

**FRODSHAM WIND FARM PLANNING
CONDITION DISCHARGE
PLANNING CONDITION 42 - ICE
THROW**

Frodsham Wind Farm Limited

Final

Frodsham Wind Farm Planning Condition Discharge

Planning Condition 42 - Ice Throw

Prepared for
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1 INTRODUCTION

- 1.1.1 Frodsham Wind Farm was consented under Section 36 of the Electricity Act 1989 on 19th October 2012. The scheme consists of 19 wind turbines, each not exceeding a height of 125 metres to tip height and associated infrastructure. 58 conditions were presented with the planning permission, of which condition 42 states the following:

Ice Throw

Prior to the commencement of the Development, a scheme for mitigating risk of ice throw from the turbines shall be submitted to [and] approved in writing by the LPA and thereafter implemented in accordance with the approved details.

Reason: To ensure the safety of residents and walkers.

- 1.1.2 Ice can build up on wind turbine blades, as with any structure, when conditions of temperature and humidity are correct. Ice build-up is more likely on a stationary wind turbine, but can still occur when a wind turbine is operating. Ice that detaches from a turbine blade will typically fall when the turbine is stationary (known as 'ice drop', where the ice falls within the oversail area of the blades), or be 'thrown' from a rotating turbine.
- 1.1.3 The ice is loosened by centrifugal forces and is thrown off the rotor blades. The loosening ice can also drift off depending on wind direction and wind speed.
- 1.1.4 The risks of fatality from ice have been calculated around 3 orders of magnitude higher than from blade failure, as a consequence of the higher frequency of ice throw/drop¹, and as such, it is important that this risk is managed properly. The following report details how Peel Energy proposes to mitigate the risk of ice throw and ensure the safety of residents and walkers in the areas surrounding Frodsham Wind Farm.

¹ Advances and Case Studies in Wind Turbine Risk Assessments, MMI Engineering.

2 METHODOLOGY

- 2.1.1 Parsons Brinckerhoff has reviewed publically available information pertaining to the ice throw phenomenon and has derived a value for the potential distance that ice would be thrown from a turbine installed at Frodsham Wind Farm.
- 2.1.2 Sections 3 and 4 below confirm the adopted distance and presents the proposed mitigation measures for use at the site in order to reduce the risk of ice-throw related safety issues to members of public in and around the site.

3 SITE SPECIFIC CONDITIONS

3.1 Ice Throw Distance

3.1.1 Guidance produced by Garrad Hassan² determines that the maximum value for ice throw from a turbine at Frodsham Wind Farm would be 250m; however, a second report produced by Garrad Hassan and referenced within the Environmental Statement states that 'that the *typical range of ice-throw from turbines is approximately 140 m and that the typical range of ice drop is 37 m*'. This report uses the value of 250m as a worst case value. The following section details how this worst case will be mitigated to a negligible level in order to safeguard users of the buildings and Public Rights of Way (PRoW) present on site.

3.1.2 Of the 19 turbines to be installed at Frodsham Wind Farm, six are more than 250m from PRoWs and six are between 140m and 250m from PRoWs on site. The ice throw and ice drop risk from these turbines is deemed to be negligible. The seven remaining turbines are within 140m of an onsite PRoW and the risk of ice throw/ice drop from these turbines is deemed to be minor.

3.2 Climatic Conditions

3.2.1 Parsons Brinckerhoff has reviewed meteorological data for the site covering the period October 2013 – August 2014. Temperature profiles were available from two sensors mounted at 3m and 75m on the on-site meteorological mast. The following results have been observed:

- The temperature dropped below 0°C at 3 metres above ground level on 14 days, over the course of the monitoring period of 325 days. This reflects 4.31% of the total time monitored.
- Incidents where the temperature dropped below 0°C at 3 metres above ground level were largely during the months of October to March inclusive, and between the hours of 11pm and 2am.
- At no point over the course of the monitoring period did the temperature drop below 0°C at 75 metres (around the hub height of the wind turbines) above ground level.
- The predominant wind directions were from the north-west and the south-west.

3.2.2 The above findings suggest the following:

- There is a low likelihood of ice forming on the wind turbine blades due to the climatic conditions on site. Temperatures monitored at the turbine hub height never fell below freezing and the marine environment present on site generally lends itself to slightly warmer and windier conditions.
- Periods of time where the temperature fell below freezing at ground level did not correspond with a subsequent drop in temperature at hub height. Periods where temperatures did reach freezing at ground level do not generally constitute times when pedestrian, or similar activity on site would be likely.

