

Lesson Learned

Adequate Maintenance and Inspection of Generator Freeze Protection

Primary Interest Groups

Generator Owners (GO)

Generator Operators (GOP)

Problem Statement

The Generator Owner (GO) and Generator Operator (GOP) of a large combined cycle gas turbine (CCGT) plant consisting of four units with a generation output of over 950 Mw did not prepare properly for extreme winter weather which resulted in the forced outages of the units at the plant and contributed to a Balancing Authority having to shed load.

Details

Before the cold weather event, the plant personnel verified that all heat trace equipment was functioning properly and all insulation was in place. The plant was designed to be able to operate at ambient temperatures below zero. The plant does not consider wind chill when forecasting temperatures. During the cold weather event, ambient temperatures were experienced by the plant to be as low as the lower teens with wind chills below zero. Temperatures remain in these ranges during the coldest time and did not get above freezing for over 3 days. One unit tripped due to an HP Bypass thermocouple failure (non-weather related) and other units tripped more than once due to the following issues:

- CT tripped due to frozen HP Steam Pressure (transmitter issue)
- Steam turbine trip due to frozen HP Steam transmitter
- Unit tripped due to frozen LP Drum Level transmitters

The plant brought extra personnel and subcontractors on site to deal with the current issues and to prevent further freezing. Severe wind chill factors caused equipment to freeze very rapidly after being thawed causing additional unit trips for the same problems. Additional heat trace was installed and insulation was added to many valves that were already insulated. Tarps were installed as windbreaks but additional tarps were needed. Portable heaters were placed throughout the plant. Operator rounds were adjusted to fill heaters, inspect tarps and attempt to prevent lines, valves and transmitters from freezing. The weather moderated.

Corrective Actions

The plant management re-evaluated its winter preparation program to give priority to the identification of the plant's vital equipment freezing points which could cause units to trip off offline and is implementing solutions to ensure the plant could operate to its designed minimum ambient operating temperature.

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Before winter, GOs/GOPs should review their plans to ensure their plants can operate reliably and safely at the plant's design minimum ambient temperature which is one degree above the temperature at which installed and operating winterization equipment is no longer effective in preventing cold weather operational problems. If they do not know this minimum temperature, they should perform a comprehensive engineering design analysis* to determine it. Although all plants may not need to actually perform pre-winter winterization due to normal temperate winter weather, they should consider the most extreme historical weather conditions they may possibly encounter and have contingency plans in place to immediately implement when necessary. Plans should be in place, operators trained and the necessary material on site to be able to handle those extreme events.

GOs/GOPs should:

- Review their plans to ensure they identify and prioritize the weak points in their plants where equipment freezing would bring a unit offline or cause an operator to take an action which would eventually lead to tripping or damaging the unit. For safety reasons, fire protection systems should also be included in this identification process.
- Review their plans to ensure they have established policies and accountabilities in place so that in the fall, winter preparation is a priority; there are sufficient funds to achieve the necessary work; there is personnel accountability and an audit procedure in place to ensure the winter preparation work is completed. Plant maintenance and work tracking systems should be modified accordingly to reflect winter preparation activities.
- Consider in their winter preparation plans the following actions:
 - Erect permanent winds break structures either with scaffolding to be used later for tarps or construct permanent walls to selected areas.
 - Install temperature gauges in transmitter boxes and modify operator rounds to check the temperatures during cold weather.
 - Evaluate the current installation of heat trace and insulation on critical lines making sure heat trace is applied properly, i.e., wrapped around the valve and not just across the valve body.
 - Have additional personnel and contractors available and onsite to work during extreme cold weather conditions.
 - Install a box or enclosure with inside heat for some transmitters.
 - Have plans in place to properly monitor the control systems which regulate heat traces to insure the heat trace is not boiling out the sensor lines.
 - Install covers on valve actuators to keep the actuator from accumulating ice.
 - Install monitoring and alarms to give advance warning of pending potential freeze related problems in critical areas.
- Review their winter maintenance freeze protection programs ensuring their programs specify intervals during the winter for inspection and specify resolution ideas of problems found. After

winter, an evaluation of the performance of the freeze protection measures should be conducted with feedback to the maintenance program as to changes needed. This review should include consideration of the following:

- Adequate reserves of 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 available if needed.
- Have in place written procedures for preparations in advance of extreme cold weather and the plant's emergency operations plans should adequately address procedures for operating the units in freezing weather conditions with potential loss of critical instrumentation. Training programs for operator should address operators having training on these procedures and the procedures should be reviewed and updated after every winter event.
- Review their plans to ensure they have procedures in place to documented and institutionalize knowledge from prior events as to what worked well or did not work well during the event. This knowledge is very helpful when a plant has new employees or new equipment or design changes occur.

* A comprehensive engineering design analysis is used to identify potential freezing problems or other cold weather operational issues. The analysis should identify components/systems which have the potential to: initiate an automatic unit trip, initiate automatic unit runback schemes and/or cause partial outages, adversely affect environmental controls that could cause full or partial outages, adversely affect the delivery of fuel to the units, or cause other operational problems such as slowed valve damper operation.

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