



NERC Activities, the Polar Vortex and Continuing Regulatory Interest

Mark Henry

Generator Winter Weatherization Workshop

September 1, 2015

Polar Vortex January 6th - 8th, 2014

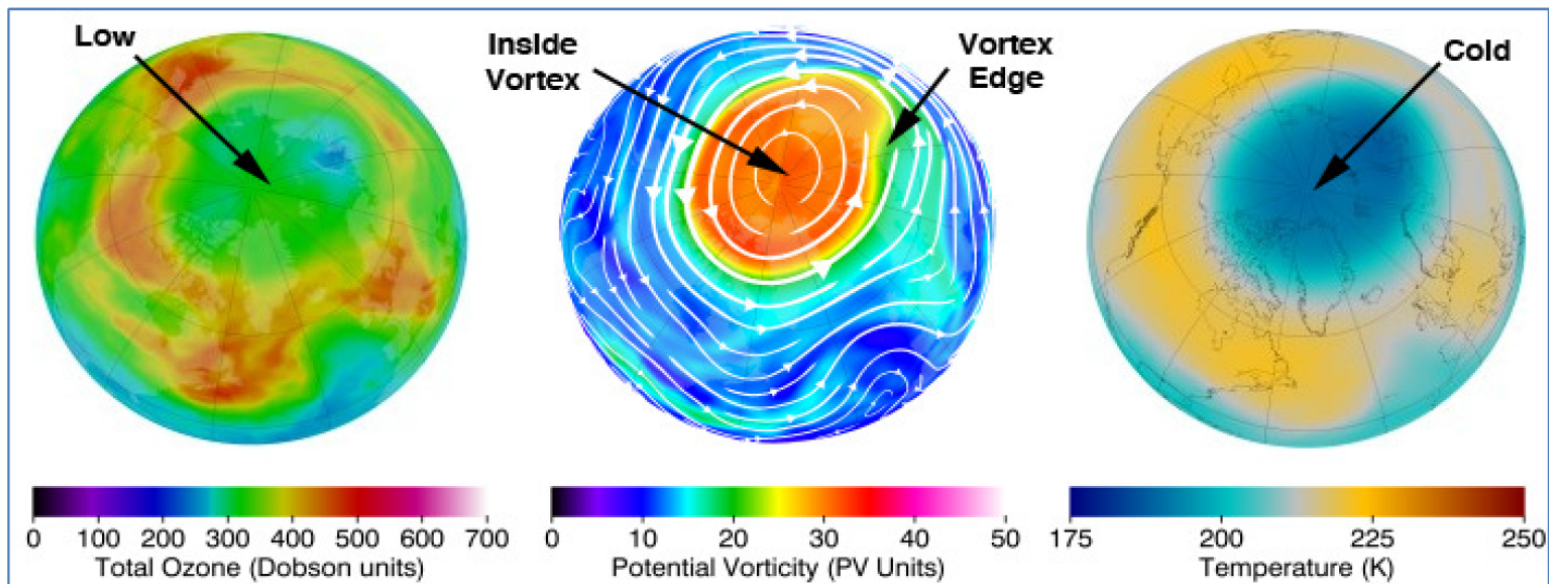
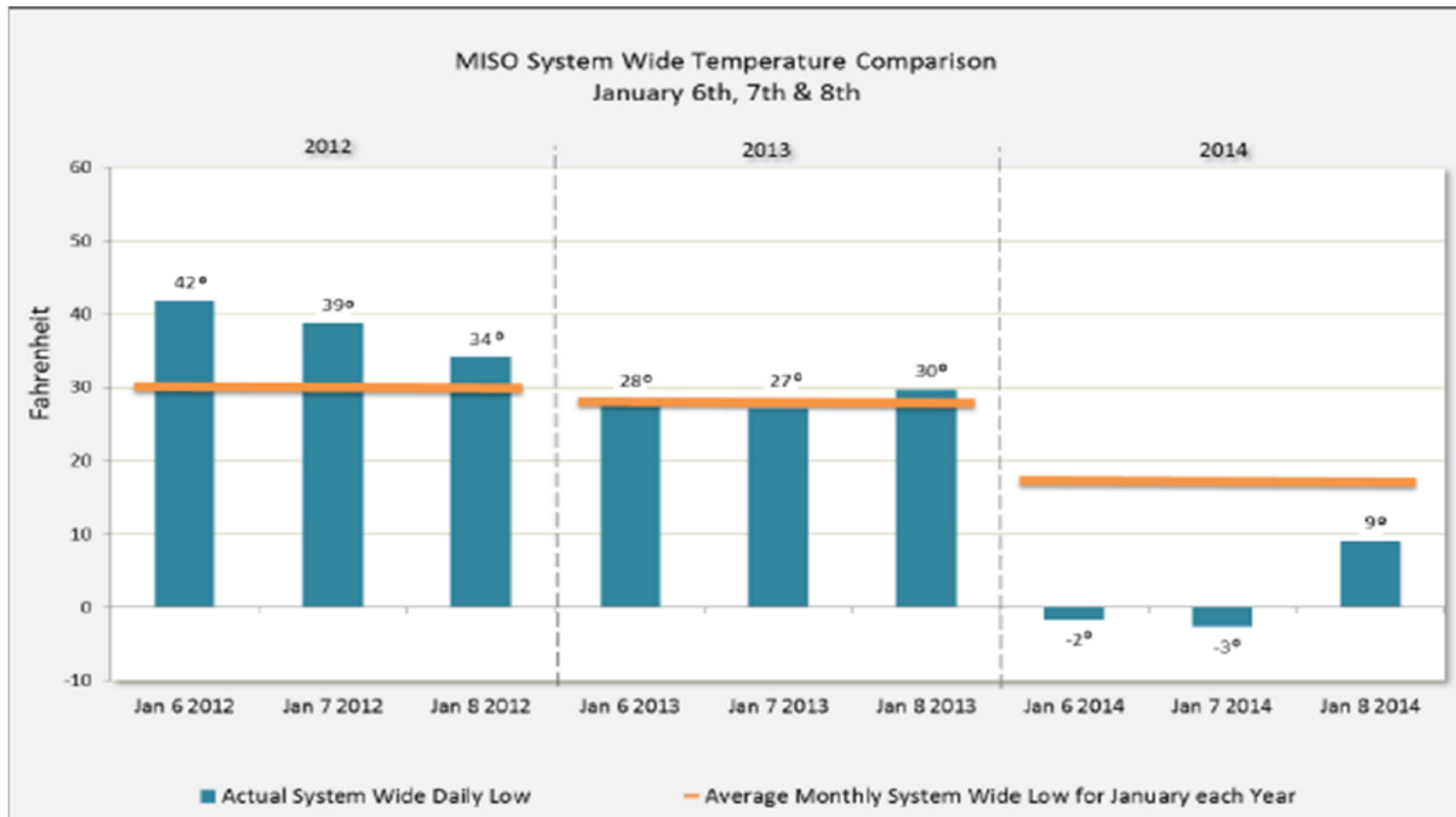


Figure 4: How a Polar Vortex Forms

Source: NASA - http://ozonewatch.gsfc.nasa.gov/facts/vortex_NH.html

MISO Temperature Comparison



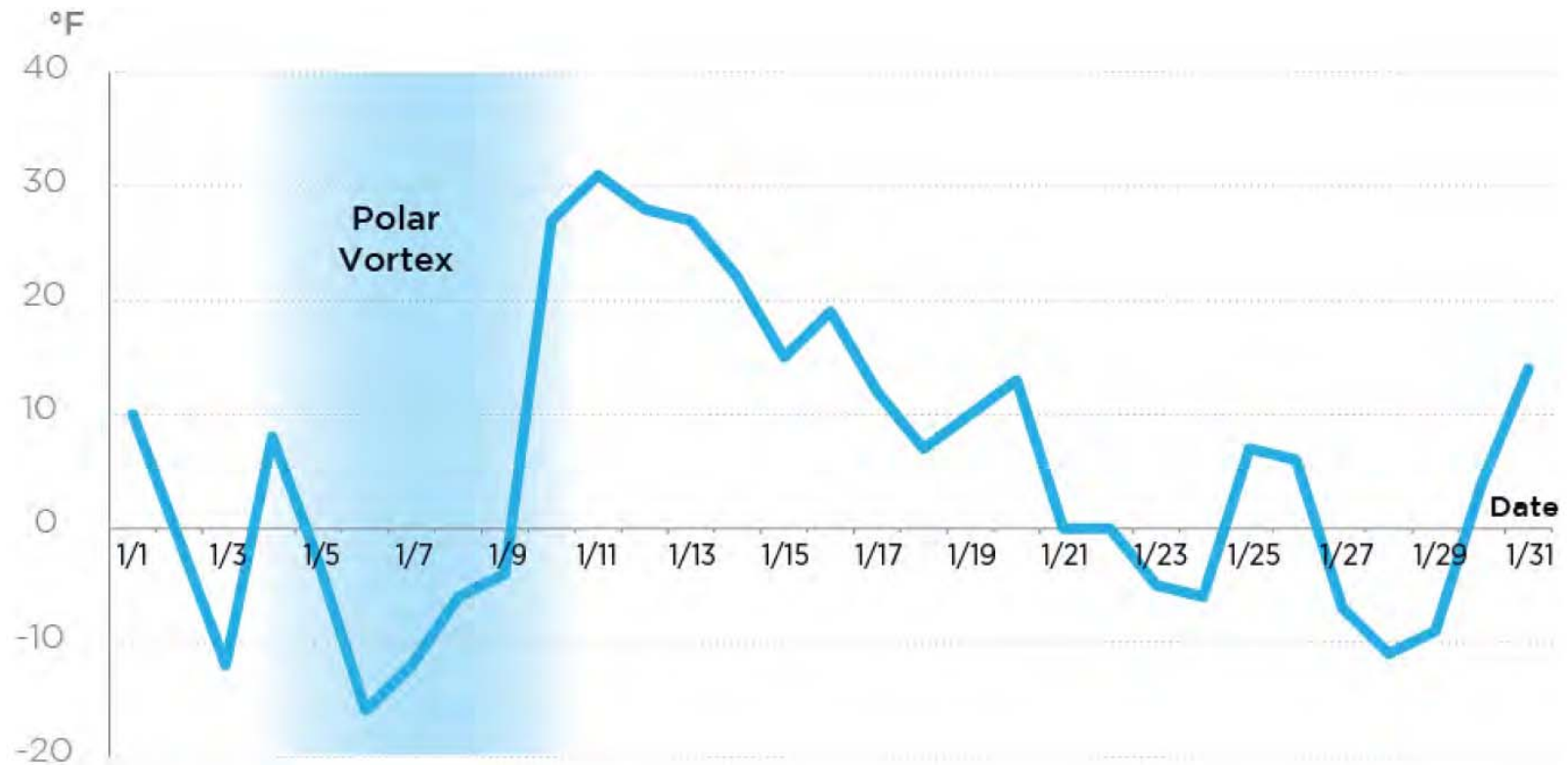
MISO Generation Impact

Most of the Generation that was unavailable during the polar vortex had suffered mechanical failures due to the unusually cold temperatures.

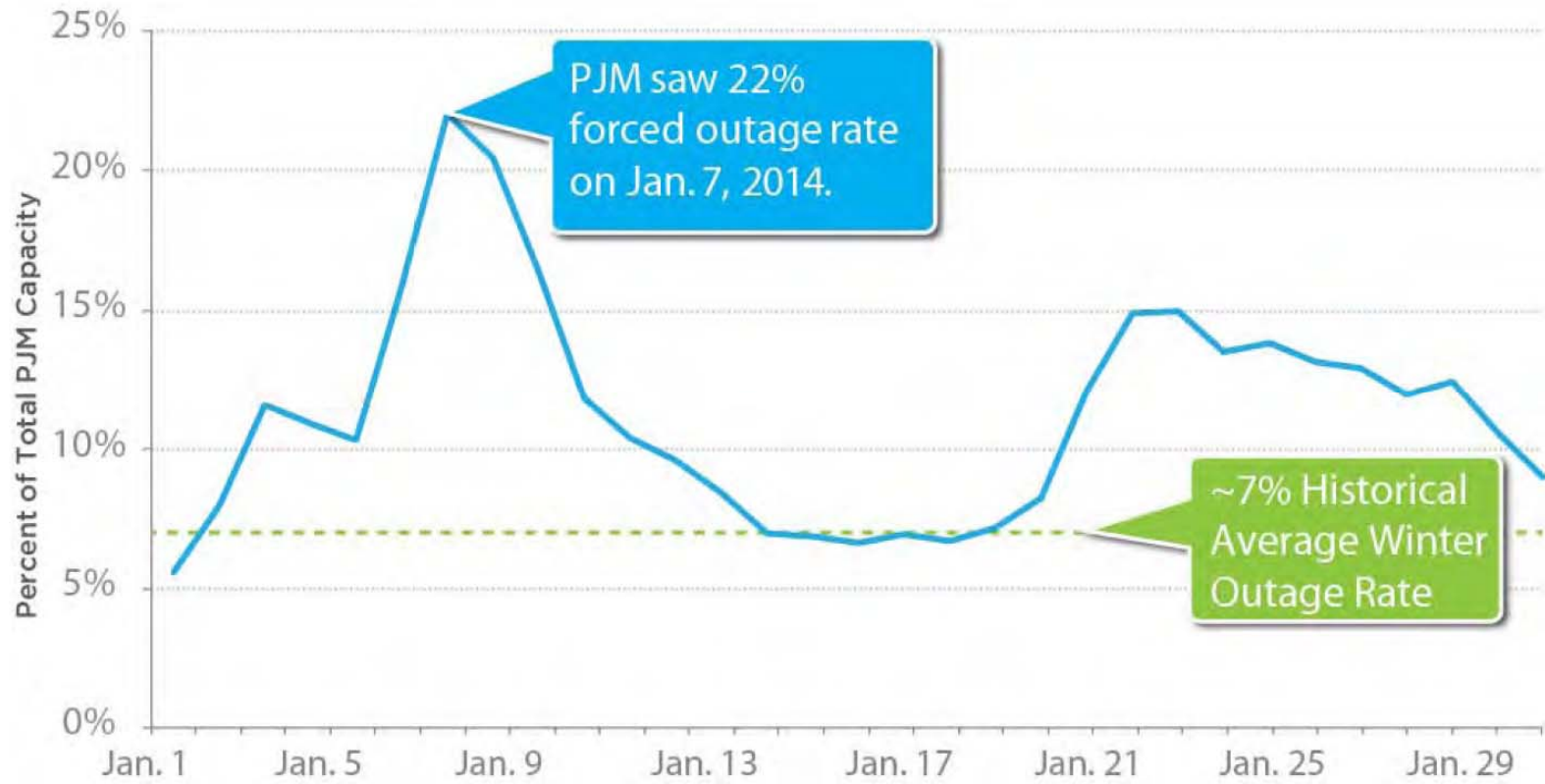
- **January 6 - 19,500 MW forced offline due to the weather**
 - 1,000 MW wind units temporarily “cutouts” from extreme weather conditions on Jan 6th - MISO reports accurate forecasting. 7,500 MW generated.
- **January 7 - 27,000 MW forced off by weather.**
 - Lower winds and “cutouts” reduced wind to around 1050 MW total.

Issue Statement (MISO 2014 Cold Weather Operations Report): The level of uncertainty in unit performance suggests our unit commitment processes and plans should be reassessed to determine potential areas for improvement.

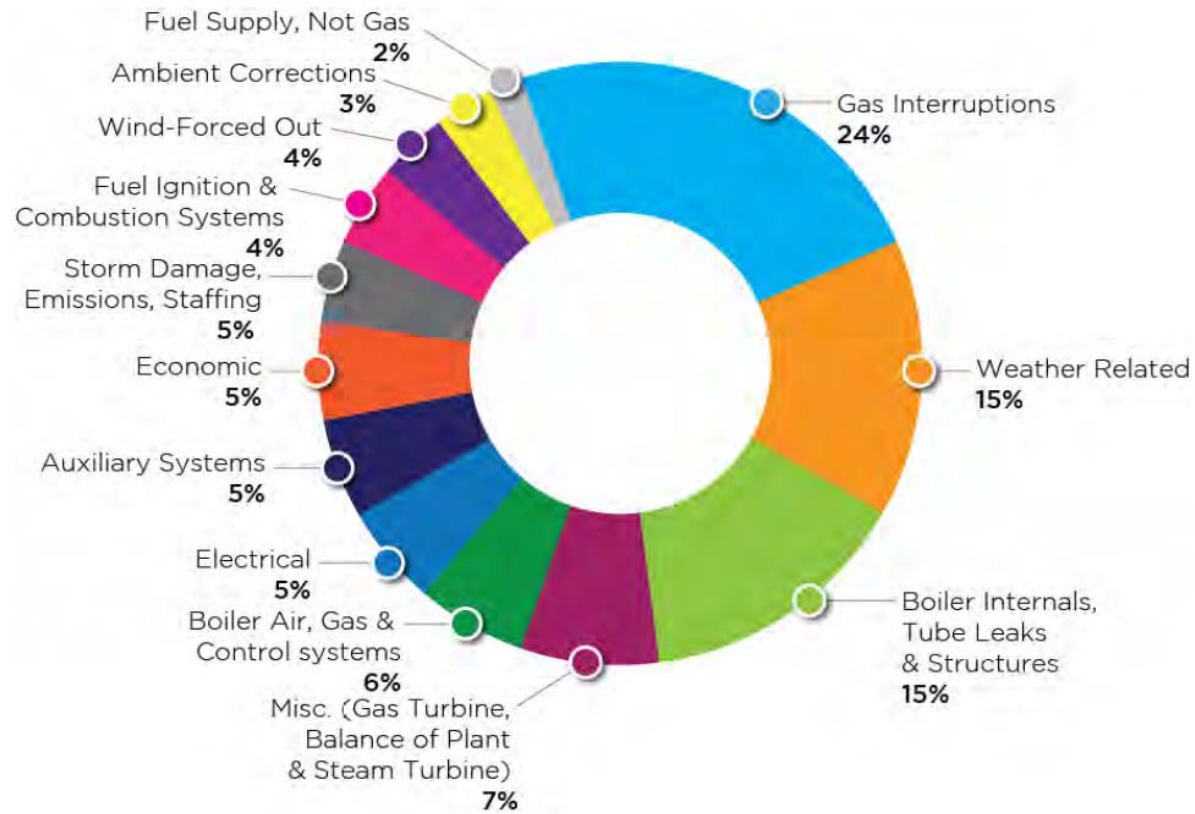
PJM Minimum Temperature Jan 2014



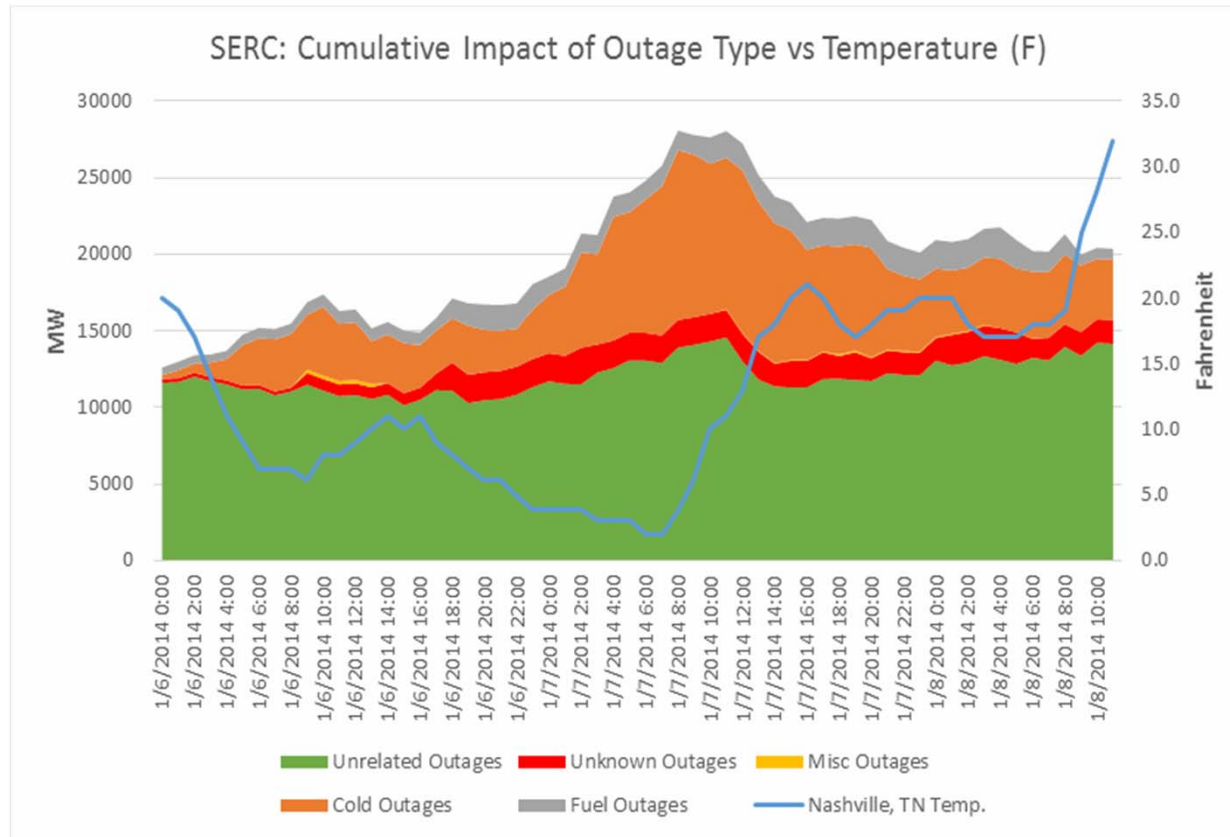
PJM Generation Outage Rate – Jan 2014



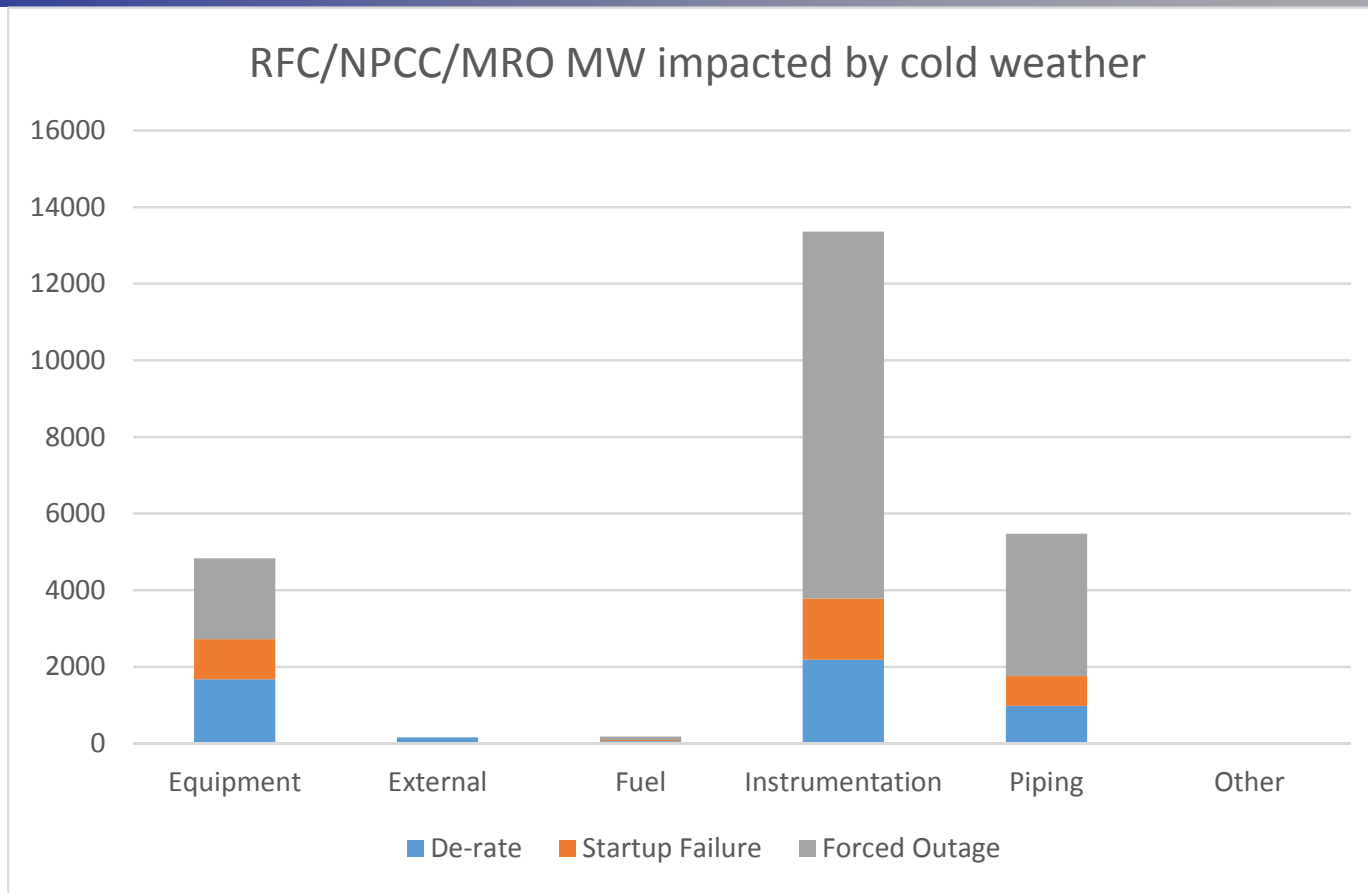
Causes of PJM Forced Outages – Jan 7, 2014



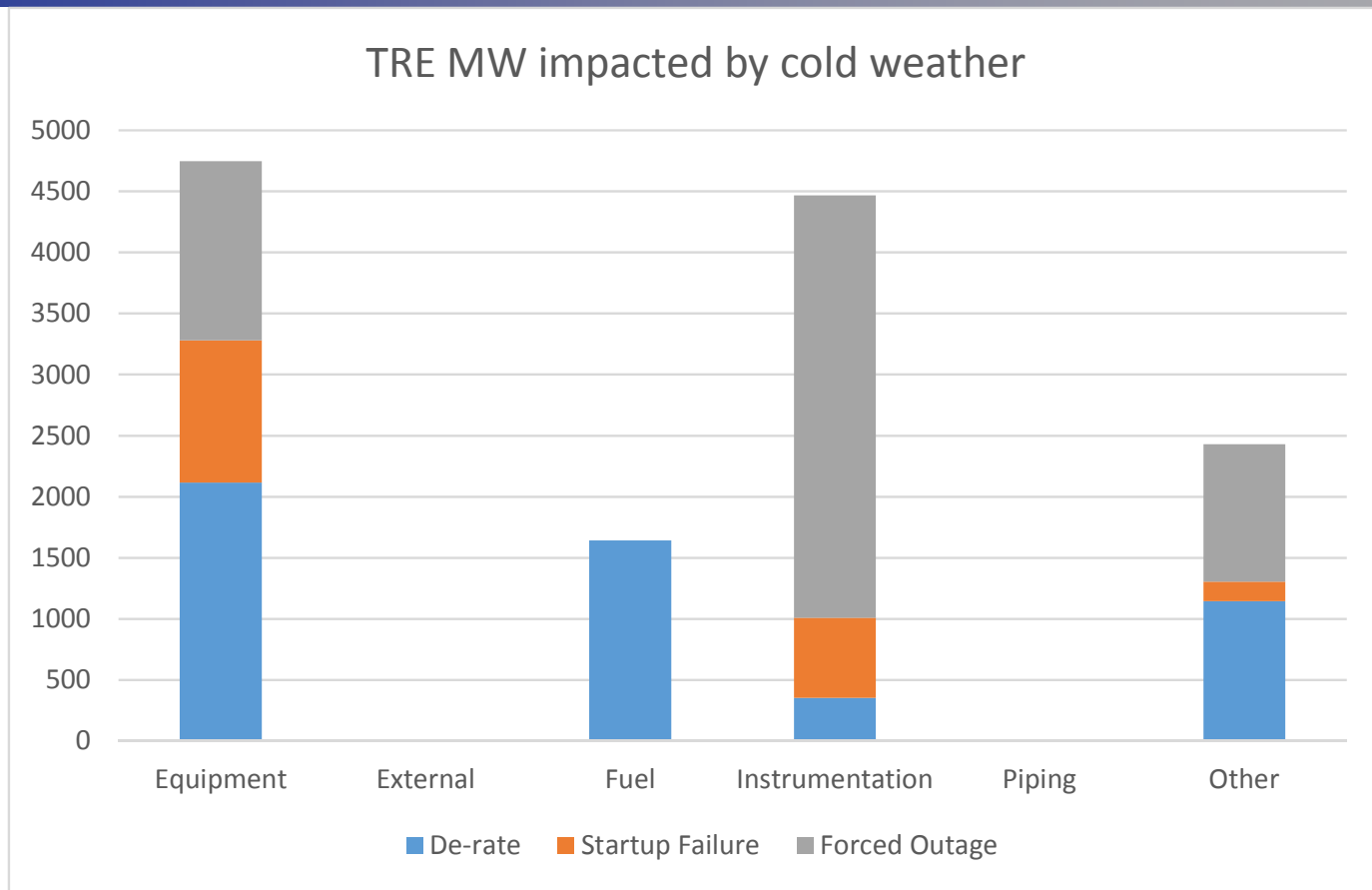
SERC (Southeast Region) Outages – Jan 6-8, 2014



Review of GADS outage data



Review of Texas RE GADS outage data



Examples of Extreme Cold Weather Effects on Generation

From NERC's Polar Vortex Report:

- **The drum level transmitter sensing lines froze, indicating a false drum level and consequently tripping the boiler.**
- **Moisture ingress caused gear boxes, valve positioners, and solenoid valves to fail due to freezing.**
- **Heat trace electric circuits not working prior to the event tripped during the event, or were miswired.**
- **Impulse tube lines, level transmitters, or pressure sensing lines were uninsulated or underinsulated, resulting in freezing components.**

More Examples from NERC's Report:

- **A plant steam pressure transmitter froze due to extreme cold conditions, which limited the operation of the condenser air removal equipment, and the unit tripped on low vacuum. The transmitter is located **inside** the main building close to an exterior wall louver.**
- **Generator logic tripped the turbine due to a frozen water flush transmitter. The transmitter was frozen due to cold weather; however, the logic should not have tripped the unit**
- **A unit heater tripped, which affected operation of VFD. During restarting the water injection VFD, unit was at upper load and flamed out from inrush of water.**
- **Frozen NOX water header pressure sensing lines in the unit resulted in no available NOX water injection for emissions control.**

More Examples from NERC's Report:

- **Insufficient brush tension resulting from cold temperatures caused collector ring failure.**
- **Fuel oil gelled the filters due to the cold temperatures.**
- **Missed process step when switching from gas to oil caused trip.**
- **Audible noise heard during hourly inspections caused shutdown of a unit for further evaluation; ice was found on inlet guide vanes.**
- **Frazil ice blocked intake, causing insufficient water supply to turbine.**

Questions?

