument air compressor air dryer froze
- Cause – Incomplete list of critical components.
- Corrective action – Critical components list is being revised to include all critical components and mitigations measures.
- ERCOT recommendation from follow-up spot check
  - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit for each component, insulation inspection, wind break installed or transmitter cabinet and heater inspection.

December 18-19, 2016 lessons learned

- Plant 2 – trip; steamer
  - Steam seal pressure transmitter froze
    - Cause – lack of heated wind break enclosure for transmitter
    - Corrective action – enclose transmitter in heated enclosure
  - ERCOT recommendation from follow-up spot check
    - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit for each component, insulation inspection, transmitter wind break installed or cabinet and heater inspection.
- Plant 3 – Derate
  - HP superheated attemperator valve frozen to the valve seat
    - Cause – loose connection on associated heat trace cable
    - Corrective action – improve details of heat trace inspection
  - ERCOT recommendation from follow-up spot check
    - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit for each component, insulation inspection, transmitter wind break installed or cabinet and heater inspection.

December 18-19, 2016 lessons learned

- Plant 4 – trip; main turbine throttle pressure control
  - Two of three main turbine throttle pressure transmitters valve bonnets froze
    - Cause – valve bonnets of the root valves were not adequately insulated
    - Corrective action – replaced insulation on the valves and sensing lines and the insulation was extended to cover the entire valve and bonnet. New self-limiting freeze protection wiring was also installed on the sensing lines and valves.
  - ERCOT recommendations from follow-up spot check
    - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit for each component, insulation inspection, transmitter wind break installed or cabinet and heater inspection.

December 18-19, 2016 lessons learned

- Plant 5 – trip; drum level transmitter
  - One of four drum level transmitters froze
    - Cause – main breaker tripped in heat trace sub-panel for a ground fault on one of the circuits, resulting in heat trace not energized to one drum level transmitter.
    - Corrective action – potential voltage indication lights were added to sub-panel to assist operator in rounds.
    - Replaced faulty circuit breaker that failed to trip.
  - ERCOT recommendations from follow-up spot check
    - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit for each component, insulation inspection, transmitter wind break installed or cabinet and heater inspection.
    - ✓ Verify critical heat trace circuits are still functioning prior to each extreme cold weather event.
    - ✓ Develop simulator training for control room operators for the loss of drum level transmitters.

December 18-19, 2016 lessons learned

- Plant 6 – trip; boiler feed pump “A” and “B” suction strainer differential pressure.
  - Boiler feed pump “A”
    - Cause – Damage to the power connection boot for the heat trace cable on the root valves was cracked and brittle. This damage indicated the cable totally failed in service.
    - Corrective action – Replaced heat trace cable with Ametek rated at 0DegF.
  - Boiler feed pump “B”
    - Cause – Heat stress cracks and brittle heat trace cable around the root valve.
    - Corrective action – Replaced heat trace cable with Ametek rated at 0DegF.
  - ERCOT recommendations from follow-up spot check
    - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit audit for each critical component, insulation inspection, transmitter wind break installed or cabinet and heater inspection.
    - ✓ Verify critical heat trace circuits are still functioning prior to each extreme cold weather event.

December 18-19, 2016 lessons learned

- Plant 7 – temporary derate
  - Moisture in instrument air
    - Cause – frozen moisture in the instrument air line caused the pressure transmitter to show a false low pressure reading. Mechanical room louver vents were left open, vent fan in manual and mechanical room space heaters were not functioning.
    - Corrective action – Weatherization plan was revised to include closing louver vents, vent fan in auto and verification of space heaters functioning in mechanical building prior to winter.
    - Corrective action – install a mechanical building thermometer for telemetering temperature to the control room.
  - ERCOT recommendations from follow-up spot check
    - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit for each component, insulation inspection, transmitter wind break installed or cabinet and heater inspection.

December 18-19, 2016 lessons learned

- Plant 8 – trip
  - Deareator level frozen transmitter
    - Cause – deareator heat trace circuit failure due to corrosion on termination to fuse block.
    - Contributing factor cause – control room operator was not aware that the deareator level was in single element control.
    - Corrective action – Update heat trace inspection to include connections to fuse block, verify critical heat trace is functioning before every extreme cold weather event.
    - Corrective action – Provide additional training to control room operators.

December 18-19, 2016 lessons learned

- Plant 8 – trip (continued)
  - ERCOT recommendations from follow-up spot check
    - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit for each component, insulation inspection, transmitter wind break installed or cabinet and heater inspection.
    - ✓ Update plan to verify critical heat trace circuits are functioning prior to every extreme cold weather event.
    - ✓ Revise cold weather plan to schedule additional staff during extreme cold weather.
    - ✓ Develop cold weather training for operators focusing on checks during extreme cold weather.
    - ✓ Revise operator freeze protection checklist to provide clarity for the operators.
    - ✓ Develop refresher training for control room operators focusing on actions due to frozen transmitters and verifying transmitters are in average and not single element control as a normal operating mode.
    - ✓ Develop a display for boiler critical transmitters as a “windshield look” for the control room operators.
    - ✓ Replace all references in weatherization plan from “may perform” to “shall perform.”

Comparing Feb 2, 2011 to Jan 7, 2017

8000MW of capacity tripped, failed to start or derated that was freeze related.

1775MW of capacity tripped that was freeze related. 260MW derate due to ice damage to FD fan.

February 2, 2011

Dallas: 13° (20MPH wind)
Houston: 21°(16MPH wind)
San Antonio: 19° (25MPH wind)
Austin: 18° (26MPH wind)
Brownsville: 32° (26MPH wind)
Abilene: 7° (16MPH wind)
Midland: 6° (16MPH wind)

ERCOT declared EEA3 – 4000MW of firm load shed.

January 7, 2017

Dallas: 14° (6MPH wind)
Houston: 21°(11MPH wind)
San Antonio: 20° (6MPH wind)
Austin: 19° (10MPH wind)
Brownsville: 30° (27MPH wind)
Abilene: 9° (3MPH wind)
Midland: 10° (4MPH wind)

Normal Operations in ERCOT

Weather Source: Chris Coleman, ERCOT

Hours below freezing comparing Feb 2, 2011 to Jan 7, 2017

City	2-Feb-11	7-Jan-17
Dallas	24	12
Houston	12	11
San Antonio	24	10
Austin	24	11
Brownsville	1	5
Abilene	24	11
Midland	24	12

Weather Source: Chris Coleman, ERCOT

ERCOT sets new winter peak demand and January peak demand records

- AUSTIN, TX, Jan. 9, 2017
  - ERCOT set another new winter demand record on Jan. 6, 2017. Electricity demand reached 59,650 MW during the 6-7 p.m. hour, exceeding the previous winter record of 57,924 MW set just a couple weeks earlier on Dec. 19, 2016.

- It is ERCOT's expectation that for every extreme cold weather event, some generation is going to experience freeze related derates or trips.

January 6-7, 2017

- ERCOT requested information related to the cold weather event on Jan. 6-7, 2017 from 9 generation units.
- Six generation units were outaged due to cold weather.
- ERCOT followed-up and performed a spot check on three of the six units.

January 6-7, 2017 lessons learned

- Plant 1 – trip; boiler feed pump trip
  - Boiler feed pump “B” suction strainer differential pressure transmitter sensing line froze which resulted in a pump trip signal and subsequent unit trip.
    - Cause – heat trace failure
    - Corrective action – replace heat trace bundles and install wind break for additional protection for wind
  - ERCOT recommendations from follow-up spot check
    - ✓ Identify all critical components in weatherization plan. Include associated heat trace circuit for each component, insulation inspection, transmitter wind break installed or cabinet and heater inspection.
    - ✓ Verify prior to every extreme cold weather event that critical heat trace circuits are functioning.
    - ✓ Install wind break as additional measure to prevent freezing.

January 6-7, 2017 lessons learned

- Plant 2 – derate
  - Steam seal leak
    - Cause – lower steam coil developed a leak inside the force draft fan intake resulting in ice forming on the bottom side of steam coil. This ice damaged the FD fan blades.
    - Corrective action – Inspect steam coil for leaks on a weekly basis during winter months. When temperatures are forecasted below 36 degrees, additional operational rounds will be made during the shift.
  - ERCOT did not perform a follow-up spot check
- Plant 3 – trip
  - HRSG HP steam flow transmitters froze
    - Cause – heat trace panel control modules 8 and 9 failed resulting in two heat trace circuits not being energized
    - Corrective action – replace modules 8 and 9
    - Corrective action – follow-up with vendor to engineer an alarm for module failure
  - ERCOT did not perform a follow-up spot check

January 6-7, 2017 lessons learned

- Plant 4 – trip
  - Deareator (DA) flow transmitter sensing line froze. Unit has three DA transmitters using two sensing lines.
    - Cause – The condensate (feedwater) to DA flow transmitter sensing line froze creating a false high flow rate, closing the DA level control valves which allowed the level in the DA to drop resulting in a Master Fuel Trip (MFT) of the boiler.
    - Heat trace on one of the circuits was found to be working but with one section that was not. The other heat trace circuit was working but out of specifications for self regulating het trace.
    - Corrective action – During the spring 2017 unit outage, these transmitters were relocated to the DA level and provided with new weatherized transmitter enclosures, new insulation, new heat trace and sensing lines shortened from 75’ to 6’.
    - Corrective action – OEM specified current and power information for all critical freeze protections circuits will be added to the critical transmitter freeze protection preventive maintenance work orders for comparison to actual operating conditions.

