Run Energy Icing Policy, part of the overall Run Energy Extreme Weather Policy

Purpose

To set company wide policies and procedures concerning dealing with ice and particularly ice conditions on wind turbine.

Importance

On a wind farm, ice can form on buildings, power lines, roads, walkways, stairs, towers, nacelles, hubs, blades, weather masts, and any other structure.

Requirements for Icing

The formation of ice depends on various conditions, including air temperature, wind speed, shape of the object, liquid water content, and droplet size distribution. However, the two principal factors to consider are:

- Air temperature ranges between 37°F and -4°F;
- The structure is within a cloud or there is precipitation.

Below -4°F, atmospheric icing is rare because clouds at this temperature consist of ice particles rather than water droplets, and therefore do not freeze on structures. Also, precipitation below 23°F is not likely to stick on structures.

Tower Related Icing

Potential wind turbine icing hazards are mainly related, but not limited, to ice shed. Ice shed can be further classified as ice fall or ice throw.

Ice fall involves pieces that fall from structures, turbine nacelles, or stopped rotor blades. Depending on the circumstances, it may pose a risk to workers or others accessing the turbine's ice fall zone.

Ice Fall

Ice may fall from any structure. The trajectory of the ice fall is subject to wind speeds, wind directions and size of ice fragments.

So, in practice, a non-operating wind turbine with a 125 m rotor diameter with a 100 m hub height in a 10 m/s wind would have a conservative *downwind* fall distance of ***118 yds*** from the base of the turbine.

Ice Throw

Ice throw involves pieces that are thrown from an iced blade when the turbine is in operation, which depending on the circumstances may pose a health and safety risk. Ice throw pieces generally reach further distances than ice fall and can weigh up to 11 pounds.

When a turbine is in operation and if the ice detaches from the moving blades, it can be projected away from the turbine. Wind direction, wind speed, rotational speed as well as position and size of the ice fragments on the blade will influence the landing position of the projected ice pieces.

So, again in practice, an operating wind turbine with a 125 m rotor diameter with a 100 m hub height in would have a conservative throw distance of ***369 yds*** from the base of the turbine.

Ice Evaluation without entering the wind farm

There are different ways to evaluate the presence of ice on site other than visual inspection of the turbine. Ice observation methods are good indicators of the actual presence of ice on site. However, since they all have their limitations, they should not be used to assess the absence of ice. Ice observation methods should only be used to postpone onsite work if they suggest icing.

Qualitative Observation

If icing is observed on components, equipment or vehicles on or near the wind farm it can be assumed that icing conditions are present at the wind turbine.

Observation Reports of Icing from other teams

As a practice, teams should record observed icing conditions in all parts of the wind farm that could be used by others to determine if icing is present in the wind farm without entering the wind farm.

Ice Evaluation upon entering the wind farm

Physical Inspection of Wind Turbines

If the icing conditions can not be determined by non-entry methods, the remaining choice is physical inspection of the wind turbine for icing conditions. Use Evaluate for Presence of Ice Decision Tree.

If ice is observed shedding from the turbine do not approach.

If ice is observed on blades or top of nacelle, do not access nacelle roof or transition to the hub and, do not open nacelle hatches.

Evaluate for the Presence of Ice Decision Tree

- If possible, use qualitative observation and/or reports of others to determine icing conditions.
- Evaluate meteorological conditions (air temperature and precipitation).
- Determine turbine operating condition (Faulted or not).

- Do any of the above non-entry ice detection methods suggest the presence of ice?
- Is the turbine operating condition related to icing?
- Has snow, freezing rain, or fog occurred in the past 24 hours?
- Has the temperature been below 37 deg f during the precipitation?
- Are there reports from others about icing conditions?

Yes to any?

No to all?

- Stop your vehicle outside the ice throw zone.
- Observe turbine with optics.

- Is ice visible on the blades or on the nacelle?
- Are there ice pieces or ice shed impacts in the vicinity of the turbine?
- Does the turbine make unusual continuous noise?

Yes to any?

No to all?

- Turbine is probably iced.

  Refer to Turbine is Iced Decision Tree

- Turbine is probably free from ice.

  Proceed to work with caution.

Turbine is Iced Decision Tree (Able to yaw nacelle remotely)

- Remotely stop the turbine. Remote stop any turbines near travel route.
- Stop your vehicle outside the ice throw zone.

- Is the entire turbine visible?
- Has ice accumulated only on rotor or blades?

Yes to all?

No to either?

- Yaw turbine remotely, positioning rotor on the opposite side of tower door and not above PMT.
- Observe turbine with optics for 20-30 minutes.

Yes

- As the turbine yaws, and when it stops yawing, is ice falling from the blades, rotor, nacelle or tower?
  - Observe for an additional 15-20 minutes.

Yes

- Will the wind blow any falling ice towards the tower door?

No

- Work may not progress. Return to O&M for further instructions.

Complete Stop Work Report

Turbine may be entered, with caution.

- All others drive back to tower and unload tools & equip.
- Stay away from blades.
- Do not approach turbine alone.
- All but the driver exits the vehicle as close as possible.
- Park the vehicle outside the ice throw zone.
- Continuously observe for shedding or falling ice. If shedding or falling ice develops while in the turbine, stay in the turbine until the shedding or falling stops.
- Remotely restart turbine and once clear of travel

Alternate Turbine is Iced Decision Tree (*NOT* Able to yaw nacelle remotely) Pre-work

- Remotely stop the turbine. Remote stop any turbines near travel route.
- Stop your vehicle outside the ice throw zone.

- Is the entire turbine visible?
- Has ice accumulated only on rotor or blades?

Yes to all?

- Stop vehicle outside ice throw zone.
- Observe turbine with optics for 20-30 minutes.
- If no ice is observed shedding, drive up to tower, one tower entrant exits vehicle and enters tower. Vehicle exits back to outside ice throw zone.
- Entrant pitches blades to 0 degs and hits e-stop and intermittently yaws turbine. While this is occurring, others watch for ice falling, communicating to entrant. This will be repeated until no ice is falling. Observe for 15-20 minutes after last ice fall.
- Position rotor on the opposite side of door and not above PMT.

- Will the wind blow any falling ice towards the tower door?

Turbine may be entered, with caution.

- All others drive back to tower and unload tools & equip.
- Stay away from blades.
- Do not approach turbine alone.
- All but the driver exits the vehicle as close as possible.
- Park the vehicle outside the ice throw zone.
- Continuously observe for shedding or falling ice. If shedding or falling ice develops while in the turbine, stay in the turbine until the shedding or falling stops.

No to either?

Yes

- Work may not progress. Return to O&M for further instructions.

Complete Stop Work Report

Post-work

- Position rotor on the opposite side of door and not above PMT.
- Before any exit of tower, pitches blades to 0 degs and hit e-stop and intermittently yaw turbine.
- Vehicle Driver exits tower and proceeds to vehicle and observes for ice shedding.
- Observe turbine with optics for 20-30 minutes, communicating within tower.
- Continue to pitch blades and yaw turbine until no ice falls.
- Place turbine back into local pause mode.
- Driver approaches tower and tools and equipment are loaded and vehicle drives away.
- Notify SOC to restart turbine and remotely shutdown any turbines on travel route.
- Notify SOC that you are clear of travel path and turbines can be restarted remotely.