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Weatherization at Johnson County



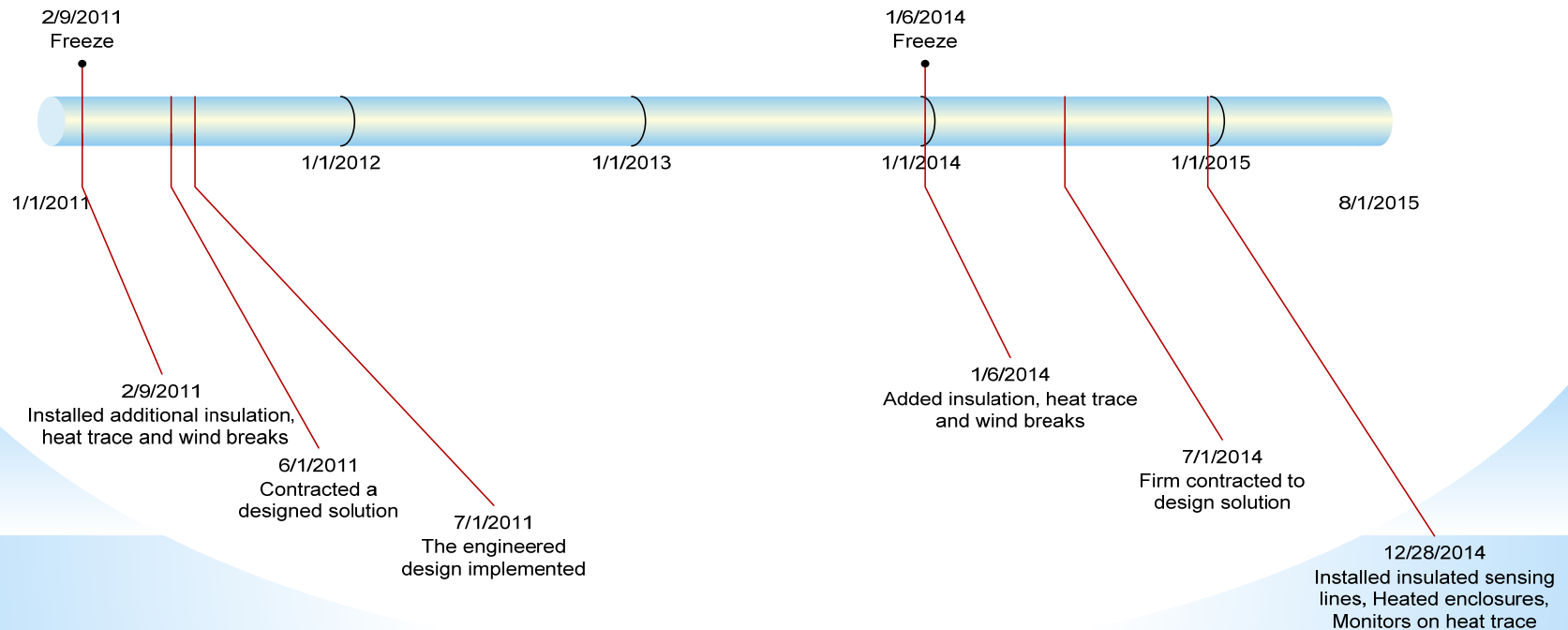
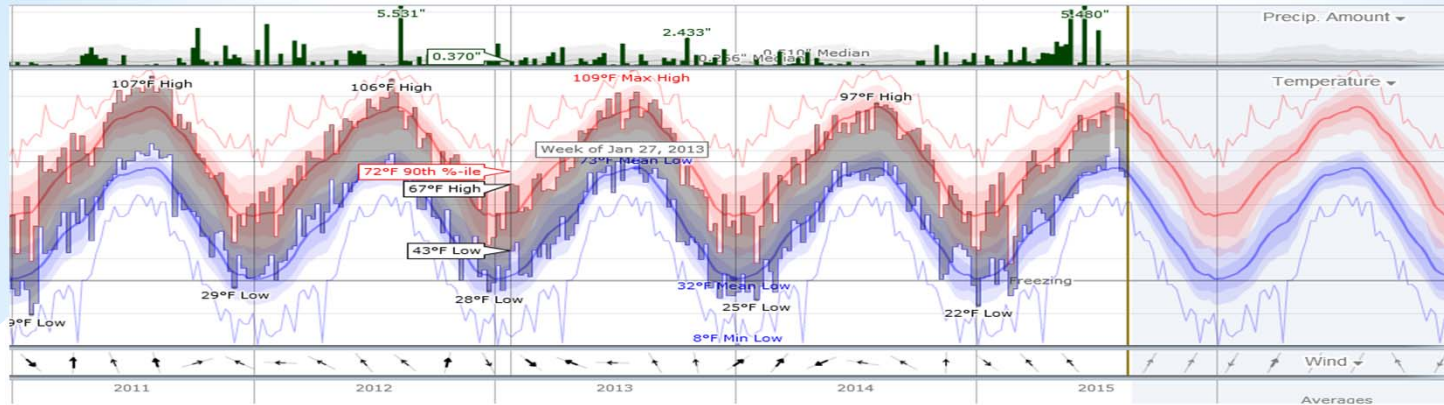
Mark Pavelka
Shari Heino
Brazos Electric Power Cooperative, Inc.

Johnson County

- 265 MW
- 1-1 Combined Cycle
- Began commercial operations in 1997
- Owned by Brazos Electric Power Cooperative
- Operated by NAES Corporation



Weather Event History



2011 Freezing Issues

➤ HP Steam Flow

- Two transmitters with freezing issues

ACTION

- A contractor was hired to investigate and recommended additional heat trace and insulation.
- Additional heat trace and insulation was added based on their designed recommendation

➤ IP Drum Level

- One transmitter had issues even though it is housed inside the drum house enclosure which is heated

ACTION

- Additional spray foam insulation was installed
- Upgraded the space heaters inside both drum enclosures

2014 Freezing Issues

- HP Steam Flow
- NOx Flow Transmitter
- 1st Stage Pressure Transmitter
- LP Drum Pressure Transmitter
- LP Economizer Vents
- IP Drum Level Control Valve

Major Upgrade to Freeze Protection

(Completed 2014)

ACTION

- 44 instruments were moved and installed into 20 heated instrument enclosures rated for 25 mph wind at -30 °F.
- All tubing sensing lines to these instruments were replaced with pre-insulated electrically traced tubing bundles rated for 25mph wind at -15 ° F.
- End of line lights were installed at the end of each tubing bundle for easy identification that each circuit is energized.
- A new smart heat trace panel was installed to handle additional loading and a monitoring screen to identify each circuit.

HP steam flow



Original Installation



Updated Installation

NOx Transmitter



Original Installation



Updated Installation

Fisher Actuators

- Rain water was penetrating the IP drum level control valve. After investigating it was determined the rain cap was missing which helped allow the ingress of water into the actuator which froze due to the extreme temperatures

ACTION

- Action taken - 19 actuators were overhauled and rebuilt and rain caps added.

Fisher Actuator IP Drum Level



Rebuilt with Rain Cap Installed



Economizer Vents

- 22 vent lines were located together, making them susceptible to collective failure

ACTION

- Rerouted on top of the boiler to help protect them from the north wind. Additional valving was added to isolate each vent independently if future problems were to occur.

Economizer Vents



Original Installation



Updated Installation

Initial Solutions

1. Plywood wind breaks
2. Blankets with Velcro attachment bands
3. Foaming
4. Tarp covering of valves/pipes/transmitters
5. Insulation with small cracks (~1/4") around critical piping/transmitters
6. Heat-lamps

Long Term Weatherization Tools

1. Check Lists
2. Thermography
3. Heated enclosures
4. Insulated and heat traced sensing lines
5. Hard wind-breaks with added tarps and heating
6. Continuous monitoring for functioning solutions

| Order | Description | W.O. Type | Equip | Start date | Complete date |
|--------|--------------------------------|---------------------|-----------|------------|---------------|
| 738620 | HEAT TRACE PANEL CHECKOUT | Winter Preparedness | 1EEAHTFP1 | 10/6/2014 | 11/19/2014 |
| 738697 | SURVEY ALL FREEZE PROT CIRCUIT | Winter Preparedness | 1EEAHTFP1 | 10/13/2014 | 11/3/2014 |
| 738929 | VERIFY HEAT TRACE PANELS ARE I | Winter Preparedness | 1EEAHTFP1 | 10/20/2014 | 11/3/2014 |
| 761117 | HEAT TRACE PANEL CHECKOUT | Winter Preparedness | 1EEAHTFP2 | 10/6/2014 | 11/19/2014 |
| 761125 | SURVEY ALL FREEZE PROT CIRCUIT | Winter Preparedness | 1EEAHTFP2 | 10/13/2014 | 11/30/2014 |
| 761133 | VERIFY HEAT TRACE PANELS ARE I | Winter Preparedness | 1EEAHTFP2 | 10/20/2014 | 11/3/2014 |
| 738953 | PERFORM FUEL OIL TRANSFER TEST | Winter Preparedness | 1TGHTRB1 | 10/6/2014 | 10/7/2014 |
| 738937 | WINTERIZE COMBUSTION TURBINE C | Winter Preparedness | CHA | 10/6/2014 | 10/31/2014 |
| 738945 | CONFIRM CHILLER WINTERIZATION | Winter Preparedness | CHA | 10/13/2014 | 10/31/2014 |
| 738689 | SURVEY ALL INSTRUMENTATION FOR | Winter Preparedness | EEA | 9/1/2014 | 11/30/2014 |
| 738700 | SURVEY ALL OUTDOOR PIPING FOR | Winter Preparedness | EEA | 9/8/2014 | 9/11/2014 |
| 738718 | SURVEY ALL BLDG SPACE HEATERS | Winter Preparedness | EEA | 9/15/2014 | 11/30/2014 |
| 738961 | VERIFY EMERGENCY HEAT TRACE SU | Winter Preparedness | EEA | 9/22/2014 | 9/22/2014 |
| 738970 | VERIFY ADEQUATE SUPPLY OF DE-I | Winter Preparedness | EEA | 9/25/2014 | 9/30/2014 |
| 739075 | VERIFY ALL PORTABLE HEATERS AR | Winter Preparedness | EEA | 11/10/2014 | 11/17/2014 |

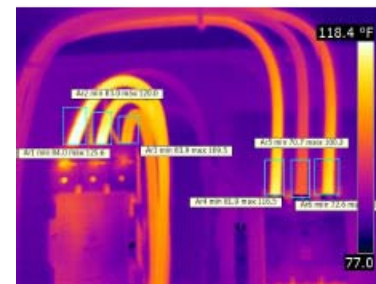


Image and Object Parameters

| | |
|--------------------------------|-----------------------|
| Camera Model | P65 NTSC |
| Image Date | 10/21/2014 8:32:11 AM |
| Image Name | IR_2724.jpg |
| Emissivity | 0.95 |
| Reflected apparent temperature | 68.0 °F |
| Object Distance | 1.6 ft |

Description

Jack 1 - 1EH-CP-0200



Text Comments

Conclusions

1. Never say never. Designs can be created to meet the expected conditions; however, the expected conditions may not be what happens.
2. Key items affecting weatherization performance:
 - Temperature
 - Duration of temperature
 - Wind speed and direction
 - Solar heating
 - Unit cycling (retained heat)
 - Quality of installation
 - Orientation of concerned area to wind path
 - Continual review of installed freeze protection



Conclusions (cont.)

3. Do not assume systems are working - verify with detailed inspections.
4. A tripped unit could have devastating financial consequences (penalties and market losses).
5. Sharing of lessons learned creates increased awareness and correction options.
6. ERCOT has been instrumental in supporting weatherization efforts. *Thanks to Alan Allgower for continued support and sharing of lessons learned.*
7. **THERE ARE NO GUARANTEES; HOWEVER, CONTINUOUS IMPROVEMENT WILL LOWER YOUR RISKS!**



Questions?



GDF SUEZ

Improving Reliability and Ensuring Safety During Cold and Icing Conditions

Mike Knisley, Midlothian Energy

UNCLASSIFIED - INTERNAL - RESTRICTED - CONFIDENTIAL

Overview of Midlothian

- **6 Unit ALSTOM GT-24 Site**
- **Rated at 1450 MW**
- **Commercial Operations began in February 2001**
- **Located 30 miles south of Dallas**
- **Outdoor facility**



- **Rash of frozen transmitters**
 - LP Drum Level
 - Feedwater Pump Suction Pressure
 - Gas Turbine Plenum Pressure
- **Heat Trace Controller Failure**
- **Transmitters were in O'Brien boxes but monitoring the box temperatures was hazardous due to icing conditions**
- **After the events of that week Senior Leadership at GDF Suez made the commitment to ensure these events did not reoccur**
- **Recommendations from the FERC/NERC Staff Report on the 2011 Southwest Cold Weather Event were used as a foundation for improvements**

Winterization Actions Implemented

- Review issues from previous year(s)
- Perform annual insulation inspection
- Perform annual heat trace inspection
- Install end of line lights on heat trace circuits
- Install remote monitoring of O'Brien box temperatures



■ Review Previous Year's Issues

- Created a WINT work group in Maximo
 - Allows for ease in tracking and reviewing previous year's issues
- Weekly winterization meetings begin on October 1st
 - 10-15 minute meeting with Electrical staff and Operations to review all open items
- Determine if capital improvements are needed to ensure continuing reliability

■ Perform Annual Insulation Inspection

- Walk downs are performed by Operations Staff
- Issues and photographs are captured on a master file
- Once completed, the issues are turned over to Maintenance

■ Perform Annual Heat Trace Inspection

- Third party contractor used to conduct annual operational test of heat trace system
- Midlothian has 20 heat trace panels – 3 per unit and 2 in the BOP area
- Actions include:
 - Testing each circuit
 - Amperage load
 - Ohm reading
 - Megohm reading
 - Troubleshooting
 - If issues are found, contractor troubleshoots the issue to the junction boxes to determine which individual heat trace line has the issue
 - Deliver functionality report
- Lesson Learned – Follow behind the contractor and verify all systems have been returned to normal state

- **Install end of line lights on heat trace circuits**
 - Allows Operations to visually verify the complete heat trace circuit is functioning
 - Allows the verification of operation from a safe distance during icing conditions



■ Install Remote Monitoring of O'Brien Box Temperatures

- There are between 34 and 38 critical O'Brien boxes per unit and 8 in BOP for a total of 228 critical boxes
- Previously all boxes were equipped with a standard thermometer to read interior box temperature without opening the box
- Operations had a rounds sheet to take box temperatures during freezing conditions
- Most boxes are located in elevated areas that become dangerous to reach during icing conditions
- Thermocouples were installed in each box and hardwired each of them into the plant's DCS
- Box temperatures were given a low temperature and a high temperature alarm value
- Box temperatures are also loaded into Pi system

Remote Monitoring



Remote Monitoring Pi Screen

| UNIT 1 | | UNIT 2 | | UNIT 3 | | UNIT 4 | | UNIT 5 | | UNIT 6 | | BOP | |
|--------|----|--------|----|--------|----|--------|----|--------|----|--------|----|-----|----|
| 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 |
| 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 |
| 7 | 8 | 7 | 8 | 7 | 8 | 7 | 8 | 7 | 8 | 7 | 8 | 7 | 8 |
| 9 | 10 | 9 | 10 | 9 | 10 | 9 | 10 | 9 | 10 | 9 | 10 | 9 | 10 |
| 11 | 12 | 11 | 12 | 11 | 12 | 11 | 12 | 11 | 12 | 11 | 12 | 11 | 12 |
| 13 | 14 | 13 | 14 | 13 | 14 | 13 | 14 | 13 | 14 | 13 | 14 | 13 | 14 |
| 15 | 16 | 15 | 16 | 15 | 16 | 15 | 16 | 15 | 16 | 15 | 16 | 15 | 16 |
| 17 | 18 | 17 | 18 | 17 | 18 | 17 | 18 | 17 | 18 | 17 | 18 | 17 | 18 |
| 19 | 20 | 19 | 20 | 19 | 20 | 19 | 20 | 19 | 20 | 19 | 20 | 19 | 20 |
| 21 | 22 | 21 | 22 | 21 | 22 | 21 | 22 | 21 | 22 | 21 | 22 | 21 | 22 |
| 23 | 24 | 23 | 24 | 23 | 24 | 23 | 24 | 23 | 24 | 23 | 24 | 23 | 24 |
| 25 | 26 | 25 | 26 | 25 | 26 | 25 | 26 | 25 | 26 | 25 | 26 | 25 | 26 |
| 27 | 28 | 27 | 28 | 27 | 28 | 27 | 28 | 27 | 28 | 27 | 28 | 27 | 28 |
| 29 | 30 | 29 | 30 | 29 | 30 | 29 | 30 | 29 | 30 | 29 | 30 | 29 | 30 |
| 31 | 32 | 31 | 32 | 31 | 32 | 31 | 32 | 31 | 32 | 31 | 32 | 31 | 32 |
| 33 | 34 | 33 | 34 | 33 | 34 | 33 | 34 | 33 | 34 | 33 | 34 | 33 | 34 |
| 35 | 36 | 35 | 36 | 35 | 36 | 35 | 36 | 35 | 36 | 35 | 36 | 35 | 36 |
| 37 | 38 | 37 | 38 | 37 | 38 | 37 | 38 | 37 | 38 | 37 | 38 | 37 | 38 |

| |
|---------------------------|
| Return To Plant Overview |
| Links We Use |
| Winter Trends & Box Temps |
| Winterization Links |
| Quick Guide |
| Ambient Temp |
| 95 deg |
| Wind Speed |
| 6 mph |

QUESTIONS



Annual Inspections at Panda Sherman for Insulation and Heat Trace Before Winter

Presented by Adrain Garner – Plant Engineer
Panda Sherman Power, LLC



PandaPowerFunds

Slide Topics

- **Our Facility**
- **Heat Trace and Insulation Preparations**
- **Preparation History: Our First Winter (2014)**
- **Heat Trace, Insulation, and Winter Preparedness Lessons Learned**

Our Facility



- 758 MW Natural Gas, 2 x 1 Combined Cycle Facility located in Sherman, Texas (Grayson County).
- Outdoor Plant Design: based on minimum temp of 15 F
- Key Project Dates:
 - Ground breaking - Nov 2012
 - First Fire – May 2014
 - Provisional Acceptance – July 2014
 - Commercial Operation – August 2014
 - Final Acceptance – July 2015



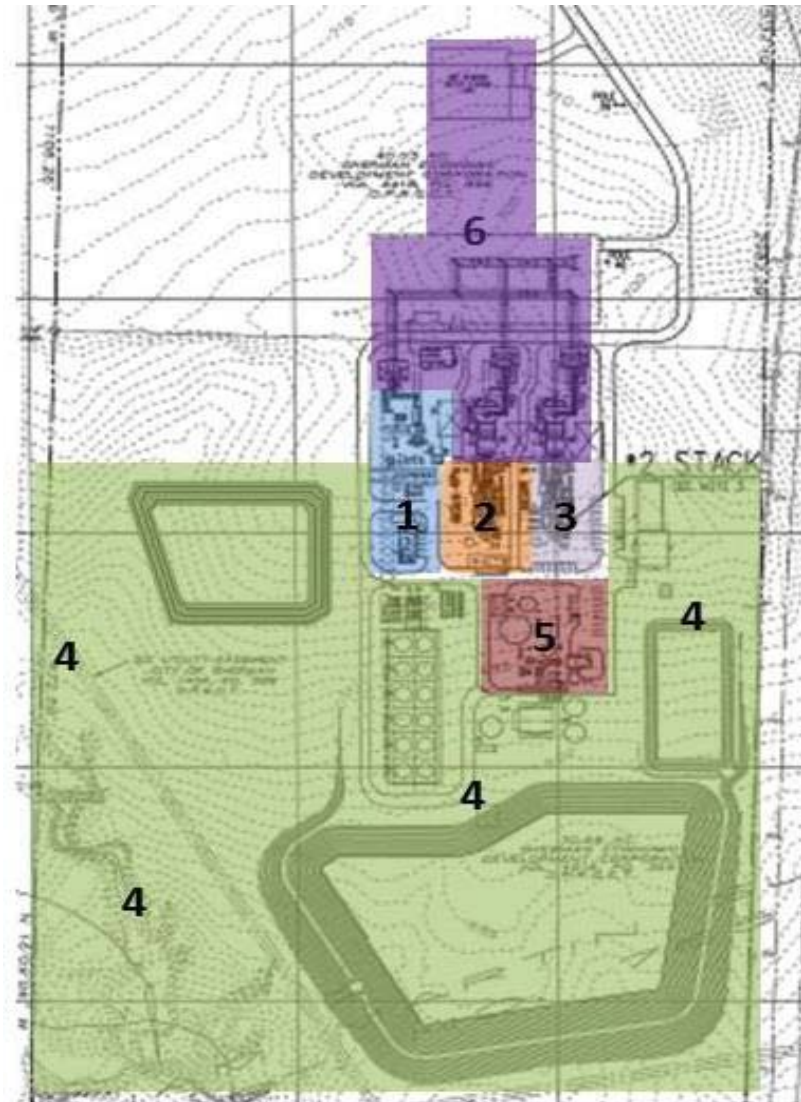
Heat Trace and Insulation Preparations: Approach

- We approach our preparation in four ways:
 - Walk downs & Surveys for Personal Safety and Equipment
 - Heat Trace and Insulation Audit
 - O&M Team Training
 - Procedures & Checklists

Heat Trace and Insulation Preparations:

Walk downs & Surveys

- We divide the plant amongst our operations shifts to identify areas of concern (i.e. windbreaks, temporary buildings, heat trace needed, etc.) and recommendations.



Heat Trace and Insulation Preparations: Audits

- Annually, we hire a 3rd party contractor (August 2015) to conduct a full heat trace and insulation audit.
- For the Audit, we provide the following:
 - Heat Trace Circuit Spreadsheet for Readings
 - Heat Trace Plant Drawings
 - General Area Maps or P&IDs of the Plant for Identification of Insulation Defects
- A plant sponsor is also assigned to photo document deficiencies for location of repair.