January 6-7, 2017 lessons learned

- Plant 4 – trip (continued)
  - ERCOT recommendations from follow-up spot check
    - ✓ Update plan as follows; prior to every extreme cold weather event, verify critical components heat trace are functioning.
    - ✓ For winter 2017-2018, verify heat trace circuit alarms are correctly programmed into system used by operators to monitor performance.
- Plant 5 – trip
  - Loss of instrument air
    - Cause – The loss of instrument air was caused by the freezing of the air dryer pre-filter, which restricted air flow to the instrument air system resulting in the gas trip valve closure.
    - Corrective action – Install a wind break with heater for additional protection to prevent freezing.
  - ERCOT did not perform a follow-up spot check

January 6-7, 2017 lessons learned

- Plant 6 – trip
  - HRSG HP Feedwater high range flow transmitter, low side sensing line froze.
    - Cause – The contractor that performed the fall audit on heat trace did not terminate the associated heat trace circuit in a junction box correctly.
    - Corrective action – Verify contractor work and only hire a contractor that has a quality control program in place.
  - ERCOT recommendations from follow-up spot check
    - ✓ Update plan as follows; prior to every extreme cold weather event, verify critical components heat trace are functioning.
    - ✓ Hire contractor with QC program for heat trace testing.
    - ✓ Add associated heat trace circuit to critical component list.

Identifying critical components or equipment is required

- §25.53. Electric Service Emergency Operations Plans.
  - (c)(2)(B) A plan that addresses any ***known critical failure points***, including any effects of weather design limits.
- Nodal Protocol 3.20 (3)
  - ✓ No earlier than November 1 and no later than December 1 of each year, each Resource Entity shall submit the declaration Section 22, Attachment K, Declaration of Completion of Generation Resource Weatherization Preparations, to ERCOT stating that, at the time of submission, each Generation Resource under the Resource Entity's control has completed or will complete all weather preparations required by the weatherization plan for ***equipment critical to the reliable operation*** of the Generation Resource during the winter time period (December through February).
  - ✓ If the work on the ***equipment that is critical to the reliable operation*** of the Generation Resource is not complete at the time of filing the declaration, the Resource Entity shall provide a list and schedule of remaining work to be completed.
- Section 22, Attachment K, Declaration of Completion of Generation Resource Weatherization Preparations

✓ "I hereby attest that all ***weatherization preparations for equipment critical to the reliable operation*** of each of the above-listed Generation Resources during the time period stated above are complete or will be completed, as required by the weatherization plan applicable to each Generation Resource."

Comments

- ERCOT will be focusing on critical components as required by §25.53, Nodal Protocol 3.20 (3), generator attestation and measures to mitigate freezing during spot checks for winter 2017/2018.
  - ✓ Critical components list as part of weatherization plan.
  - ✓ Heat trace audit testing and identifying critical components.
  - ✓ Insulation inspections on critical components.
- Best practice
  - ✓ Prior to every extreme cold weather event, verify critical components heat trace circuits are functioning.

✓ ***It is ERCOT's expectation that for every extreme cold weather event, some generation is going to experience freeze related derates or trips.***

Food for thought….

- *“do or do not; there is no try.” Yoda – Star Wars*

- *… you say to yourself, “OK, why did it happen? Why did we make those bad engineering decisions we made in 1986 with Challenger?” I'll tell you. It's the human element. I suggest that there's a **complacency** there that comes from success. — Alan Shepard*

NERC Reliability Guideline Approved

- Generating Unit Winter Weather Readiness Current Industry Practices – Version 2

- Reliability Guideline: Generating Unit Winter Weather Readiness – Current Industry Practices – Version 2

- Copies are available in the back of the room

Resource weatherization objective

"By failing to prepare, you are preparing to fail." -- Benjamin Franklin

Questions?

2016-17 Preliminary Winter Weather Outlook

Chris Coleman
ERCOT Sr. Meteorologist

Generator Weatherization Workshop
September 7, 2017

Agenda

- Review of last winter (and other recent winters)
- Current conditions
- Expectations for the upcoming winter

Seasonal versus Extremes

*****Mild winters can have very cold periods*****

- December 23, 1989:
- **Dallas**: -1° (8MPH wind)
- **Houston**: 7° (9MPH wind)
- **San Antonio**: 6° (7MPH wind)
- **Austin**: 4° (9MPH wind)
- **Brownsville**: 17° (15MPH wind)
- **Abilene**: -3° (6MPH wind)
- **Midland**:0° (4MPH wind)

Winter of 1989-90: 72nd coldest in TX weather history

(ERCOT system has not been colder since December 23, 1989)

- February 2, 2011:
- **Dallas**: 13° (20MPH wind)
- **Houston**: 21° (16MPH wind)
- **San Antonio**: 19° (25MPH wind)
- **Austin**: 18° (26MPH wind)
- **Brownsville**: 32° (26MPH wind)
- **Abilene**: 7° (16MPH wind)
- **Midland**: 6° (16MPH wind)

Winter of 2010-11: 69th coldest in TX weather history

- January 6, 2017:
- **Dallas**: 22° (14MPH wind)
- **Houston**: 34° (25MPH wind)
- **San Antonio**: 31° (18MPH wind)
- **Austin**: 30° (20MPH wind)
- **Brownsville**: 36° (18MPH wind)
- **Abilene**: 21° (17MPH wind)
- **Midland**:23° (12MPH wind)

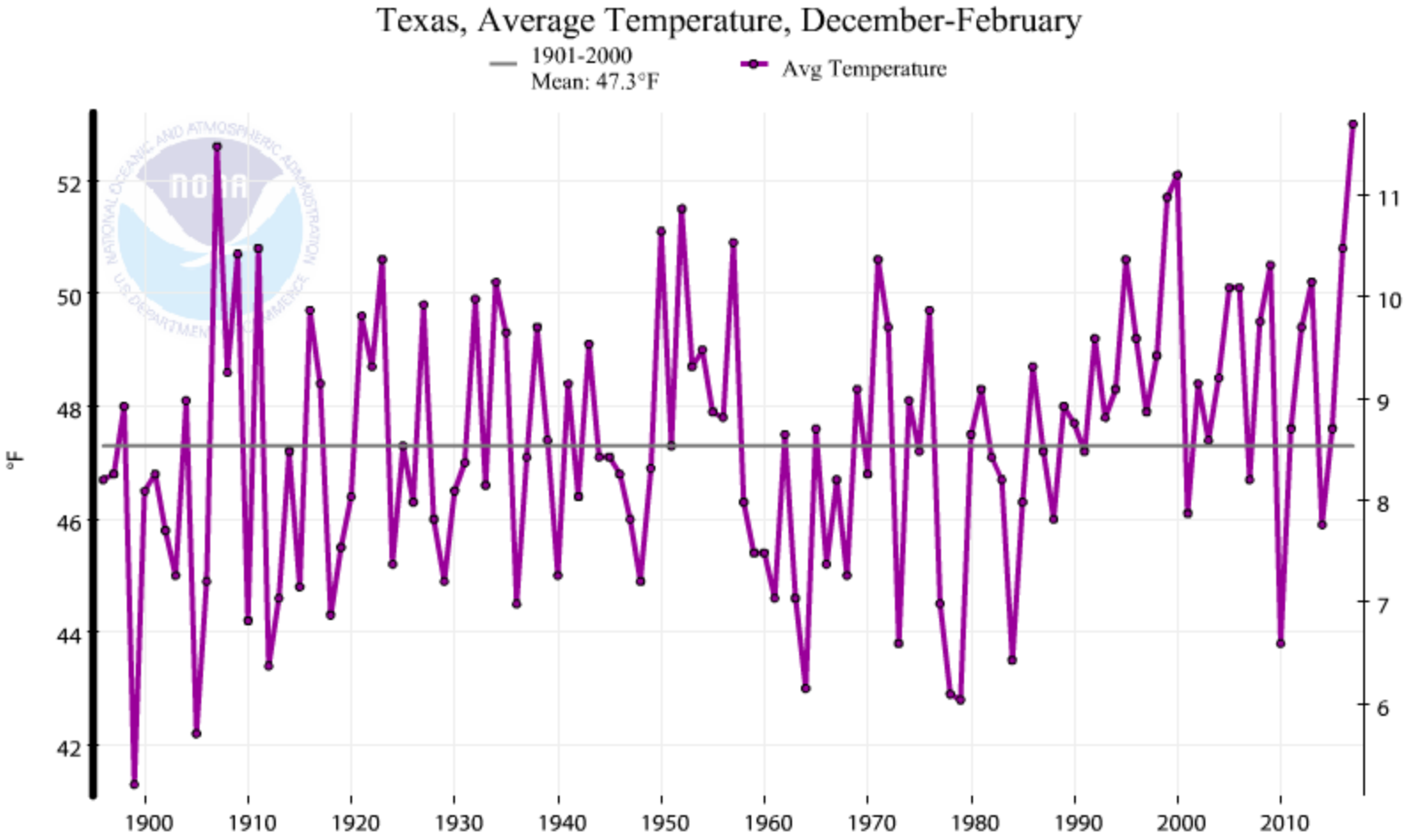
Winter of 2016-17: 122nd coldest in TX weather history
*****Warmest winter on record*****
All-time winter peak load on this date: 59,650 MW (PM Peak)
Peak would have been the morning of Jan 7, but was a Saturday
Jan 7: DFW: 14°, IAH: 21°, SAT: 20°, AUS: 19°, BRO: 30°, ABI: 9°, MAF: 10°

