TEXAS RE
Ensuring electric reliability for Texans

NERC and Texas RE Update

Mark Henry
Reliability Services, Texas Reliability Entity

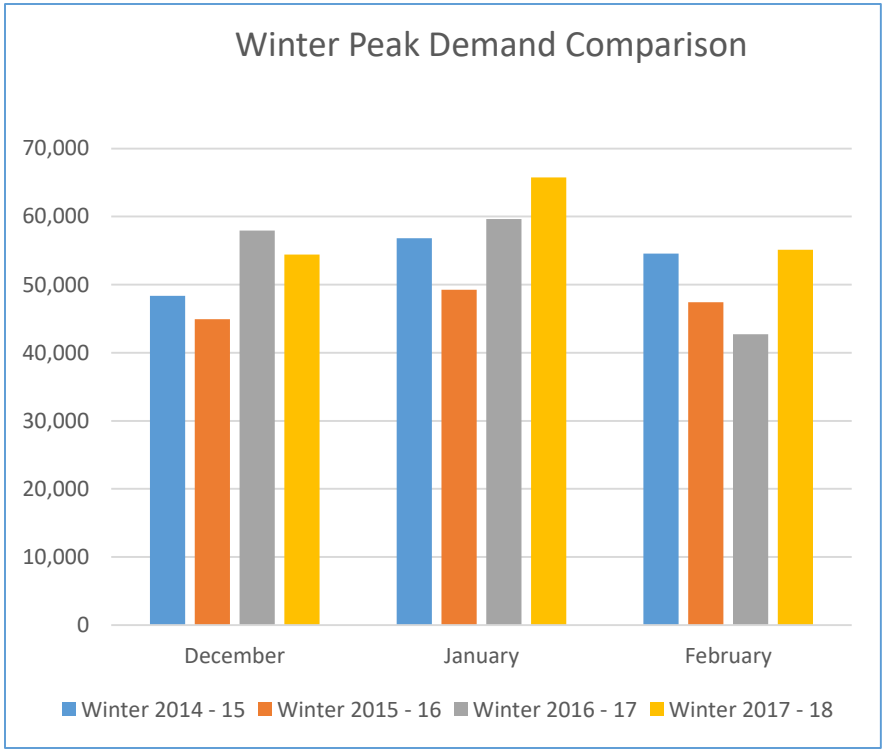
ERCOT/Texas RE Generator Winter Weatherization Workshop

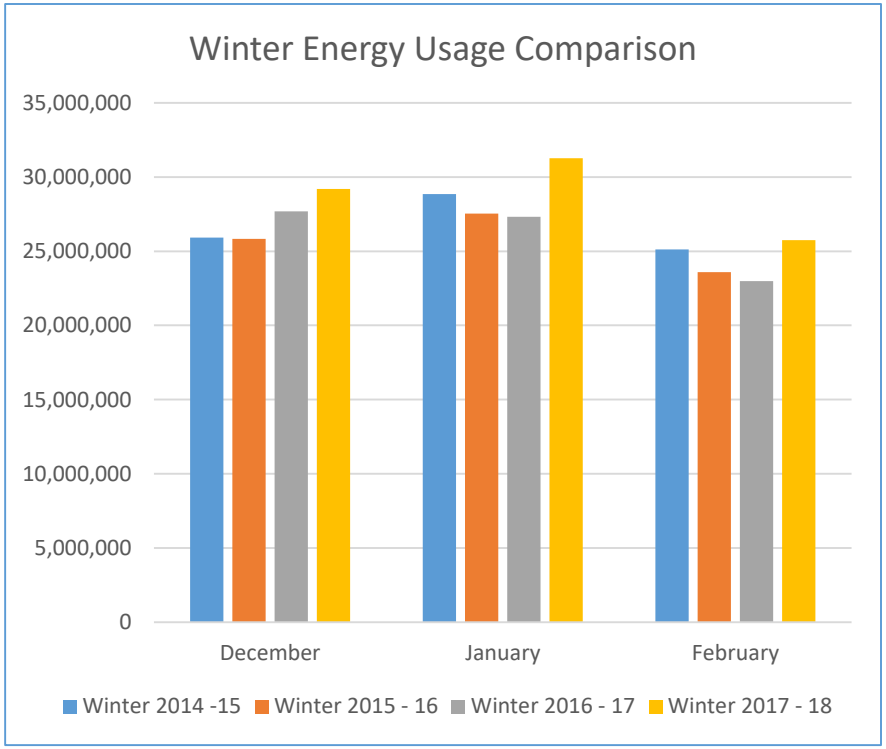
September 6, 2018

Overview

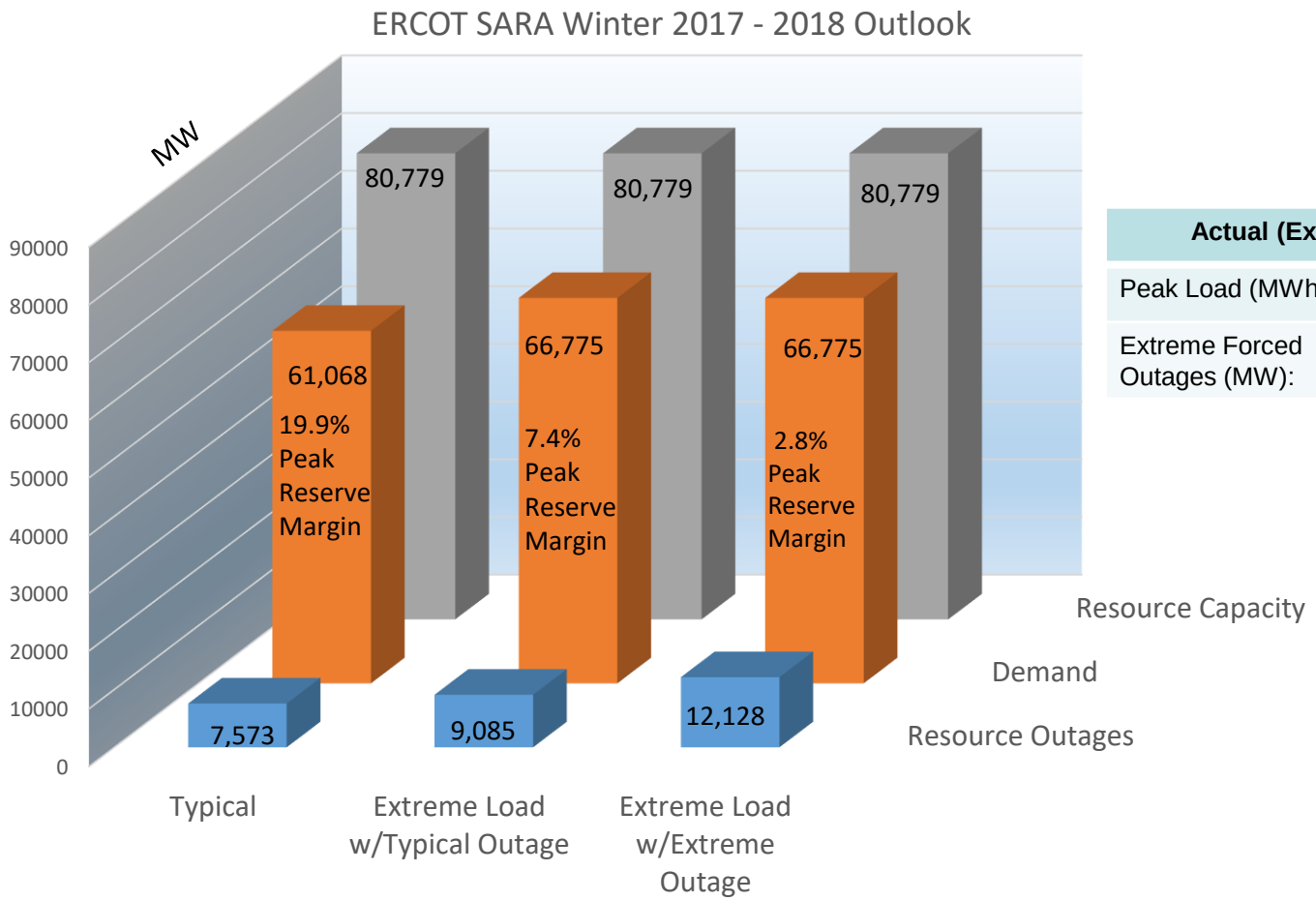
- Recap winter 2017- 2018
- NERC Metric
- Winter Day Profiles
- Wind Plant Extreme Condition Operations
- Emissions Waivers
- NERC Lessons Learned and Guidelines

Winter 2017-18 Recap



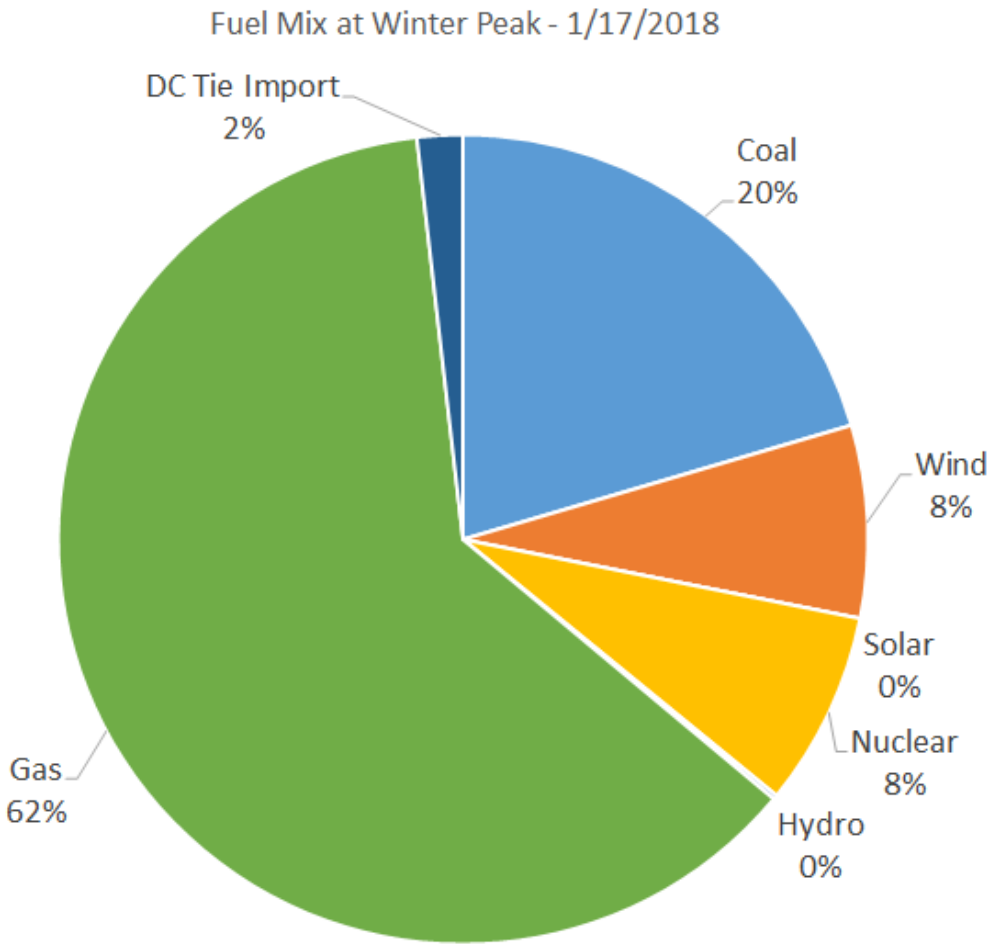


Winter 2017-18 Resource Adequacy Predictions and Actuals

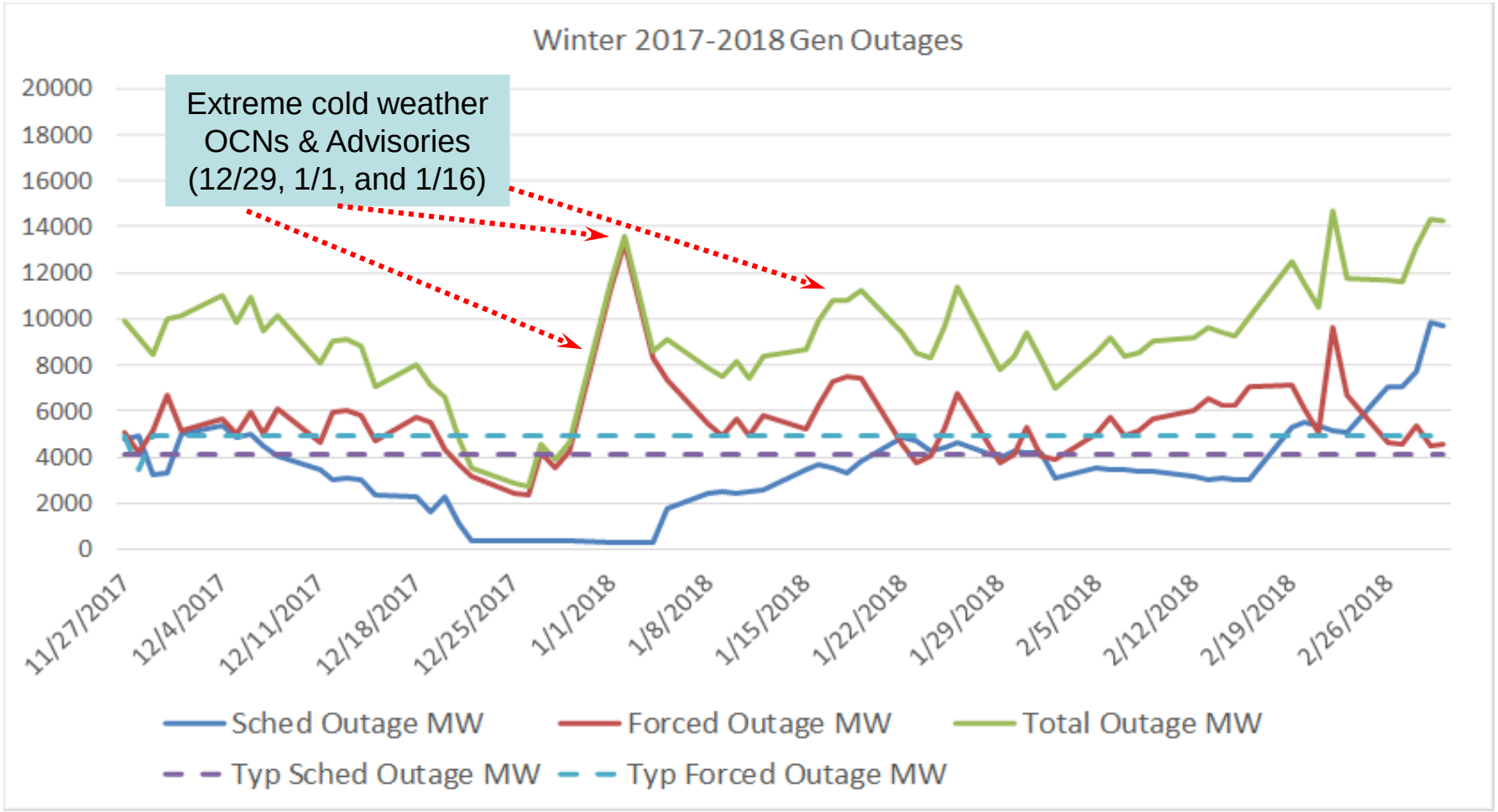


Actual (Extremes) Winter 2017-18	
Peak Load (MWh):	65,750 (1/17/18 HE08)
Extreme Forced Outages (MW):	13,287 (1/2/2019)

2018 Winter Peak Hour Generation Breakdown

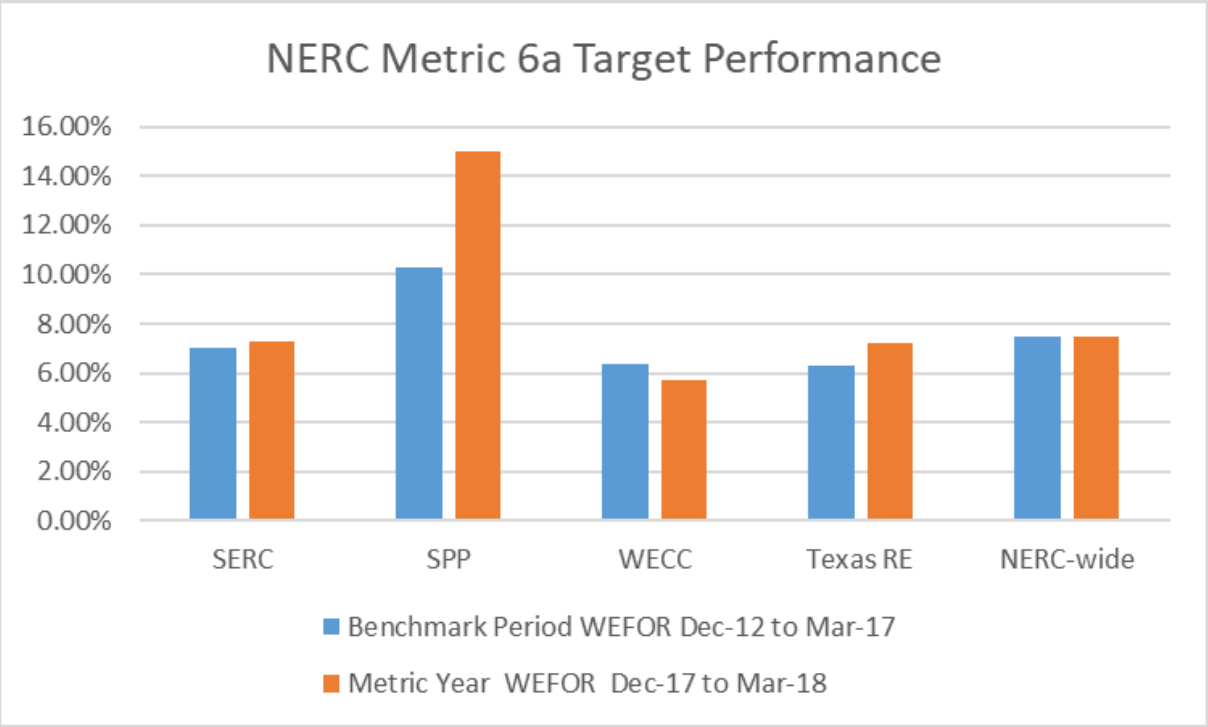


Winter 2017-18 Outages – All Causes



NERC Reliability Metric 6 – Reduced risks in targeted areas

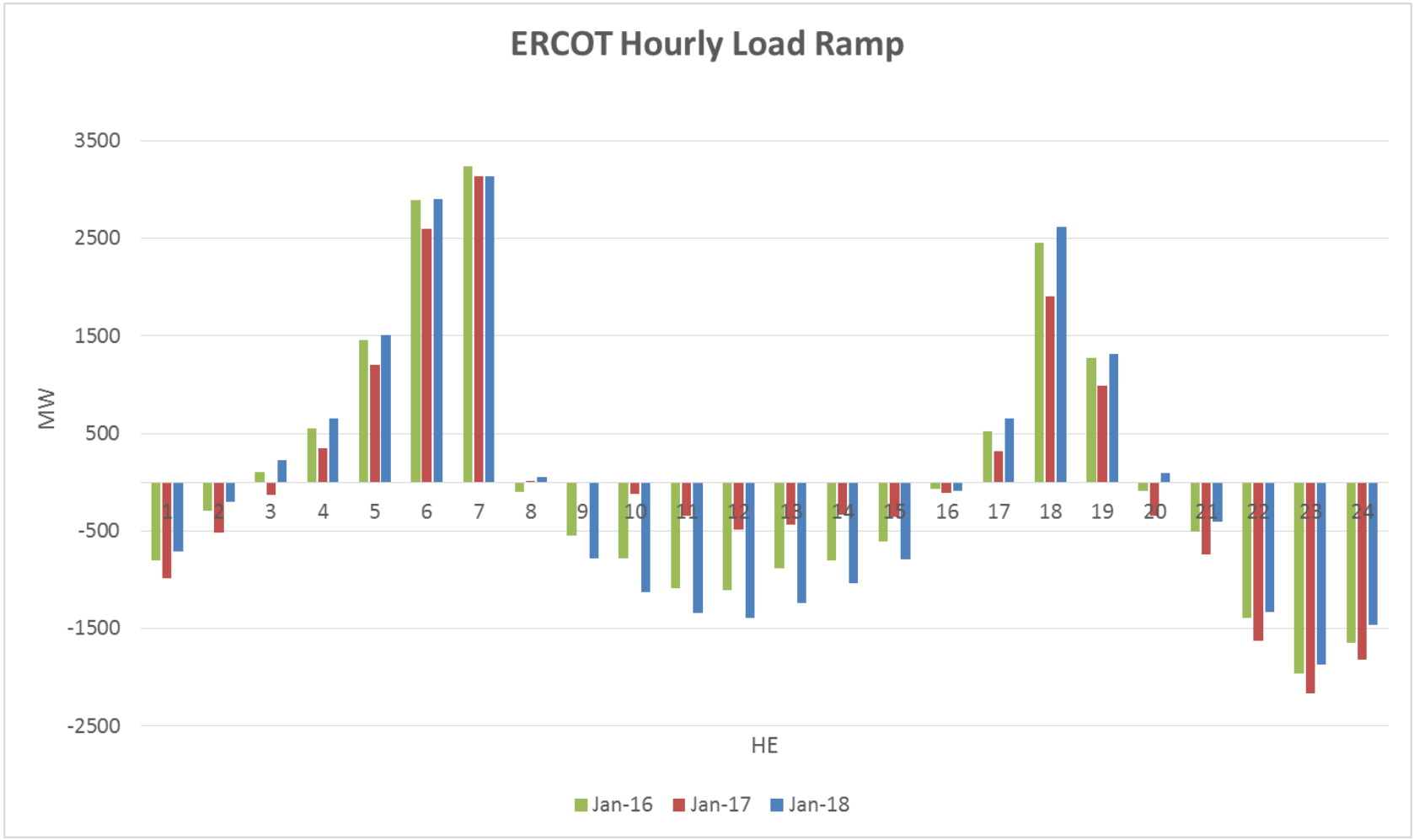
Measure of Success, Metric 6a:. Reduced events caused by generating unit forced outages due to cold weather



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

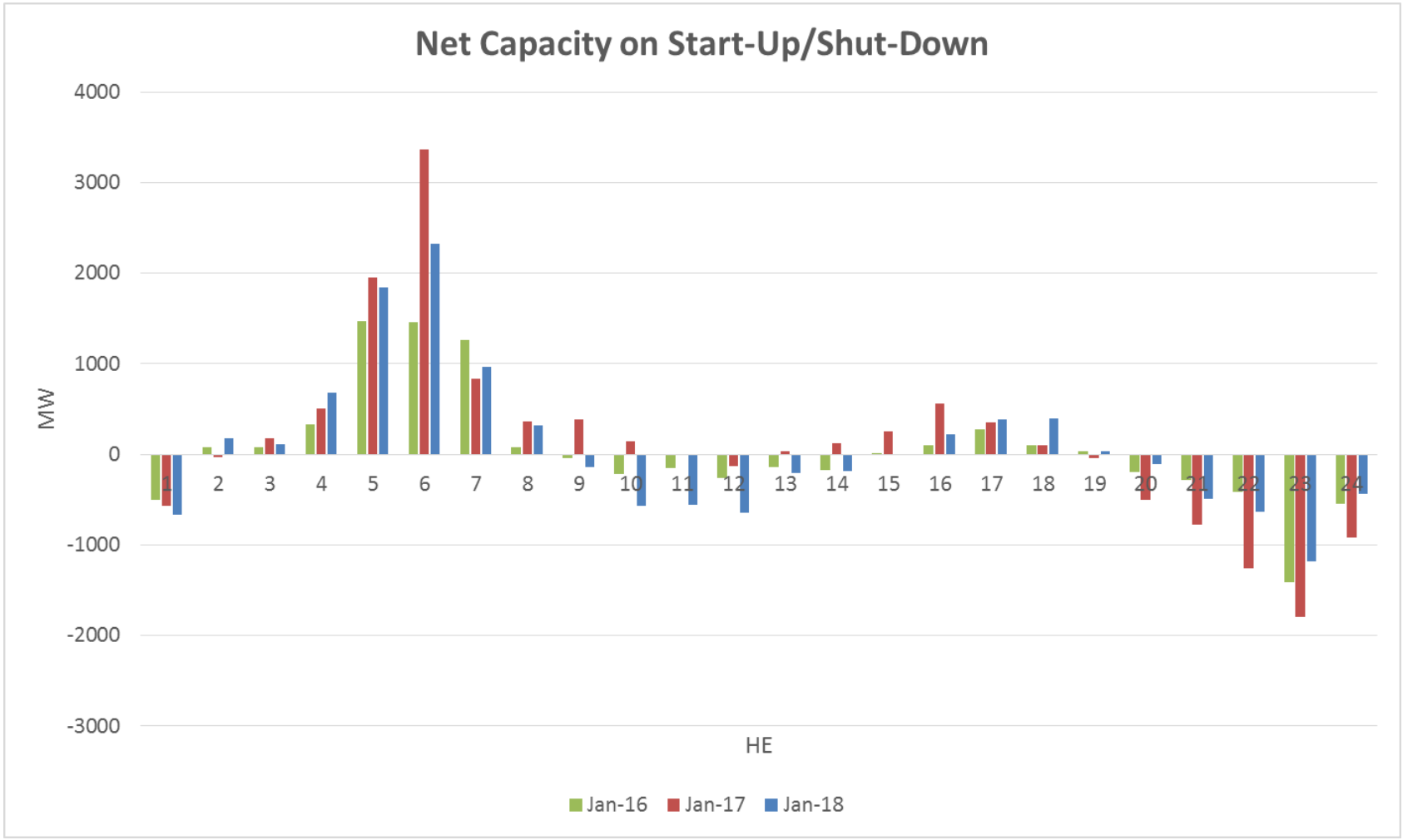
Target - Using most extreme cold winter months, the Weighted Effective Forced Outage Rate (WEFOR) decreases compared to a rolling previous 5 year benchmark average for each Regional Entity