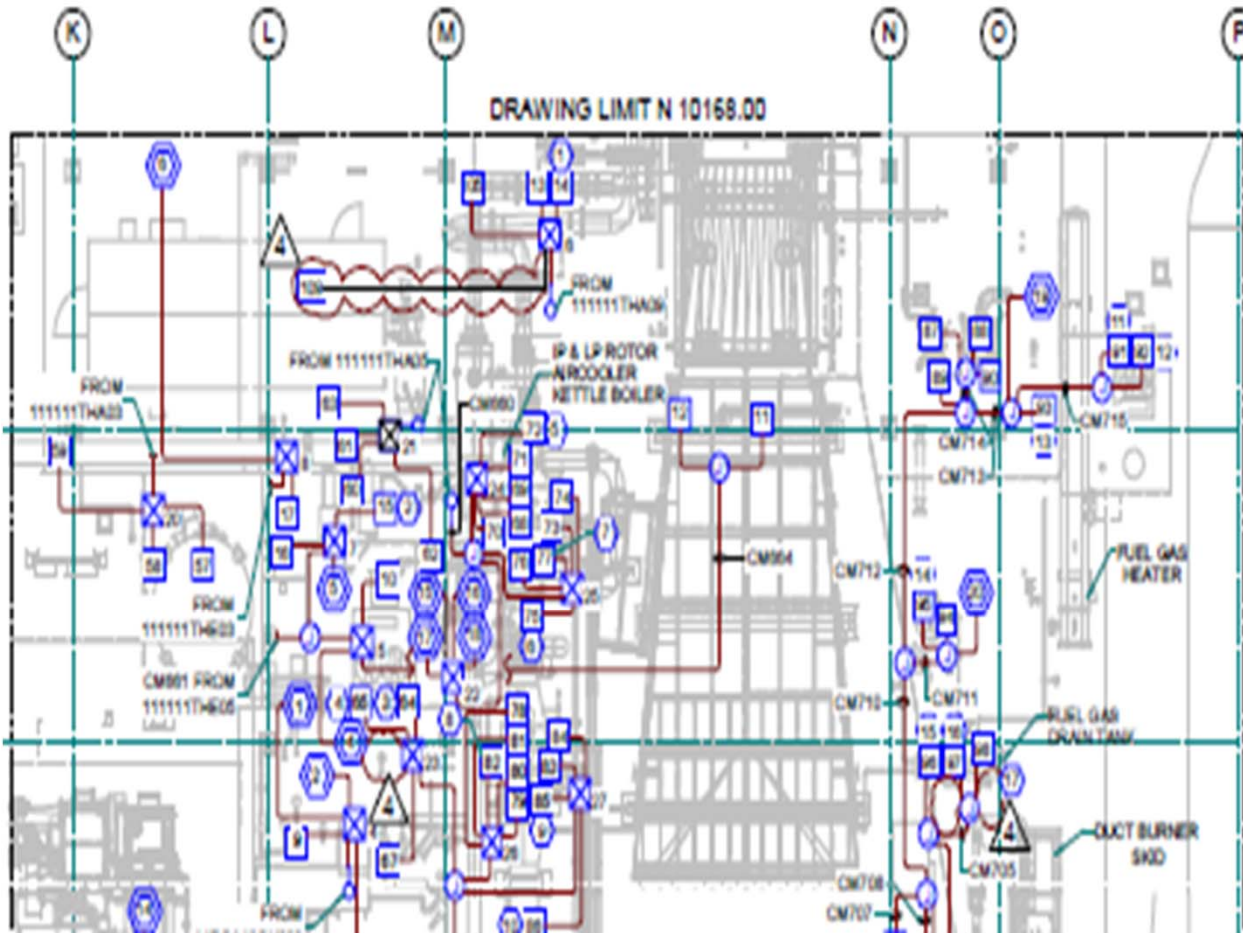
Heat Trace Spread Sheet Example

| Order Schedule No. | S. No. | Dwg Number | Vendor / Batch No | Tracer / Pre-traced Group | Line / Instrument Details | | | | | | | | | | Material | | PID | | | |
|--------------------|--------|------------|-------------------|---------------------------|---------------------------|---------|------|-------------|-----------------|---------------------|---------------------|-----------|---------------|-----------------|----------------|------|----------------|-------------------------|--------|----------|
| | | | | | Line / Instrument No. | System | Type | Size (Inch) | Heat Loss coeff | Maintain Temp Deg F | Exposure Temp Deg F | Length Ft | No. of Valves | No. of Supports | Panel Included | Type | Thickness Inch | Vendor Itemetric Number | Number | Rev |
| 1 | | B | 101-01 | | 01GCF40CP501 | 01GC-02 | CS | 1 | 1.5 | 45 | 100 | 3 | 1 | 0 | MW | 1 | | 25746-001-M6-GC-00001 | 4 | BSX3-20J |

| Tracer Details | | | | | | | | | | Tracer | | Power Connection Details | | | | | Breaker | PKT Current Draw |
|----------------|-------|-------------|------------------------|--------------------------|----------------|----------------|----------|--------------------|---------------------|-------------|--------------|--------------------------|---------------------|--------------------|-----------|------------------|---------|------------------|
| W/Ft | Valve | No. of Runs | Length in per valve Ft | Length in per Support Ft | B Current Ampr | Operating Ampr | Power VA | Breaker Load in VA | Notes Clarification | Designed Ft | Installed Ft | Cable Tag | Conduit Tag | Power JB | Wiring JB | Heat Trace Panel | | |
| 2.4 | 208 | 1 | 1.5 | 1.5 | 0.2 | 0.1 | 25.2 | | Un-clasified | 11 | 20 | 01BGA002BMA, 01BGA002BMB | 0171111CM501& CM502 | 01BGA10GH002-GQ011 | | 01BGA10GH002 | CB01 | |



Heat Trace Circuit Plant Map Example



| POWER JUNCTION BOX | | | | |
|--------------------|--------------------|------|------------|-------------|
| NO. | DEVICE NO. | LOC. | RELATION | CONDUIT NO. |
| 1 | 11RGA130-001-GQ001 | AS | RL 121-0' | CM002 |
| 2 | 11RGA130-001-GQ002 | AS | RL 127-7' | CM003 |
| 3 | 11RGA130-001-GQ003 | AS | RL 121-0' | CM004 |
| 4 | 11RGA130-003-GQ011 | 86 | RL 130-0' | CM006 |
| 5 | 11RGA130-003-GQ012 | 86 | RL 120-0' | CM007 |
| 6 | 11RGA130-003-GQ013 | 86 | RL 130-0' | CM008 |
| 7 | 11RGA130-003-GQ021 | 06 | RL 121-0' | CM010 |
| 8 | 11RGA130-003-GQ022 | 06 | RL 127-7' | CM011 |
| 9 | 11RGA130-003-GQ021 | 07 | RL 134-0' | CM013 |
| 10 | 11RGA130-003-GQ031 | 07 | RL 134-7' | CM018 |
| 11 | 11RGA130-003-GQ033 | 06 | RL 130-0' | CM020 |
| 12 | 11RGA130-003-GQ034 | 06 | RL 134-0' | CM021 |
| 13 | 11RGA130-003-GQ041 | 46 | RL 140-0' | CM022 |
| 14 | 11RGA130-003-GQ042 | 46 | RL 140-11' | CM023 |
| 15 | 11RGA130-003-GQ051 | 07 | RL 140-7' | CM025 |
| 16 | 11RGA130-003-GQ052 | 07 | RL 140-0' | CM026 |
| 17 | 11RGA130-003-GQ061 | 07 | RL 122-0' | CM029 |
| 18 | 11RGA130-004-GQ011 | 06 | RL 120-0' | CM033 |
| 19 | 11RGA130-004-GQ012 | 06 | RL 120-0' | CM034 |
| 20 | 11RGA130-004-GQ013 | 06 | RL 120-0' | CM035 |



Heat Trace and Insulation Preparations: Audits (Continued)

- Once the Audit is complete, our entire plant management team meets with the contractor and IC&E team to review the deficiencies and formulate a plan to correct them (ideally mid September).
 - Based on the discrepancy, we may elect the contractor to stay onboard and fix the errors.
 - Otherwise, we upload the deficiencies in our CMMS system, assign risk factors (by priorities), and both the Plant Engineer and IC&E technicians will work diligently to mitigate the issues.
- Our goal is to complete the high risk and medium deficiencies by November 1 and work on the remaining issues throughout the winter.



Heat Trace and Insulation Preparations: Training

- We perform Winter Weatherization training with all employees.
- Topics include:
 - ERCOT lessons learned
 - Emergency heat trace equipment
 - Procedures and Checklists associated with 32 degrees F.
 - Winter Safety
 - Including use of Space Heaters in enclosures.
 - Emergency Contractor Contacts

Heat Trace and Insulation Preparations: Procedures & Checklists

- Our procedures were developed internally using notes & Best Practices from the December 2012 meeting, NERC Winter Weatherization Presentations, and the collective personnel experience from our team.
- During cold weather operations (ambient temperature <32 degrees F), our operators initiate “Extreme Cold Weather Readiness” and “Heat Trace, Insulation, and Building” Checklists.

■ Preparation History: Our First Winter (2014)

- ERCOT toured an identical facility also owned by Panda Power Funds in December 2013 (during construction).
 - Conducted a meeting with the EPC engineers and management from both sites discussing the following:
 - Weatherization plans and preparation
 - **Heat Tracing Design and Implementation**
 - Use of Glycol and Concentration for Effectiveness
 - Recommendations & Best Practices from ERCOT

Preparation History: Our First Winter (2014)

- 7/30/2014 (11 days after Provisional Acceptance): Conducted second Summer Seasonal Readiness meeting and engage in to hiring a 3rd party contractor to perform heat trace and insulation audit.
- 8/15/2014: Panda O&M inquires with the EPC about the status of heat trace system completion (most of the EPC had demobilized and left the site) and are told that the systems are still being completed.
- 8/18/2014: Receive confirmation from EPC that the heat trace system is complete, with no turnover documentation.
- 9/30/2014: Secure 3rd party contractor for audit.
- 10/6/2014: 3rd party independent contractor conducts audit on heat trace and insulation and estimates the cost of any repairs.



Preparation History: Our First Winter (2014)

Audit Results

- 10/10/14: 3rd party contractor and operator walk downs identified at least 470 heat trace and insulation deficiencies.
 - Common problems with heat trace:
 - Piping <2” in diameter not heat traced.
 - Heat trace breakers continuously tripping.
 - Heat trace power heaters not wired.
 - Heat trace lines not completely wired.
 - Pre-insulated tubing bundles with no power (due to causing breaker faults).
 - Obrien box heaters that were left unpowered.



Heat Trace Deficiency Example 1:

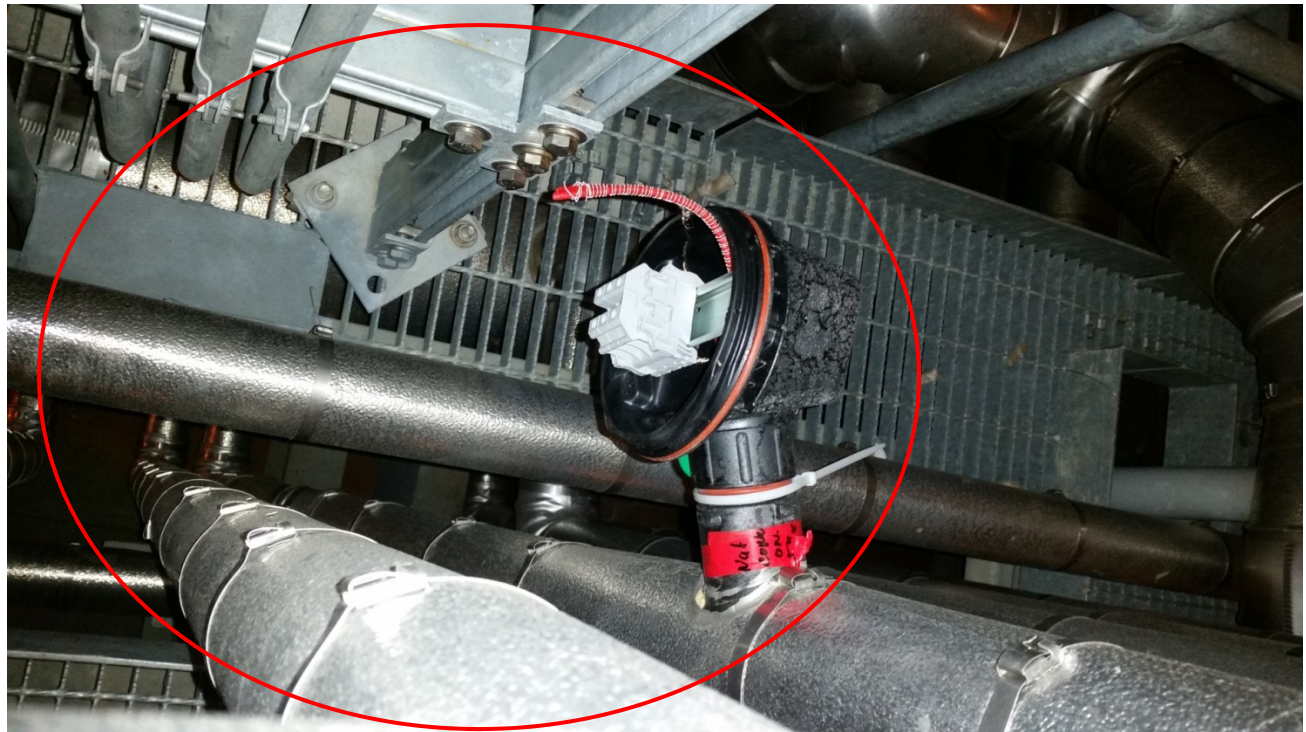
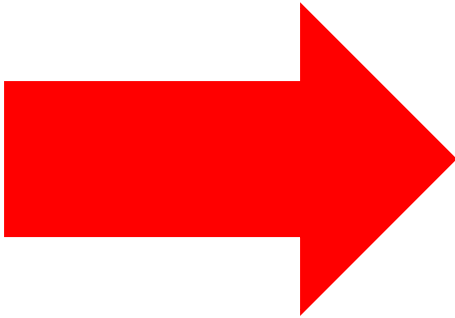


Power
Connector
Wires not
Shielded
resulting in
shorting to
the case.



Heat Trace Deficiency Example 2:

Heat Trace
Power
Connector not
Terminated
(No Wires
Landed)



Preparation: Our First Winter (2014)

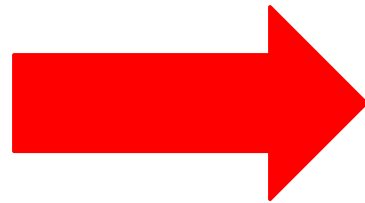
Audit Results (continued):

–Common problems with insulation:

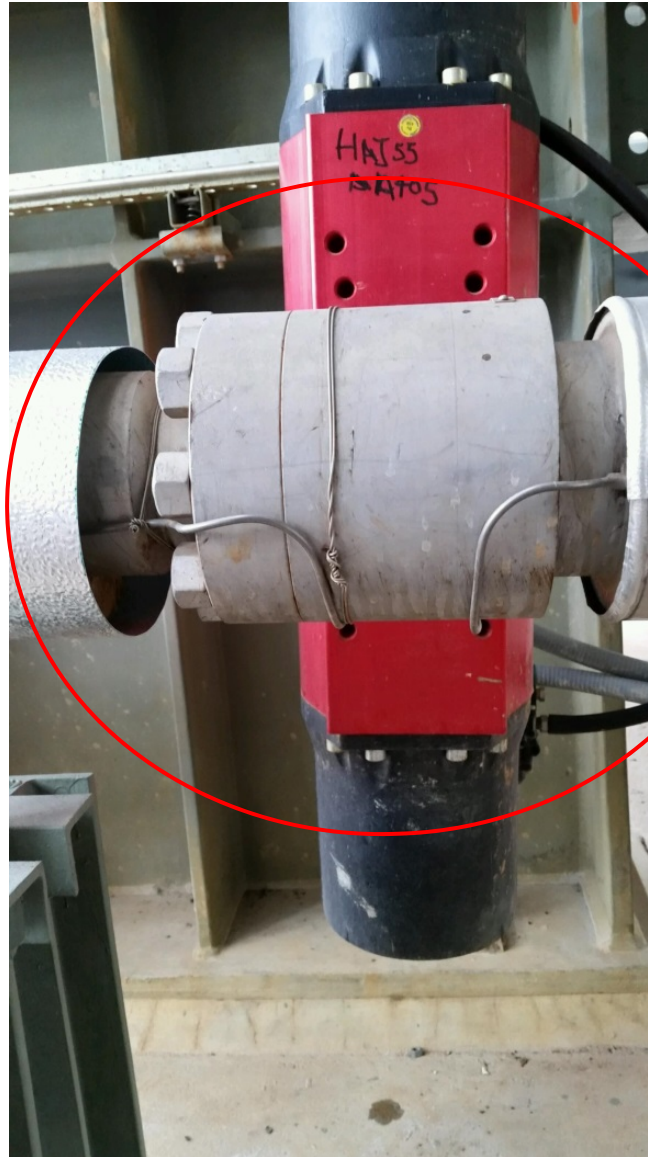
- Piping left uninsulated in many areas
- Piping insulation not finished
- Missing insulation blankets



Insulation Deficiency Example 1:



Insulation
Around the
Heat Trace
line Not
Complete



Insulation Deficiency Example 2:



Insulation Taping Not complete

Insulation and Heat Trace Deficiency Example:



This is a sump drain line (~1") not insulated or heat traced.

Preparation: Our First Winter (2014)

Audit Results (continued):

- Results of 3rd Party Audit revealed a significant list of deficiencies.
- They estimated the repair to take at least a month with approximately 10-12 men.
- Documentation from Project turnover was limited further exasperating the challenge.



■ Preparation: Our First Winter (2014):

EPC Response

- Warranty work commenced early November, 2014 anticipating 2-3 weeks to complete the corrections.
 - 6-8 electricians
 - 8-10 insulators
- 3rd party contractor kept 2 electricians and 1 insulator on site as well to assist in the efforts.
- **Remedial work scope largely completed by January 21, 2015 along with a ckt by ckt amp draw evaluation.**



Preparation: Our First Winter (2014)

Plant Trip – 1/8/2015

- 0137: the steam turbine unloaded due to high HP steam inlet pressure indication.
 - Ambient temperature: 15F Wind Speed:5-10 MPH
- 0146: only one combustion turbine was online and in danger of tripping offline.
- 0422: the root cause of the initial trip was identified:
 - Frozen Steam Turbine HP Inlet Pressure Transmitter due pre-insulated tubing bundle and Obrien Box heater not wired.
 - We would find 7 more frozen transmitters throughout the morning with the same issue (not wired/powering).
 - Due to scaling issues, frozen transmitters were unable to reach their “Bad Quality” set point (displayed on next two slides).
- Plant was back online by 1317.
 - Ambient temperature: 32F

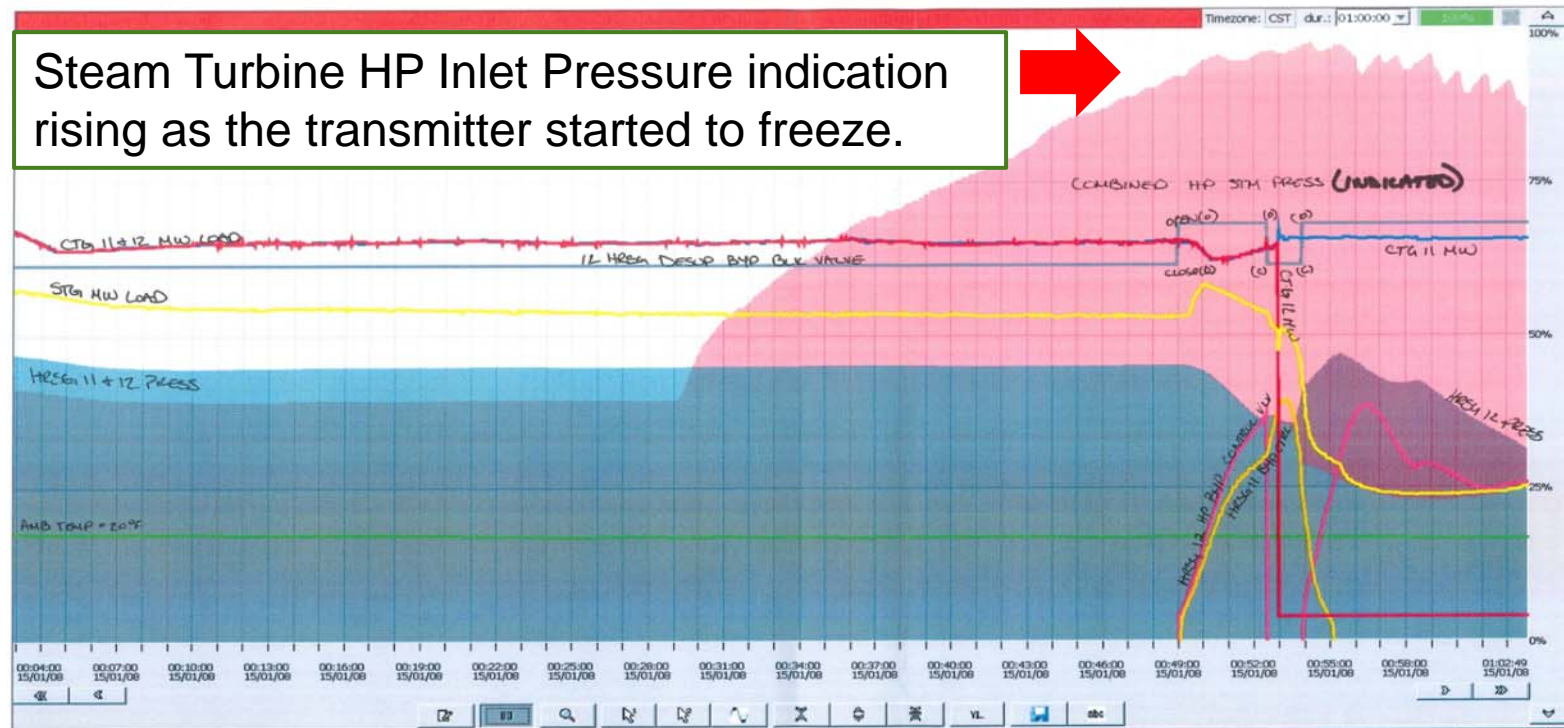


Indication of freezing transmitter with excessive scaling:

CTG 11, CTG 12, STG HP Incident Data

01/08/15 TIME 1 (0004-0102 HRS)

Steam Turbine HP Inlet Pressure indication rising as the transmitter started to freeze.

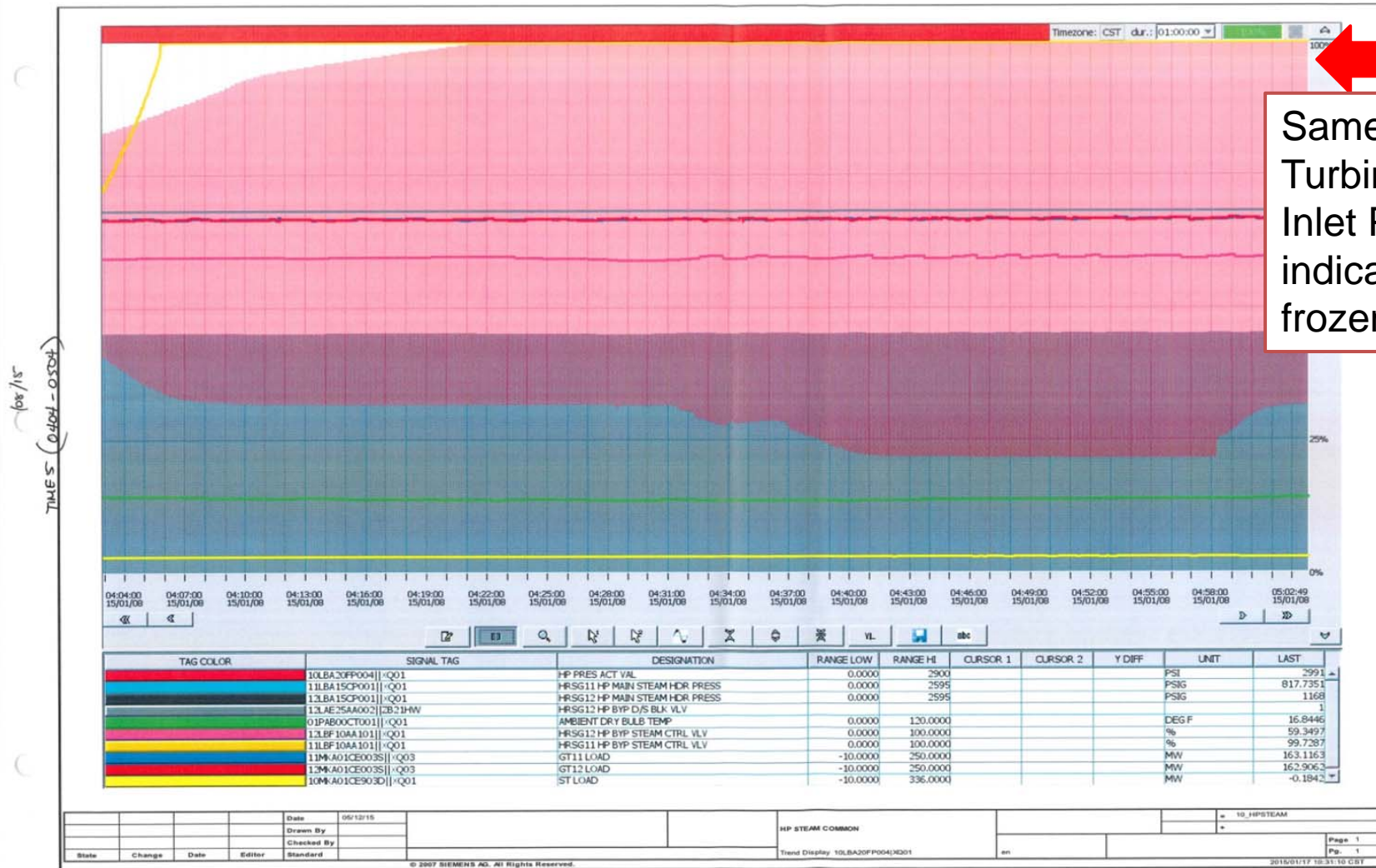


| TAG COLOR | SIGNAL TAG | DESIGNATION | RANGE LOW | RANGE HI | CURSOR 1 | CURSOR 2 | Y DIFF | UNIT | LAST |
|--------------|----------------------|--------------------------------|-----------|----------|----------|----------|--------|-------|----------|
| Red | 10LBA20FP004 -Q01 | HP PRES ACT VAL | 0.0000 | 2900 | | | | PSI | 2520 |
| Blue | 11LBA15CP001 -Q01 | HRSG11 HP MAIN STEAM HDR PRESS | 0.0000 | 2595 | | | | PSIG | 642.4059 |
| Green | 12LBA15CP001 -Q01 | HRSG12 HP MAIN STEAM HDR PRESS | 0.0000 | 2595 | | | | PSIG | 801.8052 |
| Yellow | 12LAE25AA002 2B21HW | HRSG12 HP BYP D/S BLK VLV | | | | | | | 1 |
| Light Blue | 01PAB00CT001 -Q01 | AMBIENT DRY BULB TEMP | 0.0000 | 130.0000 | | | | DEG F | 19.8915 |
| Light Green | 12LBF10AA101 -Q01 | HRSG12 HP BYP STEAM CTRL VLV | 0.0000 | 100.0000 | | | | % | 25.6149 |
| Light Yellow | 11LBF10AA101 -Q01 | HRSG11 HP BYP STEAM CTRL VLV | 0.0000 | 100.0000 | | | | % | -1.2768 |
| Light Purple | 11MKAO1CE003S -Q03 | GT11 LOAD | -10.0000 | 250.0000 | | | | MW | 160.1562 |
| Light Blue | 13MKAO1CE003S -Q03 | GT12 LOAD | -10.0000 | 250.0000 | | | | MW | 0.0000 |
| Light Green | 10MKAO1CE903D -Q01 | ST LOAD | -10.0000 | 336.0000 | | | | MW | 76.3366 |

Date: 05/12/15
 Drawn By: [Blank]
 Checked By: [Blank]
 Standard: [Blank]
 Title: HP STEAM COMMON
 Project Display: 10LBA20FP004ING01
 Page 1 of 1
 2015/01/17 10:16:34 CST



Indication of frozen transmitter with excessive scaling:



Same Steam Turbine HP Inlet Pressure indication now frozen.



Heat Trace, Insulation, and Winter Preparedness

Lessons Learned

- Preparation – Earlier is better.
- **Heat Trace Audits are essential.**
 - Check that every heat trace branch circuit has power (amp draw), not just the junction box supplying several branches.
 - Heat Trace Spreadsheets and Accurate Drawings are equally important.
 - Install operator aides in heated instrumentation boxes for verification that the box has power.
- Do not rely on a “bad quality” indication for a frozen transmitter.
- Communication – Share incidents Lessons Learned to prevent repeating the same mistakes.
- Improve – We are working to improve systems for this winter (i.e., remote indications for heated instrumentation boxes, detailed maps of each box, corrected heat trace drawings, etc.)
- Good quality control on Heat Trace and Insulation is essential for every project (even a new one).





Questions?



PandaPowerFunds



Thank You for Your Time.



PandaPowerFunds



Heat Tracing



Heat Tracing



➤ Heat Tracing Services

Gregg is a manufacturers representative of Thermon, a world leader in heat tracing systems design and manufacture. For over 25 years, Gregg's trained professionals have represented and applied Thermon products. Gregg is one of two applicators nationally with direct design and supply capability. Electric or Steam, Gregg is a one stop shop for Industrial Heat Tracing services. Acquired by Brand Energy & Infrastructures in Dec 2013.

Quick Overview

Facilities Don't Plan to Fail they just Fail to Plan!

Heat Tracing :

- Maintenance programs are extremely important for your power plants reliability.
 - ✓ Just because the heat trace circuits were operating last year does not mean they are working properly this year.
 - ✓ Documentation of prior year is vital to continued properly function heat tracing systems.
 - Comprehensive Heat Trace audit is recommended to get a base-line for future audits.

