Primary Interest Groups
Generator Owners (GO), Generator Operators (GOP)

Details and Observations
Multiple generators experienced unit trips or failures to start due to freezing equipment and instrumentation as a major cold wave swept across the ERCOT Region with extreme low temperatures, significant wind, sleet and snow. The primary causes of freezing equipment and instrumentation included trips of heat trace circuits, missing or inadequate insulation for piping and instrument lines, and inadequate quality of the existing insulation and heat trace. In some rare cases, facility design temperature (35°F as identified in one report) was also a contributing factor. Many experienced unanticipated effects due to wind, even in areas that appeared sheltered, as radiant heat dissipated. Details of instrument and equipment issues encountered during the event are listed in the following table.

Equipment	Issue
Impulse Tubes Sensing Lines Transmitters	• Impulse tube lines, sensing lines and transmitters were un-insulated, under-insulated, or without adequate heat trace protection, resulting in freezing issues. • Un-insulated line sections were behind a box and invisible to inspection. • Drum level transmitters froze due to a small gap in the insulation at a transition point that did not completely cover the sensing lines. • Impulse tubes had a thin layer of insulating material which was then severely compressed by a protective fiberglass wrap and thus rendered ineffective in these extremes. • Transmitter measurement legs were frozen due to lack of heat trace on the piping from the drum to the instrument taps. • A drum level heat trace circuit fuse blew which resulted in a frozen drum level sensing line. • A de-aerator high pressure transmitter sensing line froze up. The heat trace circuit for the line was not operating. • Industry standard insulating jackets and heat trace design were not sufficient for the extreme cold and windy conditions in some instances.
Valve Gearboxes Valve Positioners Solenoid Valves Heat Trace Circuits Disconnect Switches	• Moisture ingress caused equipment and instrument to fail. • Gear box had a broken seal and leaked. • A fuel gas charging valve actuator froze from an external water leak and could not be operated. • Improper installation of a connection box for a heat trace circuit caused moisture to accumulate in the box and short out the circuit. • A gas pressure regulator was frozen in one position due to a failed positioner diaphragm. • Water ingress in a disconnect switch's arm froze, causing the weld on the end of the arm to crack, which reduced the current carrying capabilities of the arm. This added heat to the area, which progressed to an arc.
Drain lines and vents	• Condensate drains and steam vents froze due to low temperatures combined with wind chill. • Plant air compressor drains froze. The plant instrument air pressure transmitter also froze, and the resulting incorrect high pressure readings kept the plant air compressors from cycling on to maintain the air supply. The resulting loss of instrument air affected all plant air operated valves. This transmitter was inside an enclosure supplied as part of the compressor manufacturer's skid. It was determined that the piping mounted inside had insufficient slope to avoid accumulation of ice once freezing began.

	• Air entered an inlet ductwork through a mesh "bird screen" at the top of ductwork. Ice gradually accumulated on the mesh, decreasing the cross-sectional area of the air inlet. After a significant amount of intake air was blocked by ice, inlet duct pressure dropped and caused the duct to implode.

Considerations

- Start and maintain units in Hot and Ready status prior to the arrival of extreme cold weather
    - Due to the difficulties of starting a unit in adverse weather conditions, implement best efforts to start and maintain cyclic units and steam boiler units in a hot and ready status prior to the onset of severe cold weather.
    - For quick-start combustion turbine generators, evaluate periodically starting those units to keep the lube oil warm and exercise other moving equipment (e.g., generator breakers) on those units in order to decrease the likelihood of failed starts.
    - Evaluate the practice of keeping auxiliary boilers “hot and ready” to facilitate faster restart times should a forced outage occur.
    - Written procedures in place for preparations in advance of extreme cold weather may merit review to address special procedures for operating units in freezing weather conditions with potential loss of critical instrumentation. Perform a comprehensive review of the emergency operation procedure and fill in any gaps found in the review.

- Improve, maintain and monitor instrument condition to reduce freezing risk
    - Obtain and install portable heaters, heat lamps, insulation, tarps, blankets, and wind breaks to correct insulation problems and frozen instrumentation.
    - Where feasible, install additional heat trace circuitry metering to provide more efficient verification and monitoring of circuit integrity during severe weather conditions.
    - For online units, frequent monitoring of heat tracing circuit integrity and protective equipment enclosure temperatures is the key to early identification of potential freezing issues during severe cold weather conditions. At the onset of a forecasted extreme cold weather event, re-verification of heat tracing functionality on critical unit operational systems can improve unit availability during extreme low temperature conditions. Simple actions such as briefly opening instrument enclosures to trigger thermostats can assure that they are working.
    - Where installed, increased electronic monitoring of critical smart transmitter temperatures allows plant personnel to be proactive in adding heaters and tarps to prevent freezing in vulnerable areas.

- Identification of unit-specific critical freeze protection areas and the corresponding appropriate freeze protection measures decreases the likelihood of freeze related impacts.
- Consider using an infrared gun to validate the operation condition of the heat trace circuits and identify any weak areas.
- Where heat trace or other equipment has not performed as expected, review design specifications to ensure the temperature design criteria for facilities are appropriate.
- Perform a thorough review to ensure the existing insulation/heat tracing circuits are complete and sufficient. In multiple cases, it was discovered the preparations and systems that had previously proved sufficient were stressed during the event and turned out to be inadequate to withstand the combination of extreme cold weather and high winds for an extended period.
- Additional air compressors can provide backup air supplies and supplement air system support, particularly in remote areas of the plant facilities.

- <u>Make pre-arrangement to minimize the impact of icy road condition on supply and travel</u>
  - Consider increase fuel oil inventory/ ammonia storage capacity in case that unsafe road conditions prohibit delivery of supply.
  - In order to respond quickly to changing extreme cold weather conditions, ensure that reserve cold weather supplies are on hand, and staged within the plant, prior to the onset of extreme cold weather (e.g., tarps, portable heaters, blankets, heat lamps, extension cords, kerosene/propane, etc.).
  - Pre-arrange lodging and meals for operations and support staff close to the plant and reduce travel on icy roads. Have cold weather clothing and footwear including shoe cleats available if needed.