Average January Load Ramps 2016-2018



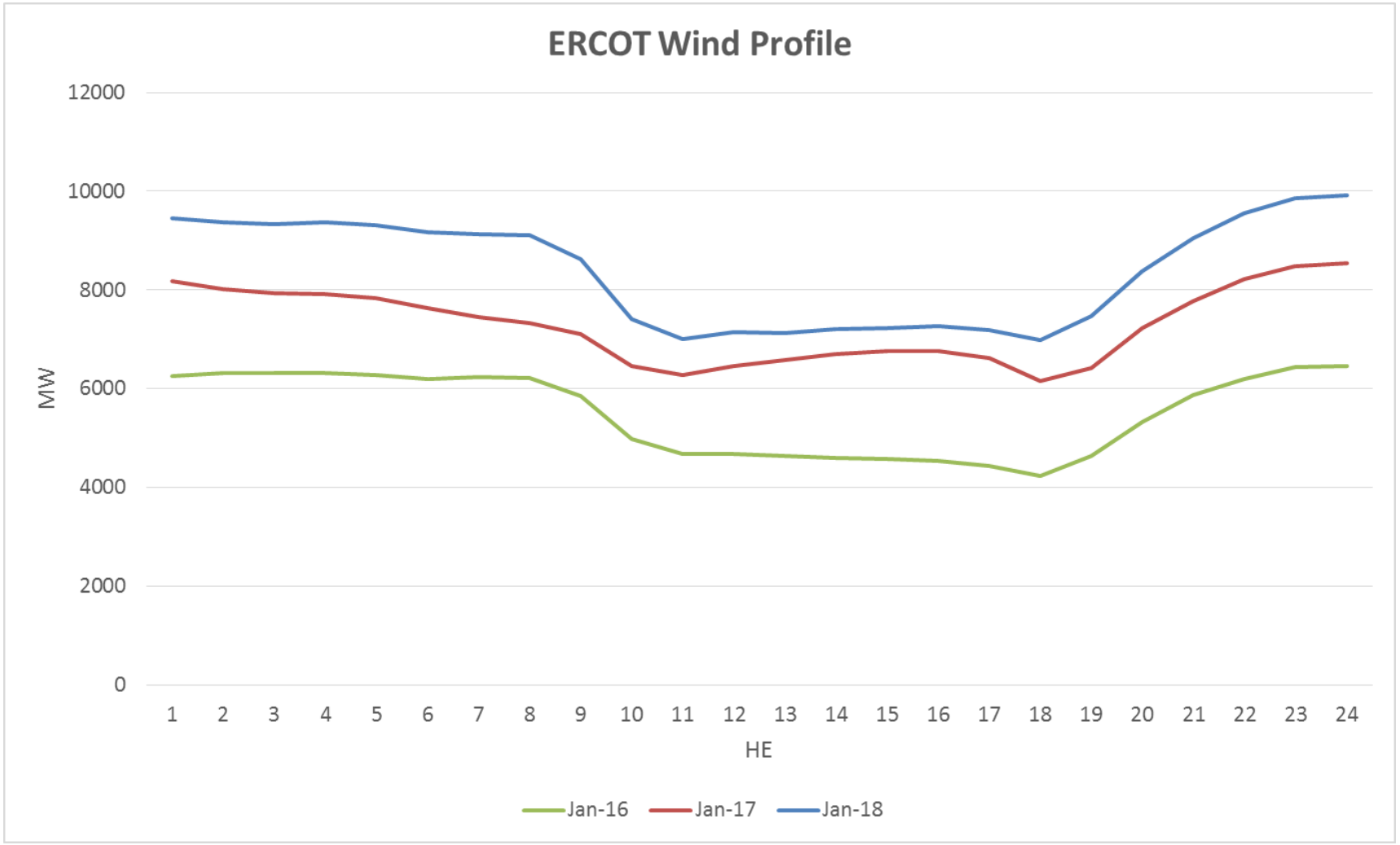
Source: ERCOT Reg Bias Analysis to PDCWG, Feb. 14, 2018

Average January Start-Up & Shut-Down Hours 2016-2018



Source: ERCOT Reg Bias Analysis to PDCWG, Feb. 14, 2018

Average January Wind Profile 2016-2018



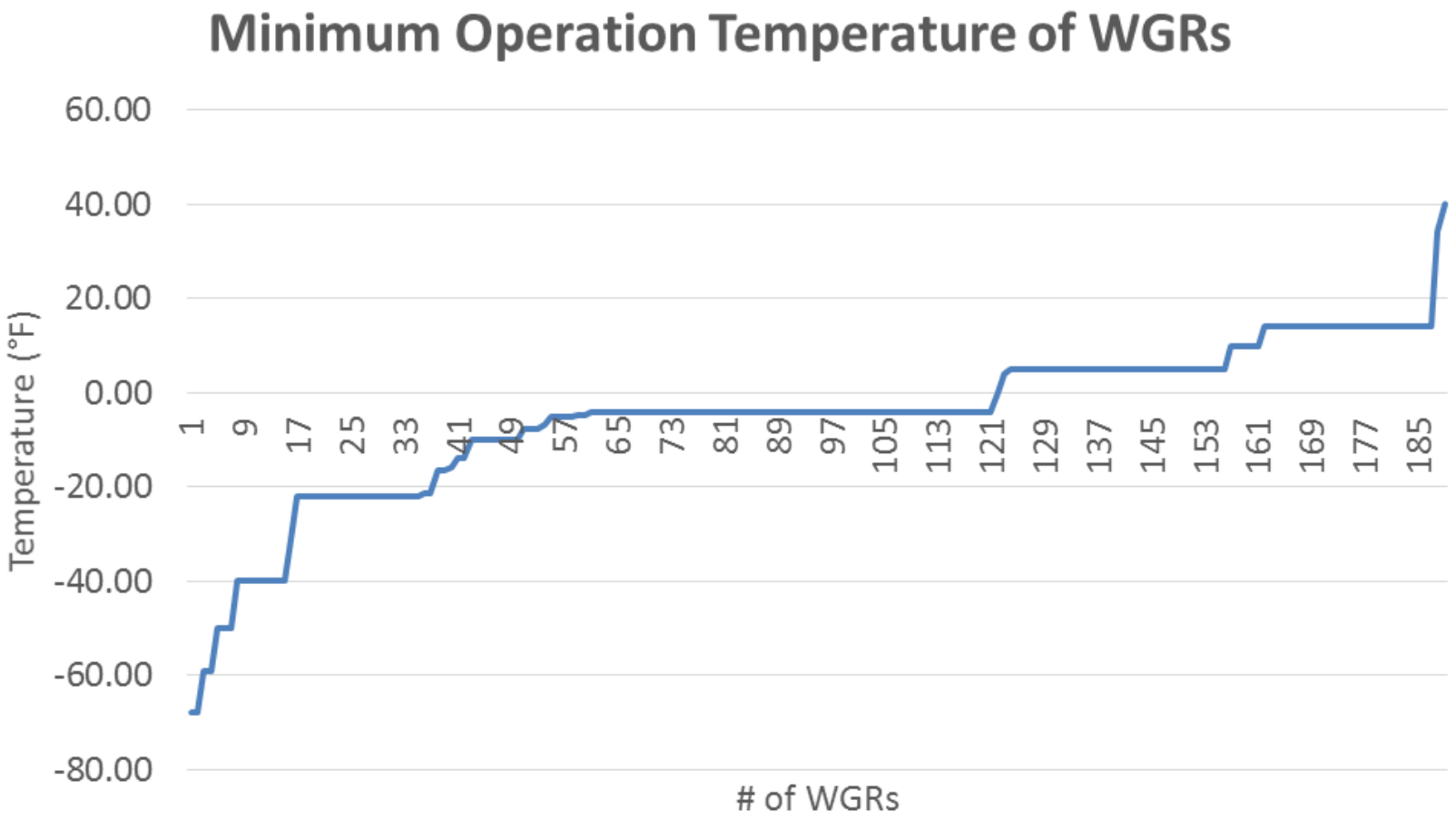
Source: ERCOT Reg Bias Analysis to PDCWG, Feb. 14, 2018

Wind Generation Derates During Winter 2017-18

	Number of WGRs Impacted	Derate Reported (MW)	Wind Forecast Manual Override Needed
Dec 7, 2017	No icing related wind operations concern on this day.		
Dec 26, 2017	18 WGRs impacted	1196 MW	Yes
Dec 31, 2017	53 WGRs impacted	3292 MW	Yes
Jan 1-3, 2018	No icing related wind operations concern on this day.		
Jan 16, 2018 (low temperature impact)	11 WGRs impacted	349.5 MW	Yes
Feb 21-22, 2018	42 WGRs impacted	3027.6 MW	No

Source: N. Mago, ERCOT

Operation Limits of WGRs (as of early 2018)



Source: N. Mago, ERCOT

Emissions in Emergencies – TCEQ Discretion

Jan 16 2018 21:16:01 CST Operations Message:

TCEQ has approved ERCOT's request for enforcement discretion for any power generating facility to exceed its air permit limits in order to provide continued or additional capacity to the ERCOT System through the morning on January 17, 2018. This enforcement discretion is effective immediately. More details will be provided in a Market Notice.

Excerpt from M-A011618-01 Operations, January 16, 2018:

“ Power generating facilities are authorized for maximum emission limits. If/when increased generation is requested, TCEQ will exercise enforcement discretion for exceedances of emission and operational limits of power generating plants for Generators who exceed air permit limits in order to maximize generation for the duration of the event.

Any Generator who will exceed its air permit limits during the event should provide a notice of this action to Kelly Cook (kelly.cook@tceq.texas.gov), Director of Critical Infrastructure Division (preferably by email). Unless ERCOT or TCEQ provides Notice otherwise, the period of enforcement discretion will end when ERCOT declares that it is no longer in this event.”

Emissions in Emergencies – Cancellation Example

Operations Message: Jan 18 2018 12:20:11 CST:

ERCOT has cancelled the following notice: TCEQ has approved ERCOT's request for enforcement discretion for any power generating facility to exceed its air permit limits in order to provide continued or additional capacity to the ERCOT System through the morning on January 18, 2018. This enforcement discretion is effective immediately. More details will be provided in a Market Notice

Market Notice:

NOTICE DATE: January 18, 2018

NOTICE TYPE: M-A011618-02 Operations

SHORT DESCRIPTION: TCEQ Notice of enforcement discretion on air permitting requirements during a power emergency

INTENDED AUDIENCE: QSEs with Resources, Resource Entities

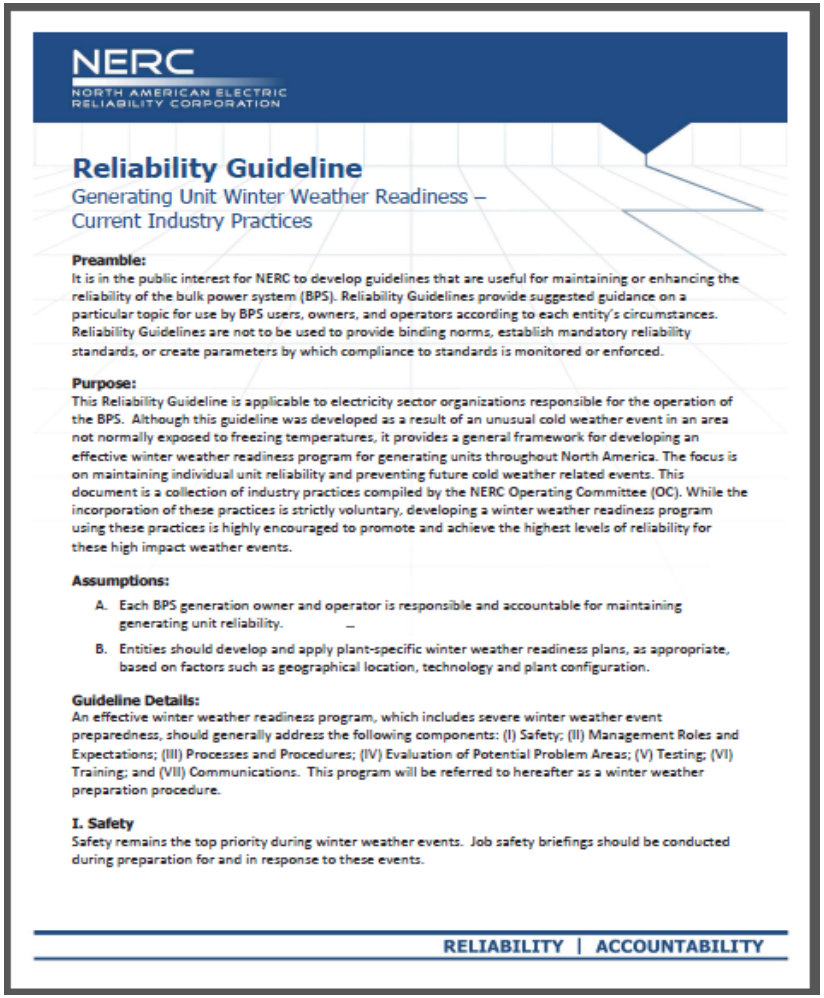
DAY AFFECTED: January 18, 2018

LONG DESCRIPTION: Due to improving system conditions resulting from warmer temperatures returning throughout the ERCOT Region, ERCOT has ended its request with the Texas Commission on Environmental Quality (TCEQ) for enforcement discretion for power generating facilities, as detailed in Market Notice M-A011618-01. Effective immediately, TCEQ has confirmed the end of enforcement discretion for power generating facilities.

CONTACT: If a QSE or Resource Entity has any questions concerning this Market Notice, please contact Chad V. Seely, ERCOT General Counsel, at (512) 225-7035.

NERC Winter Weather Readiness Guideline

- Approved by the Operating Committee on March 5, 2013
- Revised with approval of the Operating Committee 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

Preparing Circuit Breakers for Operation in Cold Weather

- **Failure-to-trip by three 500kV SF6 circuit breakers at a nuclear facility during 4 degree F conditions, recently posted as NERC Lesson Learned LL20180702**

- Thermostatically-controlled cabinet heaters added to prevent moisture from freezing inside pneumatic (air) control valve

- Areas with possible cold-temperature-related failure mechanisms, to check on all breaker types as applicable:
  - seal and compressor belt condition,
  - lubrication,
  - pressures,
  - dielectric,
  - dryers, and
  - adequate functioning heaters or heat tracing

Baker's Dozen Winter Weather "Lessons Learned"

- **LL20110902** Adequate Maintenance and Inspection of Generation Freeze Protection
- **LL20110903** Gen. Unit Temperature Design Parameters & Extreme Winter Conditions
- **LL20111001** Plant Instrument &Sensing Eqpt Freezing Due to Heat Trace & 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
- **LL20140503** Improved Contractor Oversight Needed

Questions?


For further information:
Bob Collins (512-583-4986)
Mark Henry (512-583-4988)
Email:
rapa@texasre.org

LCRA FREEZE PROTECTION

Presented by: Jason Kessel

Created by: Jack Sandel

ENERGY • WATER • COMMUNITY SERVICES

Agenda

- Background
- Heat Tracing Issues
- Transmitters
- Thermocouples
- Scaffold Wrap

Background

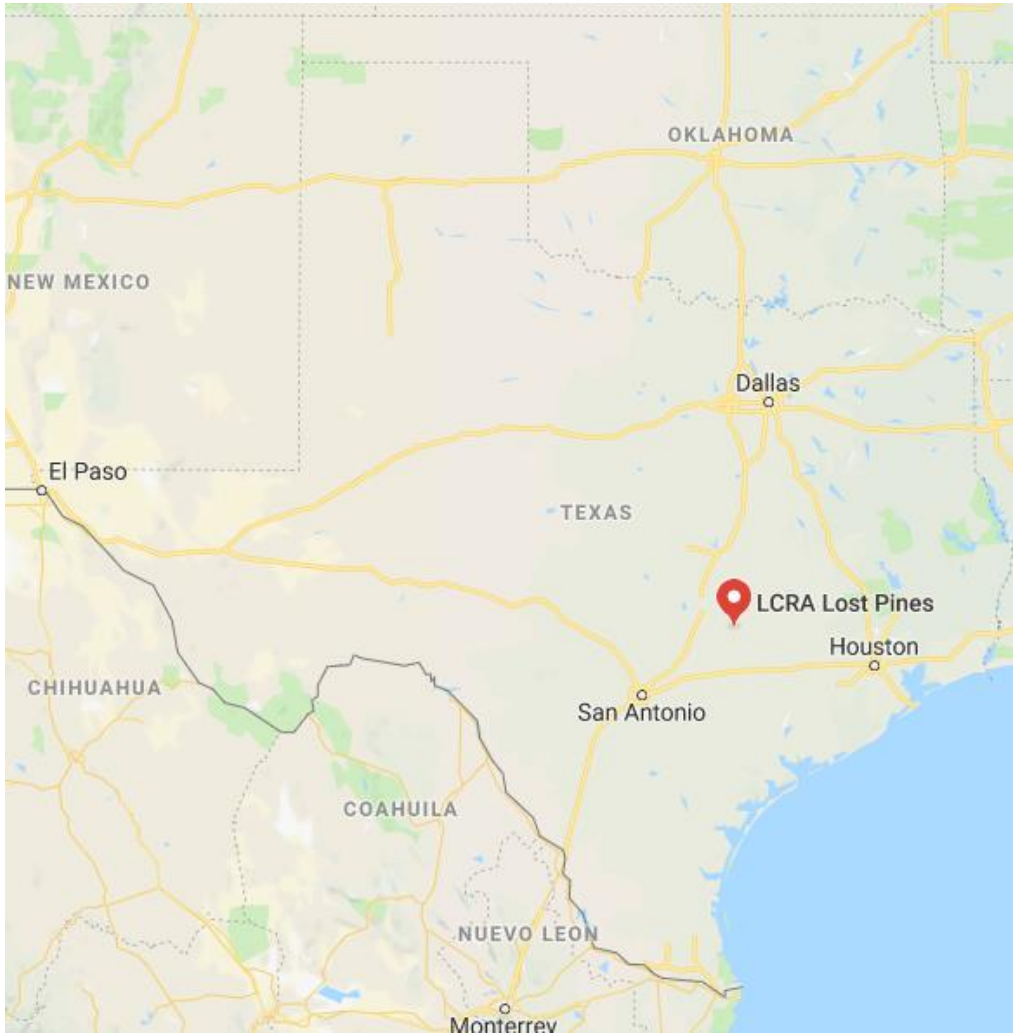
Sim Gideon
3 Conventional Gas Fired Drum Units
Capacity ~ 607 MW

Lost Pines
2x1 Combined Cycle Natural Gas
Capacity ~ 510 MW

Winchester
4 Simple Cycle Natural Gas
Capacity ~ 176 MW

LCRA
ENERGY • WATER • COMMUNITY SERVICES

Background



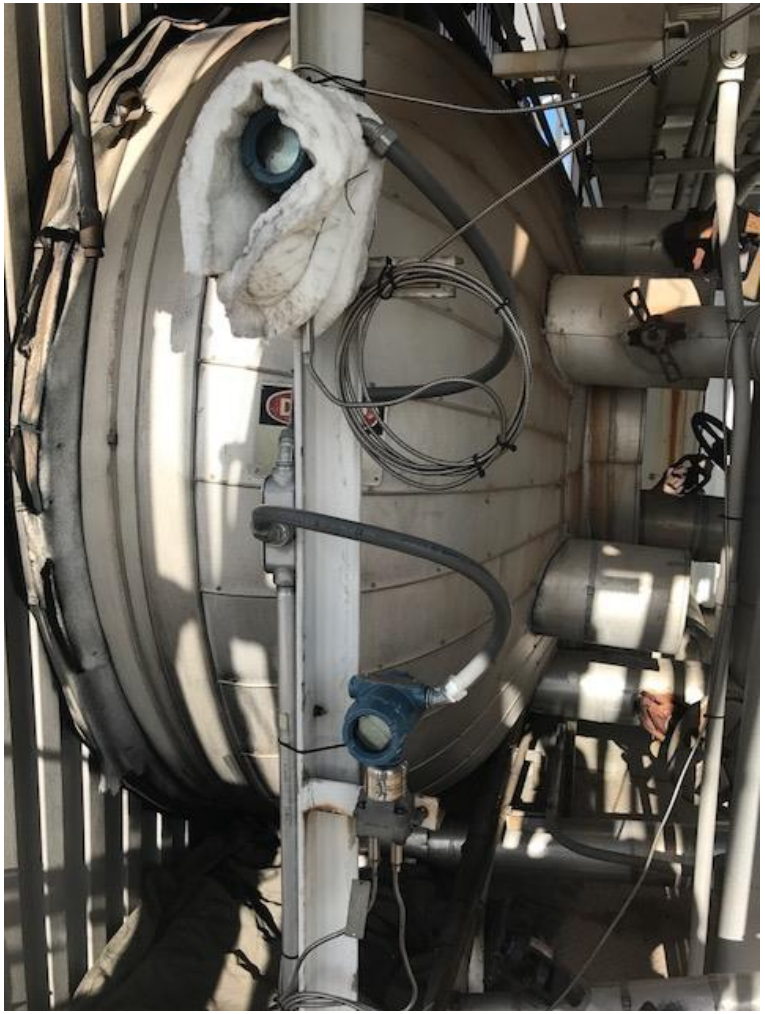
LCRA
ENERGY • WATER • COMMUNITY SERVICES

Heat Tracing Issues in the Past

- Moisture can corrode heat trace
- Insulation can fall off
- Inadvertent line damage
- Expensive to install and operate
- Test today, fails tomorrow without notice

LCRA
ENERGY • WATER • COMMUNITY SERVICES

Transmitters



LCRA
ENERGY • WATER • COMMUNITY SERVICES

Transmitters

- Capillary line
  - Silicon fill fluid
  - Freezes ~ - 40F
- Reduces heat trace and insulation requirements
- Works well during operation
- Used for level and pressure transmitters

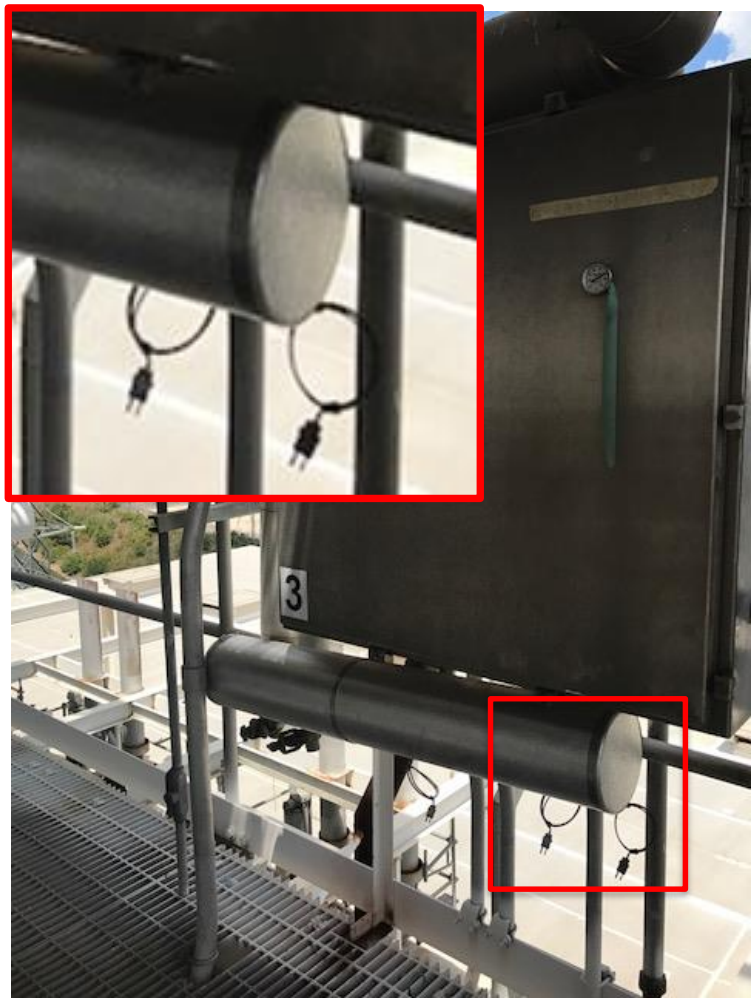
LCRA
ENERGY • WATER • COMMUNITY SERVICES

New Transmitter Issues

- Fluctuations during startup/shutdown
- Readings (fluid density) affected by:
  - Skin leaks
  - Ambient temperature
- Expensive
- Still have to heat trace leg to transmitter

LCRA ENERGY • WATER • COMMUNITY SERVICES

Thermocouples

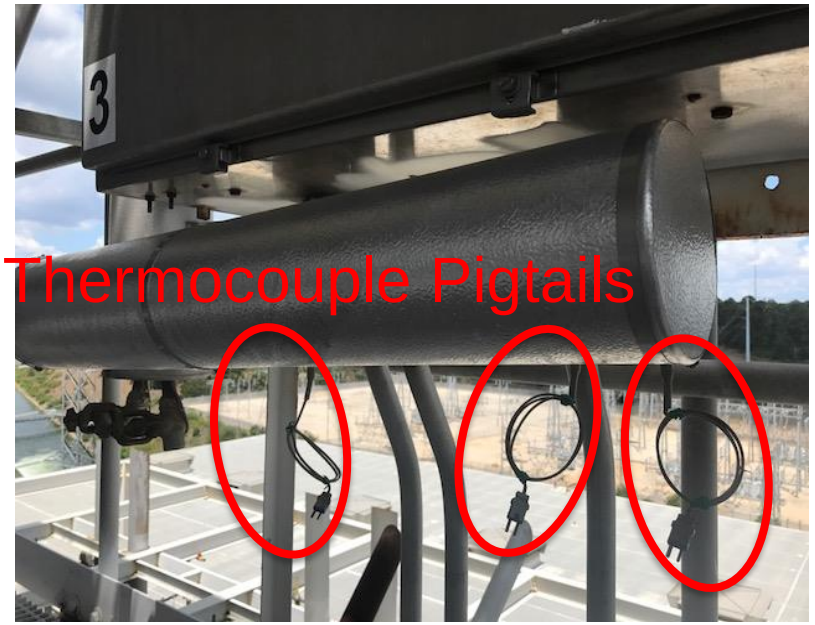


- Used for critical instrumentation
- Validates heat trace effectiveness
- Low skill set to monitor

LCRA
ENERGY • WATER • COMMUNITY SERVICES

Thermocouples

- Still take amp readings
- Place a thermocouple near end of heat trace
- Read with Fluke meter



LCRA
ENERGY • WATER • COMMUNITY SERVICES

Scaffold Wrap

Scaffold Wrap

- Acts as shield from wind
- Shrink with open flame
- Secure with rope
- Reduces convective HX
- Non-Flammable
- **More durable than tarps**

Scaffold Wrap

- Easy to install and repair
- Long lasting and effective
- More cost effective than replacing tarps
- Fire retardant
- Lightweight

LCRA
ENERGY • WATER • COMMUNITY SERVICES

Conclusion

- LCRA Freeze Protection
  - Gel filled transmitters
  - Thermocouples
  - Scaffold wrap

LCRA
ENERGY • WATER • COMMUNITY SERVICES

Questions?