Testing Best Practice

➤ **Visual Checks on Heat Trace:**

- All types of Cables and Tube Bundles
- Enclosure heaters
- Conduit Fittings and Supports for Conduit
- Wire Connections
- Thermostat Settings

➤ **Mechanical Check-out on Heat Trace:**

- Panel components
- Enclosure boxes
- Grounding
- Tagging Information

➤ **Electrical Check-out on Heat Trace:**

- Meg every: flat cable, MIQ cable, and tube bundle
- Current Amp Check: Flat cable, MIQ, tube bundle, Instrument heater enclosure
- Voltage Check: Flat Cable, MIQ, Tube Bundle, Instrument heater enclosure

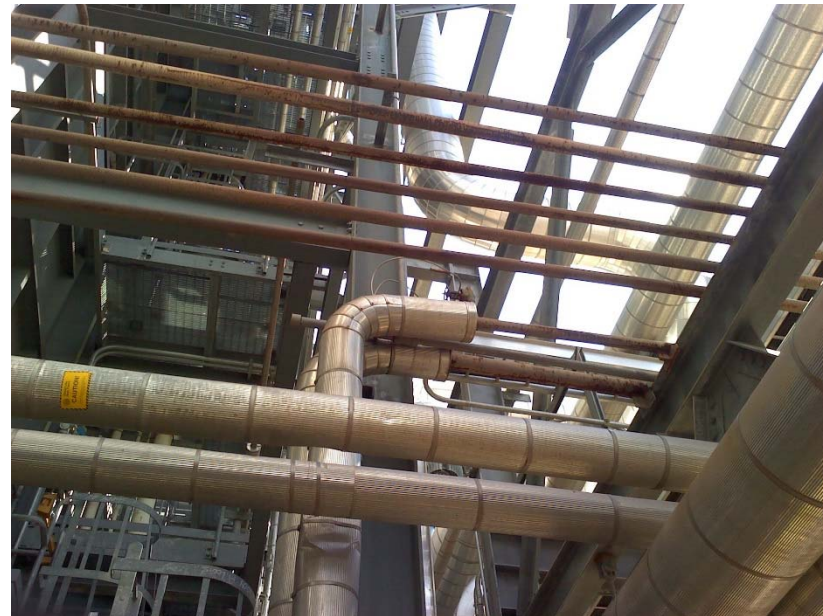
➤ **Insulation Analysis:**

- Visual check of Integrity, mechanical, and proper install
- Confirm from Engineered drawing if type and size installed is correct
- Normal pictures along with Thermal pictures of potential problems

Winterization – Heat Trace Audit



Heat Trace Audit Sample



Importance of Annual Heat Trace Audits

➤ Typical Failure Rates

✓ Critical Circuits

- Average Failure Rate is 10%
- Causes
 - Moisture/Water in Conduit
 - Human damage (welding sparks or walking on piping)
 - Improperly installed

✓ Non-critical Circuits

- Failure Ranges
 - Good Facility is less than < 10%
 - Poor Facility is greater than > 35%
 - Typical is around 20%
- Causes are the same as Critical Circuits

Records Management

| | | | | | | |
|---|--------------------------------|----------------------|--|--|--|--|
| Location | System | Reference Drawing(s) | | | | |
| CIRCUIT INFORMATION | | | | | | |
| Heater Cat. No. | Circuit Length | Bkr. Panel No. | | | | |
| Power Connection | Design Voltage | Bkr. Pole(s) No. | | | | |
| Tee Connection | Ground-Fault Protection (type) | | | | | |
| Splice Connection | Ground-Fault Trip Setting | | | | | |
| Heater Controller | | | | | | |
| VISUAL | | | | | | |
| Panel Number | Circuit # | | | | | |
| | Date | | | | | |
| | Initial | | | | | |
| Thermal Insulation | | | | | | |
| Damaged Insulation/Lagging Water Seal Good | | | | | | |
| Insulation/Lagging Missing Presence of Moisture | | | | | | |
| Heating System Components | | | | | | |
| Enclosures, Boxes Sealed Presence of | | | | | | |
| Moisture Sign of Corrosion | | | | | | |
| Heater Lead Discoloration | | | | | | |
| Heating and/or High Limit Controller | | | | | | |
| Operating Properly Controller | | | | | | |
| Setpoint | | | | | | |
| ELECTRICAL | | | | | | |
| Dielectric Insulation Resistance Testing (bypass controller if applicable) Refer to IEEE 515-1997, Section 7.9 | | | | | | |
| Test Voltage Megger Value | | | | | | |
| Heater Supply Voltage | | | | | | |
| Value at Power Source Value at Field | | | | | | |
| Connection | | | | | | |
| Heater Circuit Current Reading | | | | | | |
| Pipe Temperature | | | | | | |
| Amps Reading at 2-5 min. Amps Reading After | | | | | | |
| 15 min. Ground-Fault Current | | | | | | |
| Comments and Actions | | | | | | |

Projects



Contacts

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Jason.Bramlett@Gregg-Merico.com



Cold Weather and Wind Forecasting

Generator Weatherization Workshop
ERCOT Operations

Table of Contents

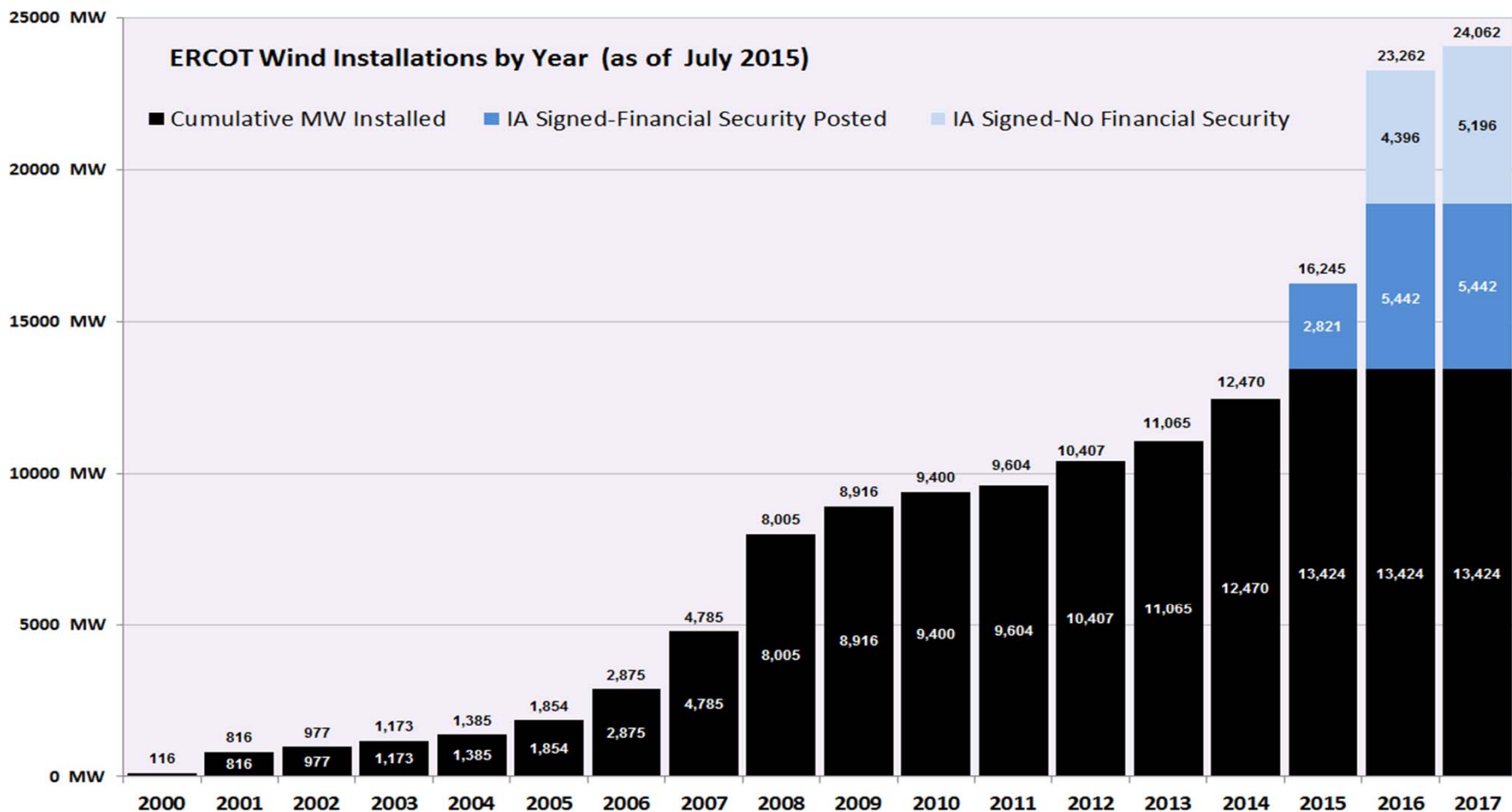
- Overview
- Wind Forecast @ ERCOT
- Wind Forecast and Extreme Weather (Icing Event)

Acronyms for this presentation:

- WGR: Wind-powered Generation Resource
- STWPF: Short-term Wind Power Forecast
- COP: Current Operating Plan

Overview

Installed Wind Generation in ERCOT



The data presented here is based upon the latest registration data provided to ERCOT by the resource owners and can change without notice. Any capacity changes will be reflected in current and subsequent years' totals. Scheduling delays will also be reflected in the planned projects as that information is received. This chart reflects planned units in the calendar year of submission rather than installations by peak of year shown.

Financial security posted for funding interconnection facilities does not include CREZ security deposits, which are refunded to the Interconnecting Entity when an IA is signed.

Wind Regions within ERCOT

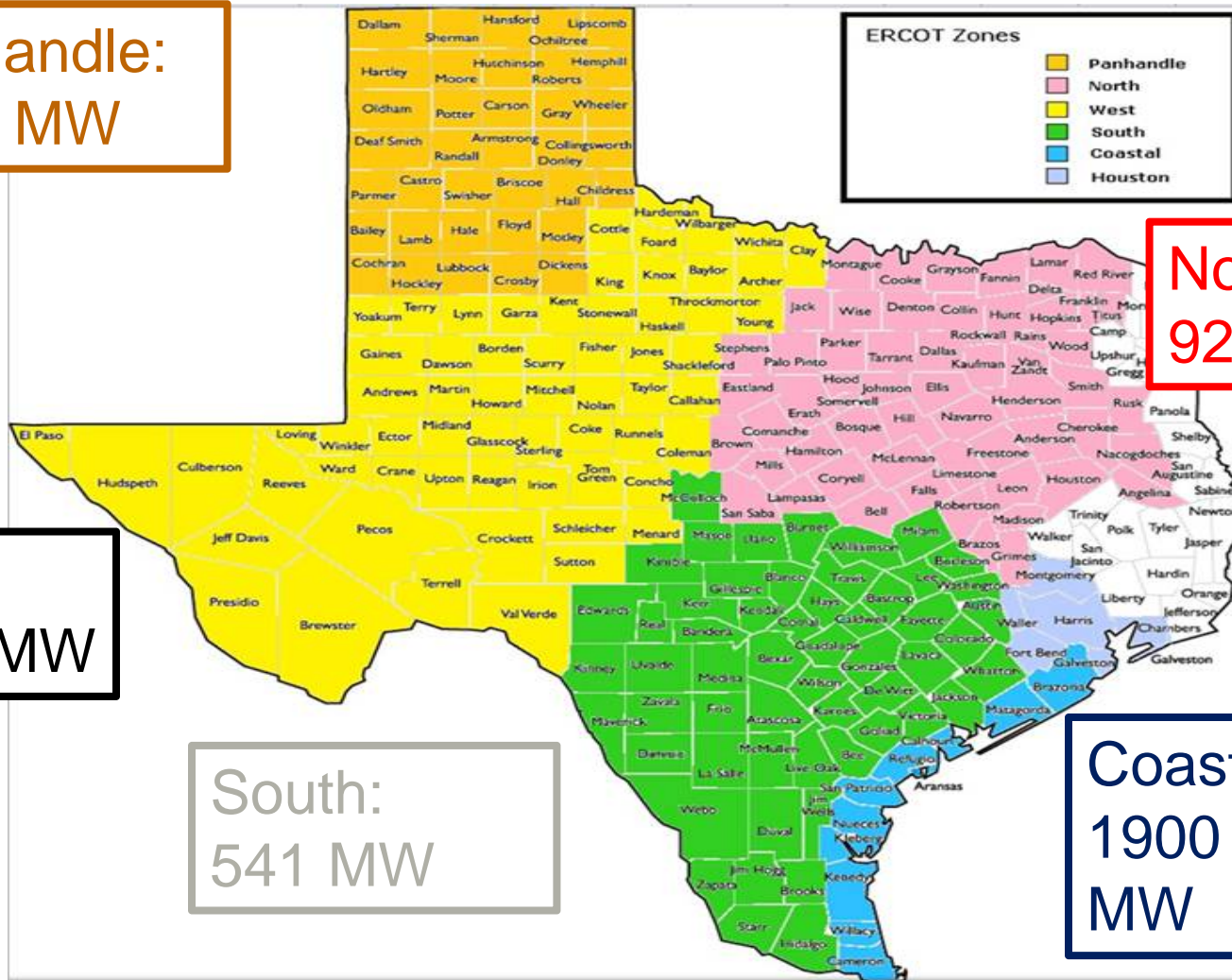
Panhandle:
2129 MW

North:
923 MW

West:
9,539 MW

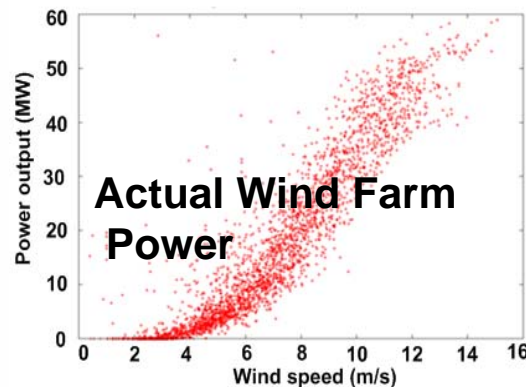
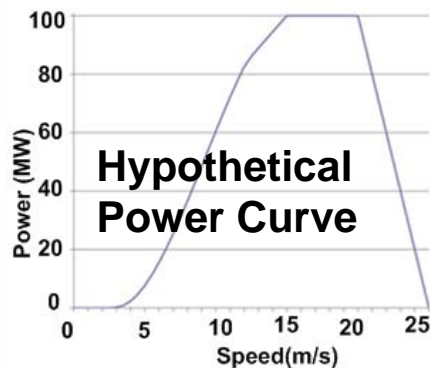
South:
541 MW

Coast:
1900
MW



Challenges in Wind Forecast

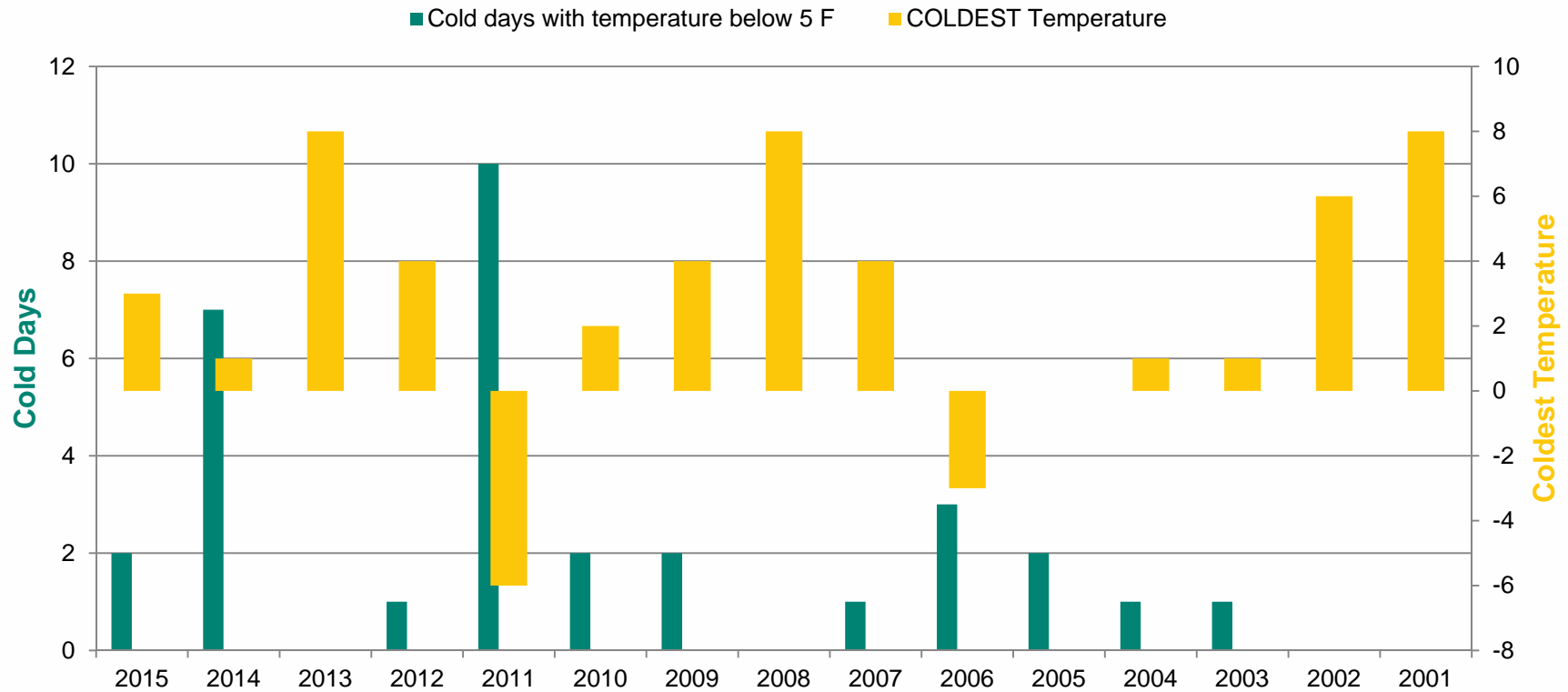
1. Relatively concentrated geographic region for wind installation (lack of spatial diversity)
2. Texas weather can change rapidly
3. Severe changes in wind generation output caused by different types of extreme weather (large wind ramps)
 - *Frontal system, trough, or dry line/Thunderstorms/Low-level jets/Weakening pressure gradients/Strengthening pressure gradients*
4. There is an approximation of hypothetical wind speed-power curve to the real one



The steep part of the power curve from 4-12 m/s is where power increases strongly with speed.

Cold Weather

Amarillo

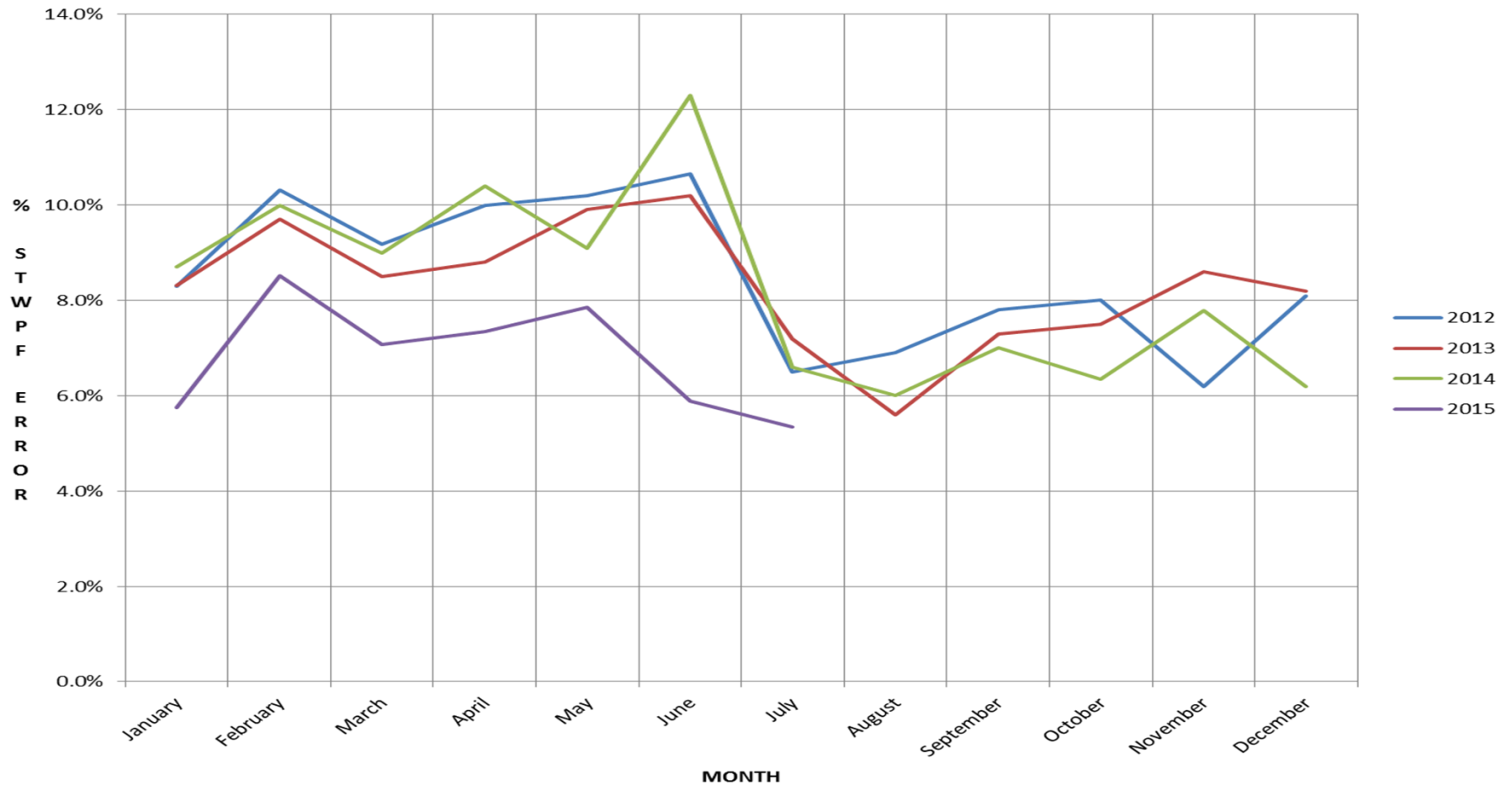


Wind Generation Record

| | WIND (MW) | LOAD(MW) | Penetration |
|------------------|--------------|----------|-------------|
| 03/29/2015 02:12 | 10,308 | 25,400 | 40.58% |
| 02/19/2015 22:25 | 11,154 | 32614 | 34.20% |

Day-Ahead Wind Forecast Error

DA STWPF ERROR FOR ALL MONTHS



Wind Forecast

4.2.2 Wind-Powered Generation Resource Production Potential

- ERCOT shall produce and update hourly a Short-Term Wind Power Forecast (STWPF) that provides a rolling 48-hour hourly forecast of wind production potential for each Wind-powered Generation Resource (WGR).* ERCOT shall produce and update an hourly Total ERCOT Wind Power Forecast (TEWPF) providing a probability distribution of the hourly production potential from all wind-power in ERCOT for each of the next 48 hours. Each Generation Entity that owns a WGR shall install and telemeter to ERCOT the site-specific meteorological information that ERCOT determines is necessary to produce the STWPF and TEWPF forecasts. ERCOT shall establish procedures specifying the accuracy requirements of WGR meteorological information telemetry.

Please note : For a WGR going through commissioning process, ERCOT will start providing STWPF to the QSE once WGR receives approval to Generate into the ERCOT Grid (Part II of the Commissioning check list)

3.9.1 Current Operating Plan (COP) Criteria

(7) For the first 48 hours of the COP, a QSE representing a Wind-powered Generation Resource (WGR) must enter an HSL value that is **less than** or **equal to** the amount for that Resource from the most recent Short-Term Wind Power Forecast (STWPF) provided by ERCOT.

NPRR 686 Changing the IRR Forecast from Next 48 Hours to Next 168 Hours

[NPRR615: Replace paragraph (8) above with the following upon system implementation:]

(8) For **the first 168 hours of the COP**, a QSE representing a Wind-powered Generation Resource (WGR) must enter an HSL value that is less than or equal to the amount for that Resource from the most recent Short-Term Wind Power Forecast (STWPF) provided by ERCOT, and a QSE representing a PhotoVoltaic Generation Resource (PVGR) must enter an HSL value that is less than or equal to the amount for that Resource from the most recent Short-Term PhotoVoltaic Power Forecast (STPPF) provided by ERCOT.

WPF Process Inputs

| Source | Data |
|--------------------------------|---|
| Registration system | <ol style="list-style-type: none">Resource Parameters<ul style="list-style-type: none">Resource NameLocation of wind farm (latitude and longitude or equivalent for the center point of wind farm)Location of the meteorological tower (latitude and longitude or equivalent)Type (manufacturer/model) and number of turbinesTurbine hub height(s) above ground level with associated number of turbines<ul style="list-style-type: none">Manufacturer's power curve (capability curve) |
| Energy Management System (EMS) | <ol style="list-style-type: none">Resource Commercial Operation Date<ol style="list-style-type: none">Most recent Resource (wind farm) status with date/timeMost recent MW output of wind farm with date/timeMost recent wind speed and direction at hub height from one meteorological tower with date/timeTemperature and barometric pressure at 2 m above ground level on the meteorological tower |
| Telemetry value | <p>SCADA telemetry values are sent every 5 minutes from EMS to the wind power forecast service provider (all of these are Unit specific information with their Qualified Scheduling Entities (QSE) mapping)</p> <ol style="list-style-type: none">MW AverageWind SpeedWind DirectionTemperatureBarometric PressureHSL AverageNum of Turbines ONNum of Turbines OffNum of Turbines UnknownCurtailment Flag |

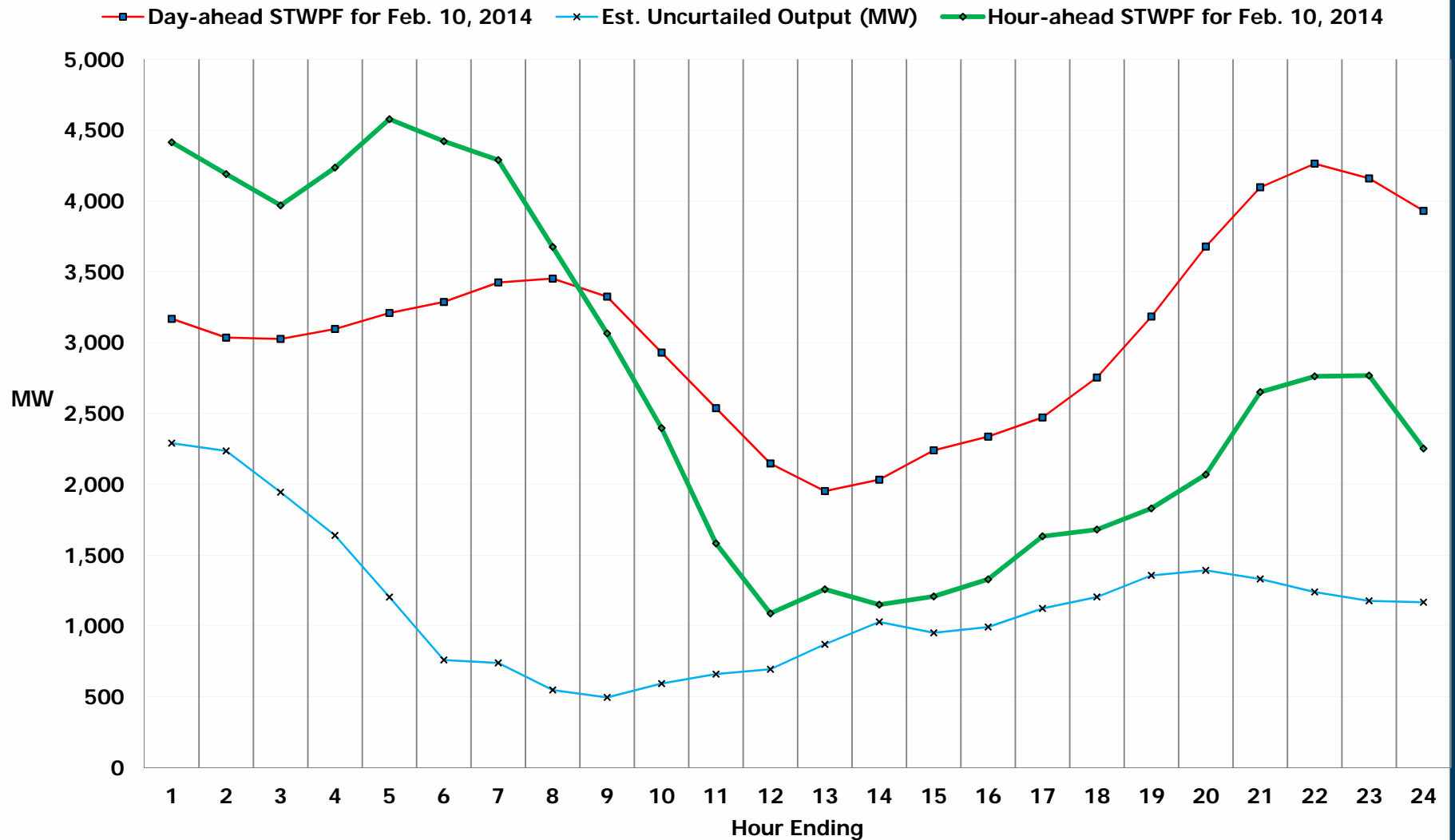
Wind Forecast and Extreme Weather (Icing Event)