Temperature Ranking of Recent Winters (Texas)

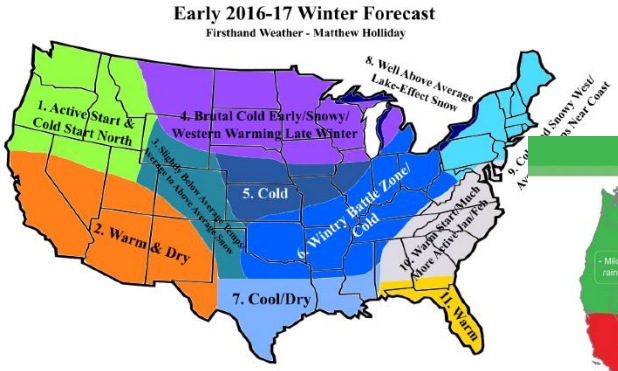
2016-17	**122nd** coldest (warmest winter on record)
2015-16	**115th** coldest (8th warmest of 122)
2014-15	69th
2013-14	30th
2012-13	**108th**
2011-12	98th
2010-11	69th
2009-10	**8th**
2008-09	**109th**
2007-08	99th
2006-07	43rd

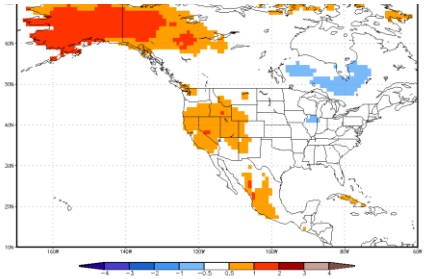
Since 2001, only two winters have ranked in the coldest third of historical winters

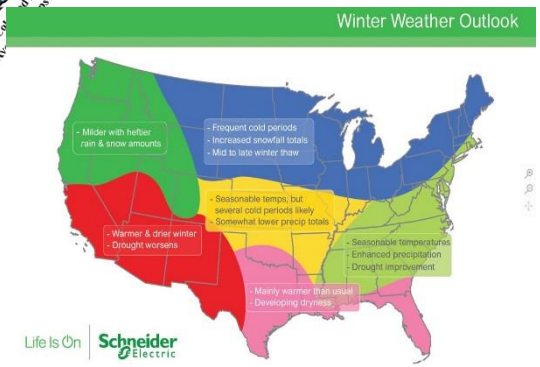
Historical Temperatures

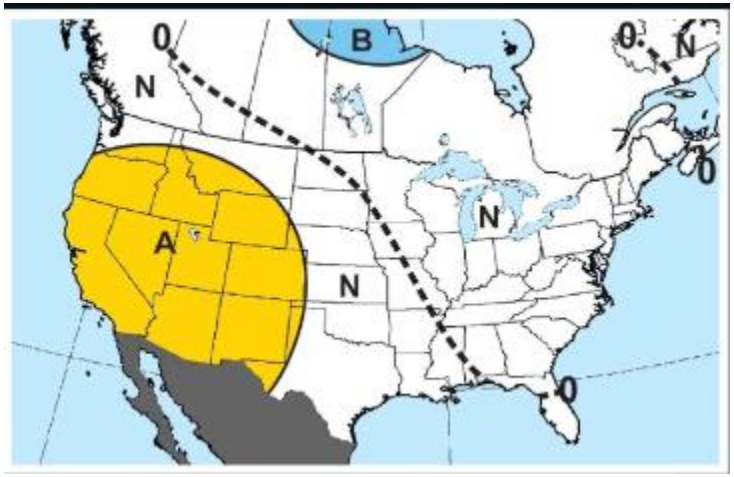


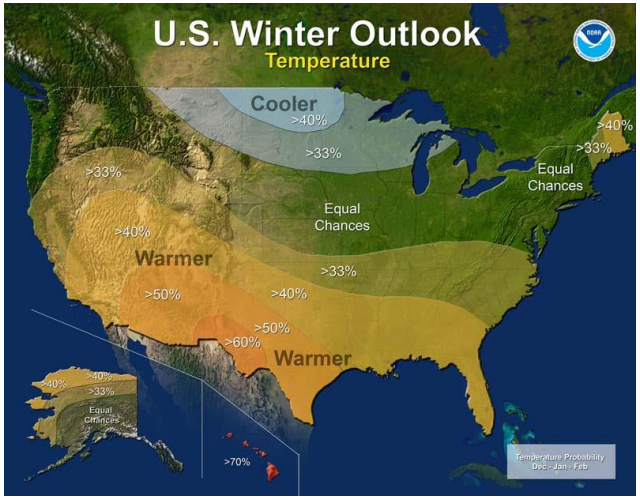
What Other Weather Sources Were Saying (last winter)