Sand Hill Energy Center

Winter Lessons Learned

Durwood L. Lewis

Plant Manager Sand Hill Energy Center

6 September 2018

Sand Hill Energy Center

- (6) LM6000 PC Aeroderivative Gas Turbines
  - (4) Units in 2001
  - (2) Units in 2010
- Combined Cycle Unit
  - 1x1
    - 7FA Gas Turbine
    - D11 Steam Turbine
    - Doosan HRSG

7 January 2017 Combined Cycle Trip

- Combined Cycle tripped at 07:23am
  - Plant ambient temperature 21° F with wind chill below 10° F

  - "B" feed pump tripped (high suction strainer differential pressure)
  - "A" feed pump not available (high suction strainer differential pressure) at 05:10am
  - Heat trace for "A" feed pump suction strainer transmitters failed
    - Pre-winter check amp draw = 6.5 amps
    - Circuit amp draw after trip on 7 January = 4.2 amps
  - Heat trace for "B" feed pump suction strainer was working
    - Low wind chill temperatures and wind direction

Contributing Factors

- Loss of heat trace on critical equipment:
  - "A" Feed pump suction strainer heat trace failed
  - "B" feed pump suction strainer inadequate for conditions
    - Sustained wind chill temperatures below 10° F for several hours
    - Direction of wind from north east
- Communications
  - Maintenance to Operations
  - Crew to crew — shift turnover
  - Plant operations crew to management
- Continuity from night shift to day shift

Contributing Factors

- Pre-winter check heat trace circuits check (several heat trace lines to each circuit)
  - Method could not verify all heat trace lines on circuit correctly working

Post Trip ERCOT Recommendations

- Develop a pre-event checklist
- Use reliable wind breaks for vulnerable areas (example: boiler feed pumps)
- Verify critical heat trace circuits are functioning prior to each extreme cold weather event

Improvements - Replace Failed Heat Trace

Boiler Feed Pumps heat trace bundle replacement installation

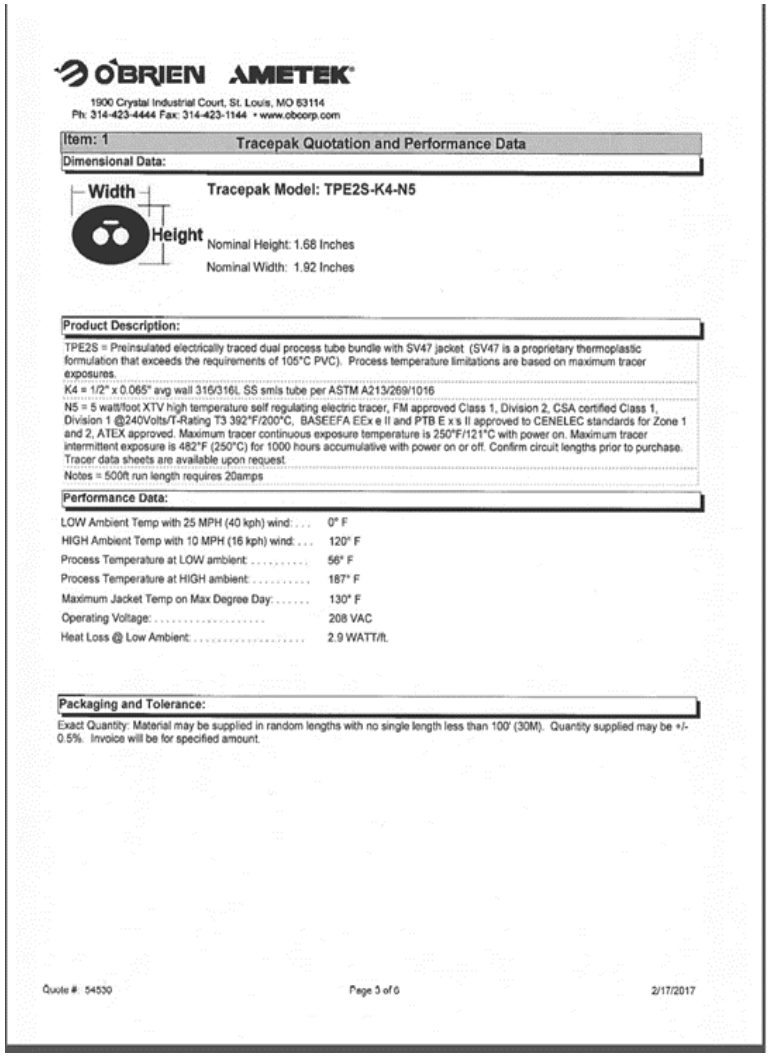
4/20/2017

AUSTIN ENERGY Completion Information Report

PNL NUM	BRK NUM	LINE NUM	HT Ohms Exsisting	HT Meg Ohms Exsisting	Description	HT Ohms Installed	HT Meg Ohms Installed	Brk Post-Install Amps	Brk Post-Install Ohms	Brk Post-Install Megohms	Comments
5APL06J		BFP FT-W	N/A	0.1	BFP # 1 Flow Transmitter Tubing Bundle, 2256 Unitherm Dual Tube, 1/2" .065 Wall, 5W/Ft, 240VAC, Low Temp Cable	238	11000	0.992	242	11000	Power Connection Boot on existing cable was damaged and heat trace cable on root valves was cracked and brittle. Heat stress cracks around root valves
5APL06J		BFP FT-E	N/A	0.1	BFP # 2 Flow Transmitter Tubing Bundle, 2256 Unitherm Dual Tube, 1/2" .065 Wall, 5W/Ft, 240VAC, Low Temp Cable	258	11000	0.905	265	11000	Existing heat trace cables had heat stress crackes and cable was brittle around root valves.

Improvements

- Installed Replacement Heat Trace rated to 0° F.



O'BRIEN AMETEK

1900 Crystal Industrial Court, St. Louis, MO 63114
Ph: 314-423-4444 Fax: 314-423-1144 • www.obcorp.com

Item: 1 — Tracepak Quotation and Performance Data

Dimensional Data:

Width / Height

Tracepak Model: TPE2S-K4-N5

Nominal Height: 1.68 Inches
Nominal Width: 1.92 Inches

Product Description:

TPE2S = Preinsulated electrically traced dual process tube bundle with SV47 jacket (SV47 is a proprietary thermoplastic formulation that exceeds the requirements of 105°C PVC). Process temperature limitations are based on maximum tracer exposures.

K4 = 1/2" x 0.065" avg wall 316/316L SS sml/s tube per ASTM A213/269/1016

N5 = 5 watt/foot XTV high temperature self regulating electric tracer, FM approved Class 1, Division 2, CSA certified Class 1, Division 1 @240Volts/T-Rating T3 392°F/200°C, BASEEFA EEx e II and PTB E x s II approved to CENELEC standards for Zone 1 and 2, ATEX approved. Maximum tracer continuous exposure temperature is 250°F/121°C with power on. Maximum tracer intermittent exposure is 482°F (250°C) for 1000 hours accumulative with power on or off. Confirm circuit lengths prior to purchase. Tracer data sheets are available upon request.

Notes = 500ft run length requires 20amps

Performance Data:

LOW Ambient Temp with 25 MPH (40 kph) wind:	0° F
HIGH Ambient Temp with 10 MPH (16 kph) wind:	120° F
Process Temperature at LOW ambient:	56° F
Process Temperature at HIGH ambient:	187° F
Maximum Jacket Temp on Max Degree Day:	130° F
Operating Voltage:	208 VAC
Heat Loss @ Low Ambient:	2.9 WATT/ft.

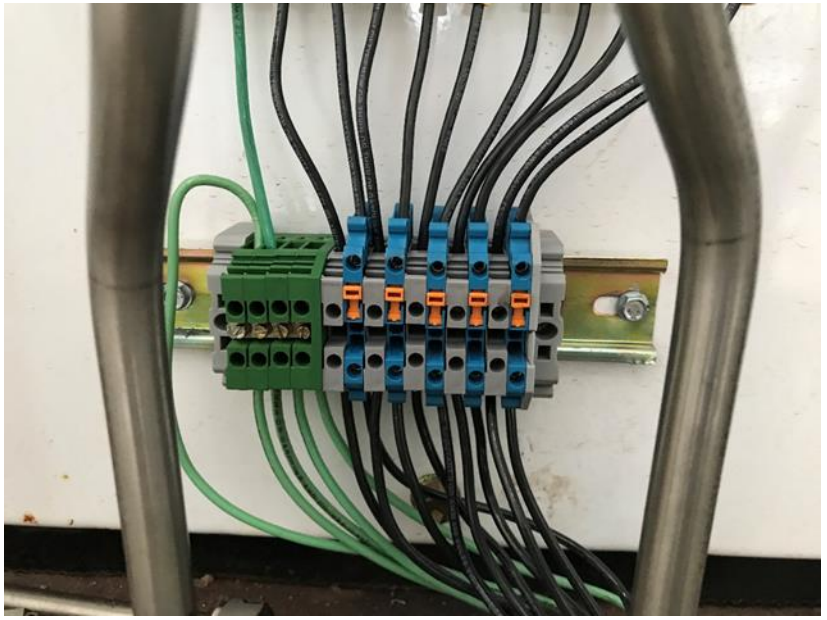
Packaging and Tolerance:

Exact Quantity: Material may be supplied in random lengths with no single length less than 100' (30M). Quantity supplied may be +/- 0.5%. Invoice will be for specified amount.

Quote #: 54530 — Page 3 of 6 — 2/17/2017

Improvements - Heat Tracing

- Added knife switches to heat trace wiring circuits
  - Enables testing individual heat trace lines rather than circuits



Improvements - Heat Trace Testing

Pre-Event Testing of Critical Heat Trace

Unit 5 Instrument Heat Trace Amp Draws 5CHT005E (Self Regulating)							
Color Designates Critical Circuits							
		Nov. 30 2017	Amb. Temp	Dec. 29 2017	Amb. Temp	2019	Amb. Temp
Heat Trace Circuit	5APL06						
Circuit Description	Transmitter Cabinet Heater and Instrument Line Heat Trace						
Transmitter Line	5APDT-FW204A	0.237	51	0.241	46		
	BFP A SUCTION PRESS						
Transmitter Line	5APDT-FW204B	0.227	51	0.257	46		
	BFP A SUCTION PRESS						
Transmitter Line	5AFT-FW215A	0.909	51	1.003	46		
	BFP A MIN FLOW RECIRC FLOW						
Transmitter Line	5APDT-FW203B	0.887	51	1.07	46		
	BFP B SUCTION STRN DP						
Transmitter Line	5APDT-FW203A	0.968	51	1.21	46		
	BFP A SUCTION STRN DP						

Pre-Winter Event Operations Checklist
Sand Hill Energy Center

Use this checklist after receiving a cold weather related ERCOT Operations Condition Notice (OCN) and/or when deemed necessary by Plant Manager or the designated senior operations personnel.

Shift Supervisor INFORMATION

Name: _____ Date: _____

_____

Forecast Conditions (see Wind Chill chart on the back of this form)

- ☐ Forecast Low Temp _____'f Expected wind chill ____'f
- ☐ Forecast wind direction _____ Forecast wind speed_____
- ☐ Forecast duration near or below freezing _____ hrs./days_____

Staffing

☐ Review plant staffing for cold weather event.

If Freezing weather is forecast before midnight and carry into the next day increase staffing.

- Operations Staffing
- Night Shift Crew _____
- Day Shift Crew _____
- Get 2 additional Operators to work a 04:00 to 04:00 shift. #1_____ #2_____

- SICE Staffing and Hours
- Have one Tech onsite overnight and an additional one on call. #1_____ #2_____
- Have the on call come in to work the following day if they don't get called in earlier.

Equipment Limitations

☐ Review Freeze protection condition 1 and 2 checklist

☐ Review plant equipment LOTO's and out of service equipment etc.

☐ Perform One Motor Rotation before the cold weather begins.
-Address and Log any Motor that fails to function.

☐ Out of Service equipment must be protected against freeze damage.

☐ Print and have Condition 2 check sheets ready to use.

☐ Print a Unit 5 HOT START and SHUT DOWN procedure. In case of a Unit trip.

☐ Check Unit 5 critical heat trace circuits.

- Plan the intervals that the check sheets will be run.
- Plan Motor rotation
- Bring some freeze protection supply from the Connex to the control room LOTO area.
- Check functionality of the instrument air systems
- Communicate to ICE to check critical heat trace circuits

Plant Logs and Alarm managing

☐ Make sure the Simple Cycle and Unit 5 Alarm managers (event recorders) are functioning.

☐ During cold weather event update Operations Superintendent (via text message or phone call) **every 4 hours** or sooner, as needed, due to problems.

OTHER INFORMATION

- ☐ Drain any containments of standing water.
- ☐ Verify Simple Cycle Units have enclosure heaters set and are operable. Check heater positioning to ensure heating of the correct area.
- ☐ Valve Out and drain any non-heat traced safety showers.
- ☐ Log additional Information on the back of this page

Pre-Winter Event Operations Checklist

Time/Date (Ex:16:00-08/17)	Information (Example) Unit 2 Turbine compartment heater will not operate Wo#123456	Turnover from/to (Example) JL/ FV

Wind Chill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

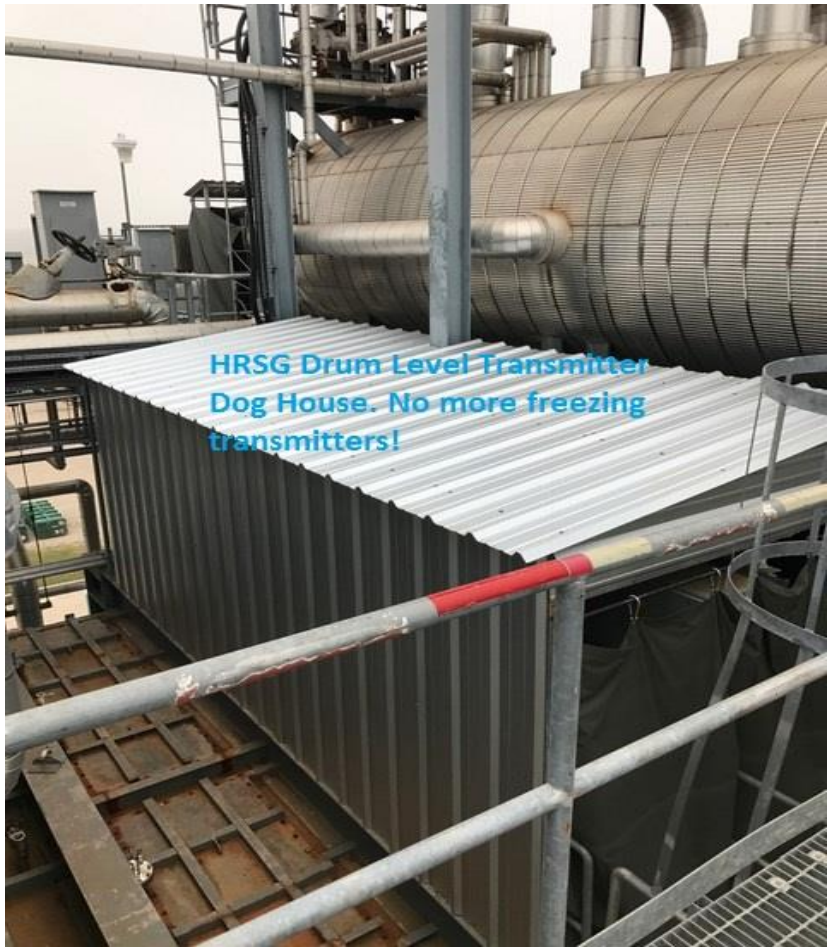
Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

	Sunday	Monday	Tuesday	Wednesday	Thursday
Day	48F	33F/ 23' wind chill	34F/ 25	49F/ 46	48F
OP's	James H	Chuck M	Chuck M	Chuck M	Chuck M
	Julio	Eric	Eric	Eric	Eric
	Jason	Bryan H	Bryan H	Bryan H	Bryan H
	Bob	Grubb	Jesse	Jesse	Jesse
		Carl out @ 10am	Jason out @ 10am	Chaz out @ 10am	Chaz out @ 10am
		Chaz in @ 10am	Carl in @ 10am		
SICE		E. Galvis	E. Galvis	E. Galvis	E. Galvis
SMX		Benham	S.Garza	D.Lawson	TBD
Wind	N@18 gust to 25	N@ 16 to 20	N@ 10	N@ 8	NE@ 8
Night	26F/ 15	23F/ 09	22F / 16	27F / 22	30F
OP's	Bryan S	Bryan S	James H	James H	James H
	Rick	Rick	Julio	Julio	Julio
	Derald	Derald	Jason	Jason	Jason
	Carl in @ 10pm	Chaz out @ 10pm	Bob	Bob	Bob
	Chuck in @ 2am	Jason in @ 10pm	Carl out @ 10pm	Chaz in @ 10pm	
		Chuck in @ 2am	Chaz in @ 10pm		
			Chuck in @ 2am		
SICE	DK-JG 19:00-07:00	DK-JG	JG+1	JG+1	JG+1
SMX	W.Brey	W.Brey	W.Brey	W.Brey	TBD

Subject to change as conditions warant.

Improvements - HRSG Wind Wall

HRSG Transmitter Protection Improvements



Instrument Air Dryer Wind Wall

HRSG Drum Protection Wind Wall Improvement

Questions?

ERCOT Winter Weatherization Workshop 2018

Jason Schauer, Plant Engineer

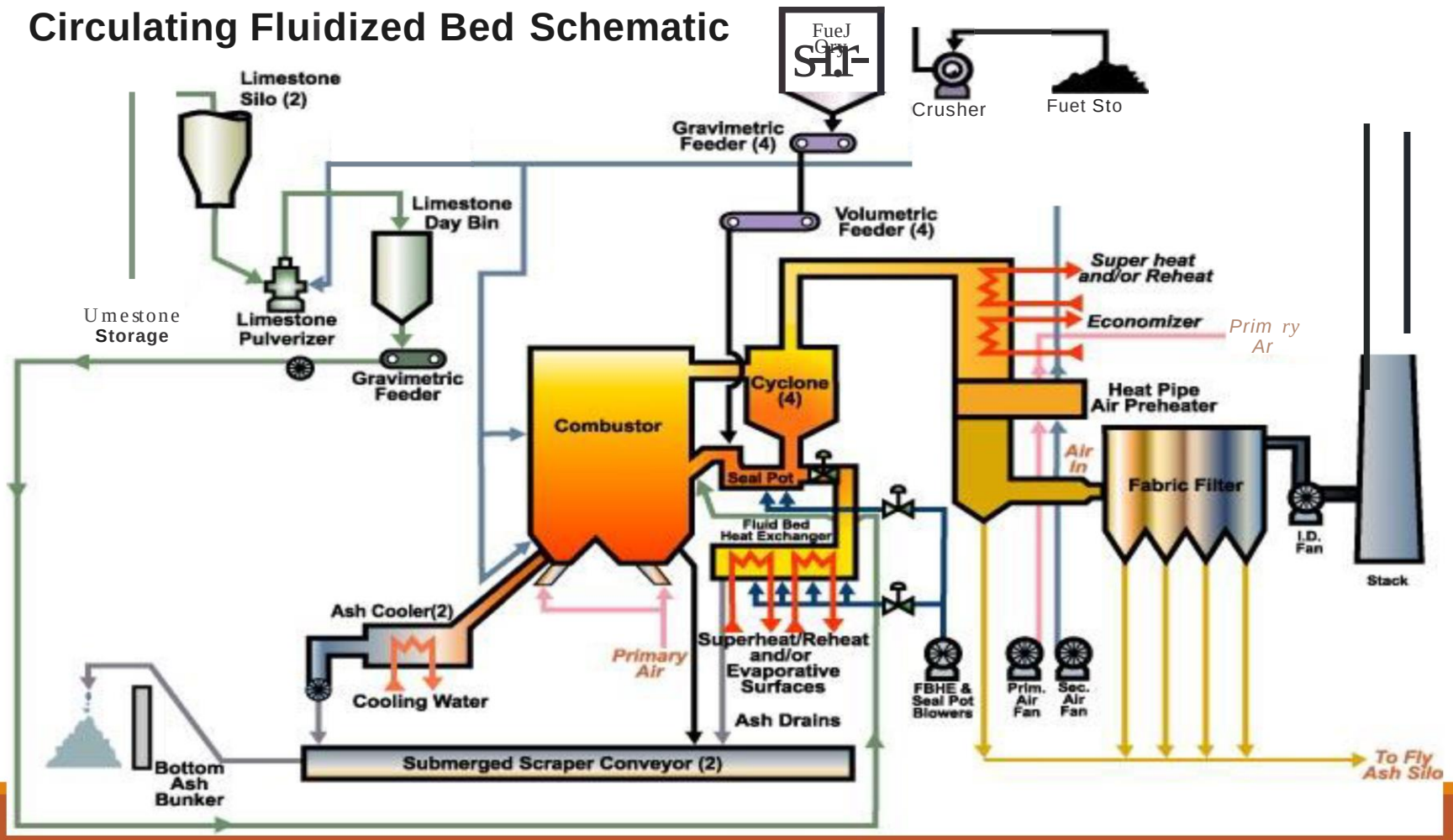
NAES

Twin Oaks Power - Overview

- A 305-megawatt merchant facility
- 2 CFB Boilers feeding 2 Westinghouse Turbines
- Commercial Operational since 1991
- 62 employees @ Twin Oaks Power
- Owned by a Private Investment Firm
- Operated by NAES
- Fueled by lignite coal from a nearby mine: Walnut Creek

Twin Oaks Power

Circulating Fluidized Bed Schematic



Twin Oaks winter history performance

February 2, 2011

- 24 hours below freezing @ 26 mph winds
- Twin Oaks Power did not trip.