Icing Impacts

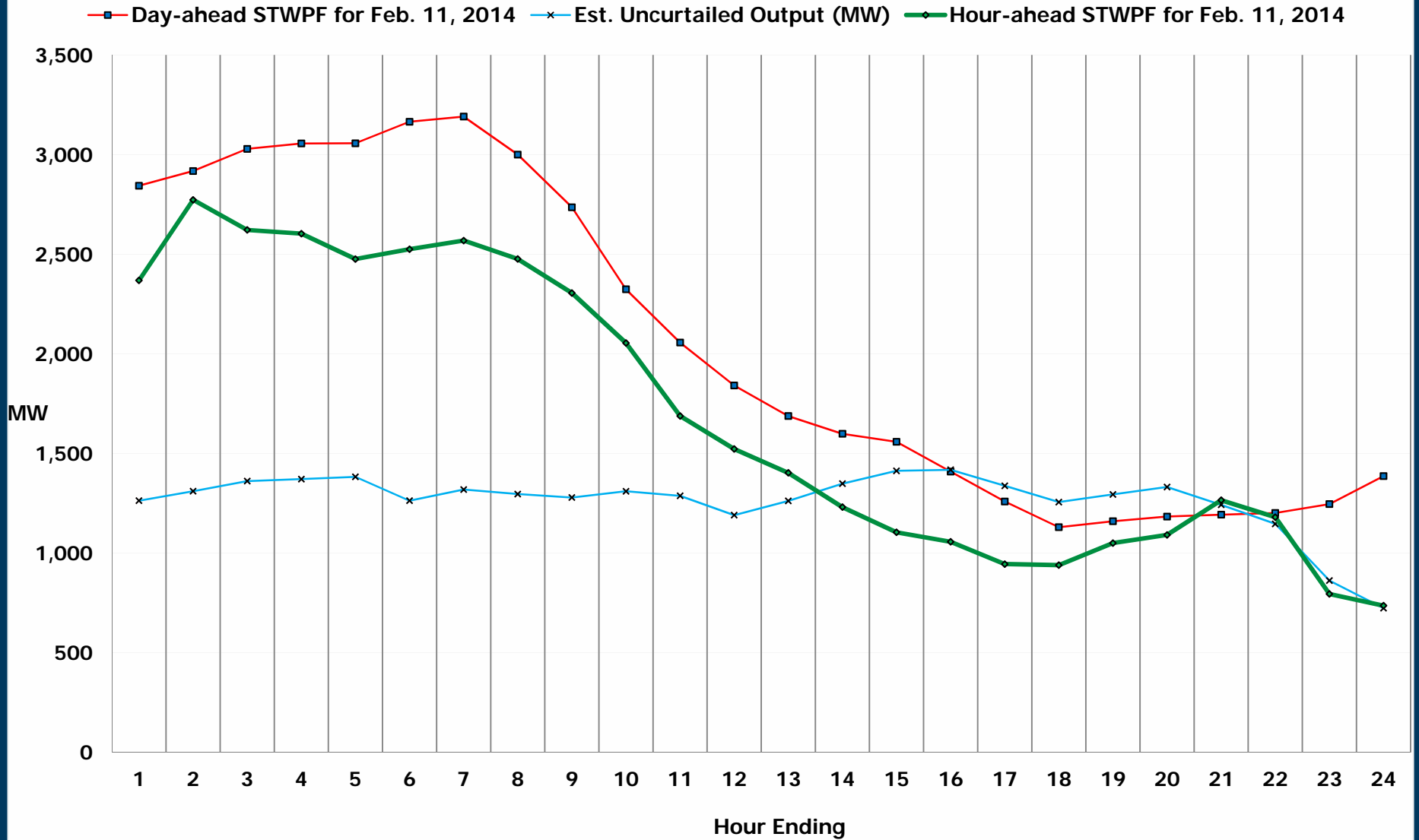


Wind Turbines in Cold Climates: Icing Impacts and Mitigation Systems, <http://www.springer.com/us/book/9783319051901>

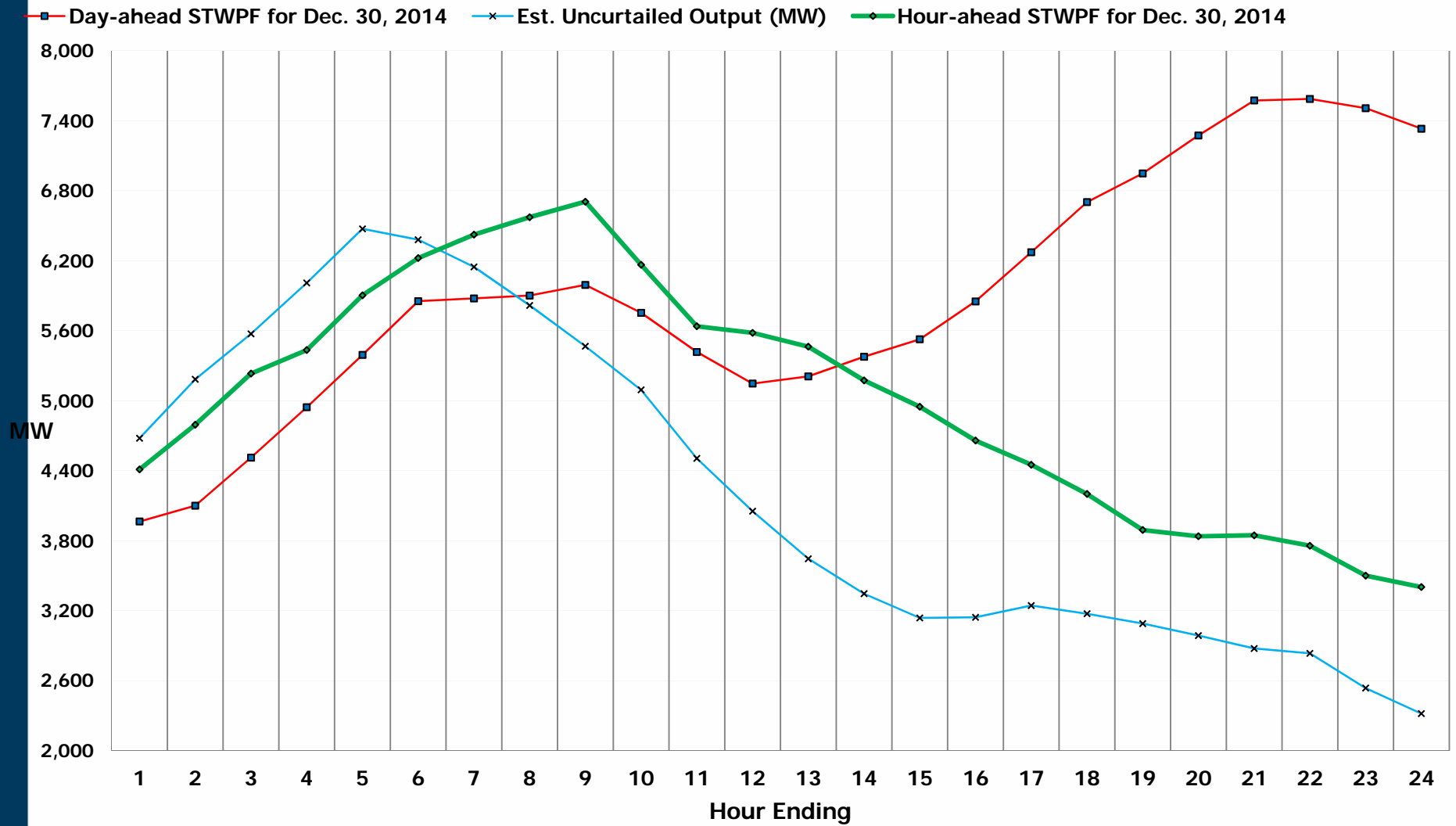
Wind forecast on Feb 10, 2014



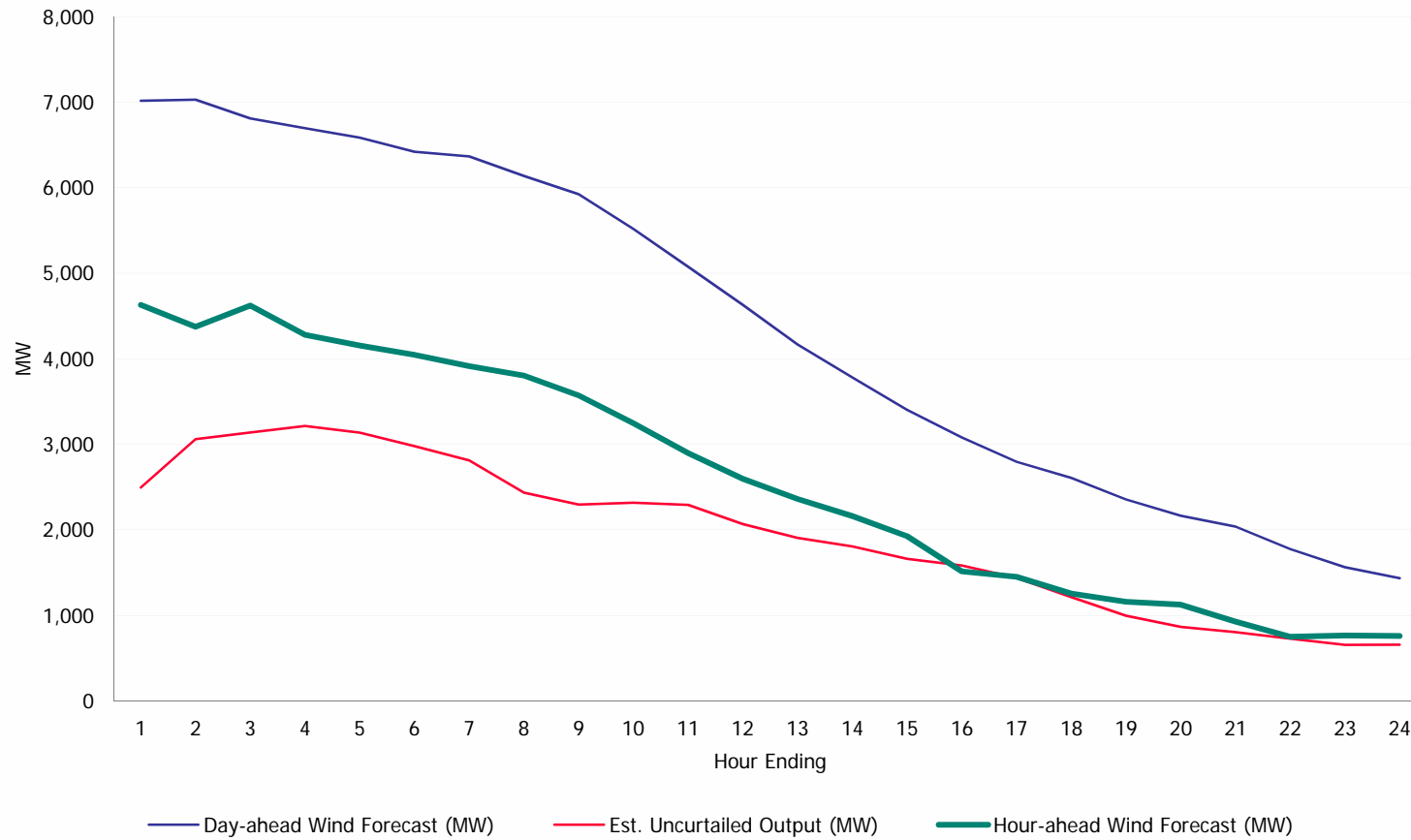
Wind Forecast on Feb. 11, 2014



Wind forecast on Dec. 30, 2014



Wind Forecast on Feb. 23, 2015



Challenges Created by Icing

- Icing created a mismatch between the forecast and actual production.
- This created an error in the forecast which then was provided to WGRs.
- This error was used in the COP for RUC.
- Could lead to ERCOT counting on more wind than WGRs are able to generate.

Addressing the Wind Turbine Icing

- Key to addressing Icing is to update the telemetry for number of turbines on and off.
- If the outage will last greater than 2 hours then enter into the outage scheduler.

3.1.4.5 Notice of Forced Outage or Unavoidable Extension of Planned or Maintenance Outage Due to Unforeseen Events

(2) Any Forced Outage that occurs in Real-Time must be entered into the Outage Scheduler if it is to remain an Outage for longer than two hours.

RRGRR-0003

- Notice of request for information for wind-powered generation resources was issued in 2015
 - SITECODE
 - Resource Entity
 - Resource Name (Unit_Code_Mnemonic)
 - WGR GROUP_CODE
 - Turbine Manufacturer/Model
 - Maximum Operating Temperature (Fahrenheit (°F))
 - Minimum Operating Temperature(Fahrenheit (°F))
 - High Wind Speed Cut-Out (meters per seconds (m/s))
 - High Wind Speed Cut-Out time (minutes)
 - High Wind Speed Cut-Out Reset (meters per seconds (m/s))
 - High Wind Speed Cut-Out Reset Time (minutes)

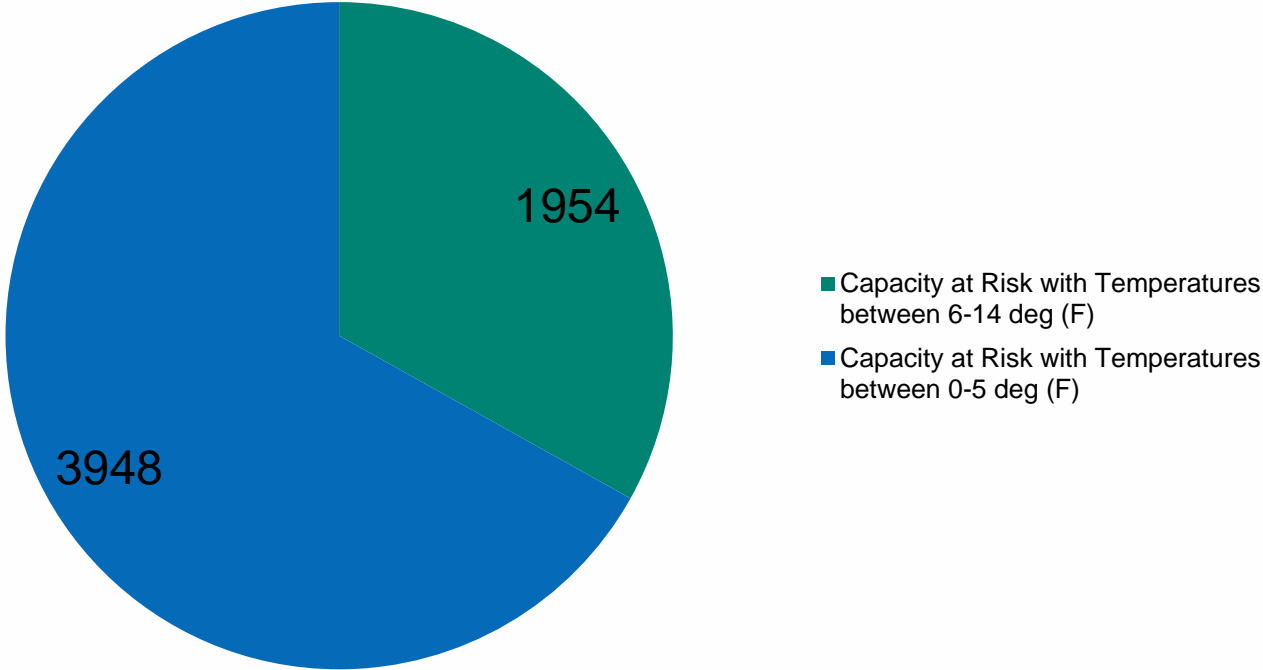
Cold Weather Extreme Package for Wind Turbines

- It ensures that wind turbine operates in temperatures as low as -30C (-22F), and in survival mode without operation, at temperatures as low as -40C (-40F) (for example GE 2.5xl wind turbines).

| | Minimum temperature (standard) operational / survival |
|--------------------------|--|
| Standard weather package | -15°C/-20°C (5F/-4F) |
| Cold weather package | -30 °C/-40 °C (-22F/-40F) |

- Similar cold weather package is also offered by other wind turbine manufactures.

ERCOT Wind Resources with Minimum Operating Temperatures > 0 deg F

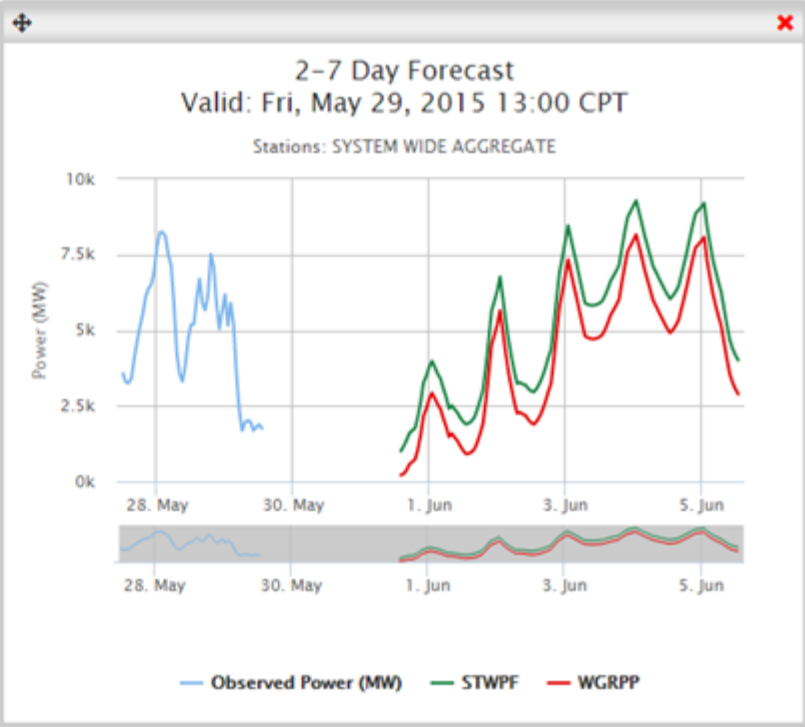
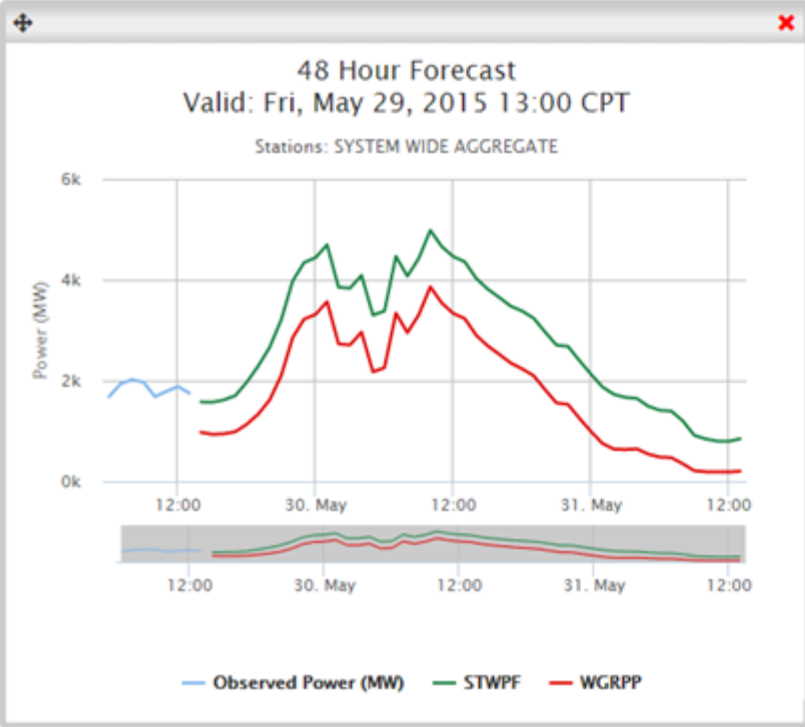


Weather Outlook

| North Central | | Normal | Fri 1/9 | Sat 1/10 | Sun 1/11 | Mon 1/12 | Tue 1/13 | Wed 1/14 | Thu 1/15 |
|--|----|--------|---------|----------|----------|----------|----------|----------|----------|
| Dallas-Fort Worth | | | | | | | | | |
| Low | 33 | 27 | 22 | 31 | 35 | 31 | 32 | 28 | |
| High | 54 | 38 | 39 | 45 | 42 | 39 | 43 | 51 | |
| South Central | | | | | | | | | |
| Austin | | | | | | | | | |
| Bergstrom Low | 38 | 37 | 29 | 31 | 36 | 35 | 32 | 28 | |
| High | 61 | 39 | 36 | 49 | 52 | 41 | 47 | 56 | |
| San Antonio | | | | | | | | | |
| Low | 38 | 36 | 30 | 35 | 40 | 40 | 35 | 31 | |
| High | 62 | 42 | 37 | 52 | 58 | 44 | 50 | 58 | |
| Coast | | | | | | | | | |
| Houston | | | | | | | | | |
| Low | 41 | 38 | 34 | 38 | 46 | 41 | 38 | 34 | |
| High | 62 | 40 | 41 | 52 | 58 | 48 | 49 | 58 | |
| East | | | | | | | | | |
| Tyler | | | | | | | | | |
| Low | 32 | 29 | 23 | 32 | 37 | 33 | 30 | 29 | |
| High | 54 | 38 | 38 | 40 | 47 | 39 | 42 | 50 | |
| North | | | | | | | | | |
| Wichita Falls | | | | | | | | | |
| Low | 28 | 23 | 17 | 28 | 29 | 20 | 23 | 26 | |
| High | 52 | 34 | 36 | 51 | 37 | 34 | 41 | 53 | |
| West | | | | | | | | | |
| Abilene | | | | | | | | | |
| Low | 31 | 24 | 18 | 30 | 30 | 25 | 25 | 25 | |
| High | 55 | 37 | 36 | 56 | 39 | 35 | 42 | 54 | |
| Far West | | | | | | | | | |
| Midland | | | | | | | | | |
| Low | 29 | 23 | 20 | 29 | 31 | 25 | 22 | 27 | |
| High | 57 | 36 | 37 | 59 | 41 | 35 | 44 | 54 | |
| Panhandle | | | | | | | | | |
| Amarillo | | | | | | | | | |
| Low | 22 | 21 | 16 | 25 | 19 | 15 | 15 | 17 | |
| High | 49 | 33 | 40 | 46 | 27 | 24 | 34 | 46 | |
| South | | | | | | | | | |
| Brownsville | | | | | | | | | |
| Low | 50 | 43 | 38 | 38 | 46 | 51 | 46 | 39 | |
| High | 69 | 53 | 42 | 56 | 64 | 59 | 55 | 61 | |
| Corpus Christi | | | | | | | | | |
| Low | 46 | 40 | 35 | 39 | 44 | 46 | 41 | 35 | |
| High | 66 | 44 | 39 | 55 | 61 | 52 | 49 | 59 | |
| 5+ abv norm 5+ bel norm | | | | | | | | | |
| Note: Normal values are 7-day averages for the location. | | | | | | | | | |
| indicates hi/lo temp occuring at non-typical time | | | | | | | | | |

Manual Override

Add A Chart



Questions?



Alan H. Allgower

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512-248-4613 (O)

ERCOT and Texas RE 2015-2016 Generator Winter Weatherization Workshop
September 1, 2015



ERCOT's Authority for Spot Checks

- PUCT Substantive Rule 25.362 (i) (2)

No later than January 15 of each year, ERCOT shall file an operations report and plan. The report and plan shall contain the following information:

An assessment of the reliability and adequacy of the ERCOT system during extremely cold or extremely hot weather conditions, or drought, for which purpose ERCOT has the right, upon reasonable notice, to conduct generator site visits to review compliance with weatherization plans and has the right to obtain from generators any information concerning water supplies for generation purposes, including contracts, water rights, and other information.

What does a spot check entail?

- Objective is to build a working relationship with generators operators so that they are comfortable sharing information and are receptive to recommendations.
- Lessons learned from previous winter, observations, best practices and NERC lessons learned are all shared at each site.
- Generators are spot checked that they are following their weatherization plan.
- The spot check is NOT a comprehensive review of all plant equipment.
- ***ERCOT does not certify a generator is prepared for winter operations.***
- Every plant is left with recommendations to improve reliability.

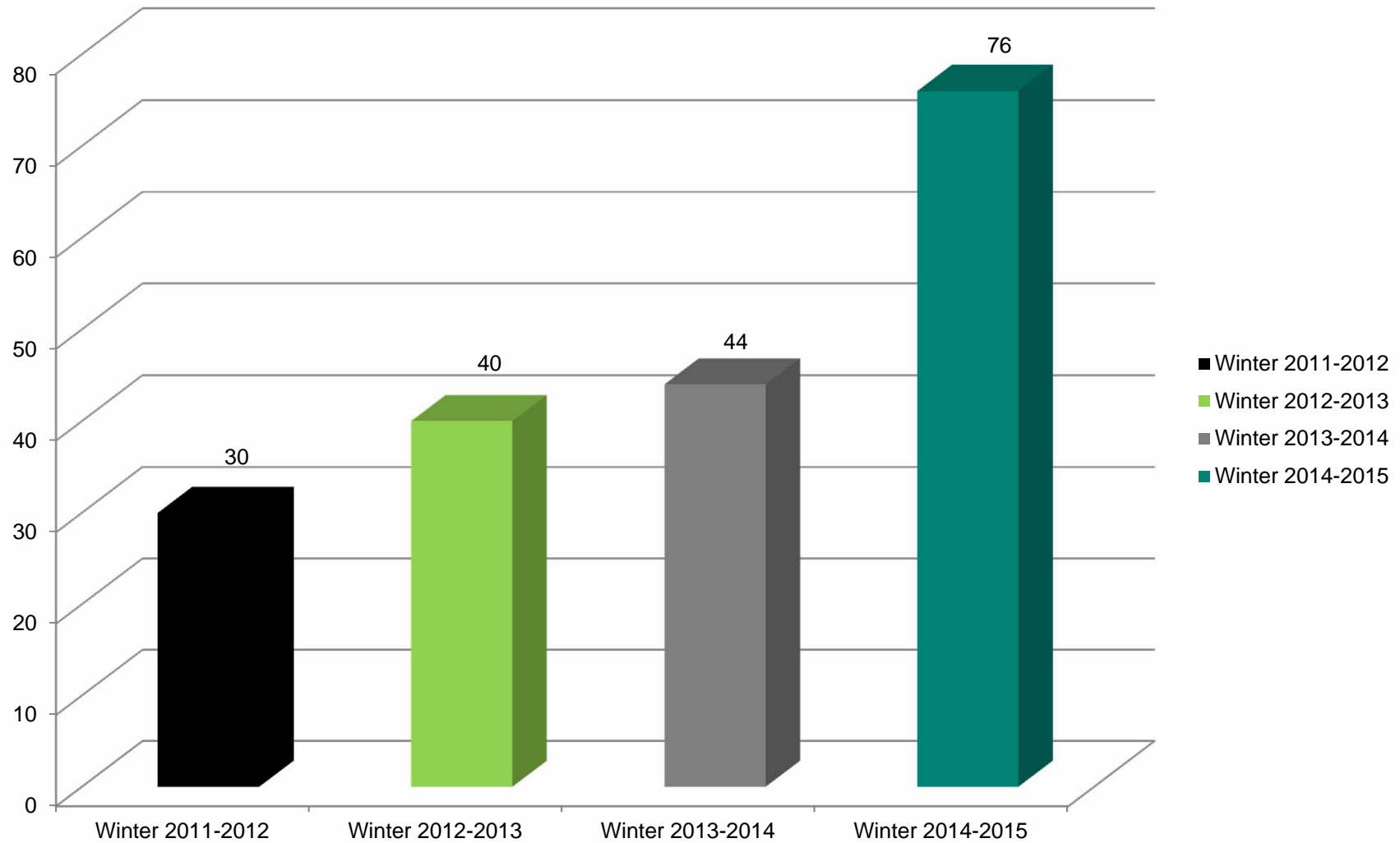
Criteria for selection of spot checks

- ✓ New generator resources commissioned start by December 1.
- ✓ Generator resources that experienced freezing equipment from previous winter.
- ✓ Generators that notified ERCOT improvements were planned from previous winter.
- ✓ Randomly selected generators, including black start or next start resources.