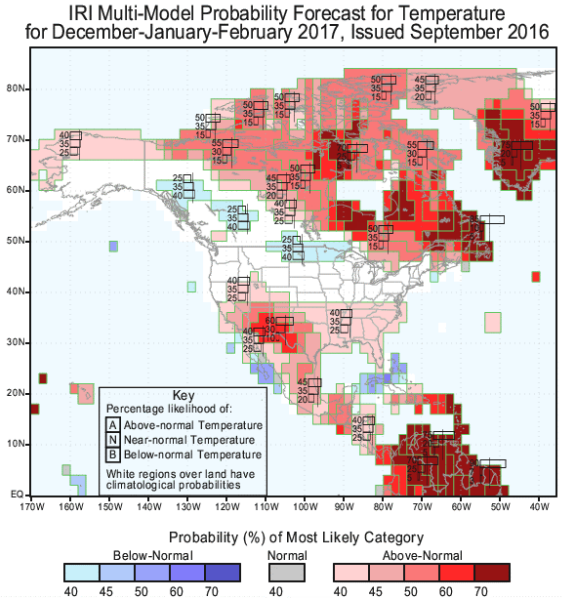


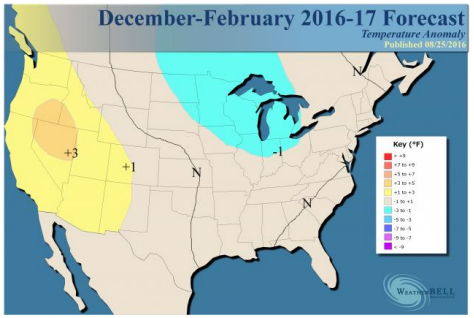


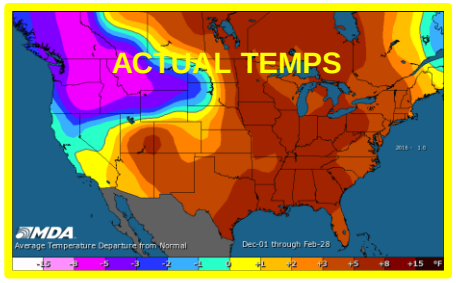










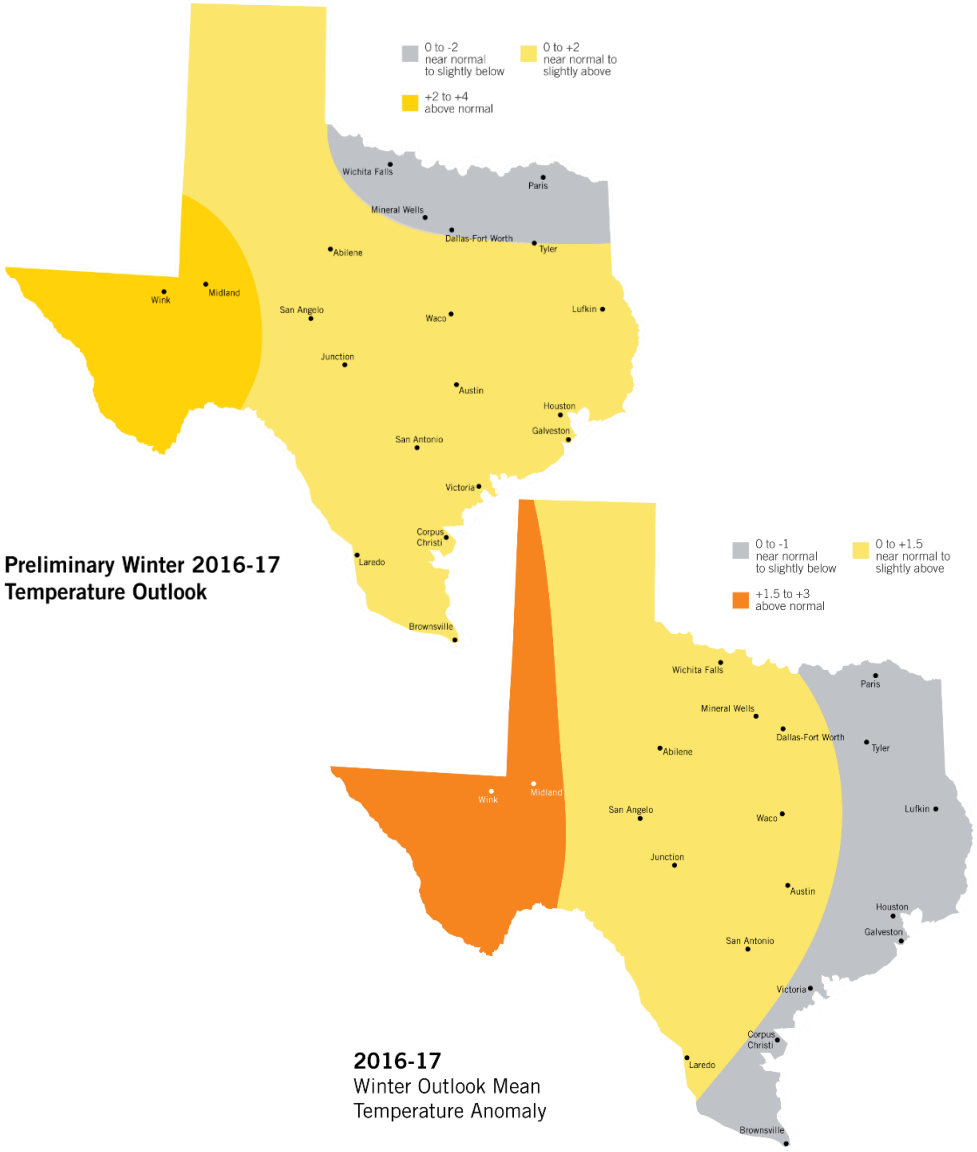


Reviewing Last Winter's Forecast

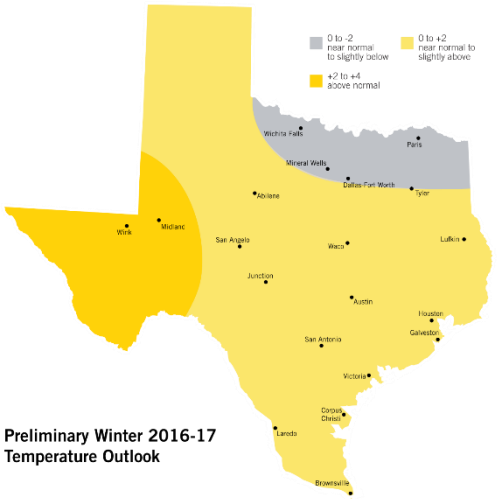
Top Row: Preliminary Forecast given at last September's winterization seminar

At this time, not seeing a strong cold signal	January and February could both feature some periods of below-normal temperatures	Unlikely to be as warm as last winter (114th coldest) … but not impossible

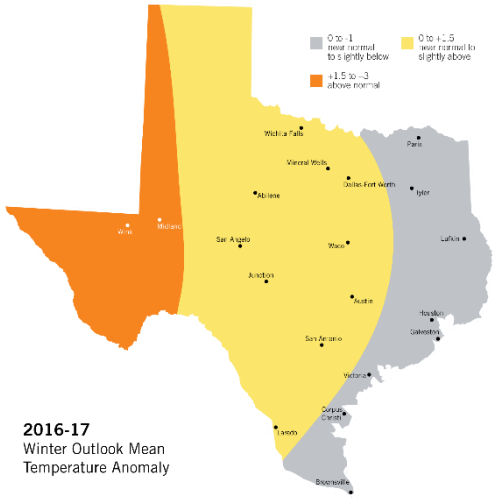
Bottom Row: Final Forecast, Issued November 1



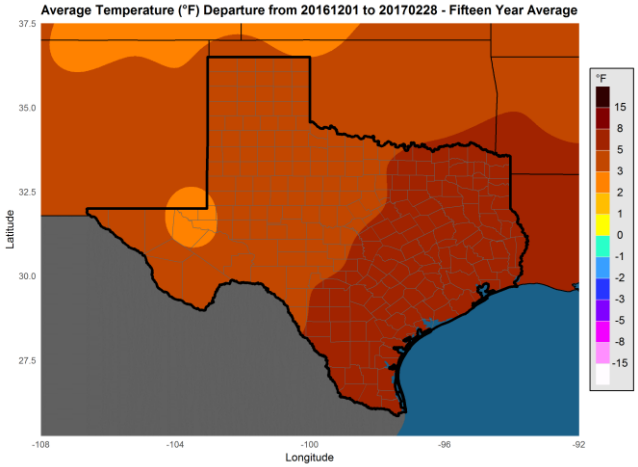
Last Winter, Forecast versus Actual



Preliminary Winter 2016-17
Temperature Outlook



2016-17
Winter Outlook Mean
Temperature Anomaly



Top 10 warmest:

1. 2016-17
2. 1906-07
3. 1999-2000
4. 1998-99
5. 1951-52
6. 1949-50
7. 1956-57
8. 1910-11
9. 2015-16
10. 1908-09

Last Winter's Lack of Austin Freezes

(122nd)

	2016-17 frz #	COLDEST	#SUB-40
November	0	35	1
December	2	23	9
January	3	19	7
February	0	40	0
	5		17

(115th)

	2015-16 frz #	COLDEST	#SUB-40
November	1	32	2
December	0	34	8
January	3	31	15
February	1	32	5
	5		30

(69th)

	2014-15 frz#	COLDEST	#SUB-40
November	4	30	7
December	2	30	6
January	4	23	20
February	5	30	15
	15		48

(30th)

	2013-14 frz #	COLDEST	#SUB-40
November	1	32	10
December	8	27	19
January	9	22	17
February	5	26	12
	23		58

(69th)

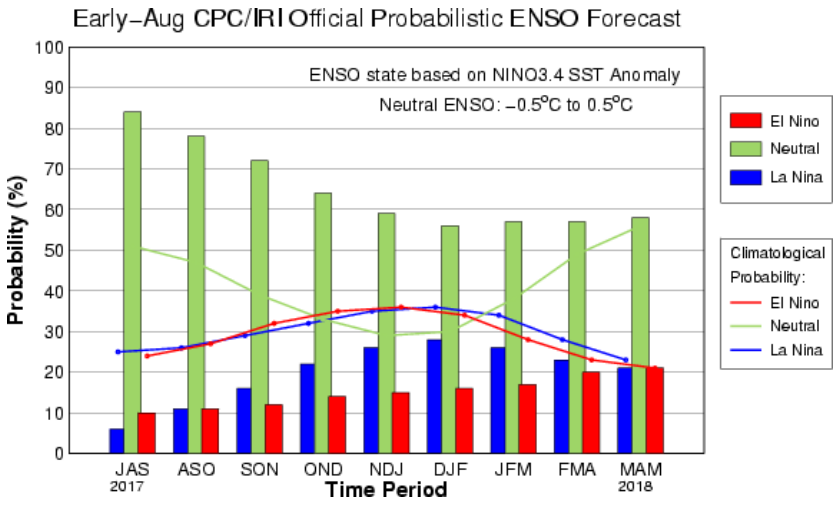
	2010-11 frz #	COLDEST	#SUB-40
November	0	34	5
December	4	28	13
January	6	26	21
February	9	17	12
	19		51

1996-2017:

	avg frz #	avg coldest	avg sub-40 #
November	0.4	34.7	4.1
December	4.1	27.8	13.5
January	4.8	26.9	14.1
February	2.8	29.2	10.3
	12	**27**	**42**

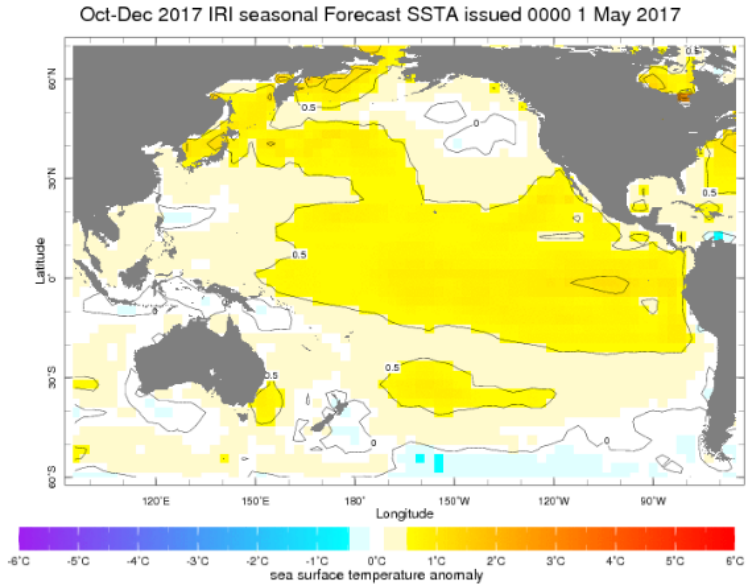
1997-98: 2 freezes. 2016-17, 2015-16, 1999-00: 5 freezes

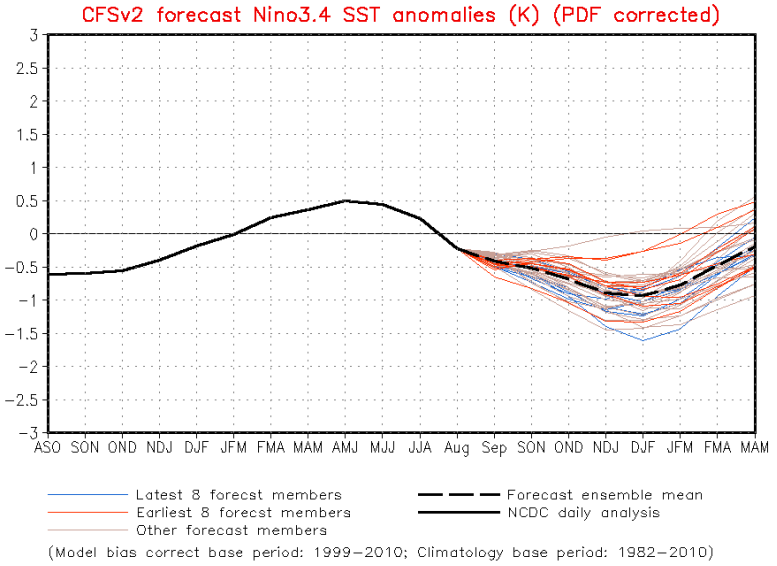
This Winter: El Niño, La Niña, or Neutral?