December 19, 2016

- 9 hours below freezing @ 12 mph winds
- Twin Oaks Power unit 2 tripped on deareator level frozen transmitter.

Winterization Spot check 2017

January 2017 ERCOT Spot Check Findings

- Cause – deaerator heat trace circuit failure due to corrosion on termination to fuse block.
  - Contributing factor – 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.

ERCOT Winterization Spot check 2017

- January 2017 spot check ERCOT recommendations
  - 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.”

Updates to Winter Procedure 2017

1. Winter Weather Preparations
   - Periodic Maintenance list and schedules
   - Critical Instrumentation list and preparation
   - DCS Alarm Band Tightened
     - ✓ To increase awareness time to help operators catch problems earlier
   - Insulation and heat trace preparation
   - Heater locations / staging
   - Enclosure locations
   - Supplemental equipment management
2. Check sheets for operations and maintenance
3. Heat trace “end of circuit” lights

Updates to Winter Procedure 2017

Event level definitions

1. Level 1 – forecasted temperature is at or below 32 DegF for at least 3 hours

- ✓ Pre-Job brief will include a winter related safety topic
- ✓ Operators will complete a pre-event walkdown and fill out check sheet
- ✓ Operators will perform check sheets at minimum of 2 per shift
- ✓ Operators will have DCS Cold Weather screen up on main display
- ✓ All critical instrumentation in SCAN unless it lowers reliability (WO written)

2. Level 2 – forecasted temperature is at or below 20 DegF for 6 hours or more

- ✓ Complete all of level 1 responsibilities
- ✓ Increase check sheet frequency for operators to intervals of no longer than 4 hours
- ✓ Bring in 2 additional Operators for the event shift
- ✓ Bring in 1 electrician and 1 I&C Tech for the duration of the event

Updates to Winter Procedure 2017

Operations winter event check sheets

Major Oak Power Winter Weatherization

Operations Cold Weather Event Check Sheet
Attachment D

Level 1 - This Checksheet will be completed by Operations AT LEAST every 6 Hours

Level 2 (20 deg) - This Checksheet will be completed AT LEAST every 4 Hours

Start Date:				
Date/Time Filled out:				
Immediately report and/or correct any issues.				
		Unit 1		
Critical Transmitters		Box Temperature	Box Light is on	Ambient Heaters On
4th Floor	BWCP Instruments			
10th Floor	East Drum Level			
10th Floor	West Drum level			
11th Floor	DA Level Transmitters			
12th Floor	DEA Enclosure			
Inspected by (Sign):				

View the DCS Cold Weather Event Screen for Defects, Bad Values, Deviations

Immediately report and/or correct any issues.

		Unit 1	
Screen		Yes	No
Cold Weather Event			
Inspected by (Sign):			

Inspect the following Transmitter readings on the DCS for Noticable Defects, Bad Values, or Deviations. Immediately report and/or correct any issues.

		Unit 1	
Transmitter	**Alarm Level**	Yes	No
Ambient Air Temp	34F / 2F		
Plant Instrument Air	>75 PSI		
DA Level A	< 5 INWC Deviation		
DA Level B	< 5 INWC Deviation		
Economizer Flow A	< 40 INWC Deviation		
Economizer Flow B	< 40 INWC Deviation		
Drum Level A	< 5 INWC Deviation		
Drum Level B	< 5 INWC Deviation		
Drum Level C	< 5 INWC Deviation		
EBWCP DP A	18 PSI Diff		
EBWCP DP B	18 PSI Diff		
CBWCP DP A	18 PSI Diff		
CBWCP DP B	18 PSI Diff		
WBWCP DP A	18 PSI Diff		
WBWCP DP B	18 PSI Diff		
Inspected by (Sign):			

The sensing lines going to the Drum level and DA level boxes should be warm at all times. If, at any time, they are not warm to the touch, call out Electricians immediately. On all transmitter boxes, open the boxes and confirm the plates are heating at least once per shift. If the plates do not feel warm, and the outside temperature drops below 32 degrees, call out Electricians immediately.

Electricians (pre-event)

Major Oak Power Winter Weatherization

Electrician Pre-Cold Weather Event Check Sheet
Attachment B

This Checksheet will be completed by Electricians prior to any cold weather event and at an interval not to exceed 8 Hours during extreme cold weather events (below 20 deg).

Start Date of anticipated cold weather event:				Expected Duration:		
Date/Time Filled out:				Ambient Temp:		

Inspect the following breakers. Ensure breaker is in the "On" position and no loss of phase.
Immediately report and/or correct any issues.

Breaker	Breaker showing On:	Yes	No	Loss of Phase:	Yes	No
1D8FMEF	Please Check:			Please Check:		
1C8FMEF	Please Check:			Please Check:		
2D8FMEF	Please Check:			Please Check:		
2C8FMEF	Please Check:			Please Check:		
Inspected by (Sign):				Date/Time:		

Inspect the following Heat Trace Panels/Circuits for fuctionality and record Amps.
Immediately report and/or correct any issues.

Unit 1				End of Circ	Unit 2				End of Circ
Panel	Circuit	Design A	Record A	Light	Panel	Circuit	Design A	Record A	Light
PNL-03	C201-003	11.2			PNL-03	C201-030	10.6		
PNL-03	C201-001	7.9			PNL-04	C201-061	13.6		
PNL-03	C201-002	2.1			PNL-04	C201-031	6.5		
PNL-03	C201-069	11.4			PNL-04	C201-032	10.4		
PNL-03	C201-072	11.4			PNL-05	C201-036	9.8		
PNL-03	C201-062	9.4			PNL-05	C245-010	9.5		
PNL-03	C201-063	8.8			PNL-05	C201-034	9.6		
PNL-04	C201-005	10			PNL-05	C201-018	10.4		
PNL-05	C201-064	10.8			PNL-05	C201-035	10.4		
PNL-05	C201-065	12.4			PNL-05	C242-001	11.5		
PNL-05	C201-046	8.8			PNL-05	C244-001	11.5		
PNL-05	C201-045	7.8			PNL-07	C201-006	10.4		
PNL-05	C244-001	5.8			PNL-07	C222-009	12.8		
PNL-05	C244-002	7							
PNL-05	C244-004	6							
PNL-07	C222-011	6							
PNL-07	C222-010	9							

Notes:

Inspected by (Sign):	Date/Time:

Updates to Winter Procedure 2017

I&C Pre-event check sheet

Major Oak Power Winter Weatherization

I&C Pre-Cold Weather Event Check Sheet
Attachment C (Page 1 of 2)

This Checksheet will be completed by I&C prior to any cold weather event

Start Date of anticipated cold weather event:	Expected Duration:
Date/Time Filled out:	Ambient Temp:

Inspect the following breakers. Ensure breaker is in the "On" position and hasn't tripped
Immediately report and/or correct any issues.

		Unit 1		Unit 2	
Breaker	Breaker showing On:	Yes	No	Yes	No
209-PNL 06 BRK 25	Please Check:				
209-PNL 06 BRK 27	Please Check:				
209-PNL 27 BRK 9	Please Check:				

Inspected by (Sign): Date/Time:

Inspect the following Instrument Panels. Review box condition, Temperature Gauge, Heater light
Immediately report and/or correct any issues.

	Unit 1			Unit 2		
Panel	Condition	Gauge	Light On	Condition	Gauge	Light On
201-PNL-21 EBWCP Instrument						
201-PNL-22 CBWCP Instrument						
201-PNL-23 WBWCP Instrument						
201-PNL-26 Economizer Flow						
201-PNL-24 East Drum Level/Pres						
201-PNL-25 West Drum Level/Pres						
11th floor DA Level						

Inspected by (Sign): Date/Time:

Inspect the Air Dryers on both units for proper operation. Review switching, heater Op, and filter DP.
Immediately report and/or correct any issues.

	Dryer Operating	Unit 1		Unit 2	
Air Dryer	Correctly	Yes	No	Yes	No
East	Please Check:				
Center	Please Check:				
West	Please Check:				

Inspected by (Sign): Date/Time:

Inspect the Cold Weather Event DCS Screen for Defects, Bad Values, Deviations
Immediately report and/or correct any issues.

		Unit 1		Unit 2	
Screen	Screen free of Issues	Yes	No	Yes	No
Cold Weather Event	Please Check:				

Inspected by (Sign): Date/Time:

Continued on Page 2

Major Oak Power Winter Weatherization

I&C Pre-Cold Weather Event Check Sheet
Attachment C (Page 2 of 2)

Inspect the following Transmitters for correct operation.
Immediately report and/or correct any issues.

		Unit 1		Unit 2	
Transmitter	No Issues	Yes	No	Yes	No
Ambient Air Temp	Please Check:				
Plant Instrument Air	Please Check:				
DA Level A	Please Check:				
DA Level B	Please Check:				
Economizer Flow A	Please Check:				
Economizer Flow B	Please Check:				
Drum Level A	Please Check:				
Drum Level B	Please Check:				
Drum Level C	Please Check:				
Drum Pressure A	Please Check:				
Drum Pressure B	Please Check:				
Drum Pressure C	Please Check:				
EBWCP DP A	Please Check:				
EBWCP DP B	Please Check:				
CBWCP DP A	Please Check:				
CBWCP DP B	Please Check:				
WBWCP DP A	Please Check:				
WBWCP DP B	Please Check:				

Inspected by (Sign): Date/Time:

Review the following alarms are set to Cold Weater Event Levels.

Alarm	Setting	Unit 1	Unit 2
DA Level Deviation Audible Alarm	5 INWC		
Economizer Inlet Flow Deviation Audible Alarm	40 INWC		
Drum Level Deviation Audible Alarm	5 INWC		
Ambient Air Temp Audible Alarm	34F/2F		
EBWCP DP Audible Alarm	18 PSID		
CBWCP DP Audible Alarm	18 PSID		
WBWCP DP Audible Alarm	18 PSID		

Inspected by (Sign): Date/Time:

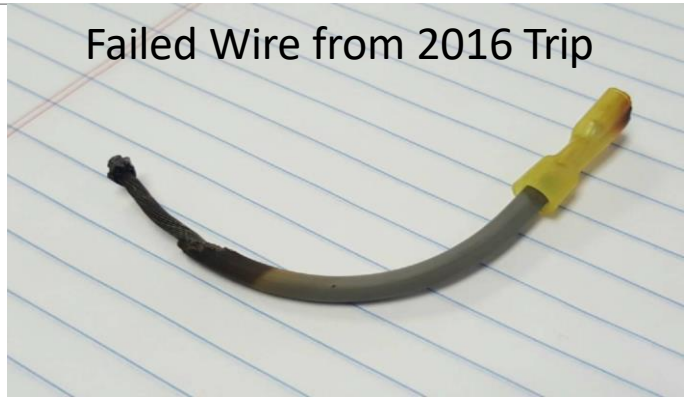
Updates to Winter Procedure 2017

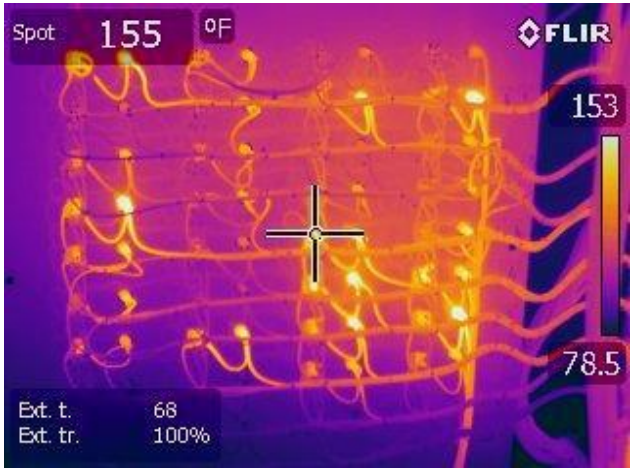
- Developed DCS Cold Weather Event Screen for control room operators
  - ✓ Contains critical Instrumentation on one screen with alarms, trips and average or single element control status.

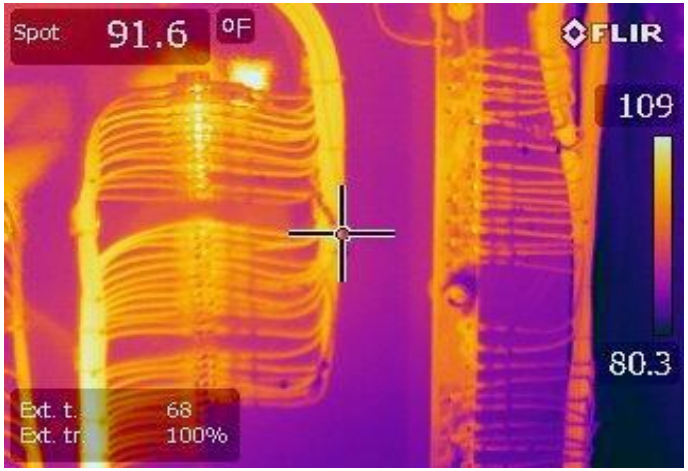
Updates to Winter Procedure 2017

Thermography

- Thermography of the heat trace panels annually
- Helps with failing connections and can identify bad circuits



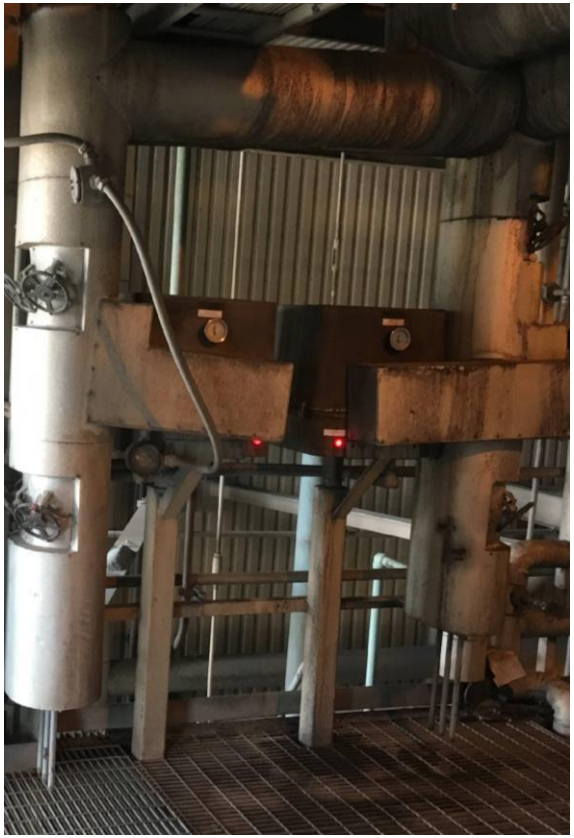




Updates to Winter Procedure 2017

End of Circuit Lights

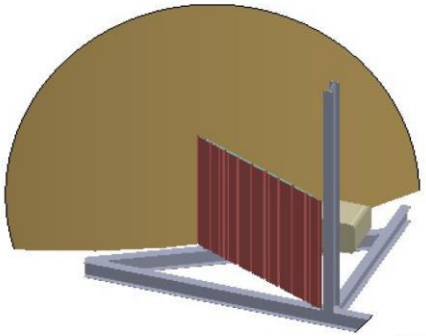
- Added to help operators and electricians quickly identify if the heat trace circuit is fully functional
- Added at critical Instrument enclosures to inform operators if there is **power to the box heaters**.
  - Note: heaters could still be bad, reduces trouble shooting time for critical components



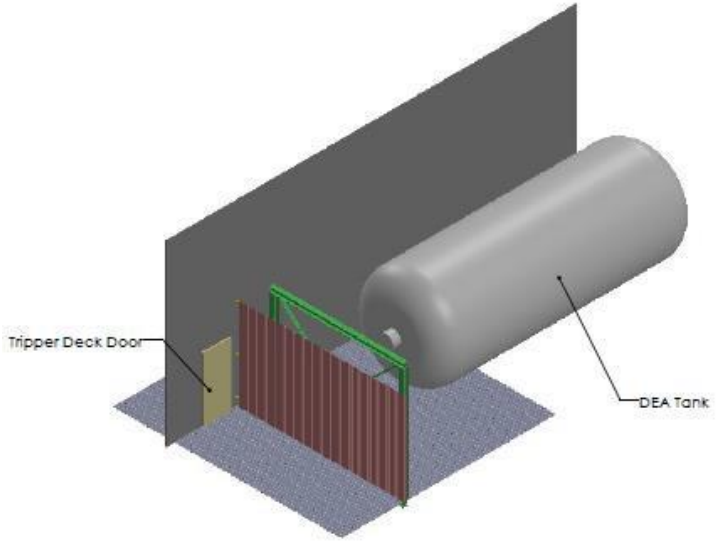
Updates to Winter Procedure 2017

Enclosures

- Fabricated wind breaks at critical boxes
- Reduces the annual prep of hanging tarps
- Removeable design to keep summer breeze for employees



Facing South East 10th Floor



Updates to Winter Procedure 2017

Winterization Inventory Control

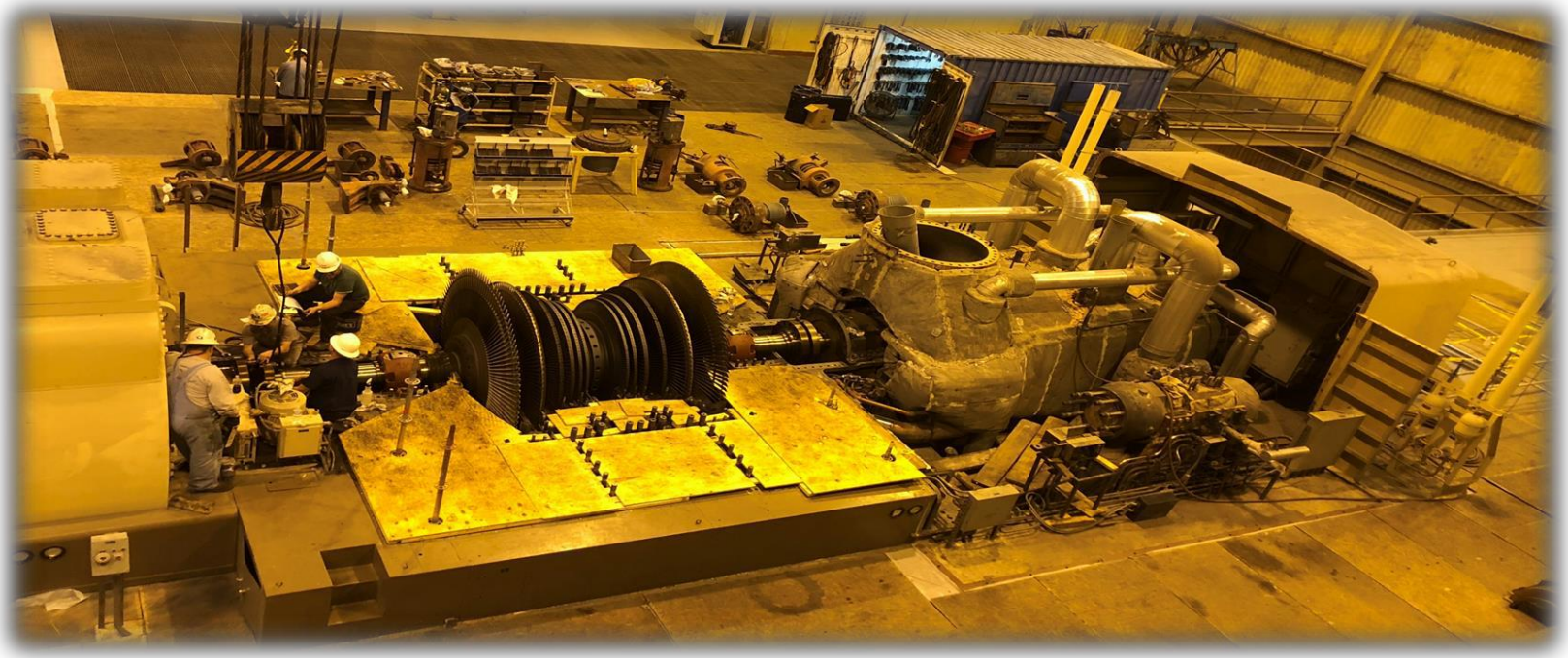
- Purchased a 20’ shipping container
- Locked all summer
- Inventory is replenished every spring

Winter Weatherization Equipment Inventory Audit

Date Completed:			Completed By:		
Item#	Description	Model Numbers (if req'd)	QTY Required	Qty On Hand	Notes
1	Flame Retardant Tarp 10'x20'		5		
2	Flame Retardant Tarp 10'x10'		10		
3	Flame Retardant Tarp 20x20		3		
4	Diesel Heaters	KFA 170PF / DFA170C	8		
5	Current Electric Heaters 15 watt	FES-1548-3E	6		
6	Current Electric Heaters 45 watt	FES-4548-3	2		
7	5gal Diesel Portable containers (yellow)	Metal JustRite 7150200	9		
8	Butane Torches	TS4000 Benzomatic	2		
9	Butane Torch Refill bottles	14.1 OZ Worthington	4		
10	Electric Heat Guns (120v)	SV800	4		
11	Heat Lamps	Bayco 10 1/2"	10		
12	Heat Lamp Extra Bulbs 250 Watt	250BR40	20		
13	100 ft Tie down ropes		6		
14	Extension Cords (100 ft) (120v)		5		
15	Extension Cords (50 ft) (120v)		10		
16	480v Extension Cords (yellow)		8		
17	Insulating Blankets		50 ft		
18	Duct Tape Rolls		10		
19	Tie Wire Roll (20 Gauge) (1lb rolls)		3		
20	14"+ Zip Ties (bags of 100)		10		

Twin Oaks Power

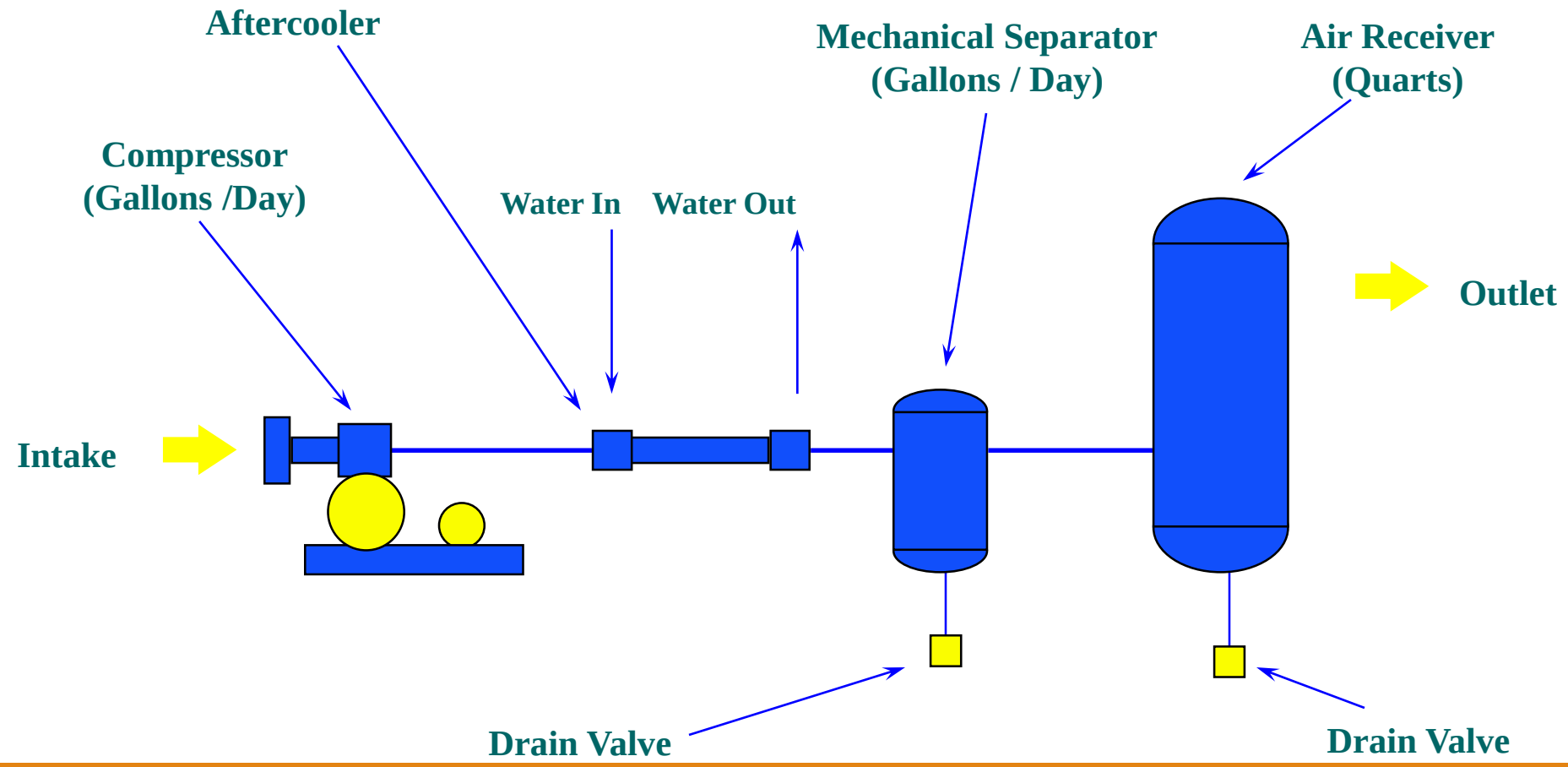
QUESTIONS?