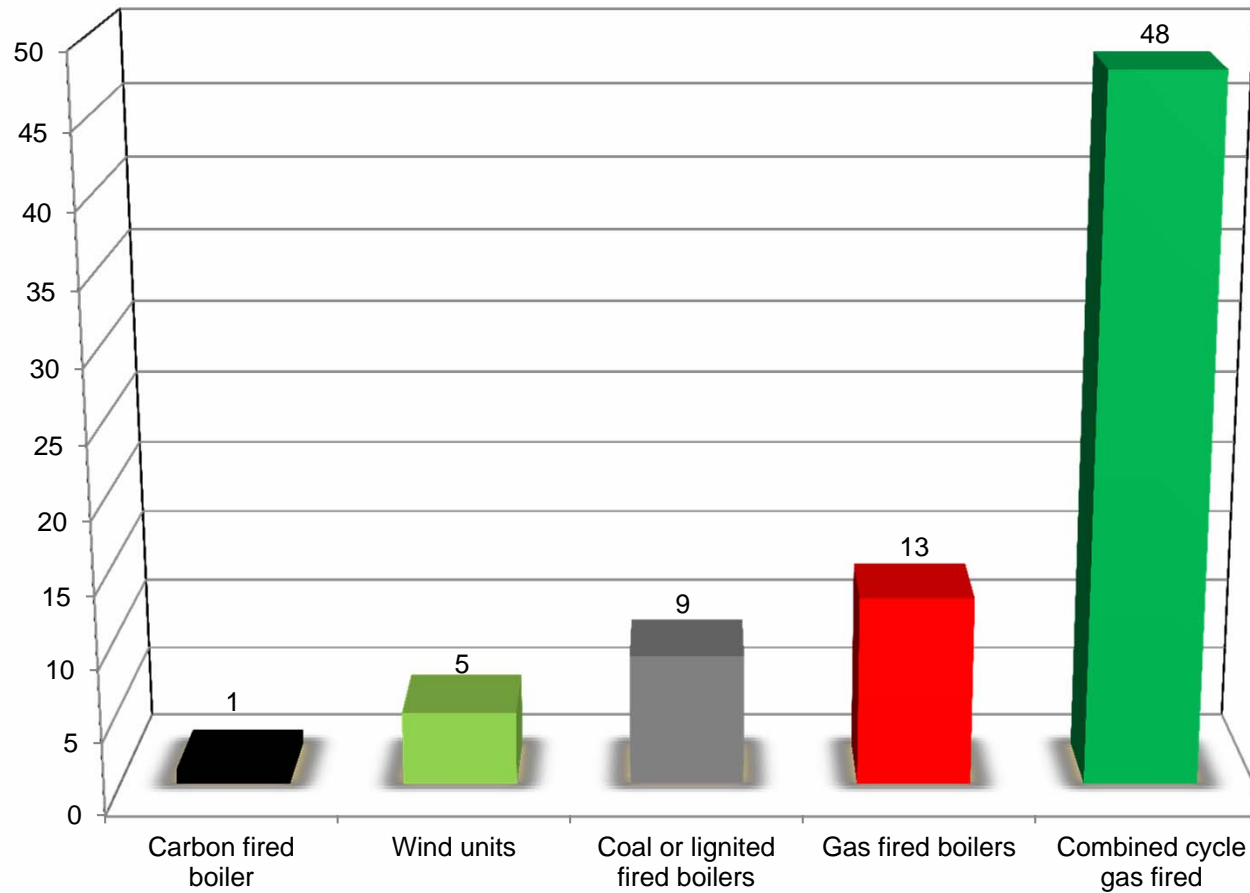
History of Spot Checks

- A check list was developed due to equipment or instrumentation freezing from February 2011, which has been updated as new issues are found. ERCOT uses the check list to cross check weatherization plans to determine if best practices and lessons learned are included.
- Spot checks start as early as November 15 and end February 28.
- There are approximately 550 generators in ERCOT, which includes conventional, wind and hydro.

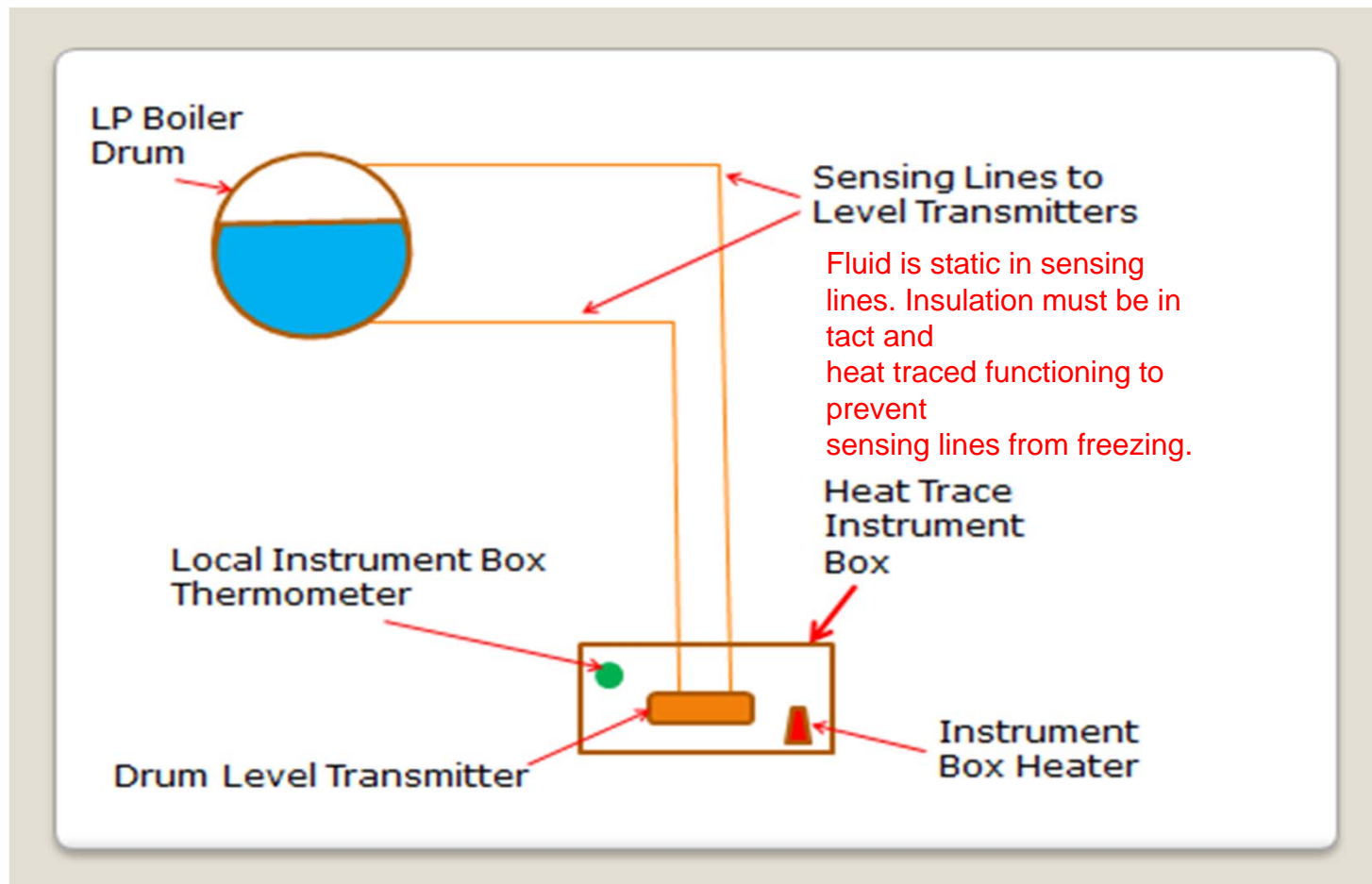
Total units spot checked by winter



Units spot checked by type for winter 2014-2015



Drum level transmitter manifolds and sensing lines freezing are the leading cause of a unit trip or derate



Insulated heated enclosure for transmitters – best practice

Insulated heated enclosure for transmitters



Outside temperature gauge to monitor inside temperature

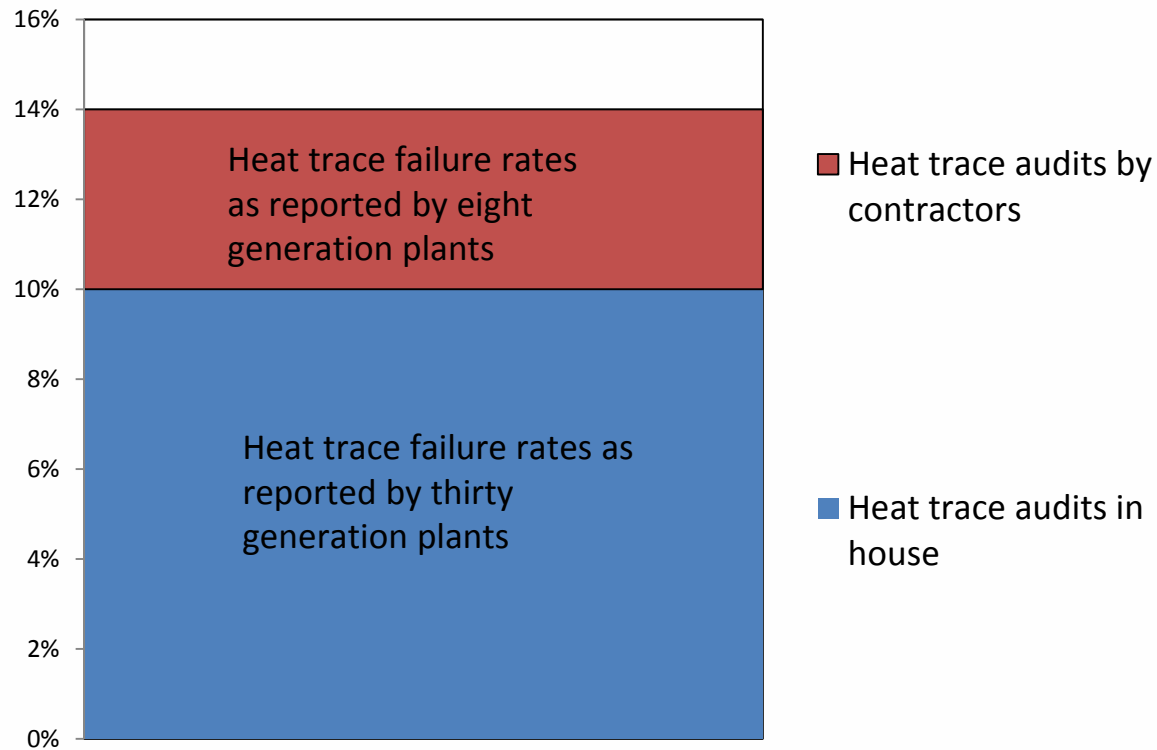
Three phase monitor on heat trace panel – best practice



Heat Trace Maintenance – Best Practice

- Heat trace maintenance testing should include meggar, voltage, amperage testing and comparing to design criteria, if known or previous season.
- Thirty eight plants spot checked report annual testing of their heat trace circuits.
 - ✓ *Recommendations given to continue annual audit on heat trace systems.*
- Six plants spot checked report they do not perform annual testing their heat trace circuits.
 - ✓ *Recommendations given to start annual audit on heat trace systems.*
- **Because heat trace circuits worked last winter doesn't mean they're working this year. Annual maintenance testing is necessary.**

Heat trace annual maintenance testing results – winter 2014/2015



Six plants reported they do not test their heat trace.

Sample spreadsheet for recording heat trace testing

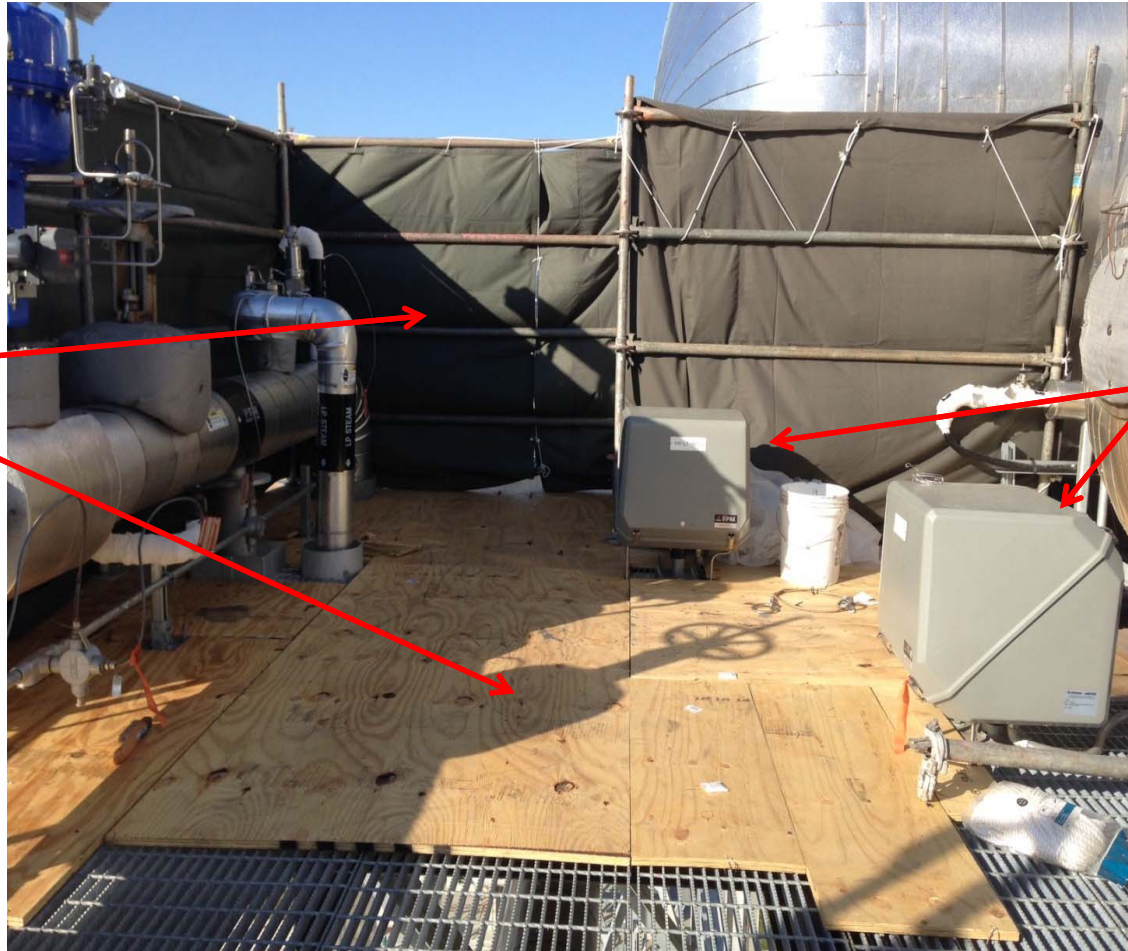
| Panel 001 Circuit breaker | Circuit description | Reference drawing number | Heat Trace type | Design amperage or previous/first year readings | 2013/2014 amperage winter readings | 2014/2015 amperage winter readings | 2015/2016 amperage winter readings |
|------------------------------|--|-----------------------------|---------------------------|---|--|--|--|
| 1 | LP drum level transmitter/sensing line | XXX-XXX-XXX | Series constant wattage | 10A | 9.5A | 9.7A | |
| 2 | LP drum level transmitter/sensing line | XXX-XXX-XXX | Series constant wattage | 7A | 7.1A | 6.8A | |
| 3 | LP drum level transmitter/sensing line | XXX-XXX-XXX | Series constant wattage | 14A | 10A | 6A | |
| 4 | IP drum level transmitter/sensing line | XXX-XXX-XXX | Mineral insulated | 11A | 10.5A | 11.2A | |
| 5 | IP drum level transmitter/sensing line | XXX-XXX-XXX | Mineral insulated | 12A | 11A | 11.5A | |
| 6 | IP drum level transmitter/sensing line | XXX-XXX-XXX | Mineral insulated | 5A | 7A | 6.5A | |
| 7 | HP drum level transmitter/sensing line | XXX-XXX-XXX | Parallel constant wattage | 7A | 7.5A | 7.2A | |
| 8 | HP drum level transmitter/sensing line | XXX-XXX-XXX | Parallel constant wattage | 12A | 10.9A | 11.1A | |
| 9 | HP drum level transmitter/sensing line | XXX-XXX-XXX | Parallel constant wattage | 5A | 4.1A | 4.5A | |
| 10 | Boiler feed water pump flow | XXX-XXX-XXX | Self regulating | 10A | 5A | 1A | |

Insulation and wind breaks – winter 2014/2015

- Insulation audit by plants was observed at 91% (40 of 44)
 - ✓ 5 plants not performing this type of audit.
 - ✓ All were given recommendation to start doing so.
- Wind Breaks
 - ✓ Plants are using wind breaks that are either plywood, heavy duty tarps, reinforced plastic or permanent structures.
 - ✓ Two plants were observed using off the shelf blue tarps as wind breaks.
 - ✓ Both plants were left with recommendation to use another heavy duty material as a wind break.

Best Practice

Best practice wind break and flooring to prevent tunneling effect.



Insulated transmitter boxes

Best Practice



New plant findings – winter 2014/2015

- Four new conventional plants visited
 - Plants heat trace audit found 10%-50% of the circuits not functioning or installed incorrectly.
 - Additional wind breaks used as a precaution.
 - Some transmitter cabinet heaters not terminated to potential.

New wind plant findings – winter 2014/2015

- Four plants visited
 - Cold weather package part of design.
 - Icing remains a concern that could impact generation. ERCOT emphasized the need to notify QSE when ice conditions are forecasted or if turbines trips due to icing for reporting to ERCOT.
 - Stressed the importance to keep plan current.

Comparing Feb 2, 2011 to Jan 6, 2014

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

ERCOT declared EEA3 – 4000MW firm load shed

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)

3541MW of capacity tripped that was freeze related.

ERCOT declared EEA2

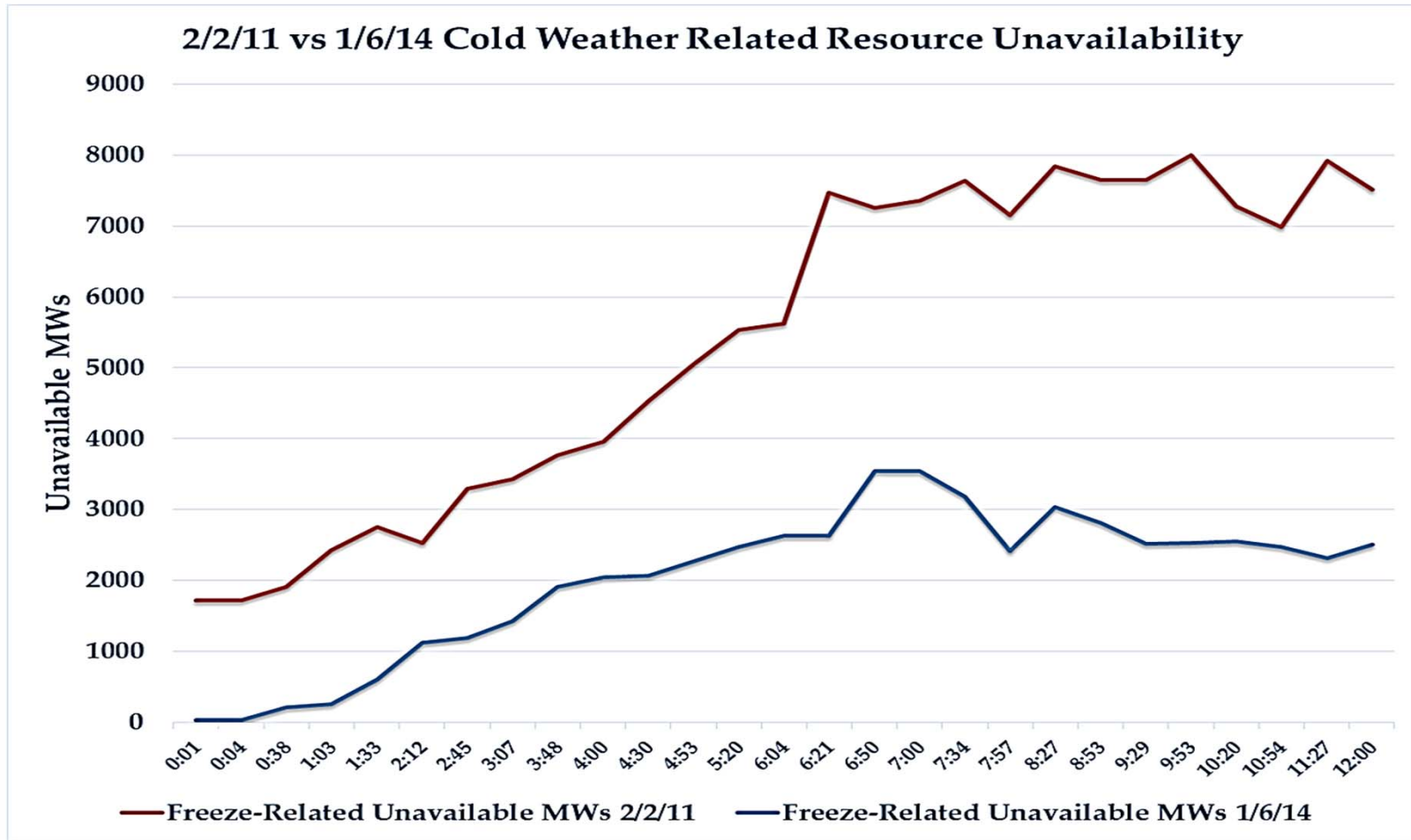
January 6, 2014

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)



Weather Source: Chris Coleman, ERCOT

Comparing February 2, 2011 to January 6, 2014



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)



January 6, 2014 EEA2 event follow up

Units that experienced freezing equipment on 1/6/14 were visited within days of the event.

- ✓ Plant 1 – Lessons Learned Event
- ✓ Plant 2 – Lessons Learned Event
- ✓ Plant 3 – Lessons Learned Event
- ✓ Plant 4 – Lessons Learned Event
- ✓ Plant 5 – Lessons Learned Event
- ✓ Plant 6 – Lessons Learned Event
 - Three of six plants were deemed preventable

Plant 1 - wind break measure after 1/6/14 event

Steam seal line froze delaying startup – **first** occurrence, lessons learned



Plant 2 – contractor error – lessons learned

January 6, 2014 derate.
Heat trace left exposed by
insulating contractor on steam seal
pressure regulator transmitter.

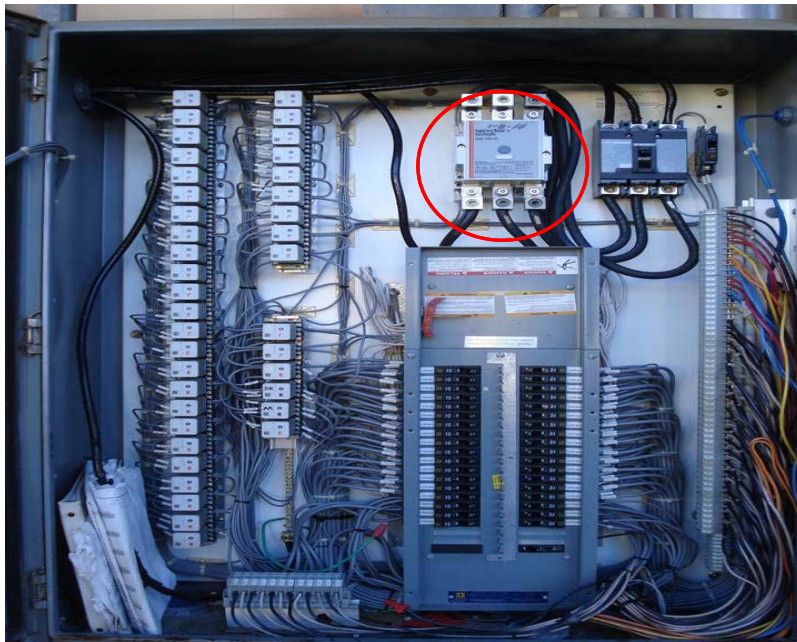


Mitigation action for remainder
of winter 2014.

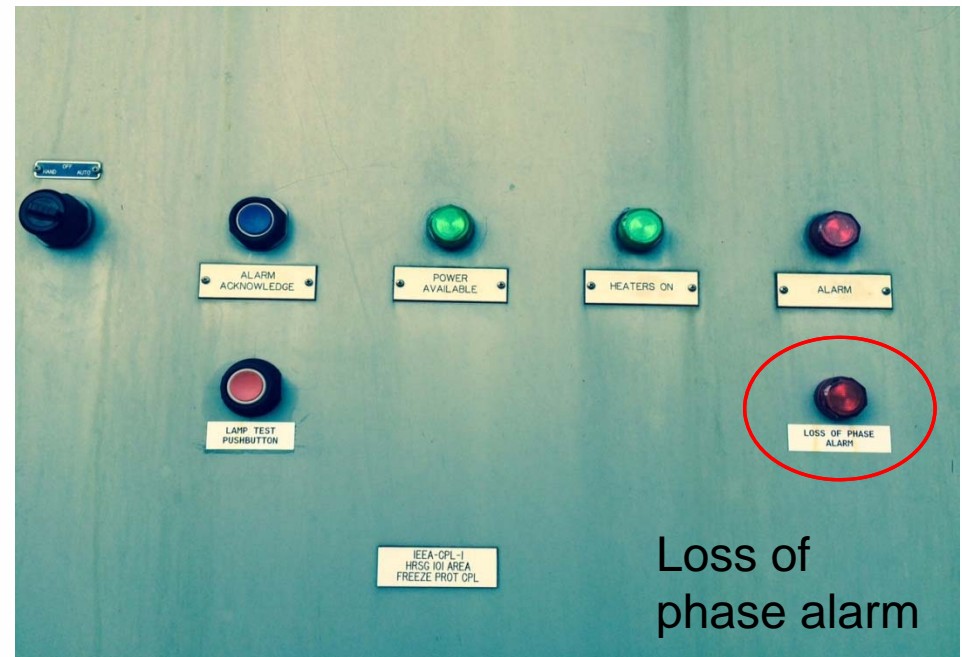


Plant 3 – heat trace panel, three phase contactor – lessons learned and best practice

Spot check after 1/6/14 event. One phase failed to close resulting in auxiliary cooling water transmitter freezing, which tripped plant. Contactor scheduled for annual replacement.