Likely either neutral or weak La Niña this winter

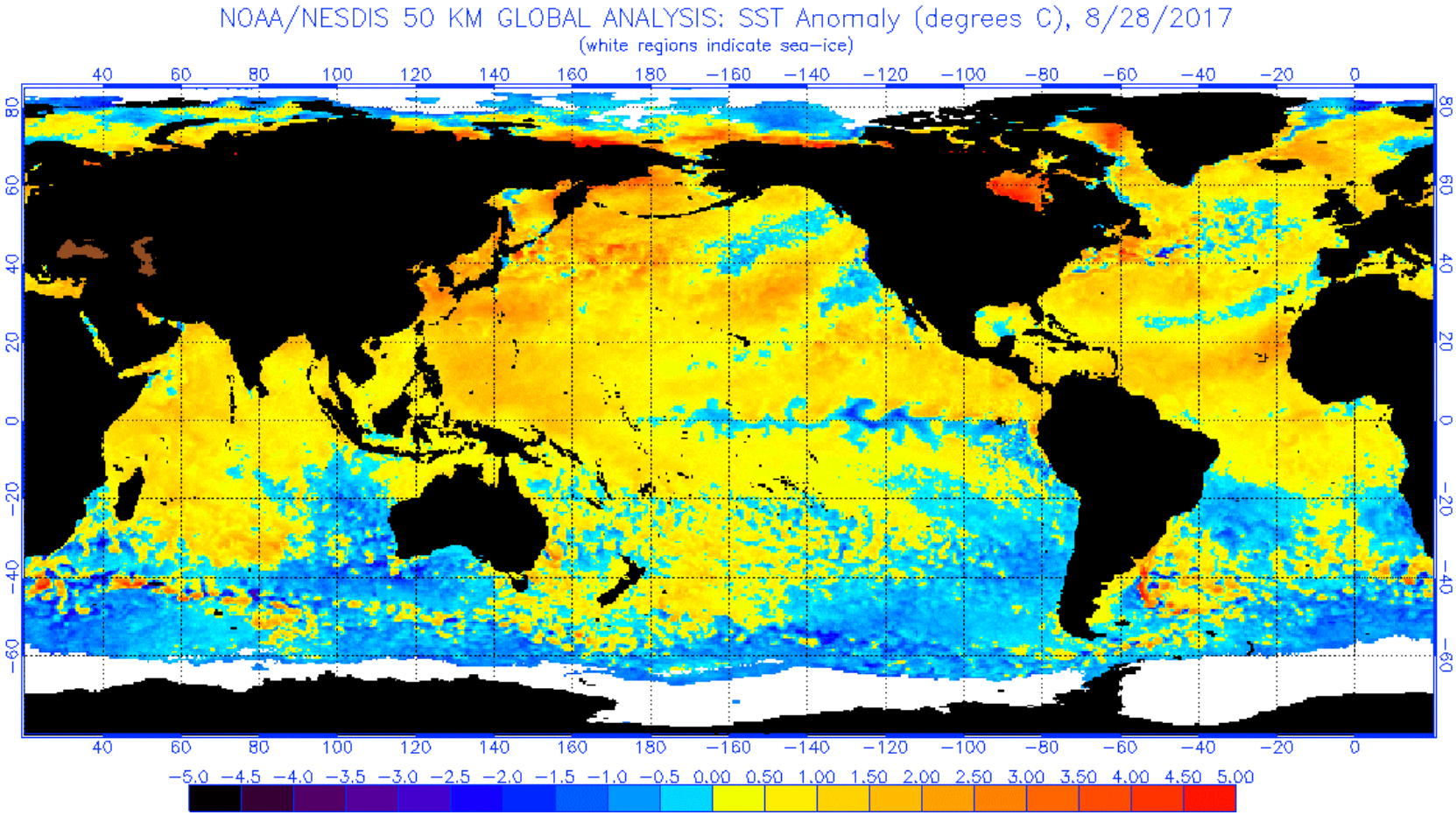
Last winter began with a weak La Niña but faded mid-winter



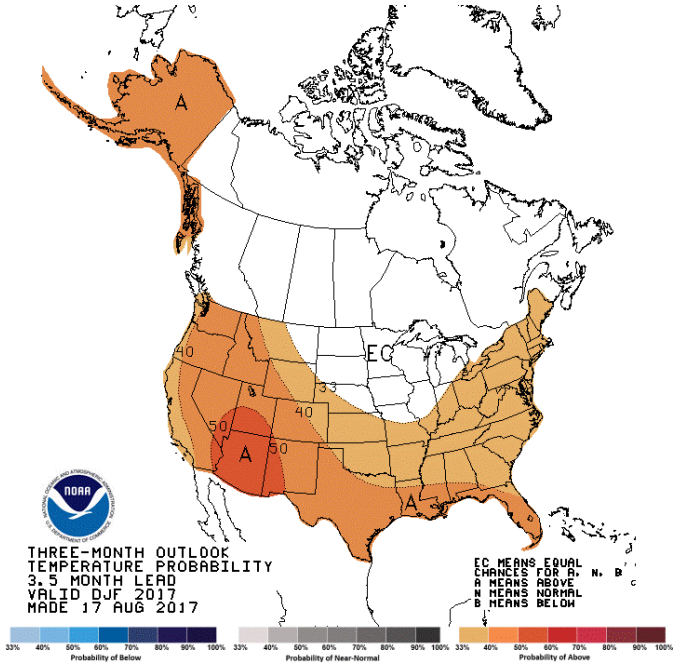


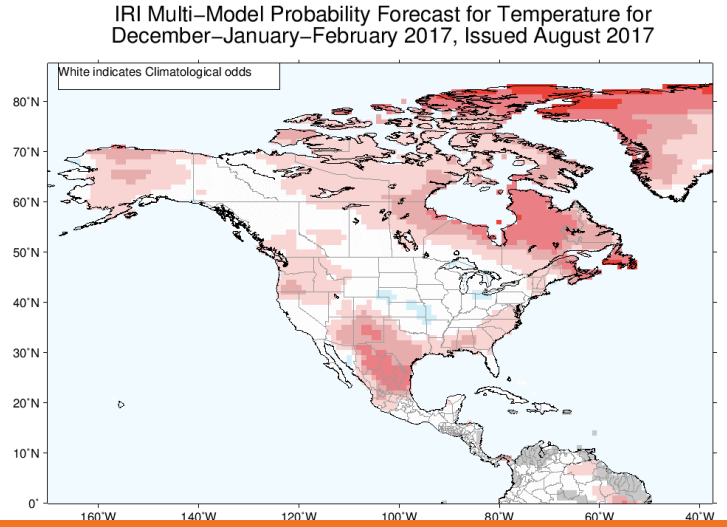
Pacific Decadal Oscillation

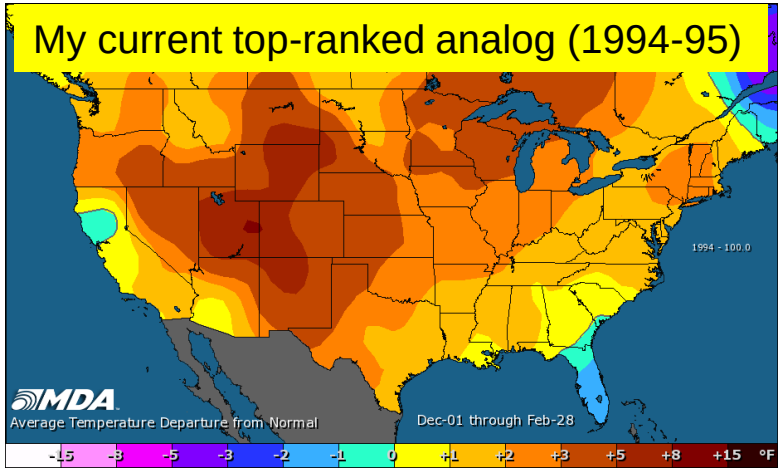
Pacific Ocean is still quite warm. The PDO remains positive (warm phase) but not as strongly positive as the three years prior. Since turning positive in 2014, it's resulted in a mostly warm, above-normal pattern for Texas.