NAES

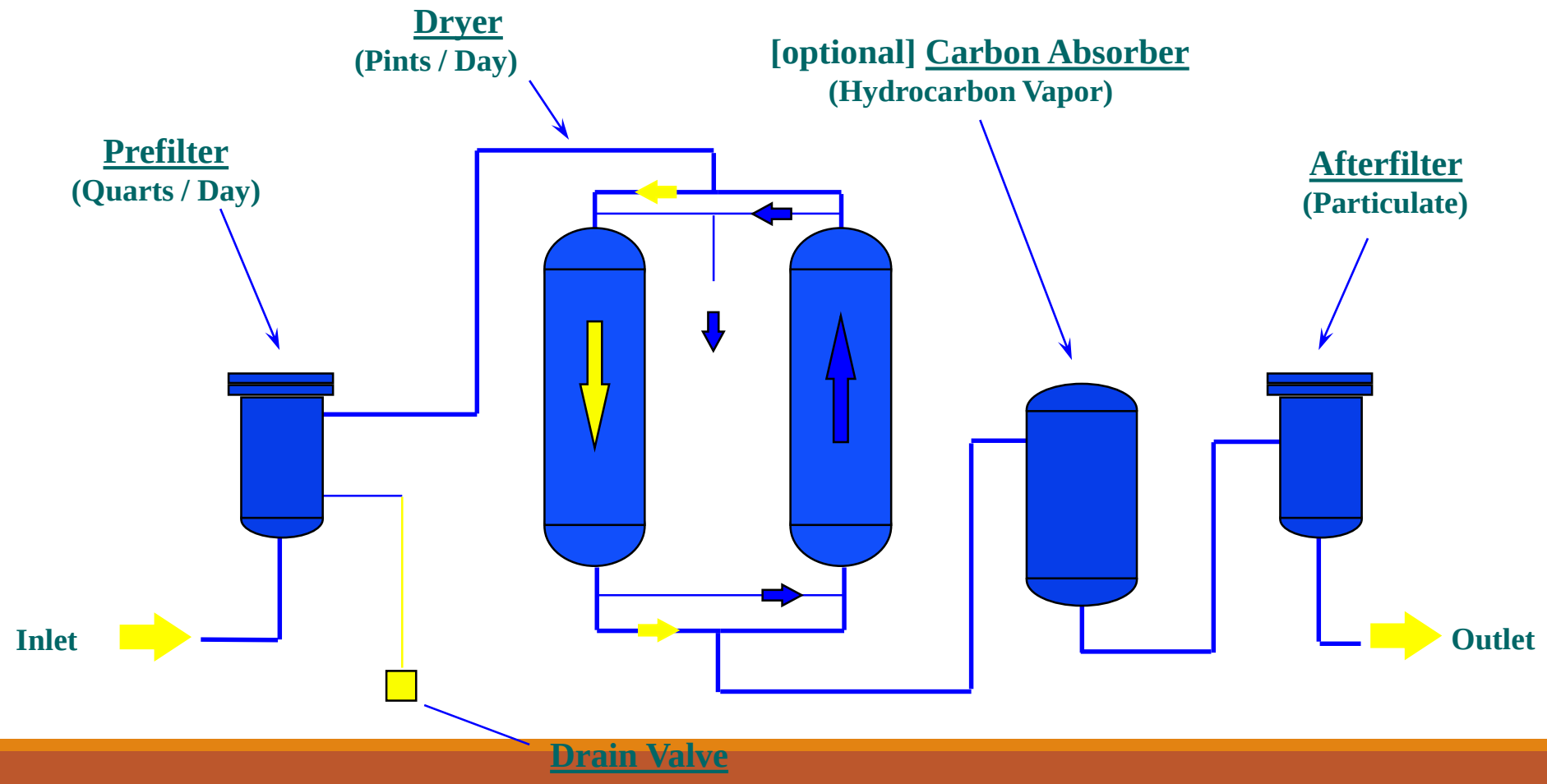
Fluid Flow Products - Texas

Typical Compressed Air System Design



FLUID FLOW

Compressed Air System Purification Zone



Common problems with dryer installations

No wet air receiver

Wet air receiver too far from prefilter

Prefilter too far from dryer inlet

- Remedied by insulating and heat tracing the pipe from the prefilter to the dryer inlet

Dew point monitors not calibrated on a scheduled basis.

- Note that they fail to the dry side and will give a false sense of security!

No provisions for rental air dryers to be used during maintenance of fixed equipment.

No bypass around dryer to utilize dedicated compressor when dryer is down.

Most common problem, drain traps

Drain traps are among the cheapest components, but also the **most important**

- They must be checked on daily rounds.
  - Bypass and replace as soon at the first sign of failure such as:
    - Standing water upstream
    - No moisture at outlet
- Do not ever manifold multiple drain lines together
- Don’t pipe discharge to a place it can’t be observed
- Heat trace discharge if subjected to freezing conditions
- Be sure to use instrument air to pilot pneumatic drains

Common problem, coalescing filters

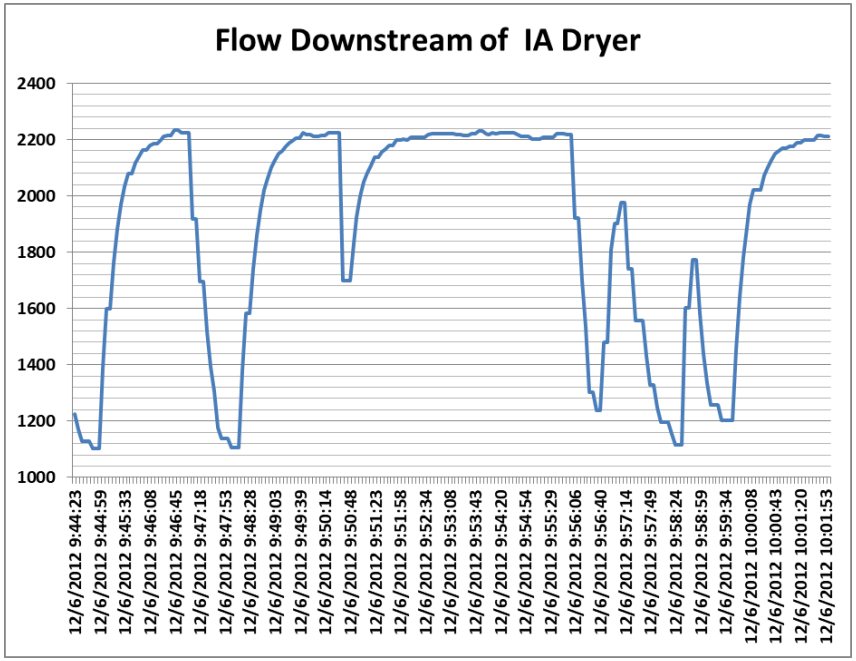
Coalescing filters (also called “prefilters”) remove free water from the air stream before a desiccant air dryer.

- Should be inspected every 6 months
- Don’t rely on pressure drop to trigger need for replacement
  - Filters split.
- While inspecting coalescing filters, check drain lines between housing and drain valve.
  - They get clogged with rust.
- Make sure you are using the right filters, not cheap replacements.
- Double check to make sure your prefilters and afterfilters aren’t swapped.
  - This happens frequently.

Common problem, excessive flow

If the inlet flow to your dryer exceeds its rated capacity, dryer performance will suffer.

- This occurs frequently in sites where system demand changes.
  - Leak rate increases
  - Production increases or header system is altered.
  - Other dryers are taken offline.
  - Larger compressors are installed upstream.
  - Rental compressors are installed.



Common problems at the dryer itself

- Desiccant degradation
  - Should not catch you off guard. Dew points will degrade during hot summer months.
- Switching valve failure or leakage
  - Heaterless dryers require a bubble tight seal. Any valve leakage causes backpressure during regeneration. Make note of regeneration pressures.
- Clogged exhaust mufflers
  - Result in backpressure during regeneration.
    - Keep spares on hand
- Control board failures
  - Keep spares on hand

FLUID FLOW

Questions?

Generator Winter Weatherization Workshop

September 6, 2018

Alan H. Allgower
Operations Analyst, Senior
alan.allgower@ercot.com
512-248-4613 (o)

February 2011 Headlines….

Four coldest days in the past eight years

	EEA3 – 4000MW firm load shed	EEA2	Normal day For ERCOT	Normal day In ERCOT
	2/2/2011	**1/6/2014**	**1/7/2017**	**1/17/2018**
Dallas	13°/20MPH	15°/9MPH	14°/6MPH	13°/5MPH
Houston	21°/16MPH	27°/16 MPH	21°/11 MPH	19°/13 MPH
San Antonio	19°/25MPH	27°/15 MPH	20°/6 MPH	23°/10 MPH
Austin	18°/26 MPH	20°/13 MPH	19°/10 MPH	18°/10 MPH
Brownsville	32°/26 MPH	37°/17 MPH	30°/27 MPH	30°/14 MPH
Abilene	7°/16 MPH	11°/5 MPH	9°/3 MPH	8°/5 MPH
Midland	6°/16 MPH	14°/12 MPH	10°/4 MPH	28°/7 MPH

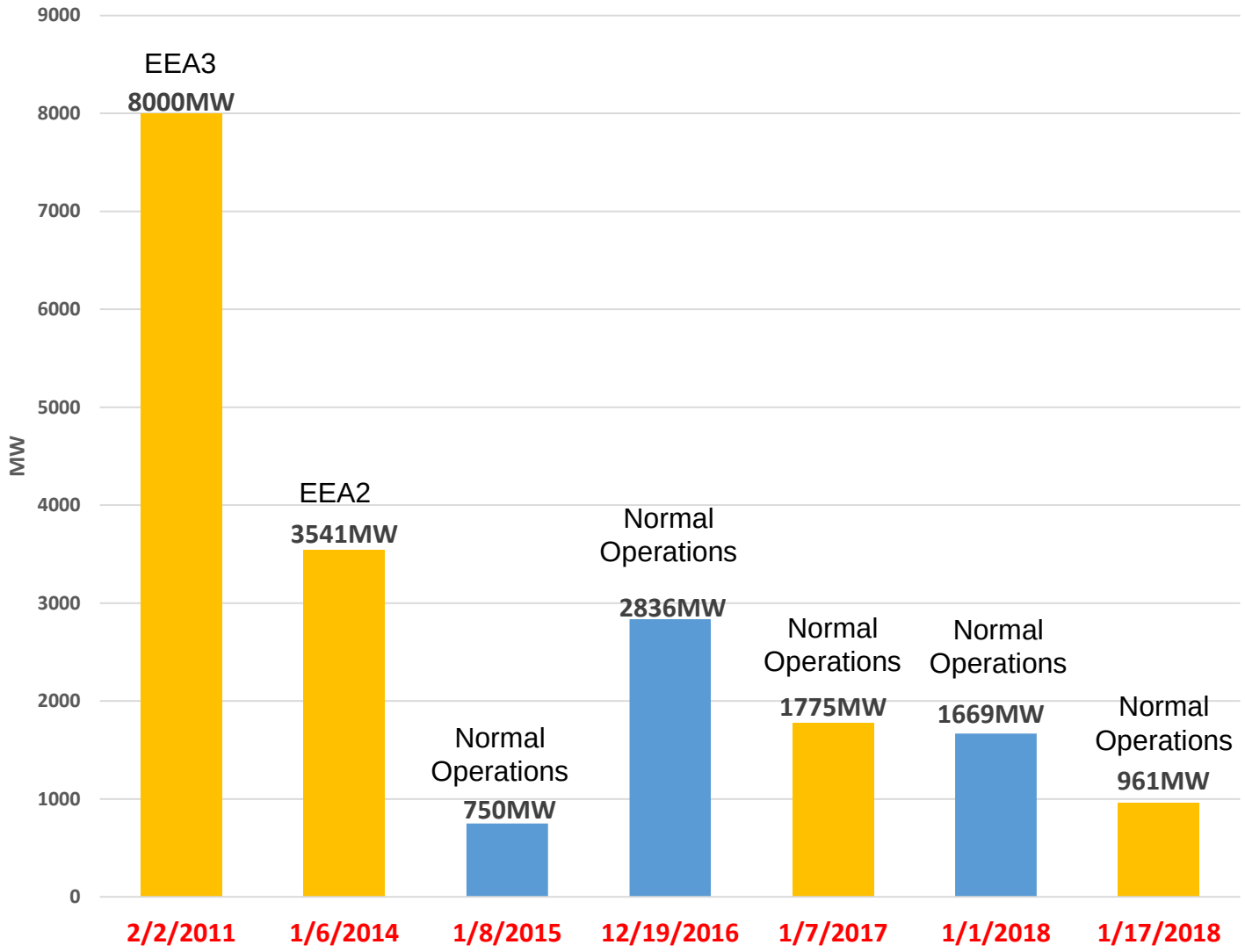
Source: Chris Coleman, ERCOT

Hours at and below freezing (32 DegF or less) during four coldest days in ERCOT in the past eight years.

	EEA3 – 4000MW firm load shed	EEA2	Normal operations	Normal operations
	2/2/2011	**1/6/2014**	**1/7/2017**	**1/17/2018**
Dallas	24	22	19	19
Houston	14	18	13	18
San Antonio	24	14	14	12
Austin	24	20	16	20
Brownsville	0	0	5	10
Abilene	24	24	16	19
Midland	24	24	15	10

Source: Chris Coleman, ERCOT

Generation MW Capacity Tripped Due to Frozen Elements



Salmon colored reflects four coldest days in ERCOT in last eight years

Plant spot checks winter season 2017_2018

- 74 units spot checked
  - Fuel types of plants
    - ➢7 lignite units
    - ➢2 coal unit
    - ➢65 gas fired units (conventional and combined cycle)
  - 16 units were scheduled early due to frozen instrumentation during previous winter.
    - ➢15 units demonstrated mitigation to prevent re-occurrence.
    - ➢1 unit will complete improvements to critical components list and mitigation measures by December 1, 2018.
  - 49 units had no deficiencies.
  - 9 units had deficiencies and with a goal to correct.

Causes of frozen elements during January 1 to 3, 2018 extreme cold weather event.

- *Plant A CC1 tripped – loss of instrument air to main gas supply valve regulator due to moisture freezing in instrument air line.*
  - *Root cause not identified.*
- *Plant B CC1 tripped – HP "A" drum level transmitter froze.*
  - *Root cause; transmitter cabinet heater not working.*
  - *Contributing factor - operator running in manual "A" transmitter for level control rather than median average, two of three "A, B or C" transmitters.*
- *Plant C Unit 1A tripped – drum level transmitter sensing line froze.*
  - *Root cause; section of heat trace not working.*
  - *Contributing factor; heat trace testing needs improvement.*

Causes of frozen elements during January 1 to 3, 2018 extreme cold weather event (continued).

- *Plant D CC1 tripped – heat trace boiling of low leg for condensate level.*
  - *Root cause; incorrect heat trace for application.*

- *Plant E CC1 tripped – three HP drum level transmitters froze.*
  - *Root cause; tripped circuit breaker in heat trace panel.*
  - *Contributing factor; operators failed to verify HP transmitter enclosures temperatures on rounds.*

Causes of frozen elements during January 15 to 17, 2018 extreme cold weather event.

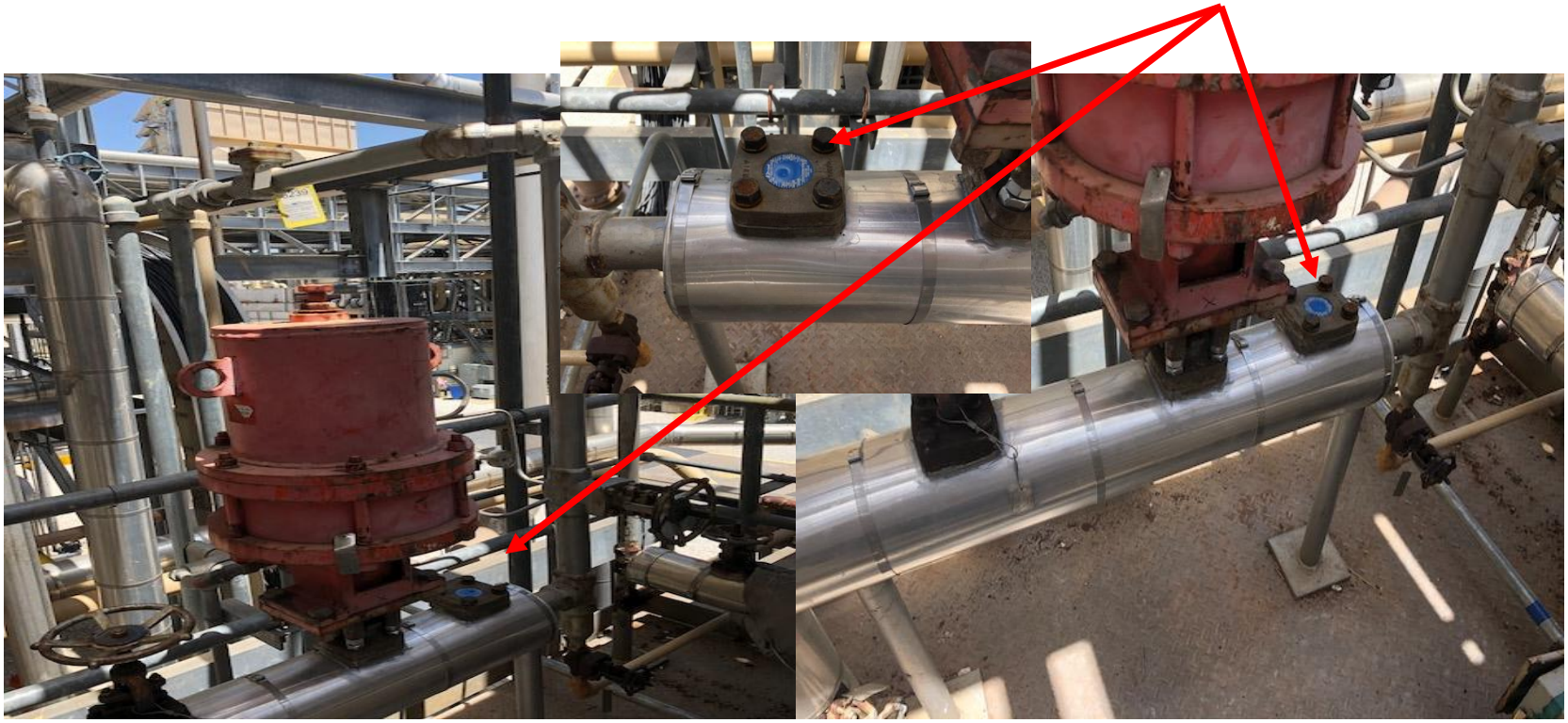
- *Plant A_CC1 tripped – loss of instrument air to main gas supply valve due to moisture freezing in instrument air line.*
  - *Root cause; steam side and air side check valves failed.*
- *Plant B_GT1 tripped – one of two rotor cooling air heat exchanger transmitter froze, which caused a low level condition.*
  - *Root cause; lack of transmitter cabinet heater.*
  - *Corrective action; plant to install cabinet heater.*
- *Plant C_G1 tripped – sensing line level transmitter froze.*
  - *Root cause; insulation missing.*
  - *Corrective action; plant to install flexible wrap insulation. Heat trace is not an option for this section of line.*

January 1 and 17, 2018 extreme cold weather event.

- *Plant A_CC1 tripped – loss of instrument air to main gas supply valve due to moisture freezing in instrument air line.*
- *Corrective actions.*
  - ✓*Replace the steam side check valves during the spring outage 2018.*
  - ✓*Rebuild the welded in check valves on the air side for the fall winter readiness outage.*
  - ✓*Additional automatic blow down valves.*
  - ✓*Convert the instrument air to natural gas feeding off of the gas line for the regulator.*

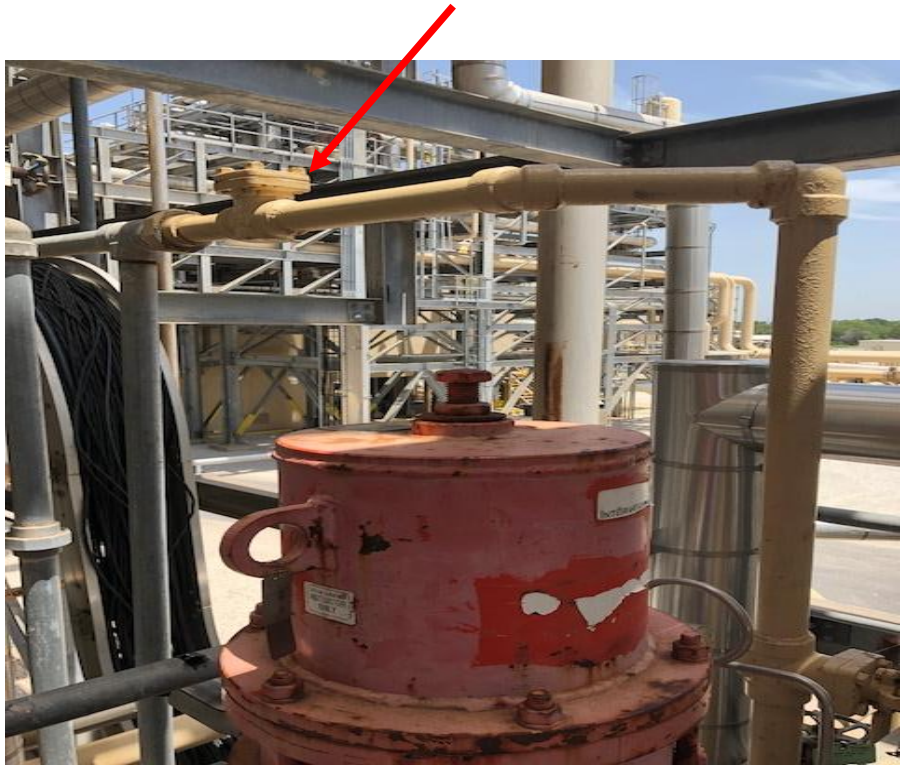
Steam side check valves for CT's

Replaced steam side check valves
on both units during Spring 2018 outage



Air side check valve

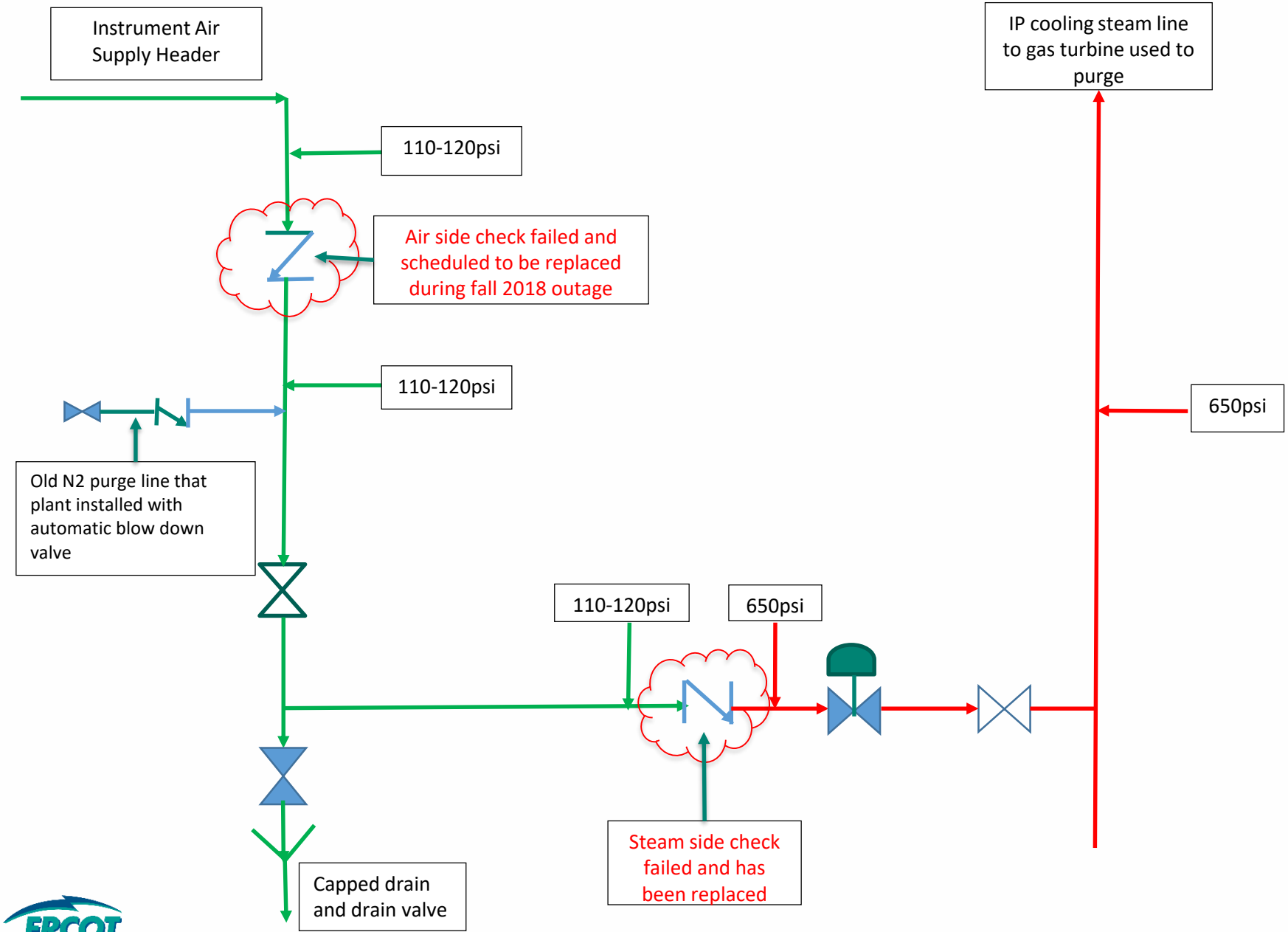
Air side check valve to be rebuilt during Fall 2018 outage.