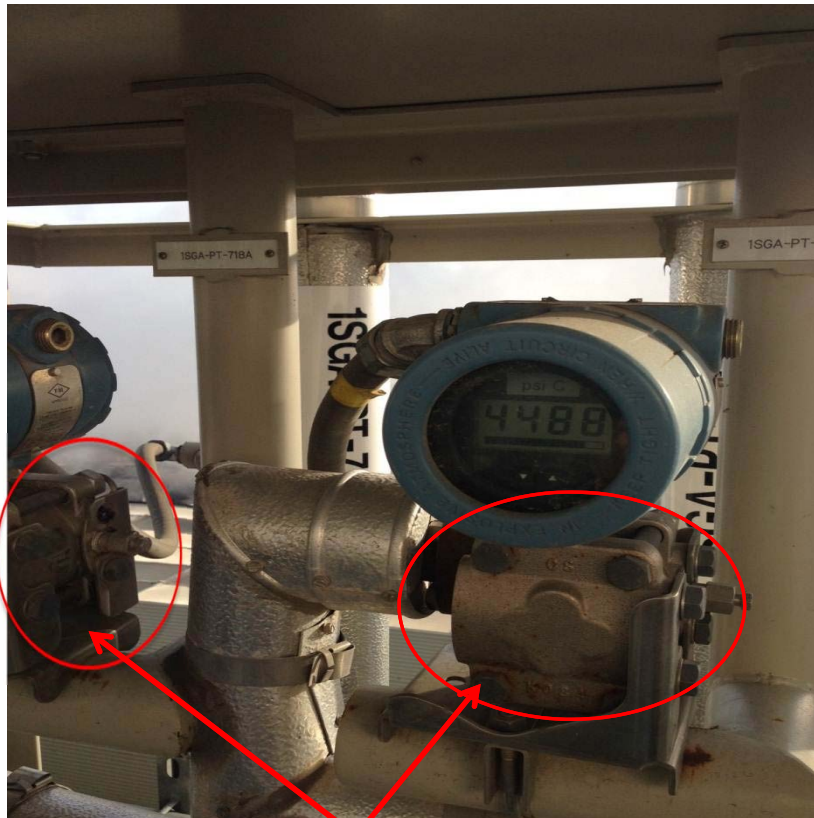


Monitoring system installed by plant as a visual for the operators making rounds to verify three phases are energized on load side of three phase contactor. **Plant experienced no freezing equipment for winter 2014/2015.**



Plant 4 – superheat steam transmitters that caused trip on 1/6/14 with boiler logic set to OR. Uninsulated transmitter manifolds.

January 6, 2014 – lessons learned



Mitigation for remainder of winter 2014



Uninsulated transmitter manifolds

Plant 4 (continued) superheat transmitters winter 2014/2015

- ✓ Relocated Transmitters
- ✓ New wind break
- ✓ Heated enclosure
- ✓ Transmitter manifolds are heat traced
- ✓ Boiler logic set to **AND** for transmitters



Plant 4 (continued) transmitters winter 2014/2015.
Relocated, wind break, insulated and transmitter
manifolds are heat traced.



Unit experienced no freezing equipment for winter
2014/2015.

Plant 5 – lessons learned

Frozen equipment (**many of the same that occurred in 2/2011**)

2 – HP steam flow transmitters

1 – 1st stage pressure transmitter in steam turbine enclosure

1 – NOX steam transmitter sensing line

1 – LP drum pressure transmitter sensing line

1 – IP drum level control valve - water penetrating resulting in valve failing to regulate due to ice

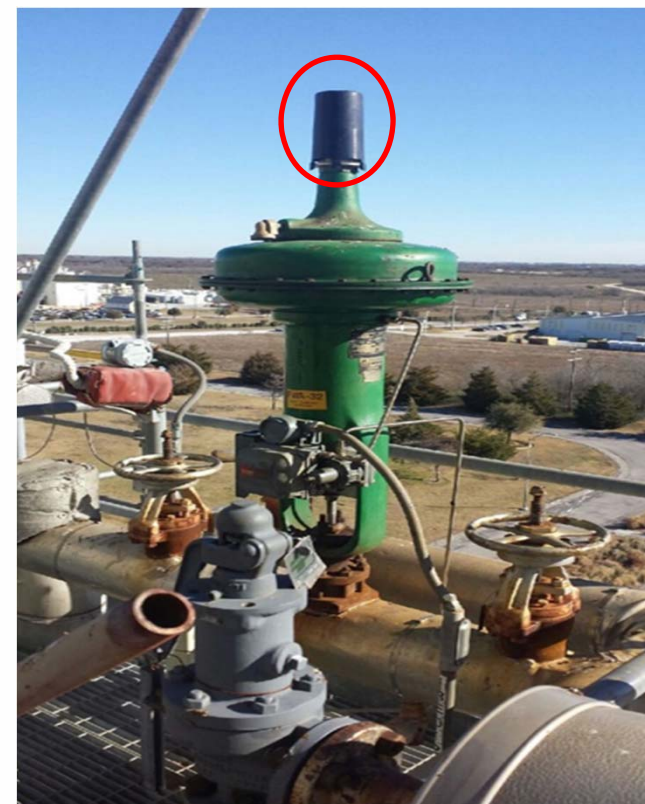
LP Economizer vents lines

Plant 5 - improvements winter 2014/2015: new heat trace smart panel, new heat trace, new critical sensing lines for transmitters.



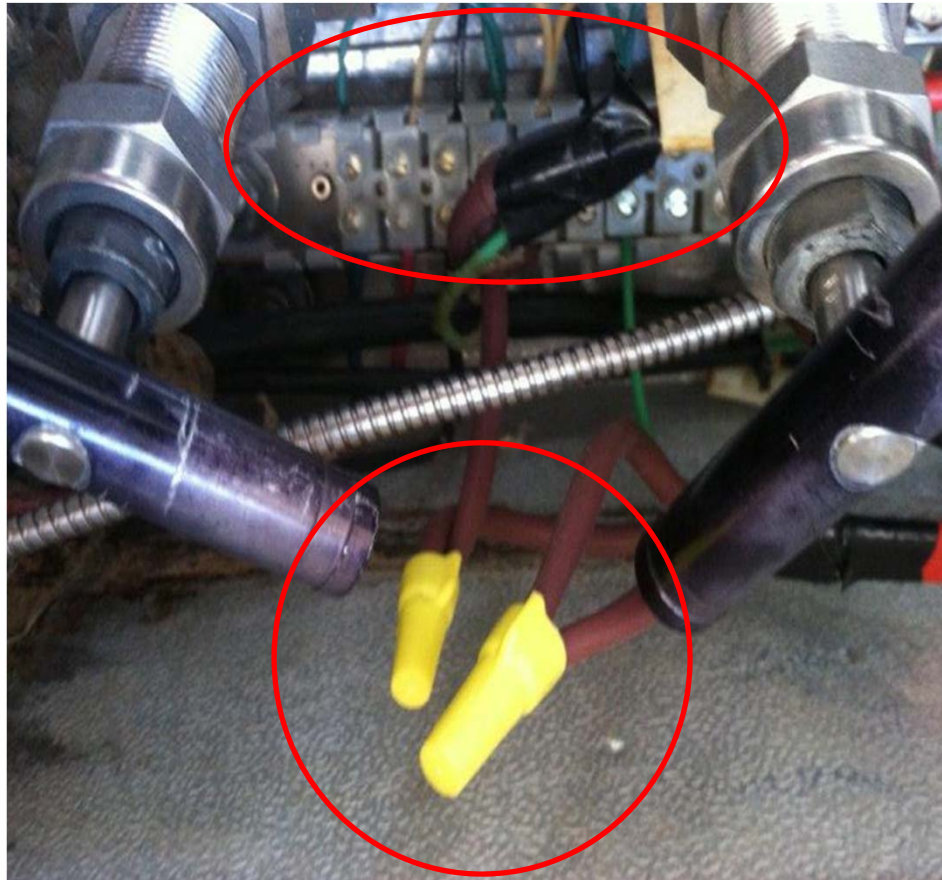
Plant 5 - regulating valve improvements. Nineteen valves rebuilt with rain caps installed.

Inspection discovered valves with water that freeze up during extreme temperatures



Plant experienced no freezing equipment for winter 2014/2015

Plant 6 - 1/6/14 unit trip. Contractor error resulting in heat trace not functioning – lessons learned



Drum level transmitter cabinet: Wires should have been connected on the terminal strip at the back of the box.

Parallel constant wattage heat trace was connected in *series*, not in *parallel*.

Corrective action: Plant requires **contractor** to have a quality control program. Plant electrician verifies work is completed correctly by testing circuits for amperage.

Root cause:

Snow and ice blocking the cooling air filters on the circulating pump motor #1 resulting in inadequate cooling of the stator windings. This resulted in a high temperature on the motor and a trip of the pump. When pump #1 tripped the resulting turbulence tripped pump #2 on high vibrations. This resulted in plant trip due to inadequate cooling of stator windings.

Corrective action:

- ✓ **Added** physical inspection of the motor filters to plants cold weather rounds sheet.
- ✓ **Added** the motor temperature readings to the operator cold weather rounds.
- ✓ **Added** Spare filters to stores stock for the motors allowing for filter replacement if they start to show ice, or snow build-up.

NOTE: First occurrence since plant was commissioned this is a lesson learned.

Plant Trip 2/25/15 – lesson learned



Plant experienced no other freezing equipment during the winter 2014/2015

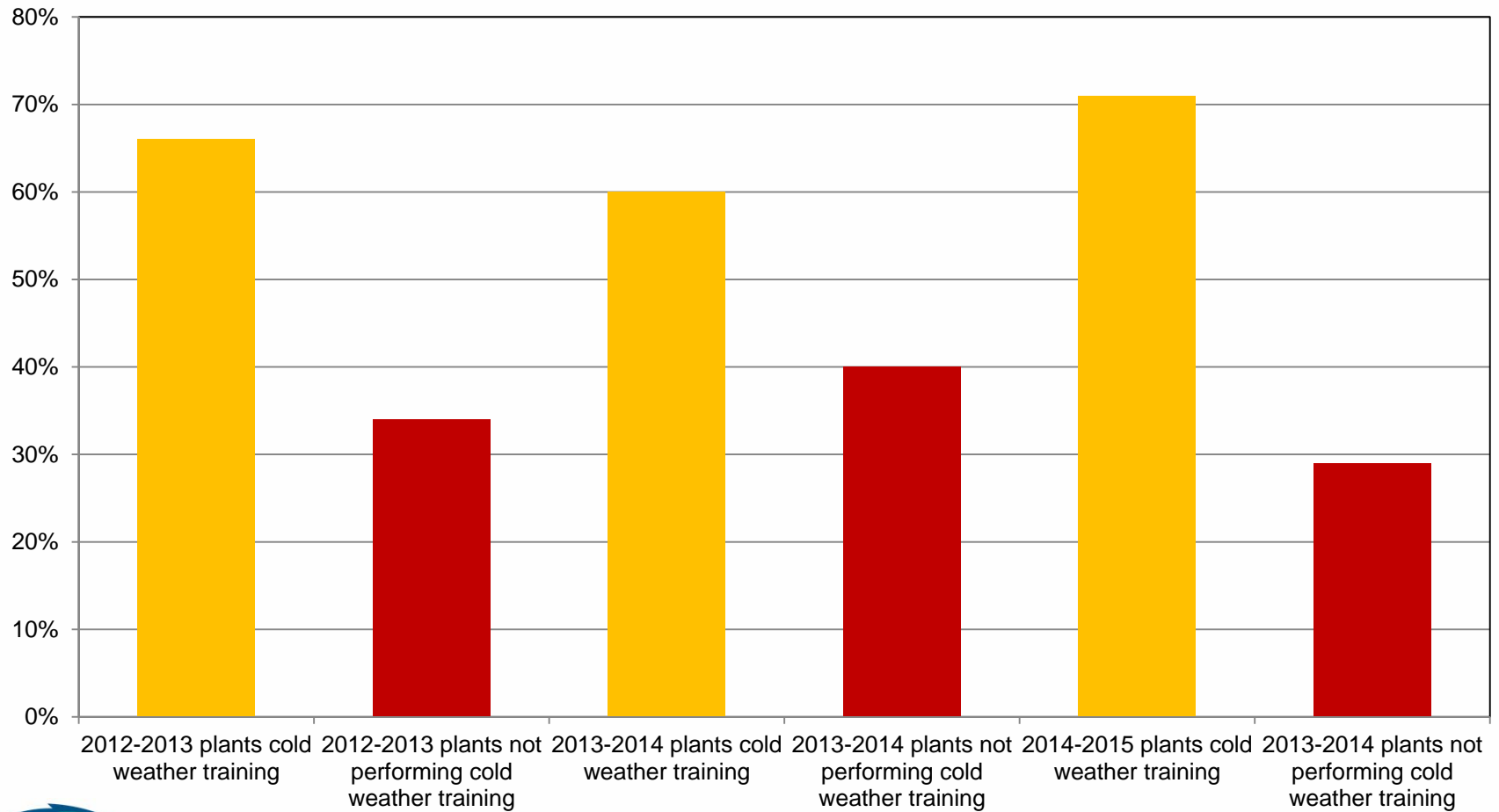
Weatherization plans, procedures and checklists

- ✓ Weatherization plans, procedures and checklists vary from detailed to general requirements.
- ✓ Plants that have detailed weatherization plans, procedures and checklists remained on line with minor problems during February 2011.
- ✓ Weatherization plans should be a living document with additions of any lessons learned.

Instrument air maintenance and dryers

- ✓ Most plants do maintenance bi annually.
- ✓ Moisture is removed by air dryers, dew point monitoring or periodic automatic blow downs.
- ✓ Instrument air drying is normally remotely alarmed.
- ✓ One plant during 2014-2015 winter experienced a 480V breaker failure that feeds block 2 instrument air compressor. The plant has failover capability for the other compressor and that failed to work as designed.

Annual cold weather training



Plant training and supplies needed for extreme cold weather event

- ✓ All plant personnel should train annually on extreme cold weather procedure.
- ✓ 100% of the plants visited have cold weather supplies in inventory.

ERCOT Recommendations

- Continue or start annual audit of heat trace.
- Continue or start annual audit of insulation.
- Improve cold weather training focusing on the type of checks required on critical equipment.
Recommended using NERC cold weather training as a possible guide.
- Capture lessons learned from previous season for inclusion in weatherization plan.
- Add cold weather supplies needed to weatherization plan.
- Improve details of weatherization plan.

ERCOT Recommendations (continued)

- Develop a pre-winter checklist for preparation.
- Install thermometers on the outside of transmitter boxes to measure inside temperature.
- Install weatherproof boxes with thermometers on outside of boxes that monitors inside temperature.
- Work with Corporate to provide clarity for weatherization plan.
- Develop spreadsheet record of heat trace audit testing. Record design amperage by circuit (if known), amperage readings, identify critical circuits. Do so for each panel for comparison review. ERCOT is promoting this for companies that have many units as a standard.
- Find another reliable wind break other than a blue off the shelf tarp.

Comments

- Overall, ERCOT was pleased with winter 2014/2015 spot checks and plants are improving weatherization as evidenced by 2014/2015 winter weather on a few occasions.
- Purpose of this program is to ensure plants can operate to their design temperatures.
- Plants should be preparing for a one in twenty year event.
- ***It is ERCOT's expectation that for every cold weather event, some generation is going to experience freeze related derates or trips.***
- “do or do not; there is no try.” Yoda – Star Wars

Scarcity Pricing

System-wide Offer Cap increased to \$9000.00
per MWh on June 1, 2015 (pursuant to
PUCT Substantive Rule 25.505 (g)(6)(B)(iii))

ERCOT would like to thank the generator owners, operators and plant staff for their cooperation and efforts on weatherization!



Questions?



2015-16 Winter Weather Outlook

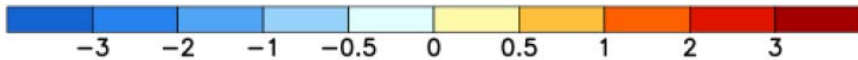
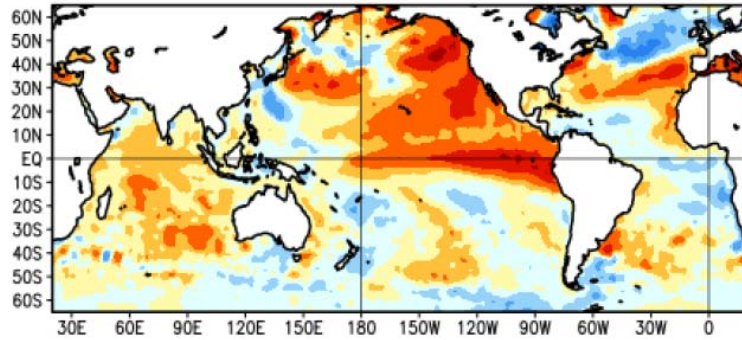
Temperatures and Precipitation

Chris Coleman
Senior Meteorologist

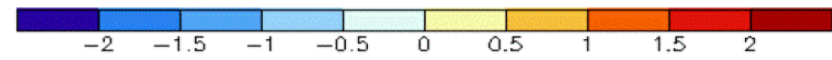
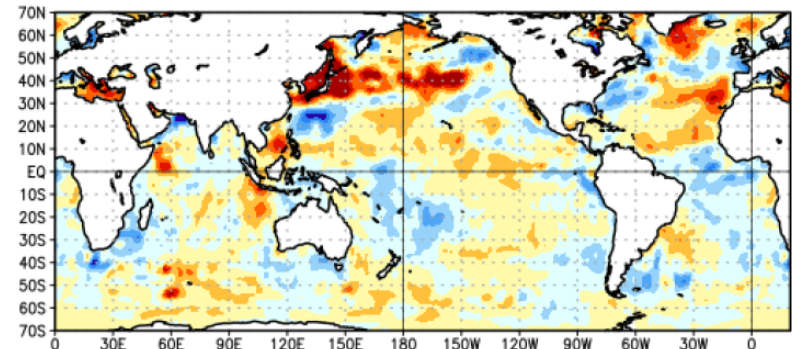
ERCOT and Texas RE Winter Weatherization Workshop
September 1, 2015

El Niño and Ocean Temperatures

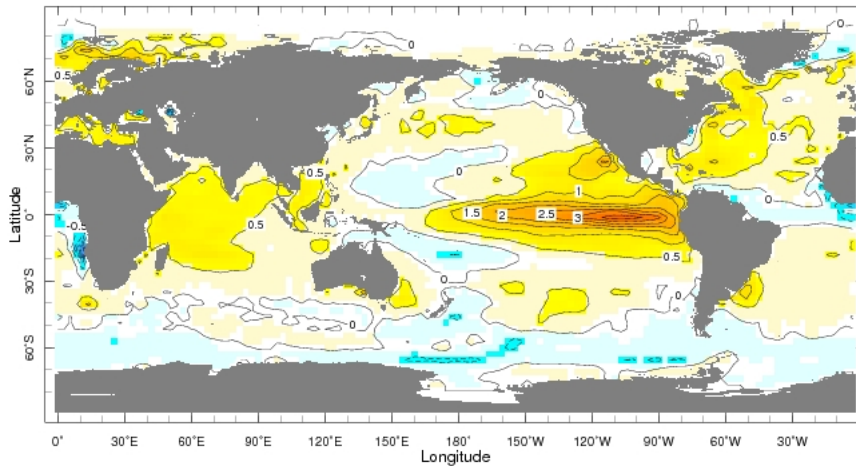
Average SST Anomalies
12 JUL 2015 – 8 AUG 2015



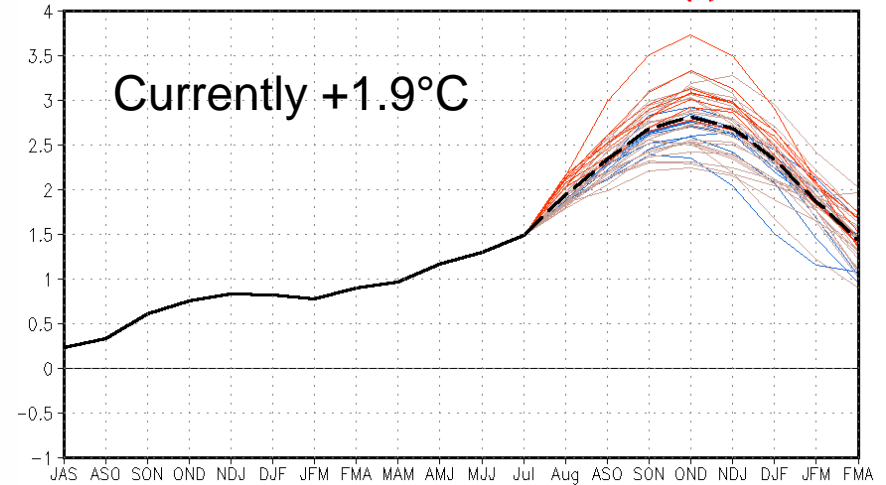
Change in Weekly SST Anoms (°C)
05AUG2015 minus 08JUL2015



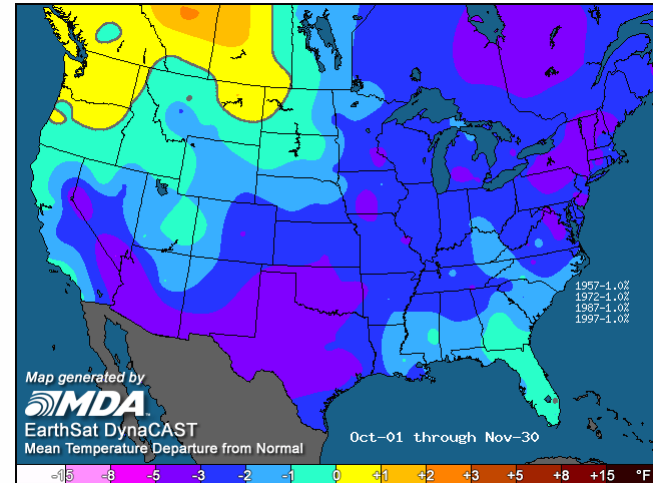
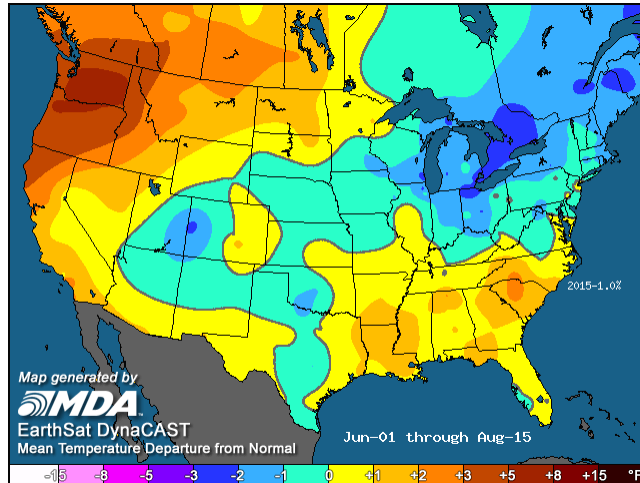
Dec 2015 - Feb 2016 IRI seasonal Forecast SSTA issued 0000 1 Jul 2015



CFSv2 forecast Nino3.4 SST anomalies (K)

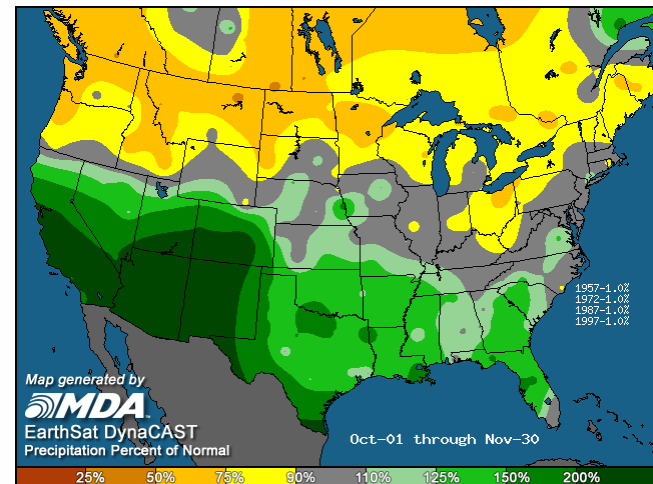
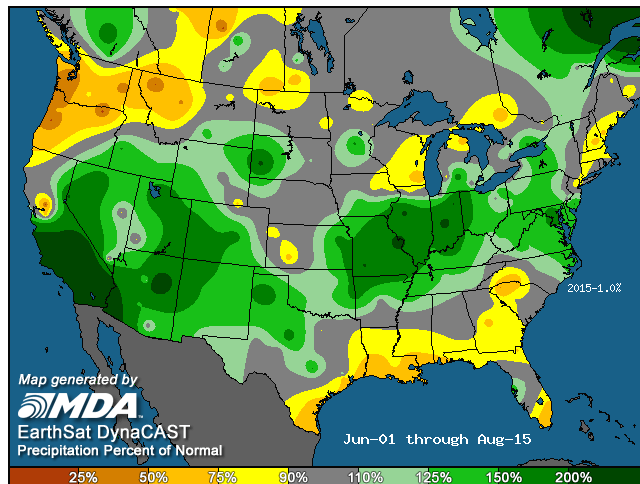


Summer and Fall 2015

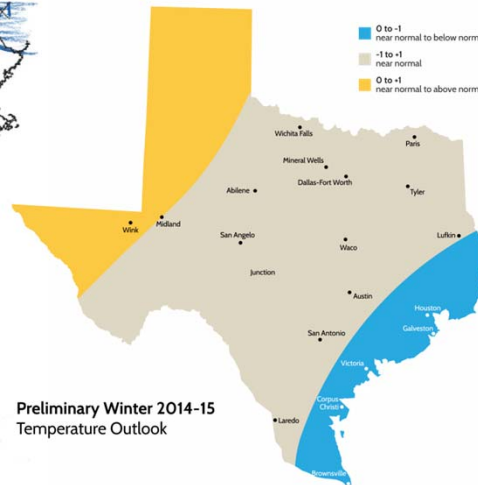
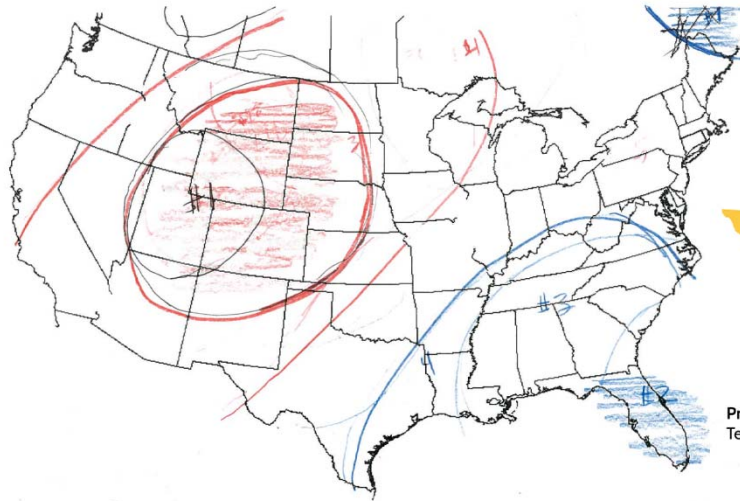
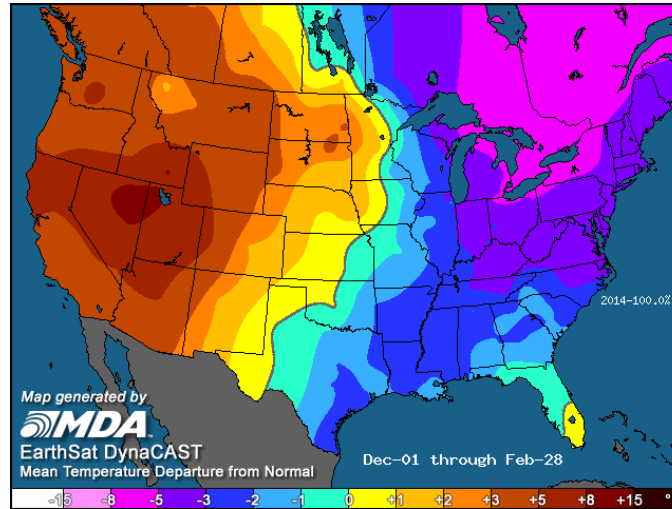


Summer has been hotter than anticipated

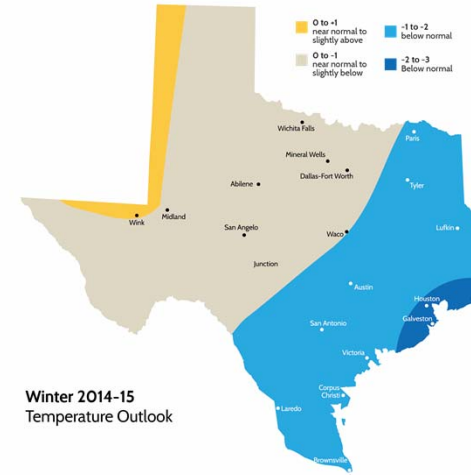
Expect a cooler, wetter fall



Last Winter's Forecast versus Actual



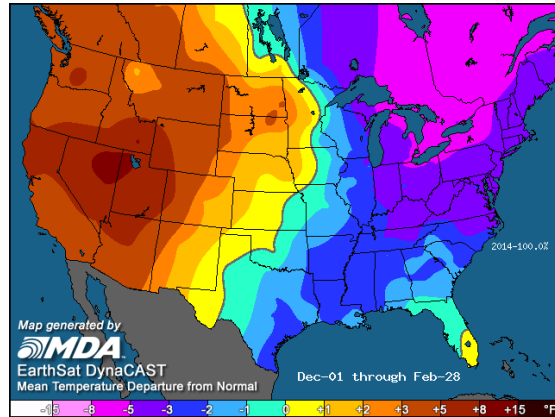
Preliminary Winter 2014-15 Temperature Outlook