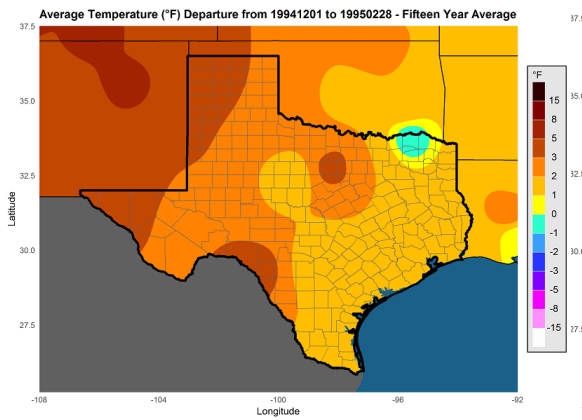
What Other Weather Sources are Forecasting (this winter)



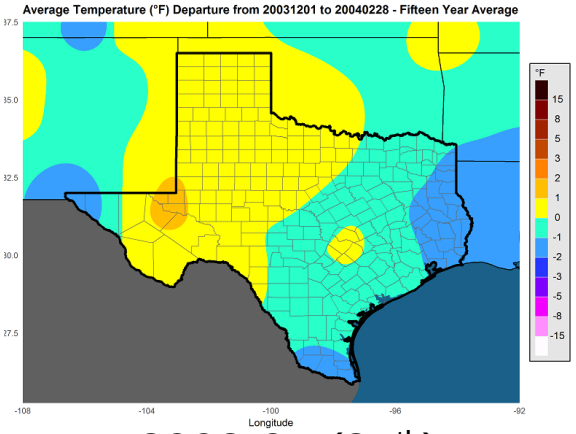




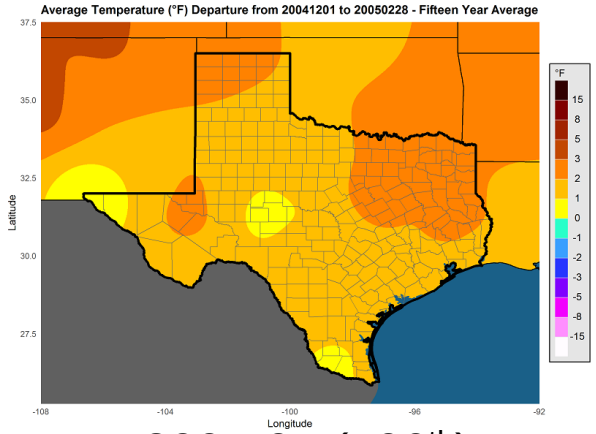
Historical Matches (Analogs)



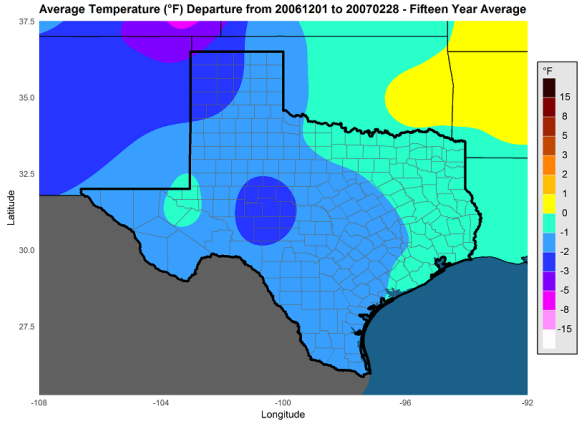
1994-95 (112th coldest)



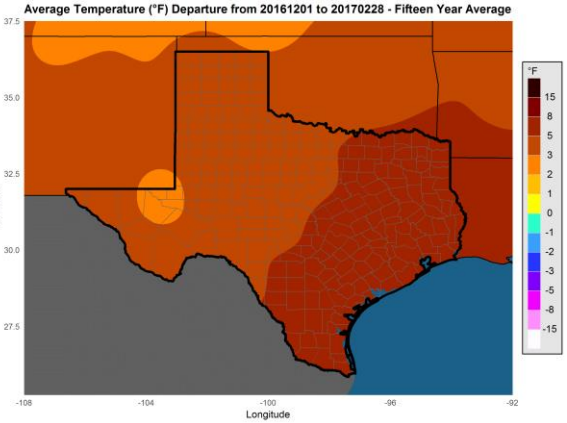
2003-04 (85th)



2004-05 (106th)



2006-07 (43rd)



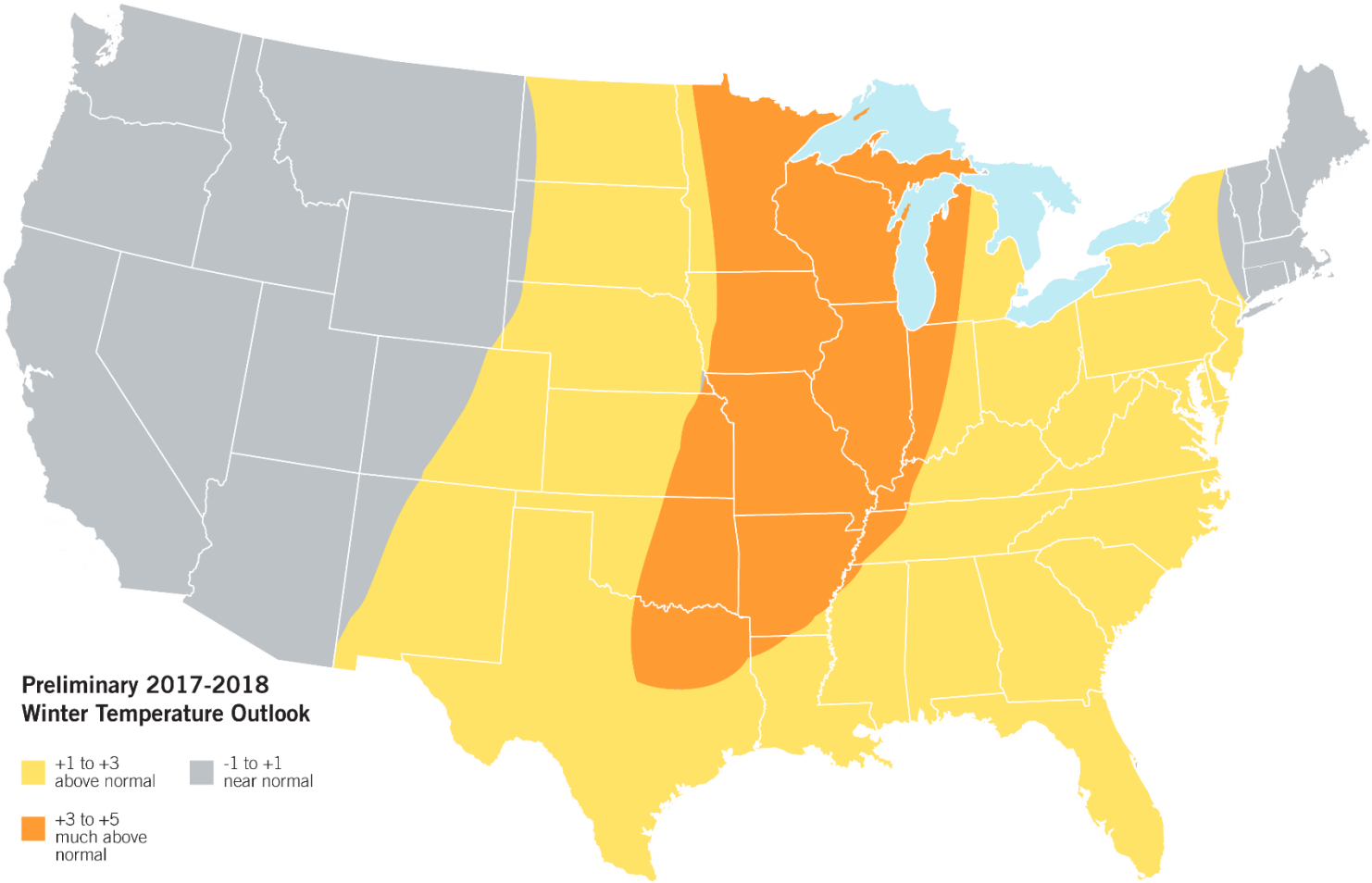
2016-17 (122nd)

2006 (4), 2016 (5), 2004 (3), 2003 (2), 1994 (1)
(ranked based on current season; ordered prior to summer)