Added instrument air blow down and gas regulator to main supply valve.

Additional automatic blow downs.

Gas supply regulator valve to be converted to natural gas during fall outage.


Instrument Air Supply Header
110-120psi
Air side check failed and scheduled to be replaced during fall 2018 outage
110-120psi
Old N2 purge line that plant installed with automatic blow down valve
Capped drain and drain valve
110-120psi
650psi
Steam side check failed and has been replaced
IP cooling steam line to gas turbine used to purge
650psi

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."

Mitigation measures to prevent freezing of critical components

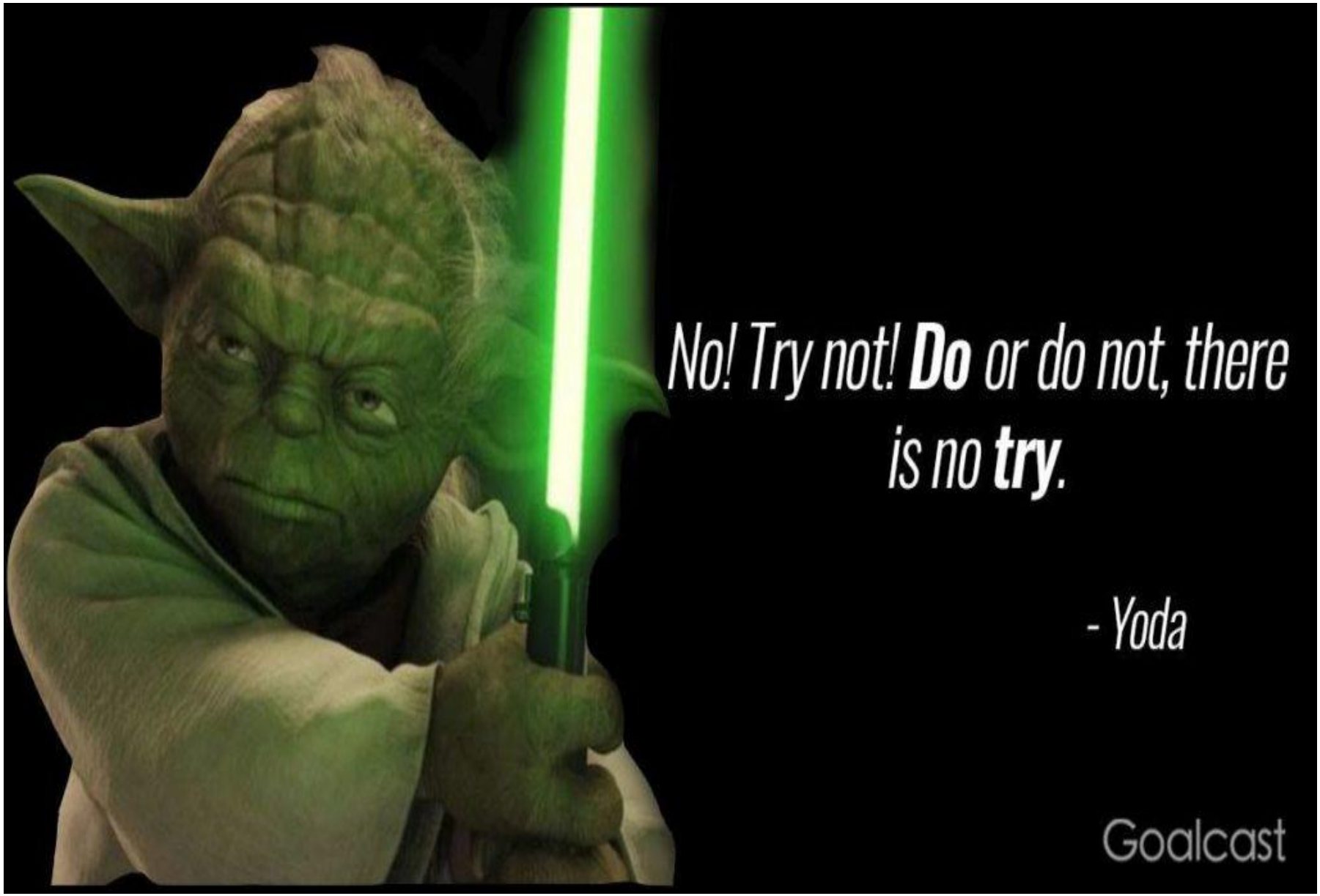
- ✓ *Test and repair all critical heat trace circuits.*
- ✓ *Inspect critical components insulation prior to winter.*
- ✓ *Test critical components transmitter cabinet heater.*
- ✓ *Inspect transmitter enclosures.*
- ✓ *Install wind breaks and/or space heaters, as necessary.*
- ✓ *Verify instrument air dryers, dew point monitoring, blow downs are operating correctly. Ensure blow down drains are insulated and heat traced, as necessary.*
- ✓ *Conduct a training drill with staff on extreme cold weather procedures.*
- ✓ *Prior to every extreme cold weather event verify critical heat trace circuits are functioning.*

Comments

- ✓ *ERCOT assists generators in preparing for winter operations with spot checks, sharing lessons learned, best practices, recommendations and the annual fall workshop.*

- ✓ *Recent history has shown us that for every extreme cold weather event, a small amount of generation will experience freeze related derates or trips.*

- ✓ *Overall, ERCOT was pleased with the performance of generators during this past winter.*


No! Try not! Do or do not, there is no try.
- Yoda
Goalcast

Thank you generator owners, operators and plant staff for your efforts on winter weatherization!

2018-19 Preliminary Winter Weather Outlook

Chris Coleman
ERCOT Sr. Meteorologist

Generator Weatherization Workshop
September 6, 2018

Agenda

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

Temperature Ranking of Recent Winters (Texas)

2017-18	77th coldest
2016-17	**123rd** coldest (warmest winter on record)
2015-16	**116th** coldest (8th warmest of 123)
2014-15	69th
2013-14	30th
2012-13	**109th**
2011-12	99th
2010-11	69th
2009-10	**8th**
2008-09	**110th**
2007-08	100th

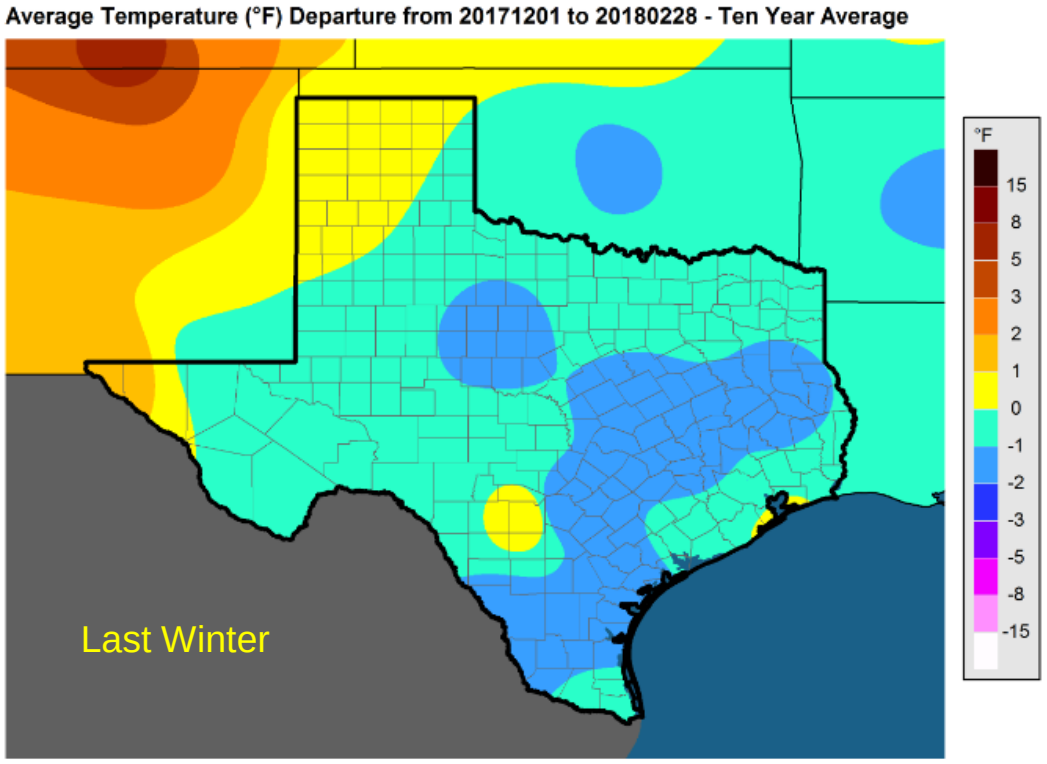
Since 2001, only two winters have ranked in the coldest third (1-41) of historical winters

While last winter seemed cold – and most certainly included periods of cold extremes – there have been 76 historical winters colder than last winter

Explaining Ranks and Normal

Last winter was the 77th coldest (or 47th warmest), dating back to 1895. That means 76 past winters were colder and 46 were warmer.

But why does the map appear “cold?”



This map shows last winter’s temperatures compared to the past 10 winters. Of the past 10, 4 were colder, 5 were warmer – thus, it ranks slightly cooler when compared to recent years.

But compared to all historical years (back to 1895), last winter was warmer than most.

Explaining Ranks and Normal

Of the past 20 winters (1999-2018),
9 ranked 24th warmest winter or warmer

20 winters prior (1979-98), 1 ranked top 24
20 winters prior (1959-78), 2 ranked top 24
20 winters prior (1939-58), 3 ranked top 24
20 winters prior (1919-38), 5 ranked top 24
23 winters prior (1895-1918), 4 ranked top 24

Texas has had a lot of warm winters this century

So much so, that it makes a “normal” or “average” winter appear colder than it is

Last winter was the 77th coldest, dating back 123 years. Not really all that cold when compared to all historical winters. But the winter prior (2016-17) was the warmest winter on record. And the winter before that (2015-16) was the 8th warmest winter on record.

Seasonal versus Extremes

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

- 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)

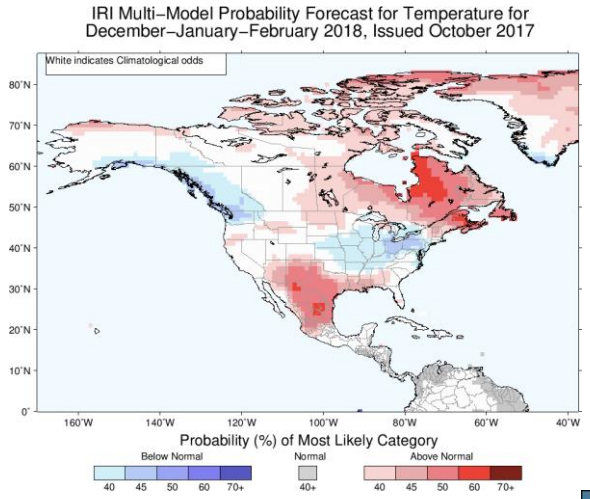
Winter of 2010-11: 69th coldest in TX weather history

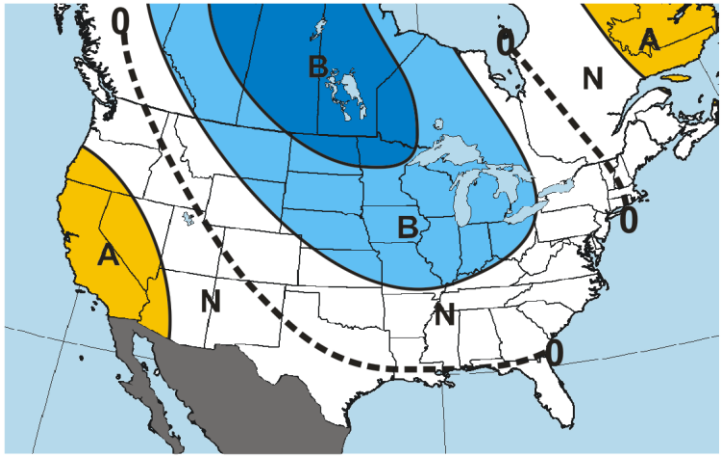
- January 17, 2018:
  - **Dallas**:13° (5MPH wind)
  - **Houston**: 19° (13MPH wind)
  - **San Antonio**: 23° (10MPH wind)
  - **Austin**: 18° (10MPH wind)
  - **Brownsville**: 30° (14MPH wind)
  - **Abilene**: 8° (5MPH wind)
  - **Midland**:28° (7MPH wind)

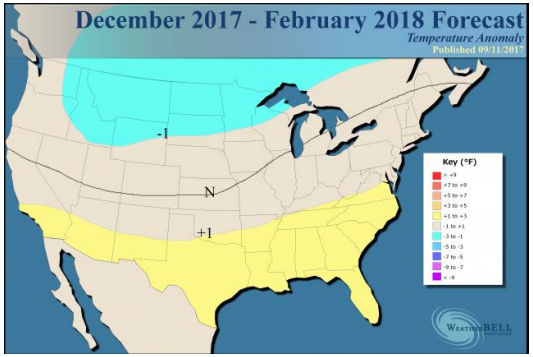
Winter of 2017-18: 77th coldest in TX weather history
*****Coldest day since February 2011*****
All-time winter peak load on this date: 65,750 MW

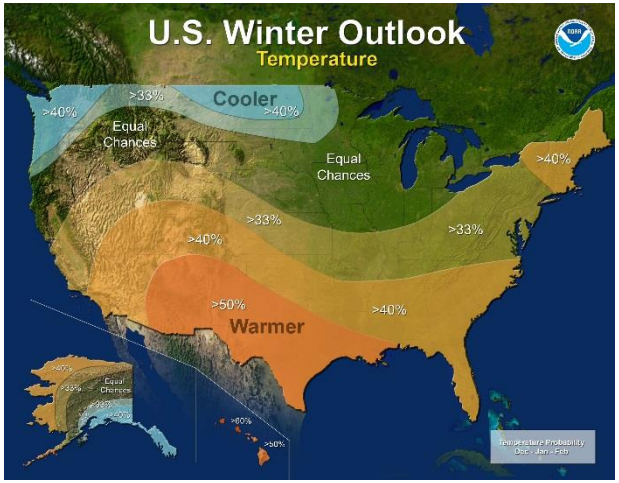
Winter 2013-14 was the coldest this decade (polar vortex winter) – but no single day that winter approached the cold extremes of 1/17/18

What Other Weather Sources Were Saying (last winter)

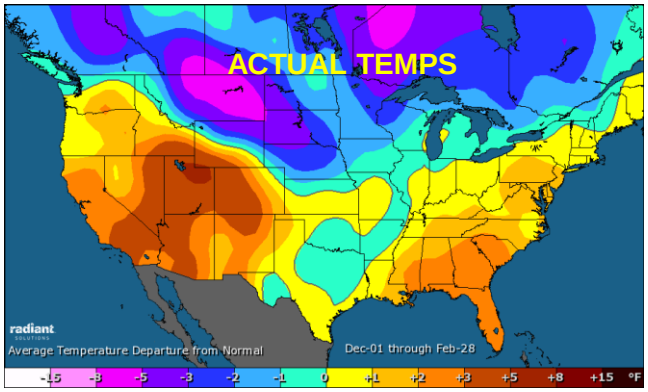






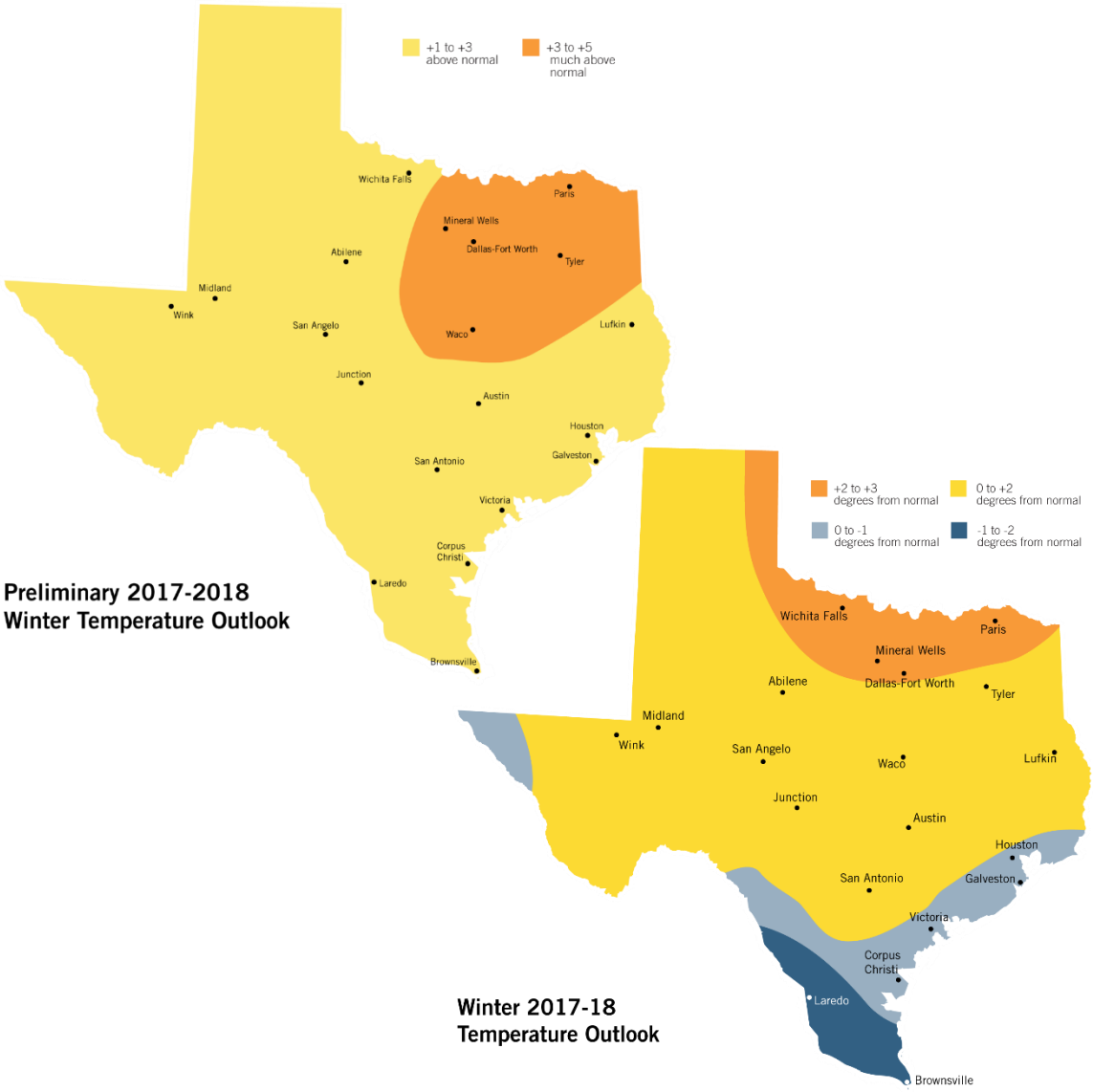


(All based on 30-year normal)

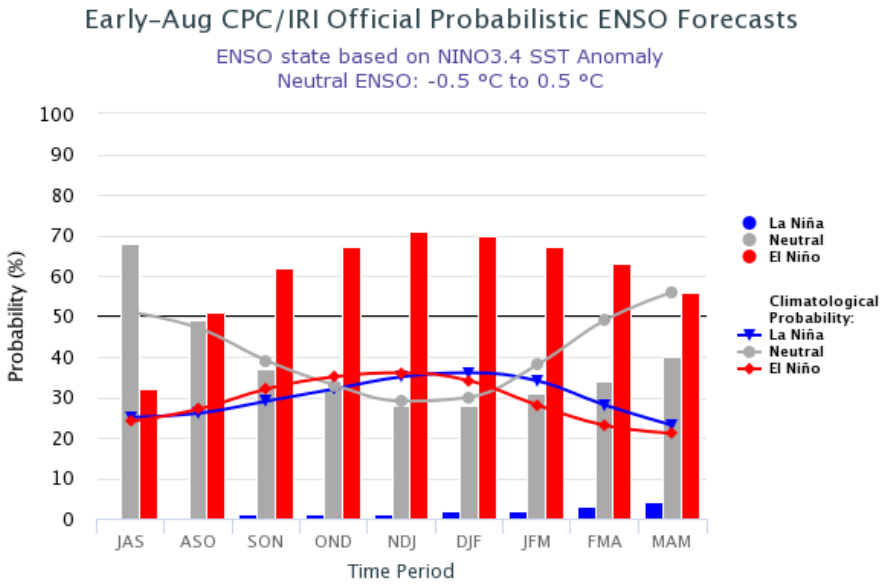


Reviewing Last Winter's Forecast

- General pattern may change with finalized forecast (Nov 1)
- If trends toward 1994-95, would be warmer (especially West Texas)
  (West TX was warmer, but not the rest of ERCOT)
- Can't yet rule out a finalized, colder forecast (2006-07?)
  (it was colder, but not as cold as 06-07, which was 43rd coldest)
- Nothing currently to suggest, however, it will be among the coldest winters (upper-third)
  (it wasn't)
- Mild winters can – and oftentimes do – have very cold periods!
  (yes, as this past winter did)

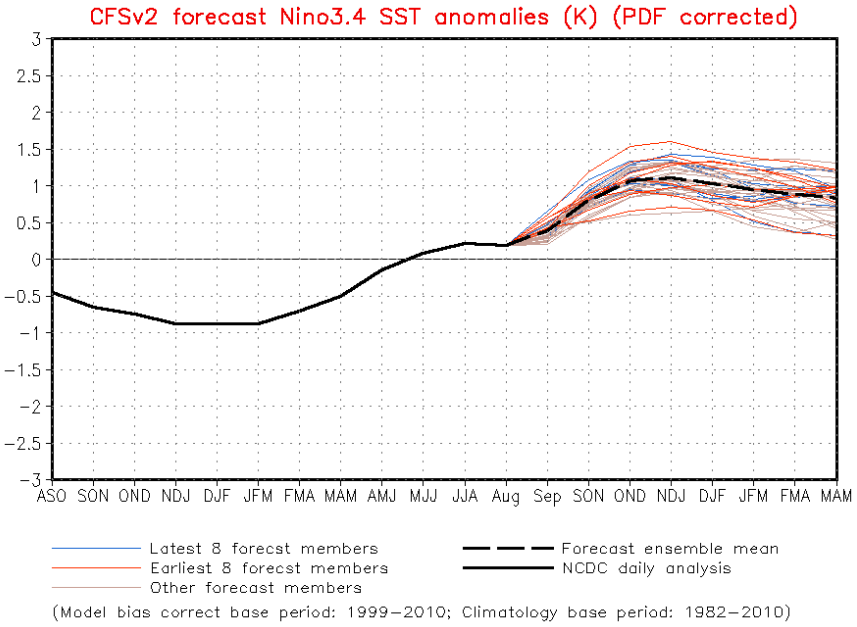


This Winter: El Niño, La Niña, or Neutral?