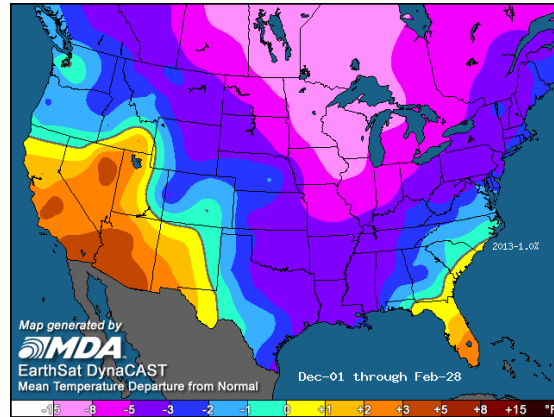
Winter 2014-15 Temperature Outlook



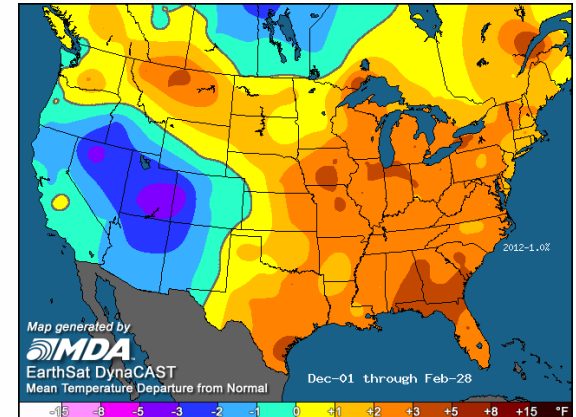
Past Six Winters



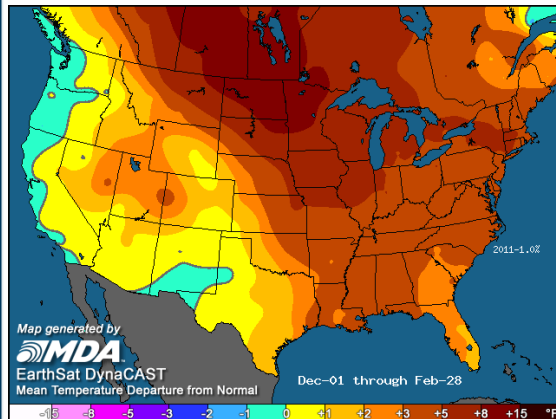
2014-15



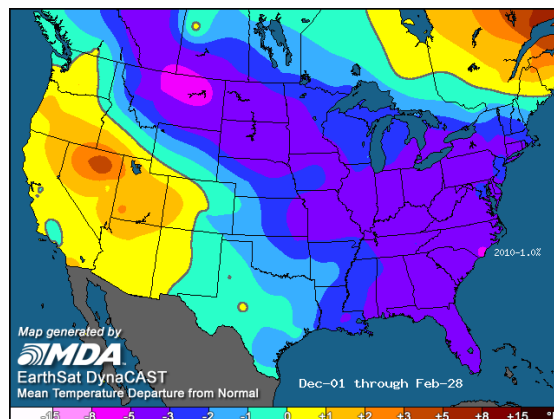
2013-14



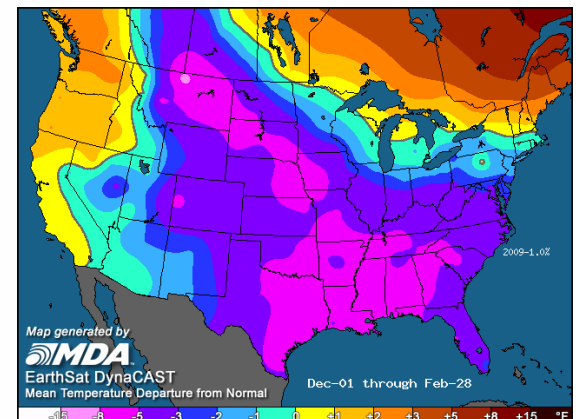
2012-13



2011-12



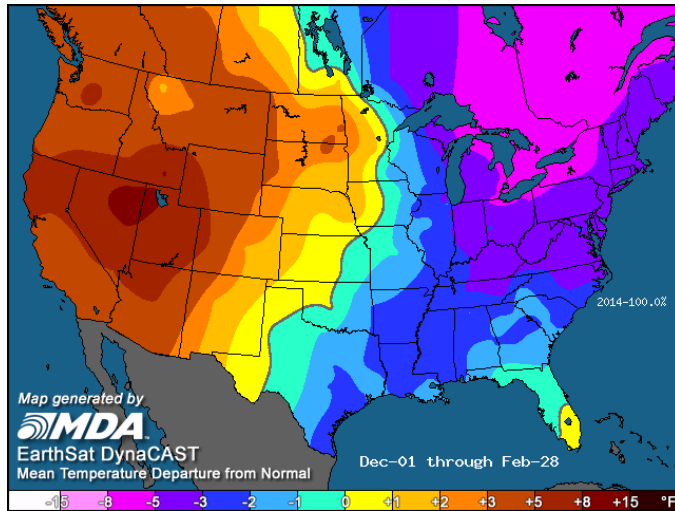
2010-11



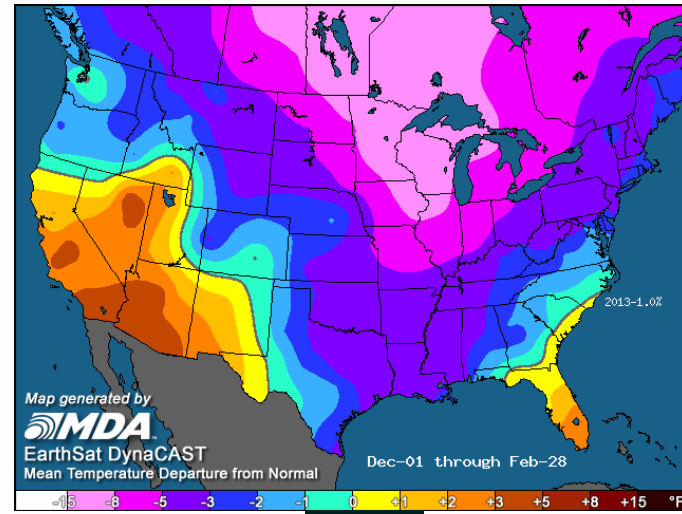
2009-10



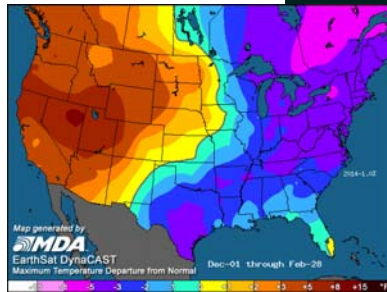
Comparing Winter 2014-15 to Winter 2013-14



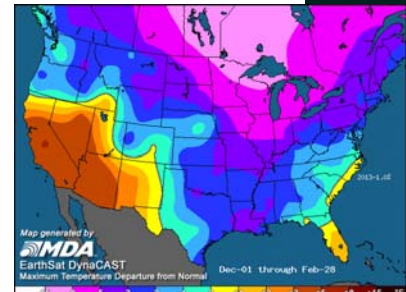
2014-15



2013-14

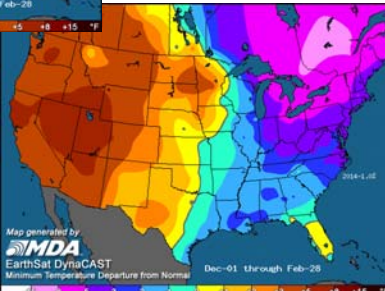


69th
coldest

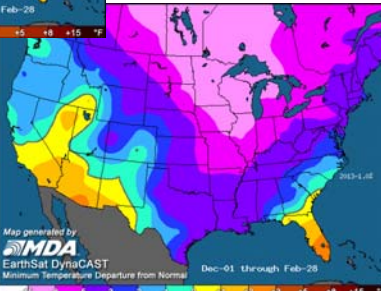


30th
coldest

41st coldest
max;
101st
coldest min

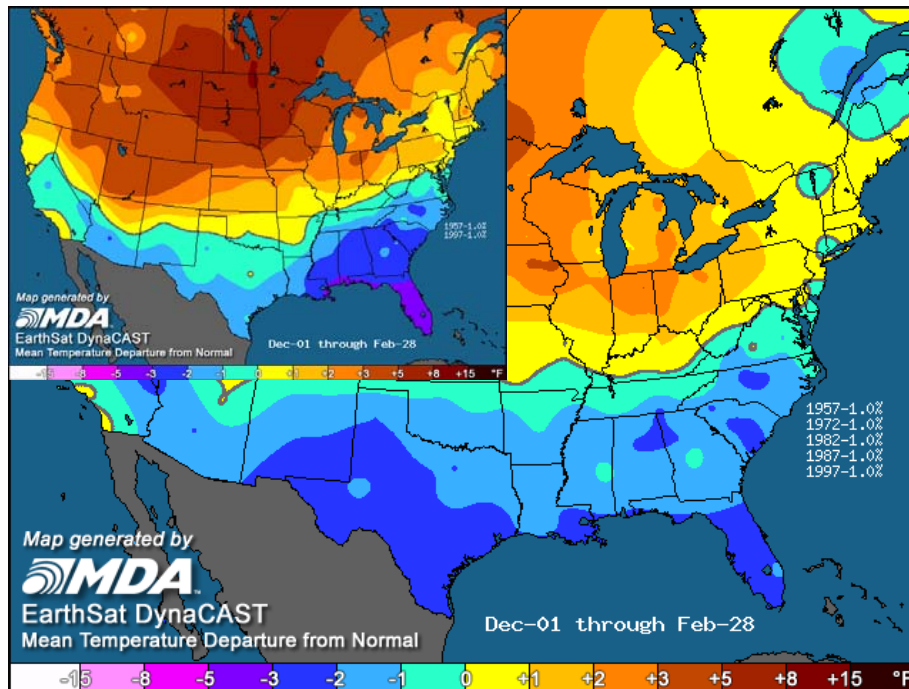


48th coldest
max;
20th coldest
min

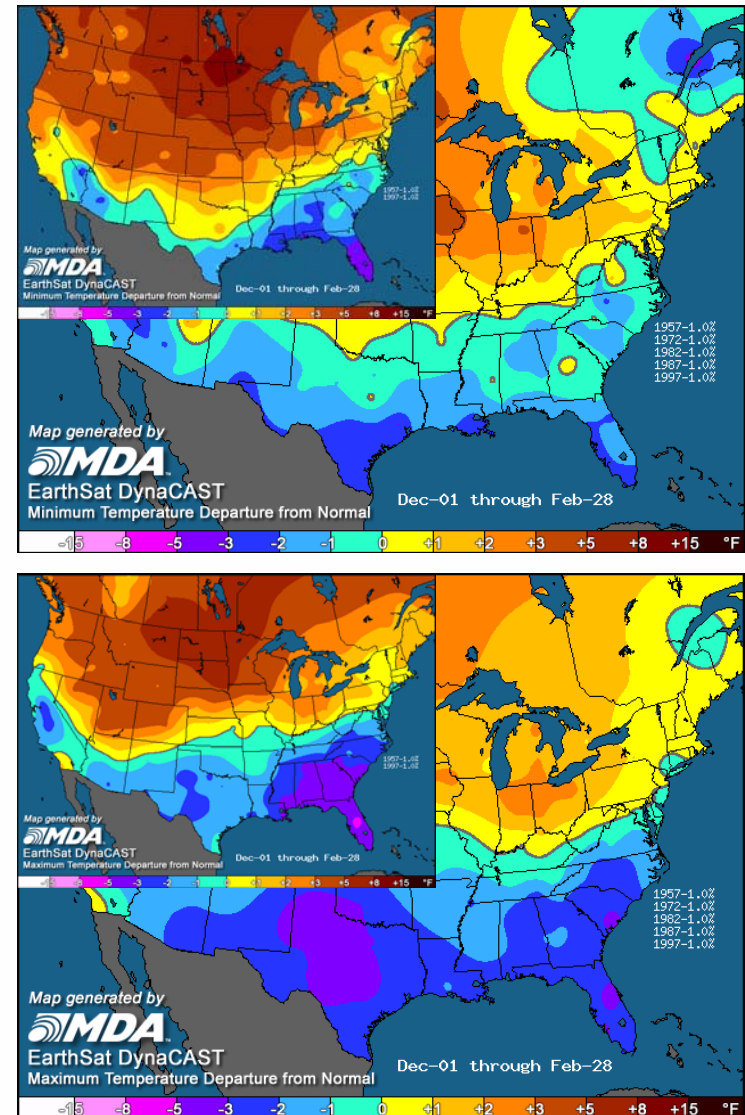


Similar El Niño Winters

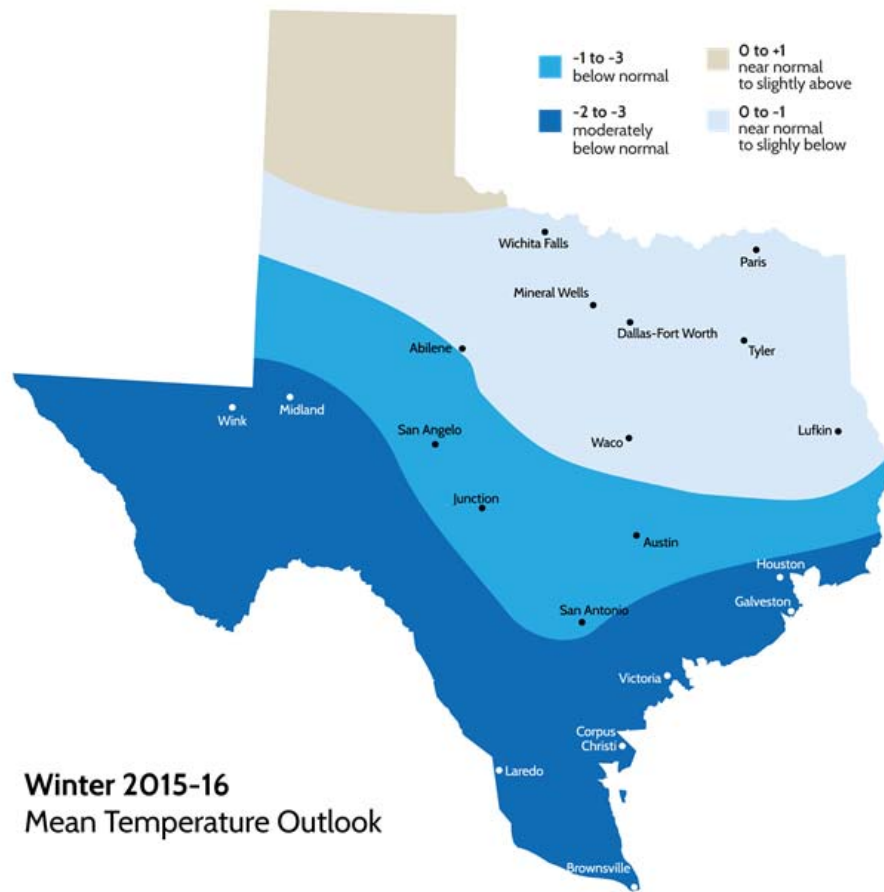
1957-58, 1972-73, 1982-83, 1987-88, 1997-98



1997-98 is a warmer solution
Both '57 and '97 are mild min temperatures



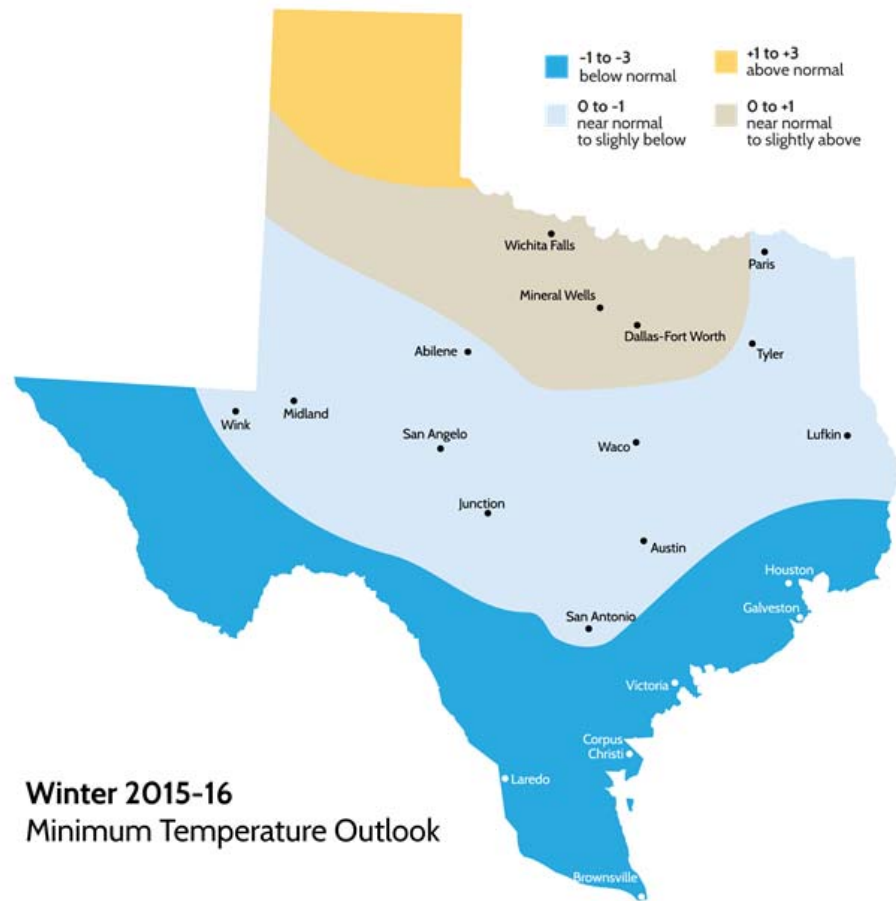
Winter 2015-16 Mean Temperature Outlook



Potentially similar to last winter. More warmer potential than cooler – but TBD.

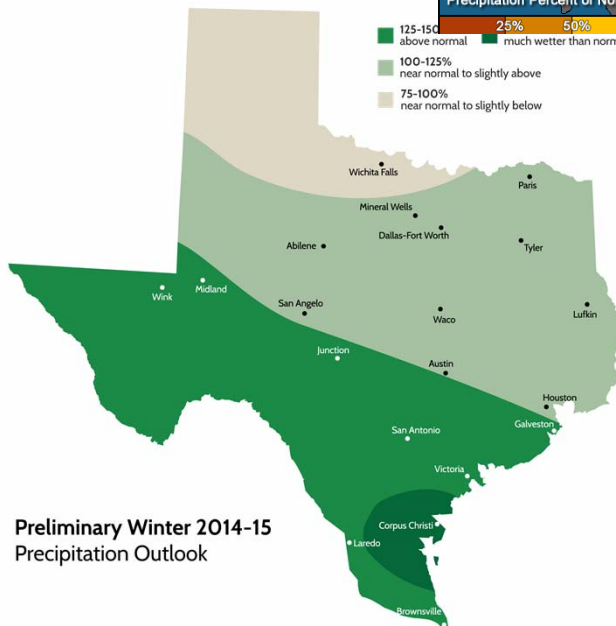
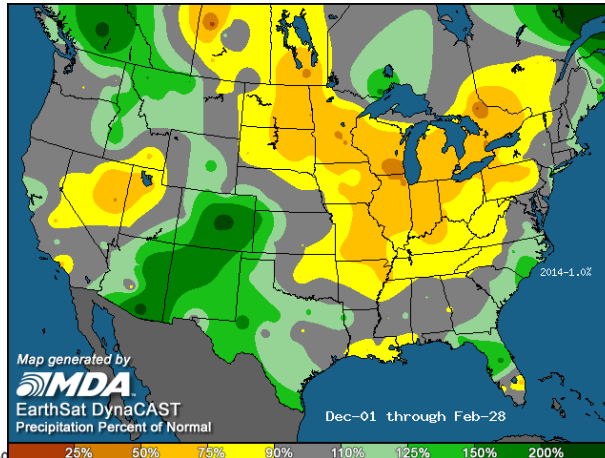
Coast, South, and West likely below normal.

Winter 2015-16 Minimum Temperature Outlook

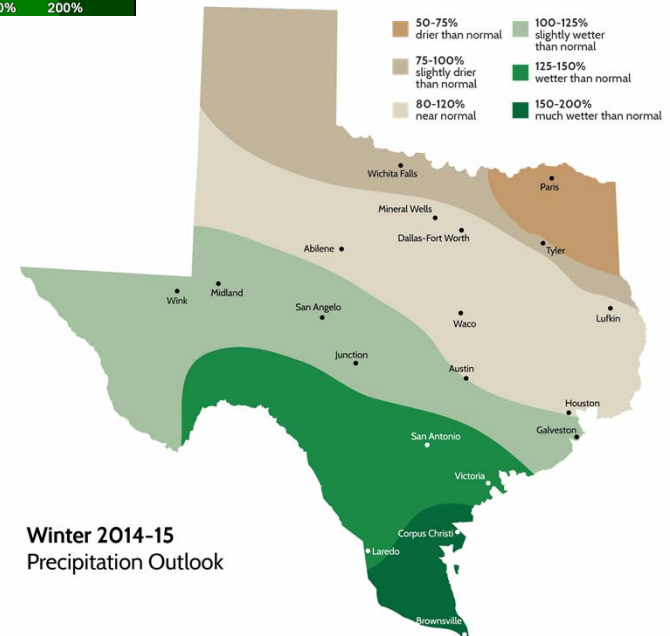


Important to emphasize the daytime highs have more below normal potential than the nighttime/morning lows.

Last Winter's Forecast versus Actual



Preliminary Winter 2014-15
Precipitation Outlook

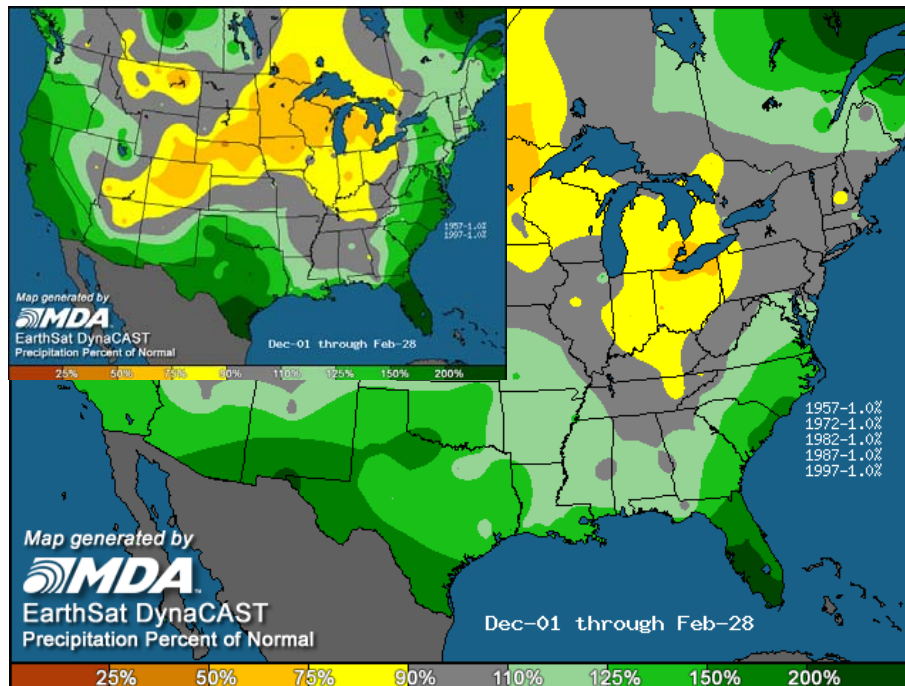


Winter 2014-15
Precipitation Outlook



Similar El Niño Winters

1957-58, 1972-73, 1982-83, 1987-88, 1997-98



1997-98 is a wetter solution

Snow

Dallas

Average: 1.5"

Last Winter: 5.8"

1957-58: 0.9" (Feb)

1972-73: 3.7" (Dec, Jan)

1987-88: 3.5" (Jan, Feb)

1997-98: 0.5" (Mar)

Austin

Average: 0.6"

Last Winter: 0.0"

1957-58: 0.3" (Feb)

1972-73: 0.6" (Feb)

1987-88: 0.0"

1997-98: 0.0"

San Antonio

Average: 0.7"

Last Winter: 0.0"

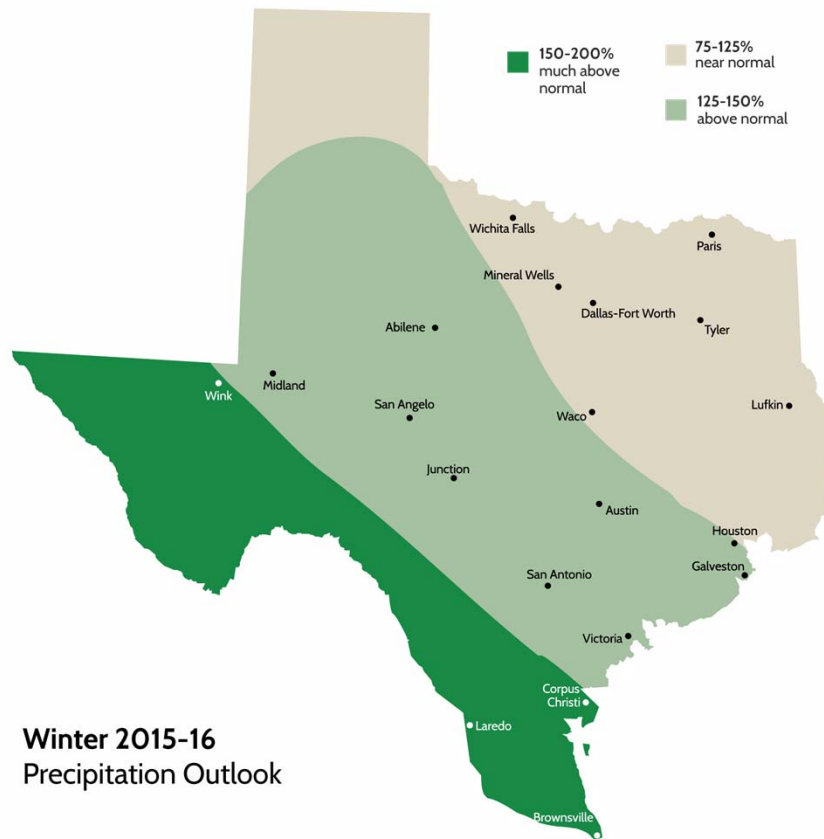
1957-58: 1.5" (Nov, Feb)

1972-73: 2.9" (Jan, Feb)

1987-88: 1.4" (Jan, Feb)

1997-98: 0.0"

Winter 2015-16 Precipitation Outlook



Overall, wetter than last winter and much wetter than the previous winter.

North Central, East, and Panhandle have both wetter and drier potential

Winter Forecast Summary



Final Forecast
will be published
by November 2
on website



Overall, a wetter than normal winter is expected.

Best opportunity for above normal precipitation will be South and West.

Both drier and wetter potential Panhandle, North Central, and Northeast.

Preliminary temperature forecast has both warmer and cooler potential. More similar to last winter than winter 2013-14.

Minimum temperatures not likely bitterly cold. Daytime highs have more potential below normal impacts.

Coast and South have greatest below normal potential. North and West have greatest above normal potential.

The Blob!