None ranked in the bottom third of coldest winters for Texas

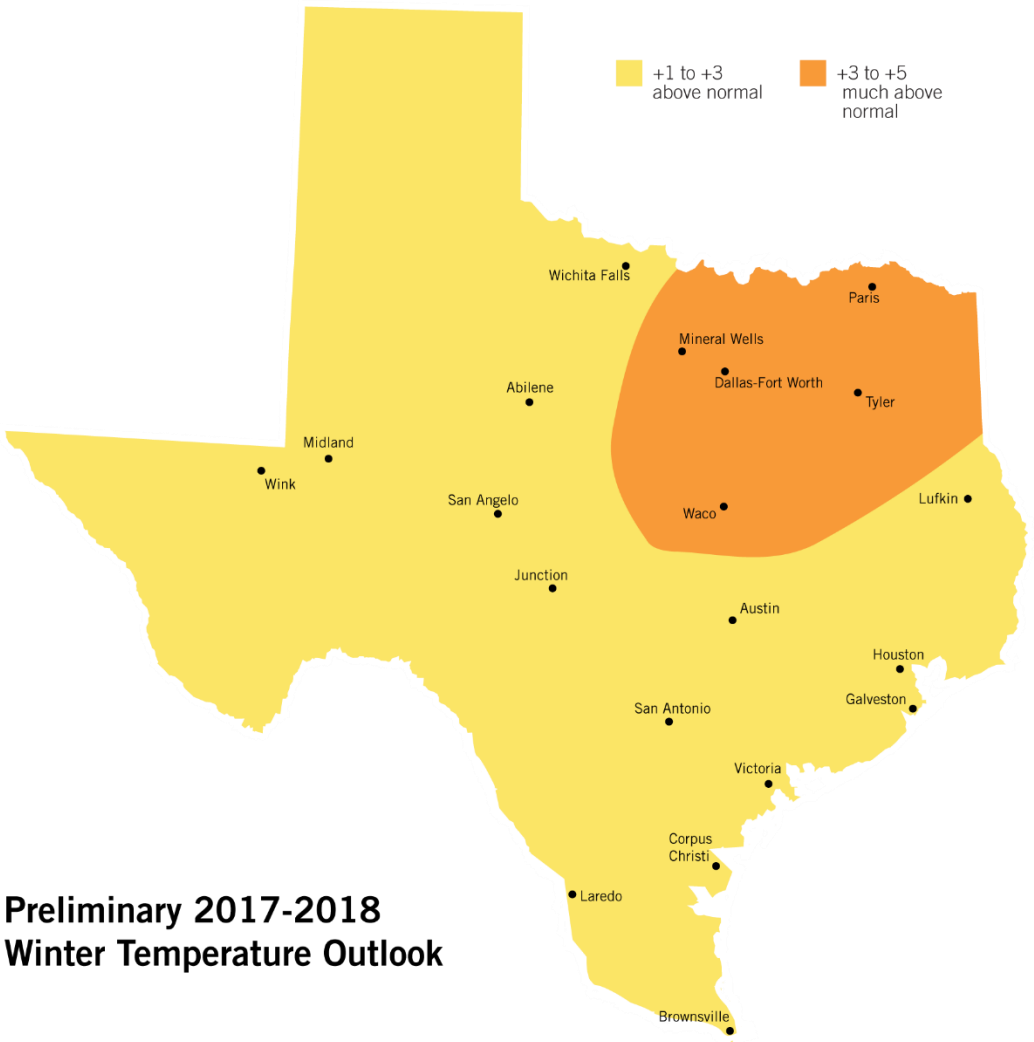
Winter 2017-18 Temperature Outlook

Analog weighted consensus:



Winter 2017-18 Temperature Outlook

- General pattern may change with finalized forecast (Nov 1)
- If trends toward 1994-95, would be warmer (especially West Texas)
- Can't yet rule out a finalized, colder forecast (2006-07?)
- Nothing currently to suggest, however, it will be among the coldest winters (upper-third)
- Mild winters can – and oftentimes do – have very cold periods!

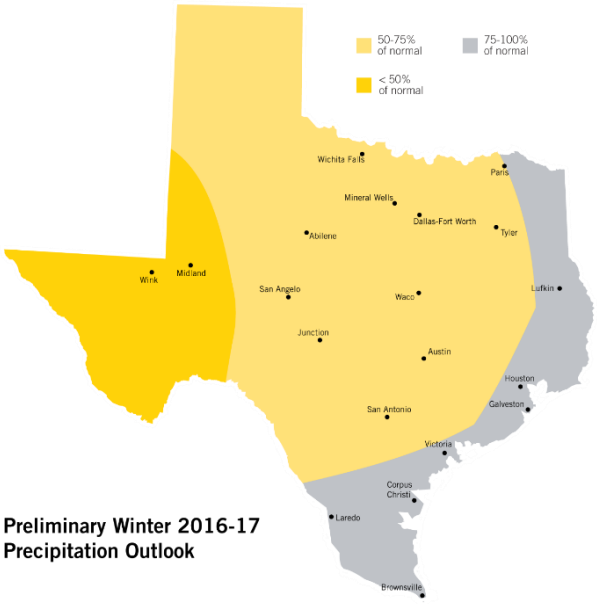


Preliminary 2017-2018 Winter Temperature Outlook

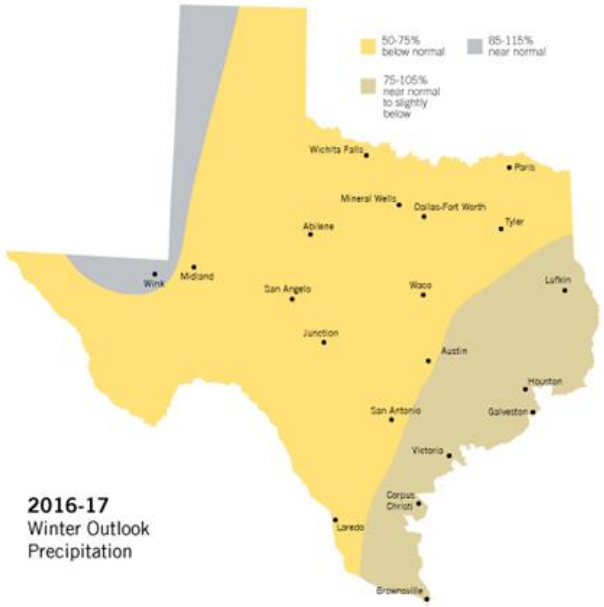
Precipitation Ranking of Recent Winters (Texas)

2016-17	**93rd wettest (out of 122)**
2015-16	56th
2014-15	70th
2013-14	**11th**
2012-13	60th
2011-12	**112th**
2010-11	**17th**
2009-10	**111th**
2008-09	**1st**
2007-08	24th
2006-07	**104th**

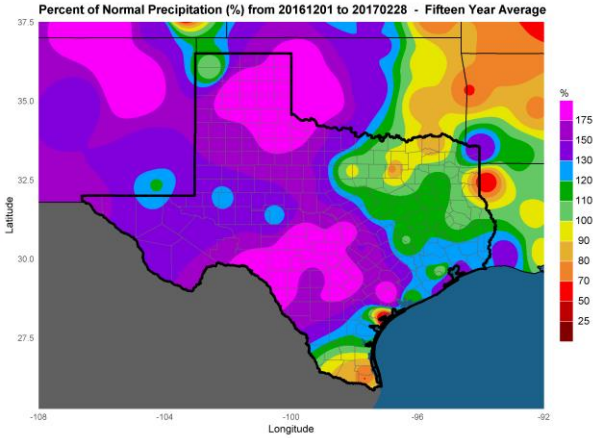
Reviewing Last Winter's Precipitation Forecast



Preliminary Winter 2016-17 Precipitation Outlook



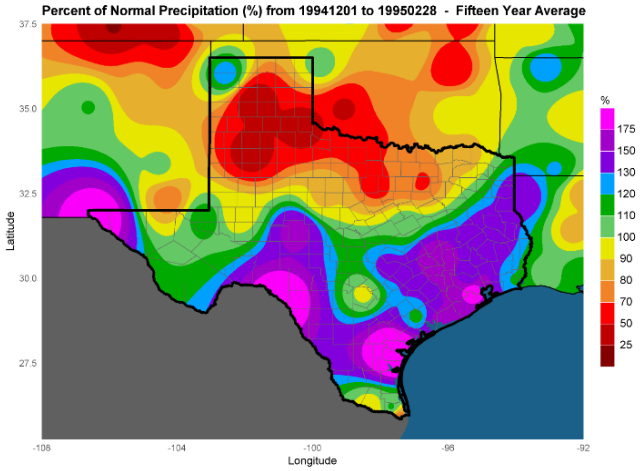
2016-17 Winter Outlook Precipitation

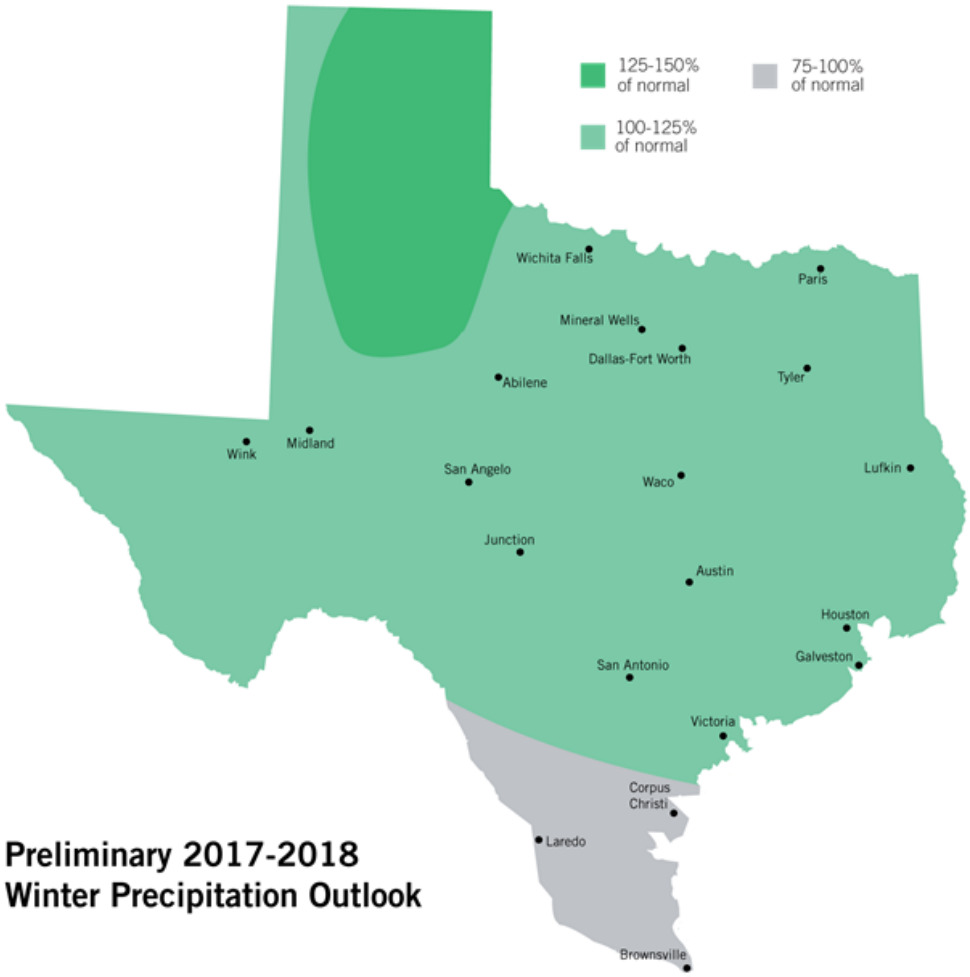


Unlike the temperatures, last winter's precipitation forecast was a bust (other than Northeast Texas and the Rio Grande Valley)