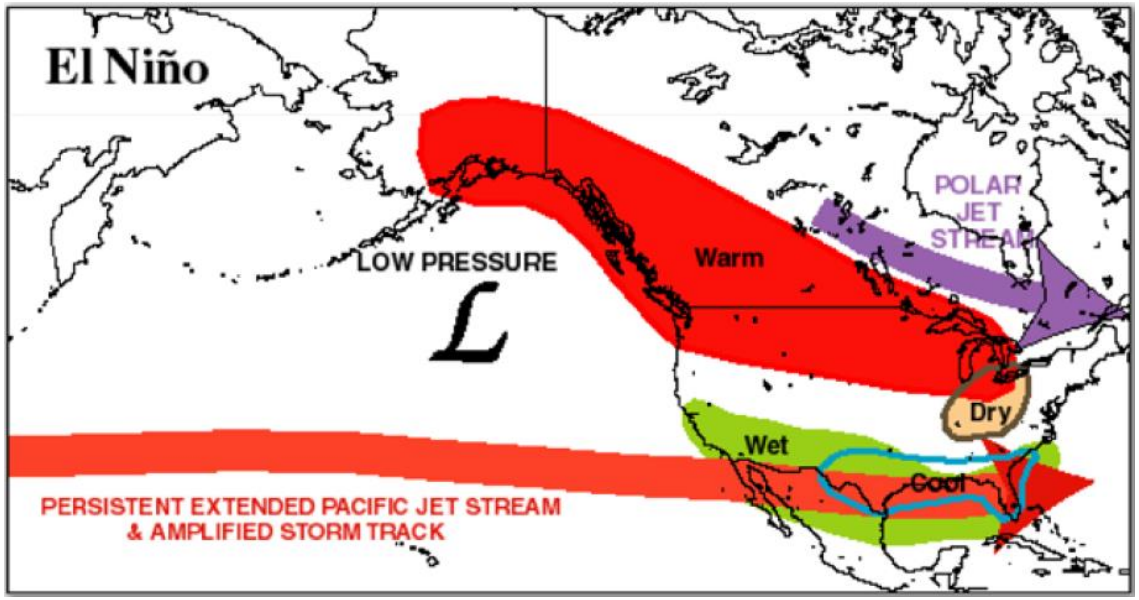


Likely El Niño this winter

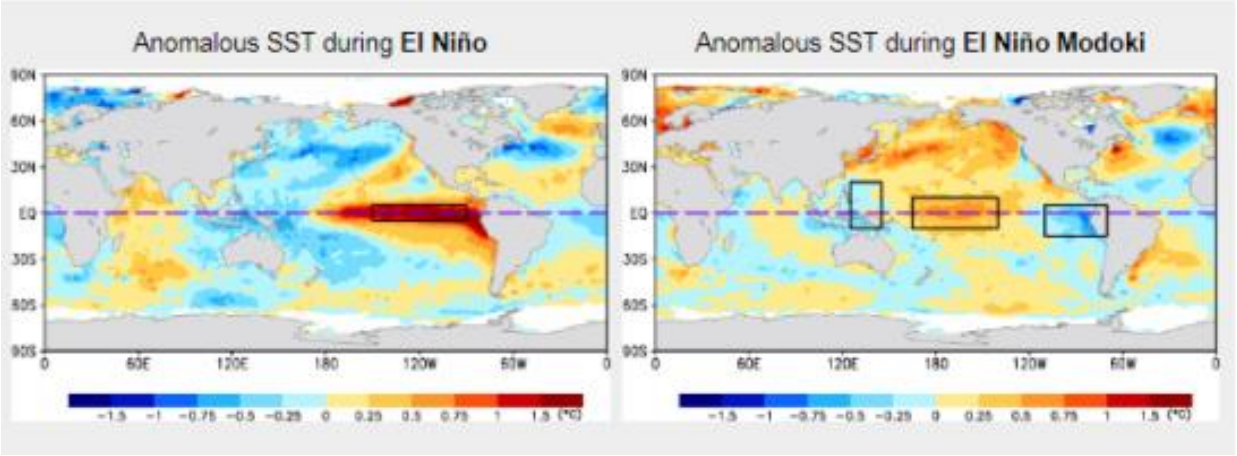
Not likely to be a strong El Niño – thus other factors will come into play



Typical El Niño Weather Pattern

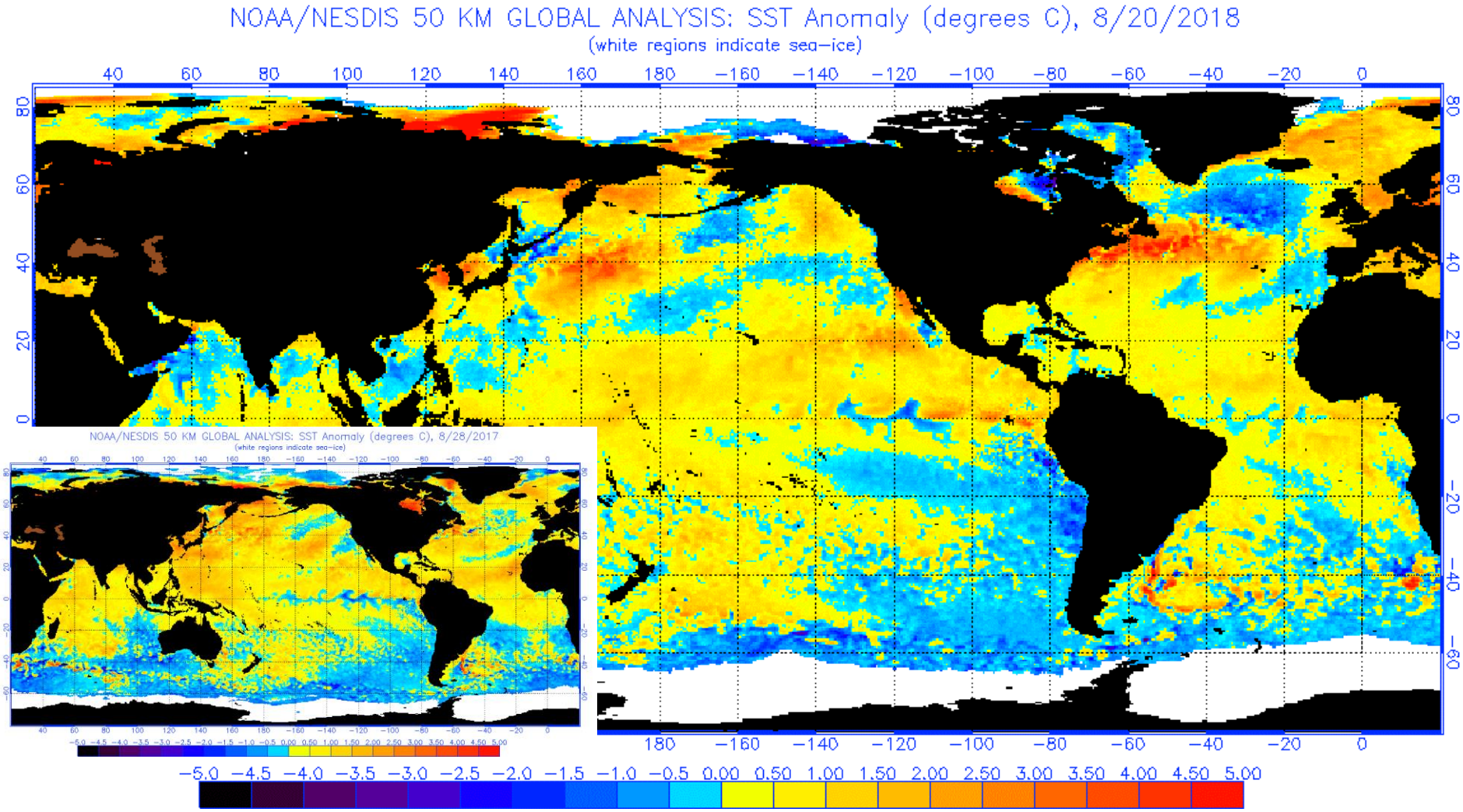


This pattern is most likely with a strong El Niño. This is not likely to be strong.

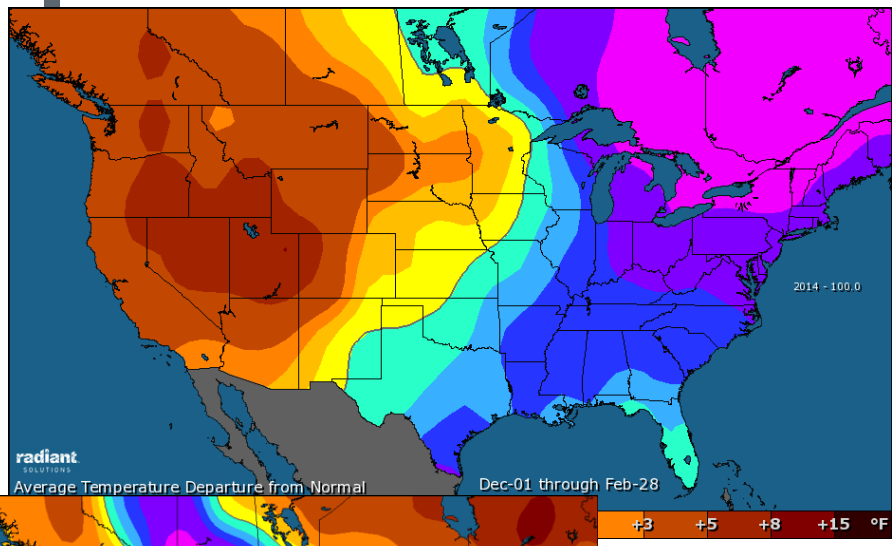


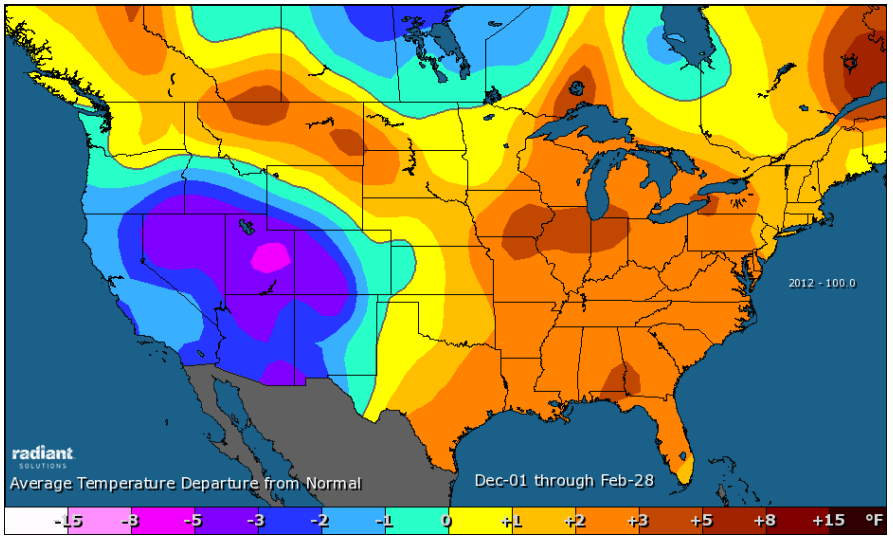
Modoki is colder, wetter for Texas

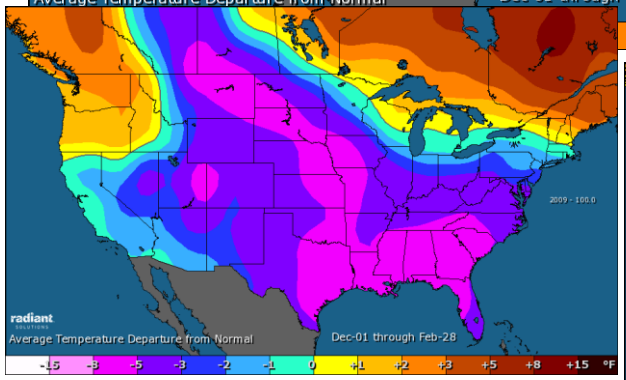
Ocean Temperatures

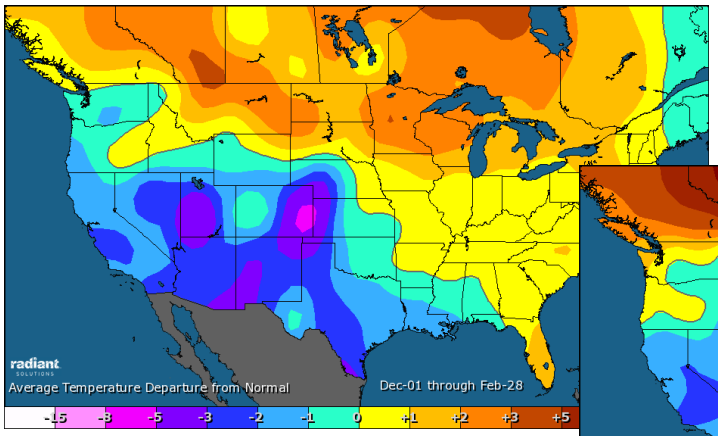


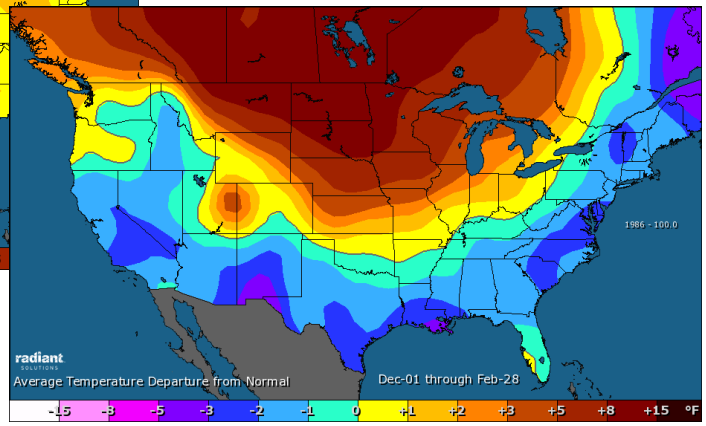
Historical El Niño Winters (mean temperatures)





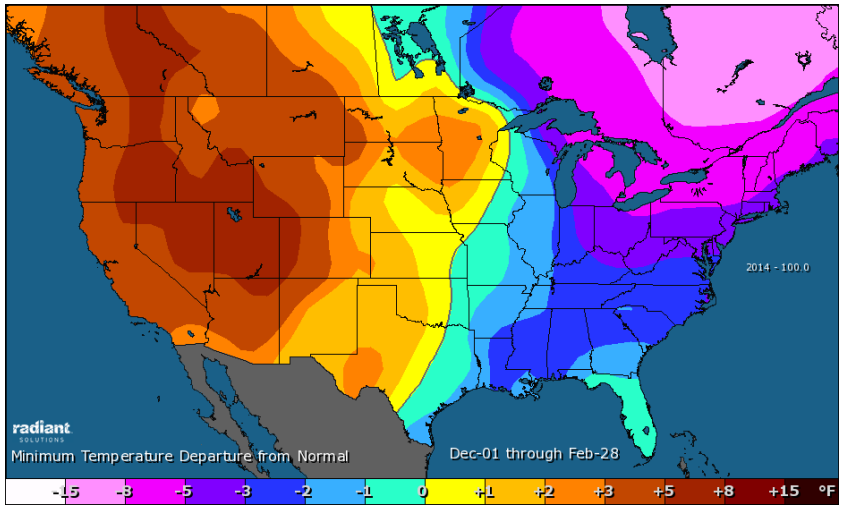


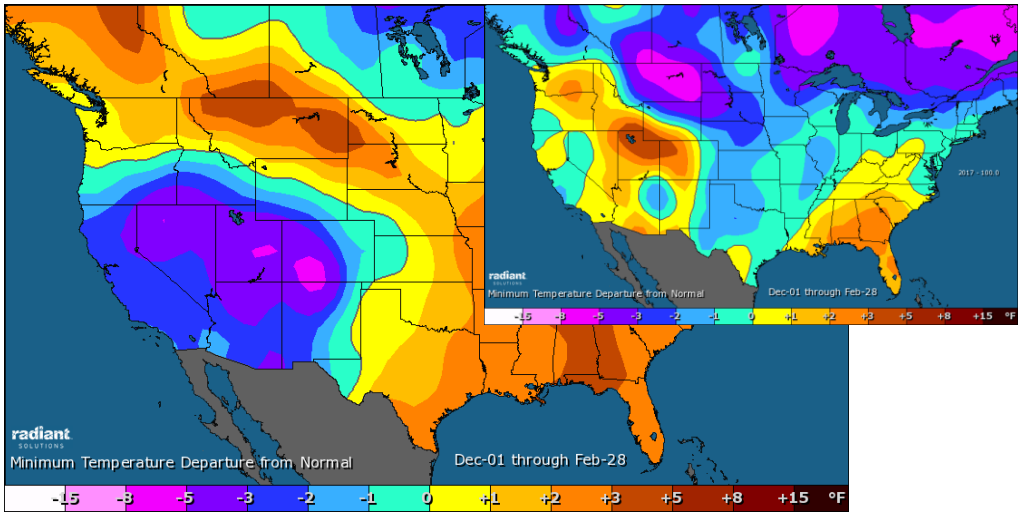


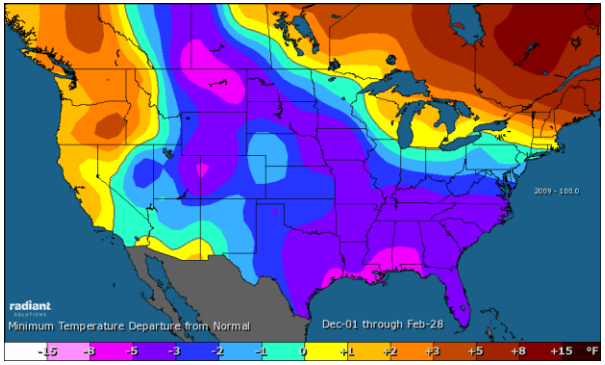


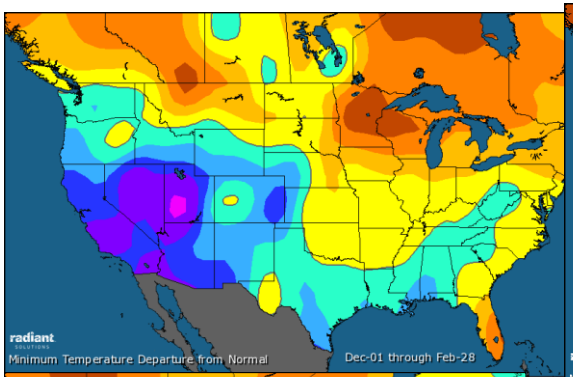
2014-15
2012-13
2009-10
2006-07
1986-87

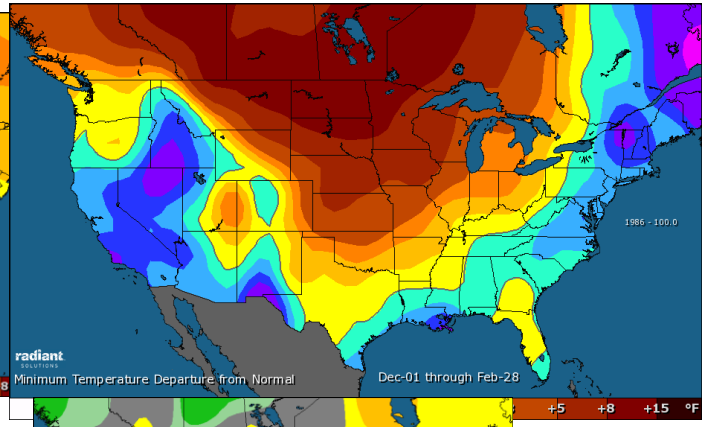
Historical El Niño Winters (minimum temperatures)

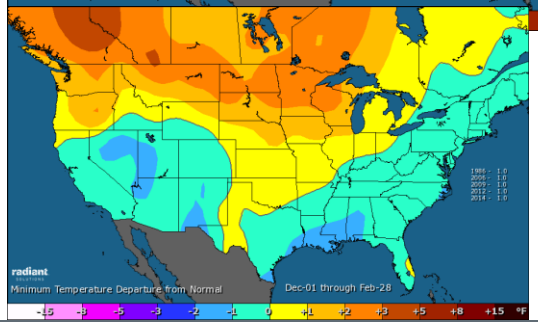


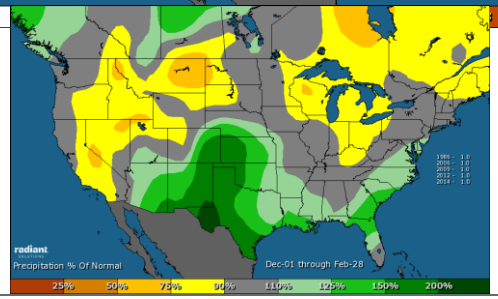






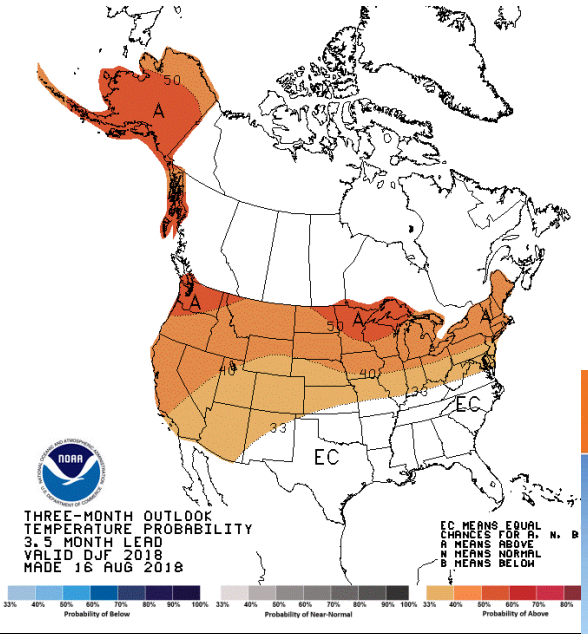


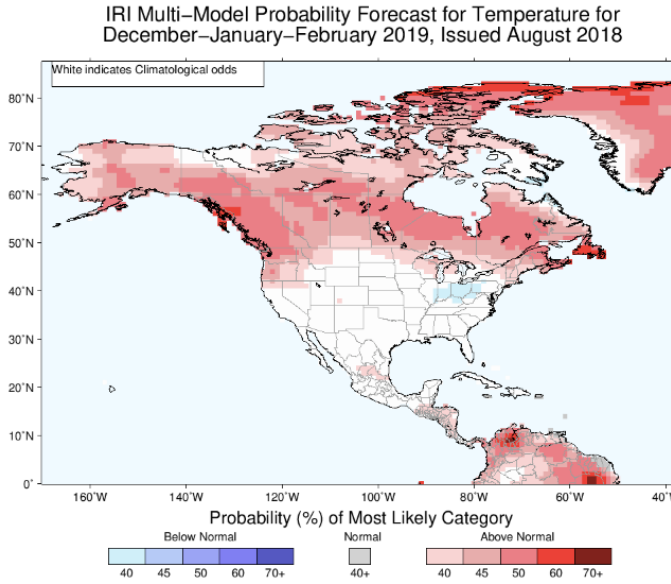


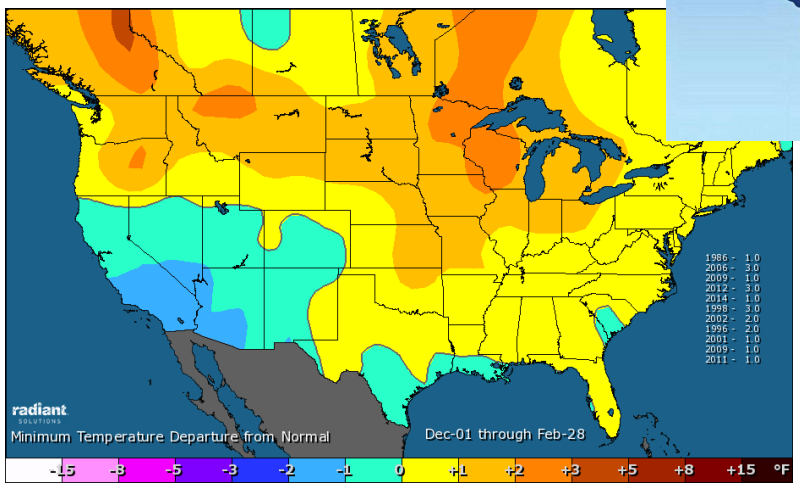


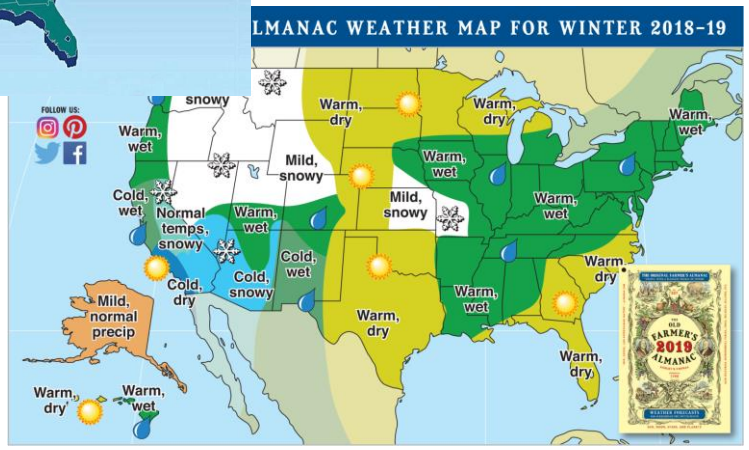
2014-15
2012-13
2009-10
2006-07
1986-87

What Other Weather Sources are Forecasting (this winter)