² Wind Turbine Icing and Public Safety – A Quantifiable Risk?, Garrad Hassan and Partners Ltd.
<http://easthavenwindfarm.com/filing/feb/ehwf-ml-reb4.pdf>

- Ice build-up is typically accompanied by winds from the north-east quadrant which typically bring cold and wet weather³. Winds from this direction were rarely present on site.

4 PROPOSED MITIGATION

4.1.1 Modern day wind turbines are fitted with sensors that detect rotor imbalance and/or vibration. Rotor imbalance/vibration can occur as a result of ice build-up on one or more of the turbine blades and the turbine will shut down when the imbalance exceeds a pre-set level. Halting the turbine minimises the area of risk to the ground exactly below the turbine, where ice could still continue to fall, but would prevent ice throw.

4.1.2 All turbines will be fitted with ice detection technology.

4.2 Detecting Ice Accretion

4.2.1 Each wind turbine is able to indirectly identify ice accretion with its sensors. For this purpose, there are three different and independent ways of doing so:

- Detecting unbalances and vibrations

Normally, ice accretes on rotor blades both irregularly and asymmetrically. These weight differences on the rotor blades cause an unbalance in the drive train when the rotor turns. This unbalance also affects nacelle and tower. The resulting vibrations are detected by the continuously operating, standard vibration monitors.

- Identifying implausible operating parameters

Every important operating parameter is continuously recorded during turbine operation. The values for wind speed and output are compared to the set points in the control system. In case of ice accretion the aerodynamic profile of the rotor blades changes very fast. The actual output deviates from the set point output. The deviation may not exceed specified tolerances. This detection method "wind speed unequal to output" also works if the ice accretes regularly and symmetrically, i.e., no unbalances can be detected.

- Identifying different measured values of the wind sensors

Each wind speed and wind direction are normally measured by a cup anemometer and an ultrasonic anemometer. The bearing of the cup anemometer is heated, however, ice can form on the cups. In case of ice accretion, the measured wind speed decreases. The ultrasonic anemometer is also heated. However, it still measures the correct wind speed as it does not have any moving or unheated parts. The measured values of the two anemometers are constantly compared. Greater or permanent deviations between the measured values indicate ice accretion.

4.2.2 If one of the three conditions occurs, the wind turbine is stopped and the respective fault is automatically reported to the remote monitoring team.

³ Advances and Case Studies in Wind Turbine Risk Assessments, MMI Engineering.

4.3 In the Event of Ice Accretion

- 4.3.1 The wind turbine reacts to possible ice accretion with defined measures:
- The wind turbine is immediately stopped gently.
 - Each stop of a wind turbine is reported automatically to remote monitoring. Among other information, the error message includes the cause of the fault.
 - While any of these error statuses are pending, the wind turbine is secured against automatic restart. Thus, ice throw can be excluded.
 - All events of the wind turbine (e.g., stops and restarts) are recorded in the logbook of the control system. The logbook is available for subsequent verification.
 - After a stop due to ice accretion identification, the wind turbine can be restarted by remote monitoring. The wind turbine will not be restarted until the reason for the error message and the turbine parking is confirmed to have been resolved.
- 4.3.2 The risks from falling ice that can arise from a wind turbine at standstill are the same as those that can arise from any other building or tree. Ice throw is excluded by shutting down the wind turbine. Warning signs or adhesive labels can be installed on or near the turbine as a warning of falling ice.
- 4.3.3 In case of ice accretion and providing climatic conditions on site allow, the wind turbine can also be turned into a specified parking position. In this way the blades are not located directly above sensitive areas such as PRow.

5 CONCLUSION

- 5.1.1 The findings outlined above demonstrate that the potential for ice build-up on the turbines to be installed at Frodsham Wind Farm is reduced dramatically by the climatic conditions on site.
- 5.1.2 Studies indicate that ice throw from turbines is usually less than 140m, with a worst case distance of 250m. A third of the turbines are more than 140m from public rights of way on site and a further third are more than 250m. The remaining turbines are within 140m of public rights of way onsite; however the mitigation measures outlined within this report ensure that any risk of ice drop or ice throw from these turbines is deemed to be negligible.
- 5.1.3 The wind turbines proposed will include technology that reduces the risk of ice throw by detecting ice accretion on the wind turbine blades and automatically brings the turbine to a standstill until such time as the wind turbine can be started again remotely once the icing event has passed.