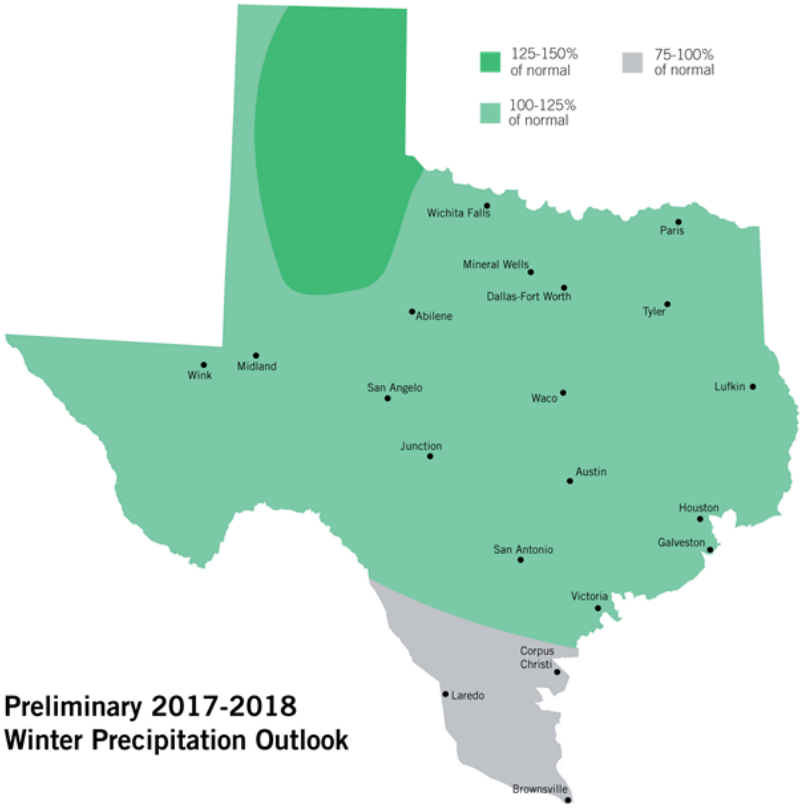
Winter 2017-18 Precipitation Outlook

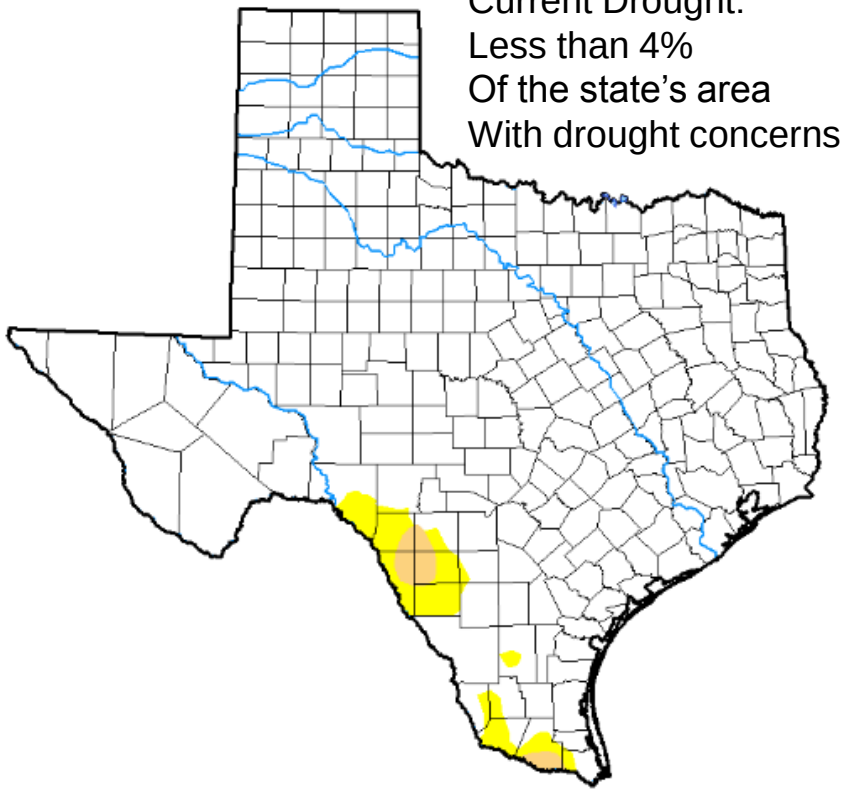
- **Current consensus of all historical analog years results in a wet winter for all but South Texas**
- **The current best-performing analog (1994-95, shown below) has a drier North Texas and the Panhandle**
- **It's possible I will adjust drier for the finalized forecast – but unlikely widespread dry**





Winter 2017-18 Precipitation Outlook vs Drought



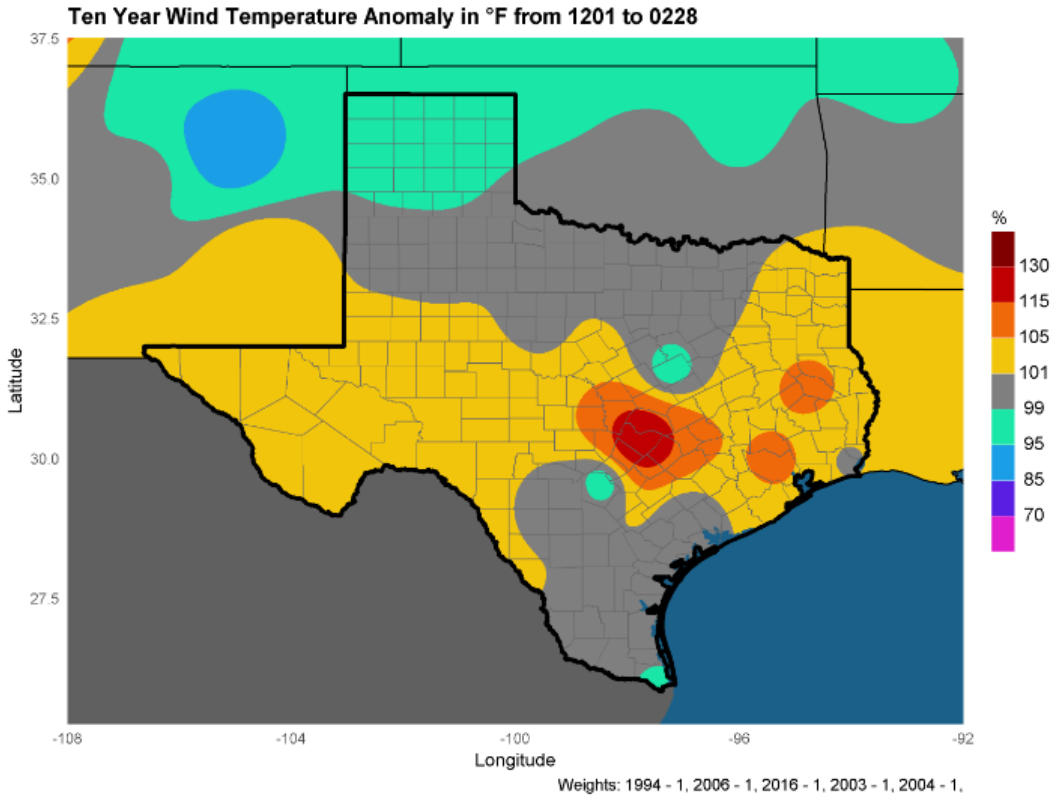


Current Drought:
Less than 4%
Of the state's area
With drought concerns

Can't rule out regional concerns, but widespread drought is unlikely to develop this winter

Historical Analog Winds

- 1994-95, 2003-04, 2004-05, 2006-07, 2016-17
- Would project normal to above-normal wind this winter (most of ERCOT)
- At this point, highly-experimental forecast



Summary

- This is a preliminary forecast. It will be **finalized by November 1** and posted to ERCOT.com
- Some changes possible with the finalized forecast
- Early indications suggest a **mild, wet winter**
- **Even with a mild winter forecast, you should always be prepared for a very cold period/worst case scenario!**
- **Unlikely to be as warm as last winter**
  (122nd coldest / #1 warmest)
- **Unlikely to be as cold as the winter of 2013-14** (30th coldest)
- Too early to project ice or snow concerns. Check the website on or after Nov 1 for some thoughts on ice and snow.
- Have I yet mentioned that you can have periods of extreme cold in otherwise mild winters?