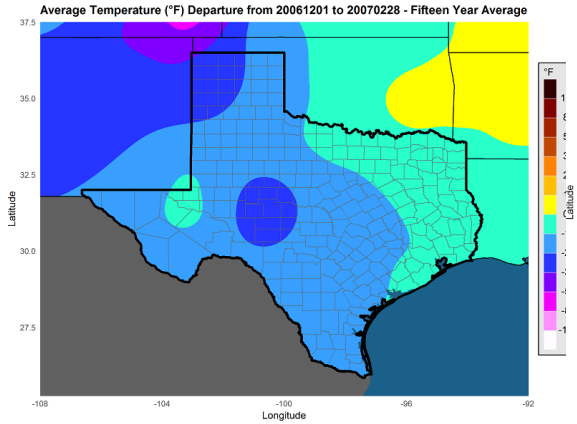




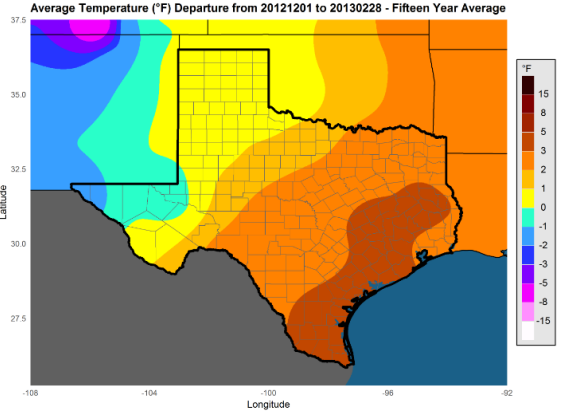




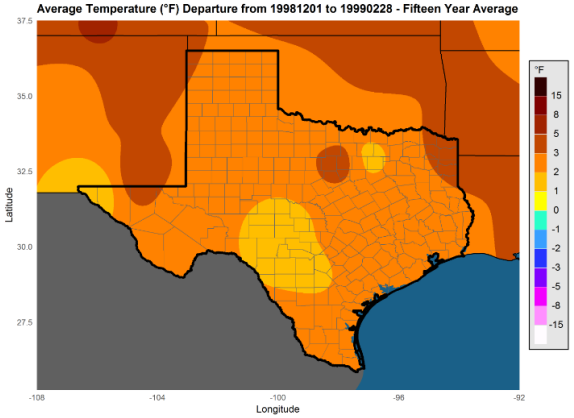
Historical Matches (Analogs)



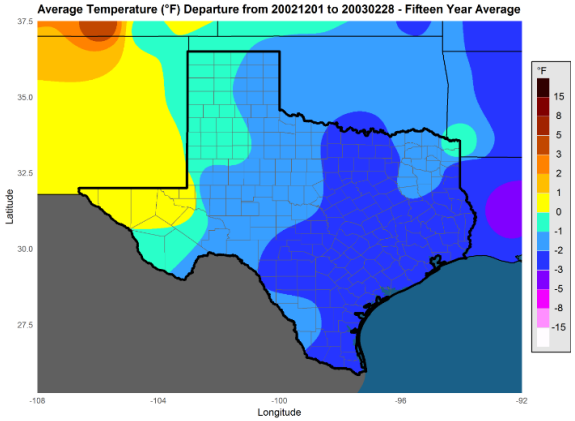
2006-07 (43rd/71st coldest)



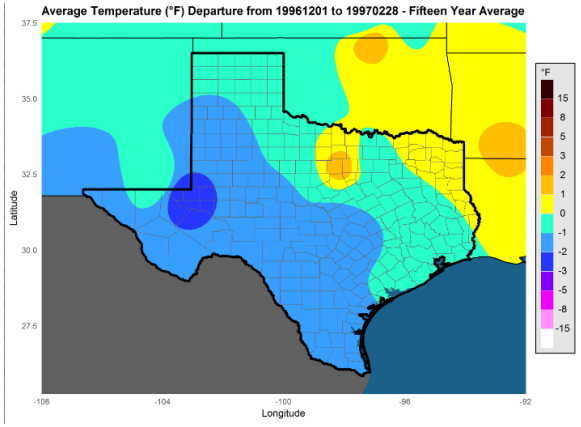
2012-13 (109th/105th)



1998-99 (120th/113th)



2002-03 (64th/84th)



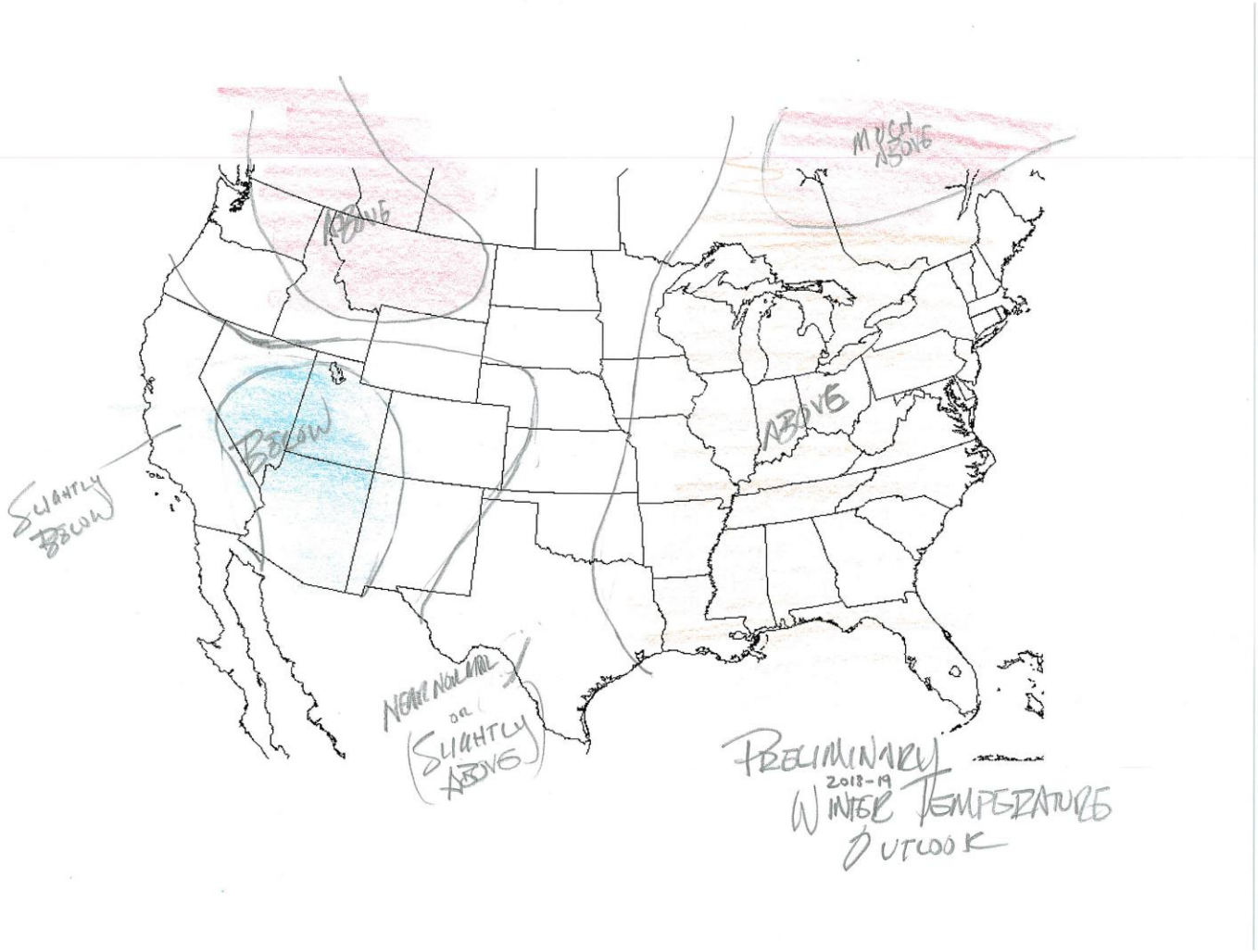
1996-97 (74th/95th)

Last winter ranked 77th/71st **(mean/min)** coldest; this winter could be similar. Better chance warmer than colder.

None rank in the bottom third of coldest winters for Texas

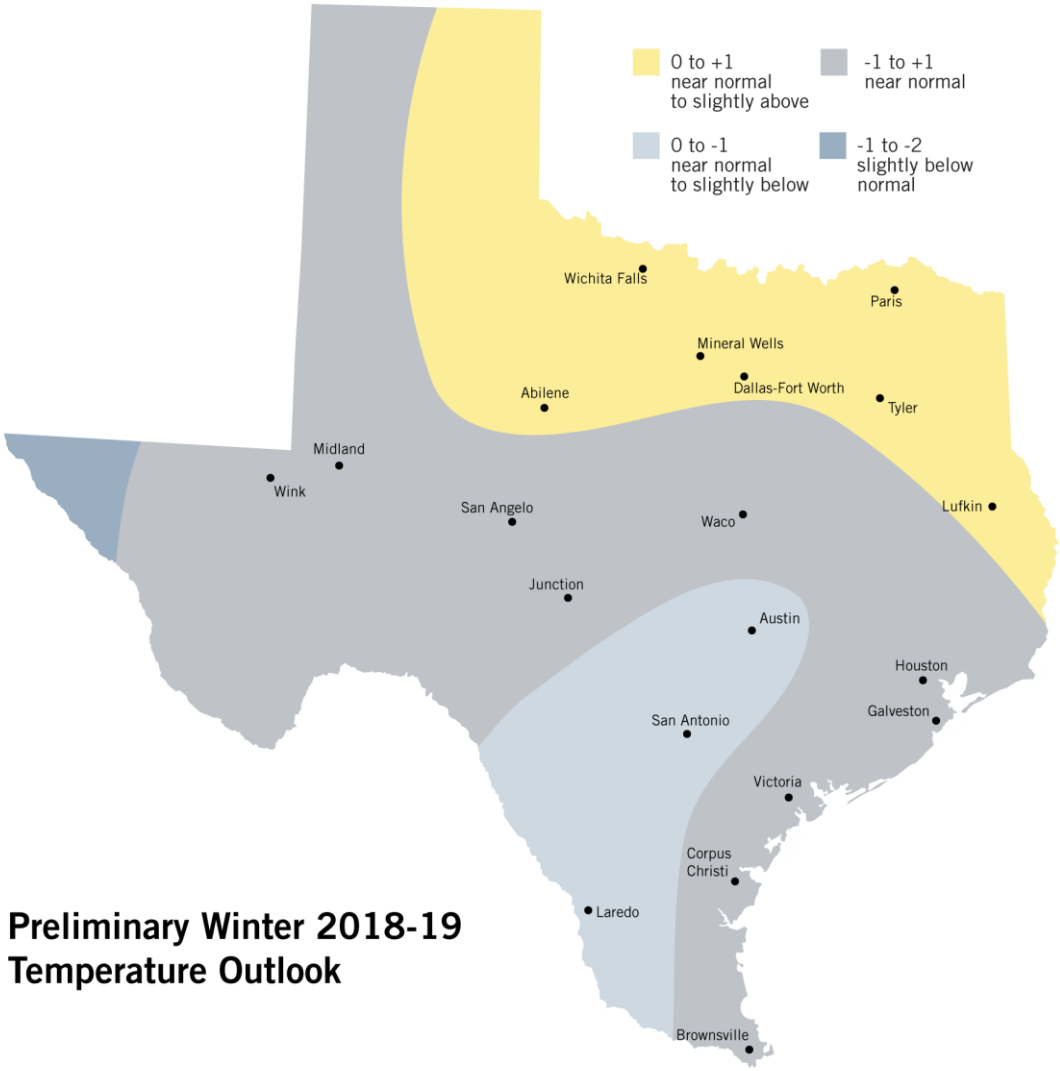
Preliminary Winter 2018-19 Temperature Outlook

Analog weighted consensus:



Winter 2018-19 Temperature Outlook

- 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)
- Can't yet rule out a finalized, colder forecast (2006-07?), which would be on the cusp of the coldest third and colder than last winter
- But the preliminary forecast suggests similar to or less cold than last winter
- Mild winters can – and oftentimes do – have very cold periods!



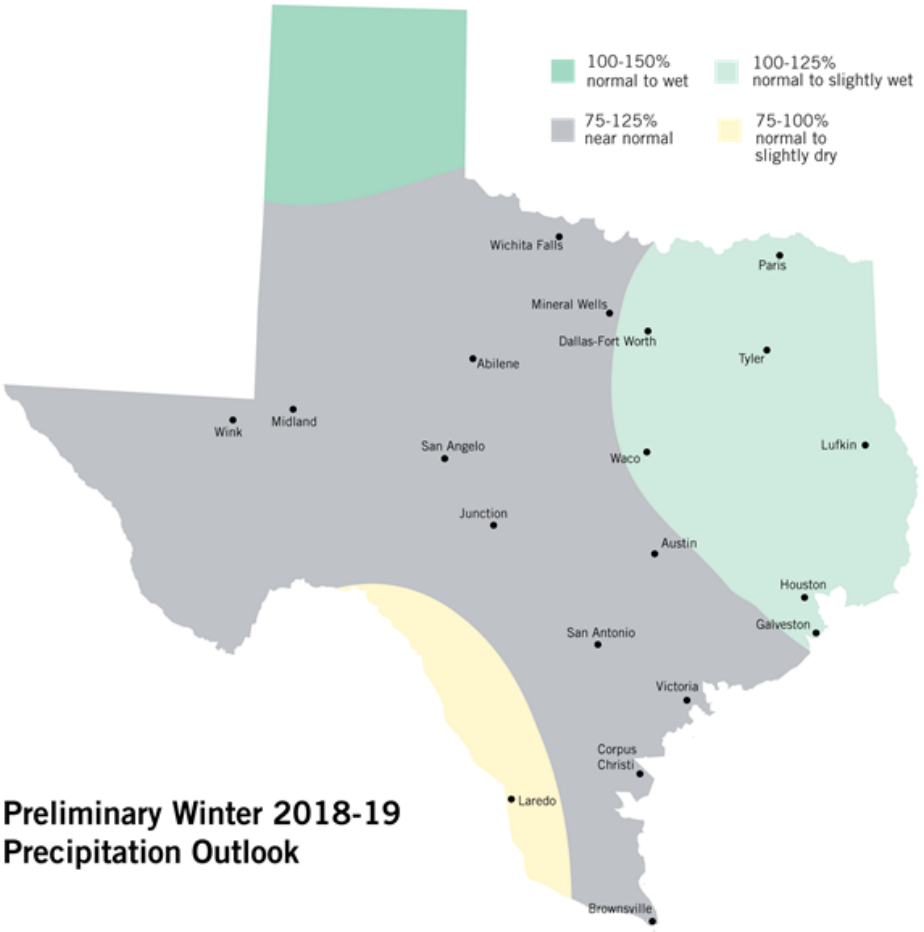
Preliminary Winter 2018-19 Temperature Outlook

Precipitation Ranking of Recent Winters (Texas)

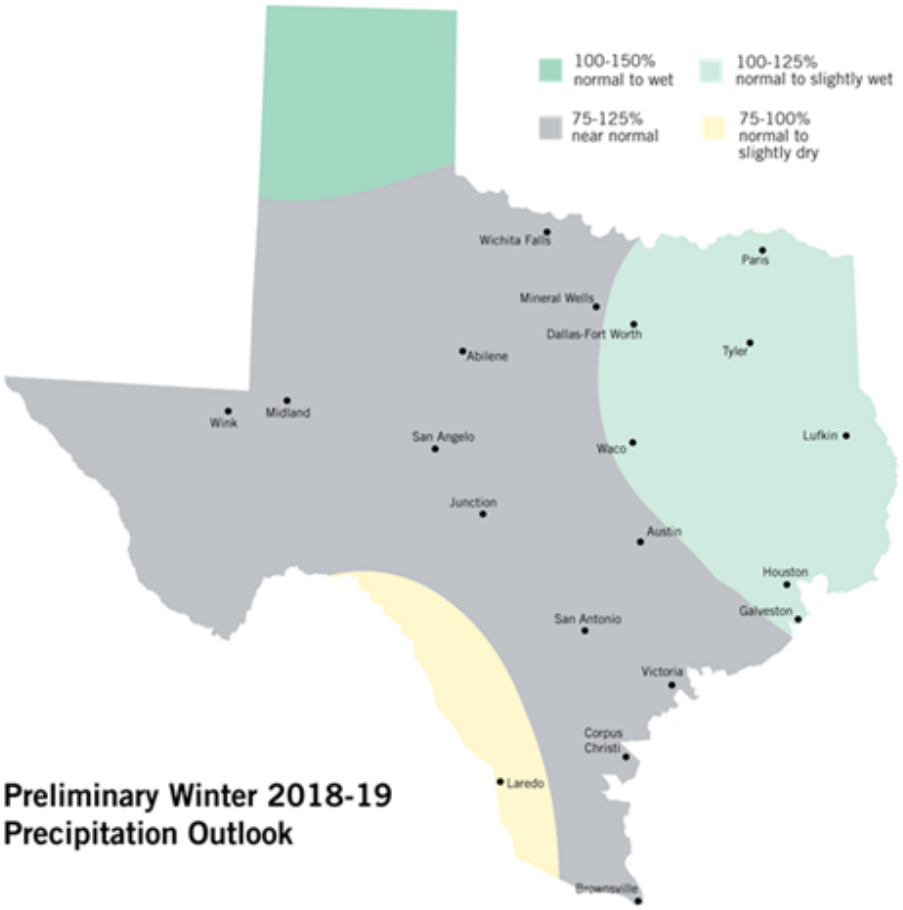
2017-18	**71st driest (out of 123)**
2016-17	**94th**
2015-16	56th
2014-15	70th
2013-14	**11th**
2012-13	60th
2011-12	**114th**
2010-11	**17th**
2009-10	**113th**
2008-09	**1st driest**
2007-08	24th

Winter 2018-19 Precipitation Outlook

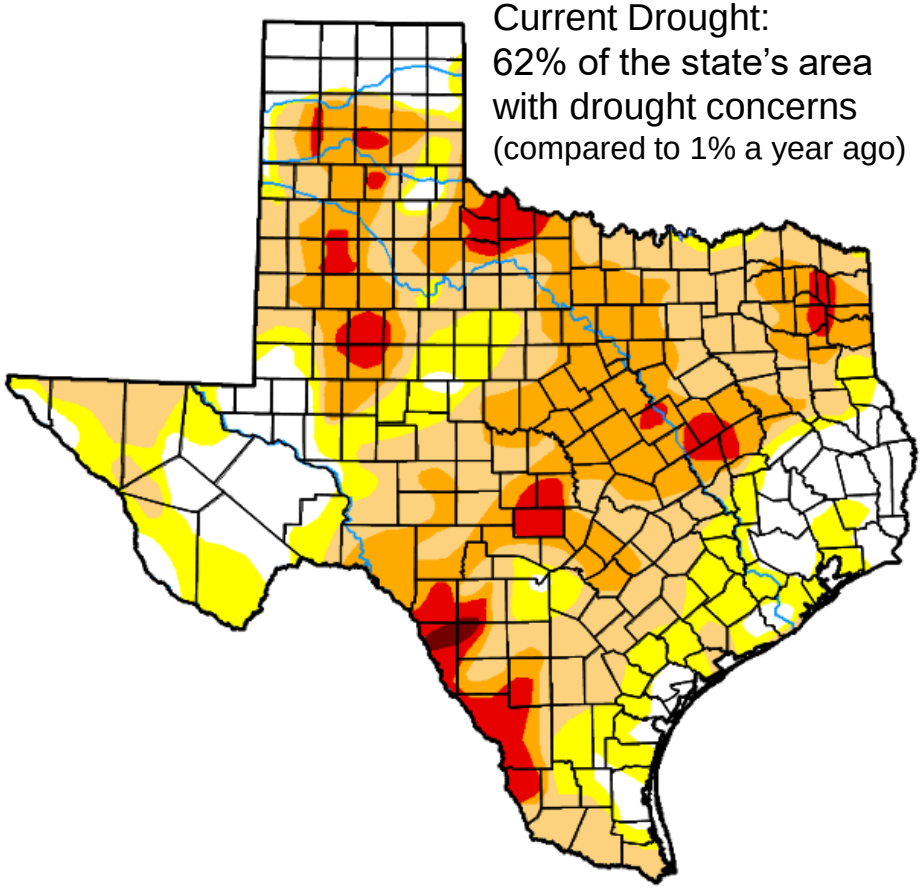
- **Most solutions are wetter rather than drier. El Niño most times (not always) support relatively wetter winters.**
- **North Texas has higher potential than South Texas for precipitation**
- **Austin recorded snow on 4 of the 9 historical analog (matching) winters**



Winter 2017-18 Precipitation Outlook vs Drought



Preliminary Winter 2018-19 Precipitation Outlook

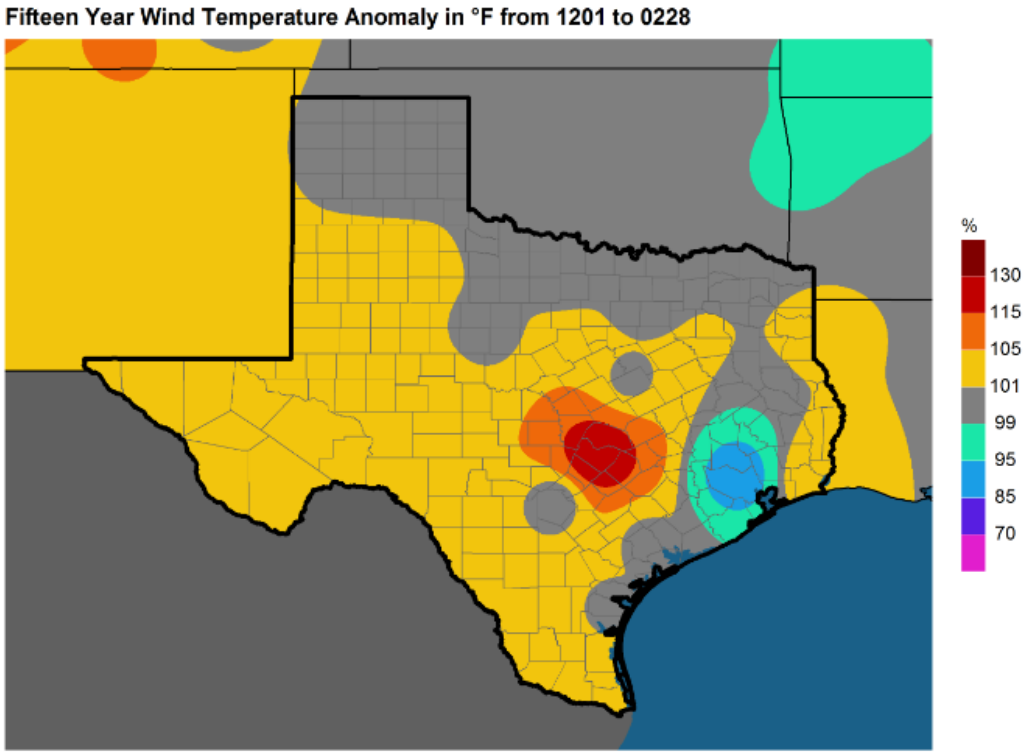


Current Drought:
62% of the state's area with drought concerns
(compared to 1% a year ago)

Improvements to the Panhandle and parts of North Texas are possible; South Texas may worsen. In all, more opportunities for improvement than deterioration

Historical Analog Winds

- **2006-07, 2012-13, 1998-99, 2002-03, 1996-97**
- **Would project normal to above-normal wind this winter (most of ERCOT)**
- **Obviously, however, wind matters most on the handful of days when you really need it (high load, tight on generation) – and this is a very broad brush forecast**



Summary

- This is a preliminary forecast. It will be **finalized by November 1** and posted to ERCOT.com
- **Early indications suggest a normal winter in terms of temperatures and slightly wet in regards to precipitation**
- A normal winter may seem cold compared to most winters over the past 10-20 years – but it's not strongly cold on a 100+ year comparison
- **There's slightly more potential for this winter to be warmer than forecast rather than cooler**
- **There's slightly more potential for this winter to be warmer than last winter rather than colder. Even if colder, that doesn't necessarily equate to a higher winter peak.**
- Unlikely to be as cold as the winter of 2013-14 (30th coldest)
- **Even during a mild winter, you should always be prepared for a very cold period/worst case scenario!**
- The winter should provide opportunities to improve on a drought that has developed in 2018